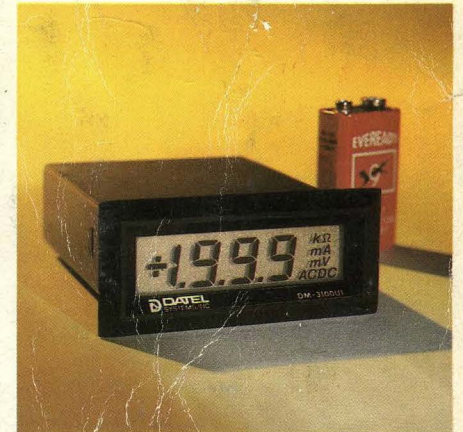
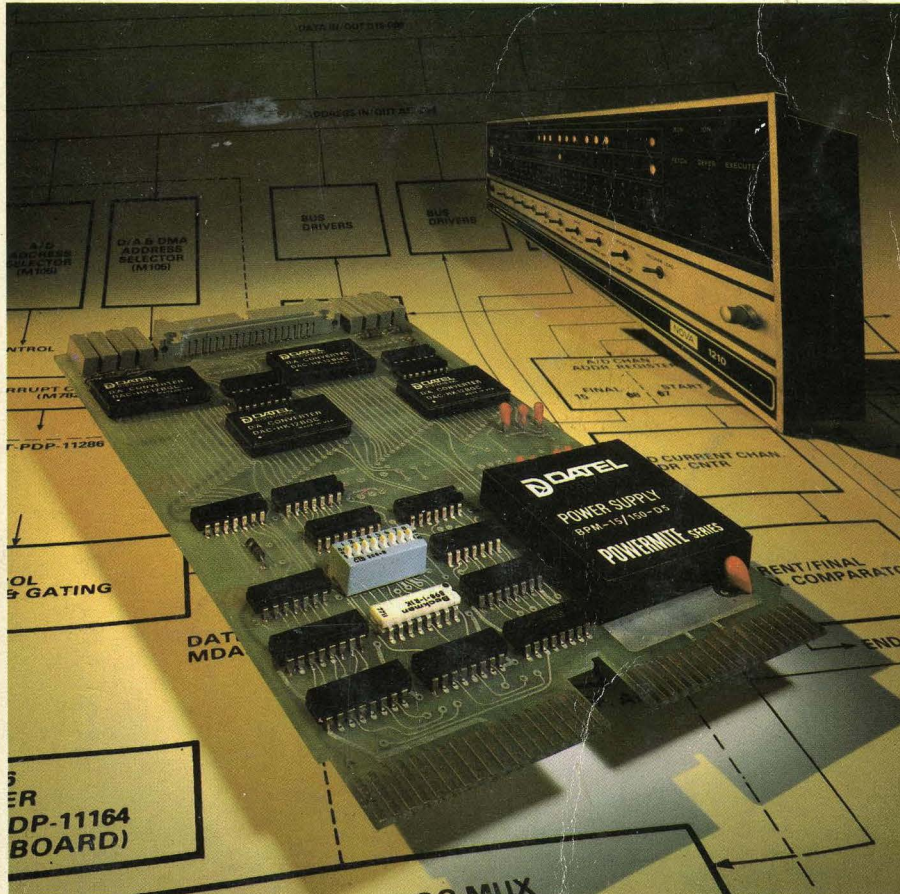
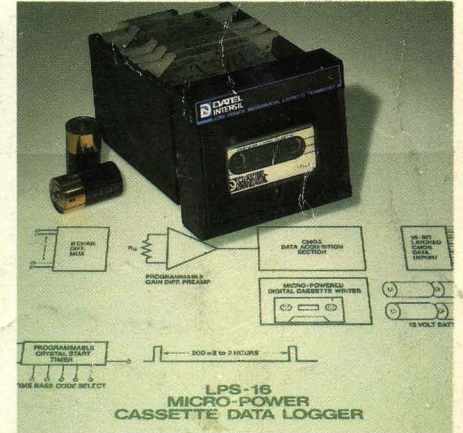




**D** **DATTEL**  
**INTERFIL**

**INSTRUMENTS AND  
SYSTEMS HANDBOOK**

# INSTRUMENTS AND SYSTEMS HANDBOOK



**DATA ACQUISITION  
COMPONENT HANDBOOK**

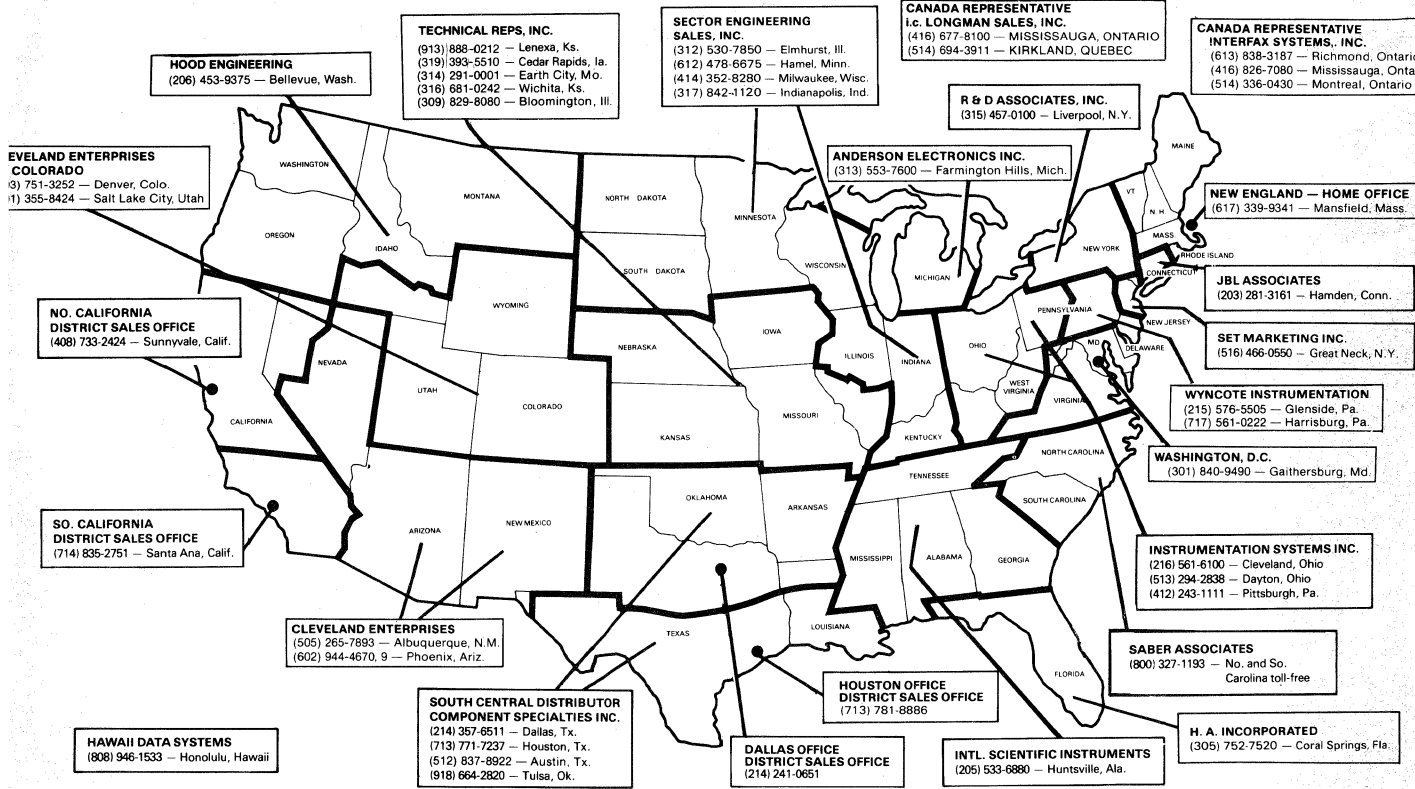


# SALES OFFICES

**BOWTEK ELECTRIC CO.**  
(604) 736-1141 — Vancouver, B.C.

COMPONENTS ONLY

SYSTEMS ONLY



## INTERNATIONAL SALES OFFICES

### FRANCE SUBSIDIARY

**INTERSIL DATEL SARL**  
216, Bureaux De La Colline DE Saint-Cloud  
Batiment D-2EME ETAGE  
92213 SAINT CLOUD  
Tel: 602 5711  
Telex: (842) 204280

### JAPAN SUBSIDIARY

**DATEL KK**  
Kyoden Building  
2-8-2 Ebisu Minami  
Shibuya-ku, Tokyo 150  
Tel: Tokyo 793-1031  
Telex: 246-8205 (DACADC J)

Yachiyo Bldg. Higashikan  
2-Kita 1-21 Tenjinbashi  
Kita-Ku, Osaka 530  
Tel: (06) 354-2025

### UNITED KINGDOM SUBSIDIARY

**INTERSIL DATEL (U.K.) LTD.**  
9th Floor  
Snamprogetti House  
Basingstoke  
Hants, ENGLAND  
Tel: (0256) 57361  
Telex 858041 "INTRSLG"

### WEST GERMAN SUBSIDIARY

**INTERSIL DATEL GmbH**  
Postfach 150620  
Bavariaring 38  
8000 Muenchen, West Germany 15  
Tel: 089-776095  
Telex: 5212855

Vertretung In Berlin  
**BRIEGER GmbH**  
Tel: 030-3664433

### AUSTRALIA

**DIGITAL ELECTRONICS PTY. LTD.**  
Artarmon, N.S.W. 2064  
Tel: (02) 438 2444  
TLX (790) AA20906

### AUSTRIA & E. EUROPE

**BACHER Ges.m.b.H.**  
Tel: Vienna 835646  
TLX: (847) 131532

### OTHMAR LACKNER

Elektronische Bauelemente und Gerate  
Singerstrasse 2  
A-1011 Vienna  
Tel: 0222 531185 or 531186  
TLX: (847) 111198

### BELGIUM

**SIMAC ELECTRONICS sprl**  
B-1000 Brussels  
Tel: 219 2451 Thru 53  
TLX 23 662

### REPUBLIC OF TAIWAN

**MULTITECH INTERNATIONAL CORP.**

Taipei 105 Taiwan  
Tel: (02) 768-1232, 7654092

### DENMARK

Paratron A/S  
Gronrisvej 12  
DK-2450 Copenhagen SV  
Tel: (01)-16-25-88

### FINLAND

**HAVULINNA OY**  
SF-0081 Helsinki 81  
Tel: (90) 755 4144  
TLX 857-124426

### GREECE

**GENERAL ELECTRONICS LTD.**  
Nikia 77  
Piraeus  
Tel: 491 3595  
TLX 212949

### INDIA

**KAYTRONICS BOMBAY-400002**  
Tel: 334450

**SECUNDERABAD-500003.**  
Tel: 76025

### ISRAEL

**MTI ENGINEERING LTD.**  
P.O. Box 16349  
182, Benyehuda Street  
Tel-Aviv  
Tel: 249273  
Telex: 3-2200

### ITALY

**3G — ELECTRONICS s.r.l.**  
20135 Milano  
Tel: 544291, 543096  
TLX (843) 321024

### SIRCES

20129 Milano  
Tel: 747649-730932  
TLX (843) 321024

### NETHERLANDS

**SIMAC ELECTRONICS b.v.**  
Veldhoven  
Tel: 040-533725  
TLX 51037

### NEW ZEALAND

**DAVID REID PROFESSIONAL PRODUCTS LTD.**  
Auckland 1  
Tel: 492-189  
TLX NZ 2612

### NORWAY

**MORGENSTIERNE & CO. A/S**  
Oslo 5  
Tel: 02/35 61 10  
TLX 11719

### SOUTH AFRICA

**PETER JONES ELECTRIC EQUIPMENT (PTY.) LTD.**  
Johannesburg  
Tel: 22-3658  
TLX: 8-6935

### SPAIN

**EMECO, S.A.**  
Caídos de la Division Azul1-F.1°  
MADRID-16  
Tel: 4-58-06-45  
Telex: (831—23742 (AUPOC E)

### SWEDEN

**MARTINSSON & COMPANY INSTRUMENT AB**  
Box 960  
S-126 09 Hagersten  
Tel: 08-7440300  
TLX: 13077

### SWITZERLAND

**TRACO ELECTRONIC CO. LTD.**  
8002 Zurich  
Tel: 01/201/0711  
TLX 845-54318

Printed in U.S.A. Copyright © 1980 Datel-Intersil, Inc. All rights reserved.



11 CABOT BOULEVARD, MANSFIELD, MA 02048/TEL. (617)339-9341/TWX 710-346-1953/TLX 951340 Santa Ana, (714)835-2751 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490 • Houston, (713)781-8886 • Dallas, TX (214)241-0651 OVERSEAS: INTERSIL DATEL (UK) LTD — TEL: BASKINGSTOKE (0256)57361 • INTERSIL DATEL SARL 602-57-11 • INTERSIL DATEL GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

**ABOUT THIS INSTRUMENTS AND SYSTEMS HANDBOOK**

You are holding two Datel-Intersil catalogs. This section is the Instruments and Systems Handbook. For the Datel-Intersil Data Acquisition Components Handbook, simply turn this whole volume over to the opposite cover. The Instruments and Systems Handbook covers pages 1S through 226S. The Data Acquisition Components Handbook at the opposite end of this volume covers pages 1C to 566C.

This full Instruments and Systems Handbook reflects Datel-Intersil's maturity in digital instruments and A/D-D/A systems — particularly in Digital Panel Meters, Miniature OEM panel-mount thermal printers, micropowered digital cassette data loggers and SineTrac A/D-D/A computer boards.

In this year's expanded Handbook, we have included full, detailed, complete information on most products. In fact, whole reproductions of product catalogs and data brochures are included in this one volume.

Please note that current prices (as of May 1980) are included in the selection tables beginning each category, rather than on individual product pages.

Historically, instruments and systems has been a natural evolution for Datel-Intersil which began shortly after Datel's founding over a decade ago. As repeated user requirements for systems grew, products were developed based on Datel-Intersil's comprehensive data acquisition component technology. This offered a cost savings to the user and gave the best possible insight into real-world applications and specifications of those components. This synergism developed better components and then better instruments and systems. This ongoing worldwide real-time laboratory of data acquisition usage has been refined into today's advanced products.

These products are fully supported by an Applications Engineering Department at the Mansfield, MA home office and by factory-trained sales engineers and representatives around the world. Many systems products also include comprehensive systems applications user manuals which are included with shipments and on letterhead request. In addition, most products are also available under GSA Contract for U.S. Government Agencies.

If you need further assistance, contact your nearest Datel-Intersil sales office.

**INSTRUMENTS AND SYSTEMS TABLE OF CONTENTS**

**PAGE**

**Digital Panel Meters**

**5S**

**Digital Voltage Calibrator**

**63S**

**SineTrac Computer A/D-D/A Boards**

**67S**

**Panel-Mount Thermal Printers**

**131S**

**A/D-D/A Computer Data Systems**

**175S**

**Low-Power Digital Cassette Data Loggers**

**199S**

**COMPONENTS**

**A/D Converters**

**7C**

**D/A Converters**

**121C**

**Sample-Holds**

**209C**

**Analog Multiplexers**

**233C**

**Data Acquisition Modules**

**269C**

**Operational Amplifiers**

**307C**

**Instrumentation Amplifiers**

**363C**

**Special Functions**

**387C**

**Analog Switches**

**441C**

**Counters and Display Drivers**

**463C**

**Power Supplies**

**533C**

**Product Index**

**2S**

**New Products**

**4S**

**Sales Offices**

**Inside Systems**

**Cover**

**Ordering Guide**

**Inside Components**

**Cover**

# Product Index

## A/D CONVERTERS

ADC-E Series	10C, 90C
ADC-Econoverter	10C
ADC-EH8B	14C, 94C
ADC-EH10B	14C, 96C
ADC-EH12B1, B2	14C, 98C
ADC-EH12B3	14C, 100C
ADC-EK Series	8C, 16C
ADC-ET Series	8C, 20C
ADC-G8B, 10B	14C
ADC-HC12B	12C, 66C
ADC-HS12B	12C, 70C
ADC-HU3B	14C
ADC-HX12B	8C, 74C
ADC-HZ12B	12C, 74C
ADC-L Series	10C
ADC-M Series	10C
ADC-MA Series	10C
ADC-MC8B	8C, 26C
ADC-SH4B	14C
ADC-TV8B	14C, 106C
ADC-UH Series	14C, 102C
ADC-89A	10C
ADC-149-14B	12C, 110C
ADC-815	14C, 78C
ADC-816	14C, 82C
ADC-817	14C, 86C
ADC-825	12C, 78C
ADC-826	12C, 82C
ADC-827	12C, 86C
ADC-856	8C, 62C
ADC-876	14C, 112C
ADC-881	12C, 116C
ADC-7104	12C, 30C
ADC-7109	8C, 46C
ADC-8068A	12C, 30C

## D/A CONVERTERS

DAC-DG12B	130C, 196C
DAC-HA Series	126C, 174C
DAC-HF Series	130C, 180C
DAC-HI Series	130C, 200C
DAC-HK Series	128C, 184C
DAC-HP Series	132C, 188C
DAC-HR Series	132C, 204C
DAC-HZ Series	122C, 192C
DAC-I Series	124C
DAC-IC8B	122C, 134C
DAC-IC10B	122C, 138C
DAC-UP8B	122C, 142C
DAC-V Series	128C
DAC-VR Series	128C
DAC-08B	122C, 146C
DAC-9	124C
DAC-19	124C
DAC-29	124C
DAC-49	124C
DAC-69	124C
DAC-169	132C
DAC-681	122C, 150C
DAC-7520	126C, 154C
DAC-7521	126C, 154C
DAC-7523	126C, 160C
DAC-7533	126C, 164C
DAC-7541	126C, 168C

## SAMPLE-HOLDS

SHM-IC1	210C, 212C
SHM-LM2	210C, 216C
SHM-HU	210C, 218C
SHM-UH	210C, 224C
SHM-UH3	210C, 224C
SHM-1	210C
SHM-2	210C, 228C
SHM-2E	210C, 228C
SHM-5	210C, 230C
SHM-6	210C, 220C

## ANALOG MULTIPLEXERS

MU-6108	234C, 236C
MU-6116	234C, 242C
MU-6208	234C, 248C
MU-6216	234C, 254C
MV-Series	234C, 260C
MX-Series	234C, 264C

## DATA ACQUISITION SYSTEMS

DAS-250	270C, 298C
DAS-952R	270C, 272C
HDAS-8	270C, 278C
HDAS-16	270C, 278C
MDAS-8D	270C, 286C
MDAS-16	270C, 286C
MDXP-32	270C, 292C

## OPERATIONAL AMPLIFIERS

AM-100	312C
AM-101	312C
AM-102	312C
AM-103	312C
AM-303	310C
AM-410	308C, 314C
AM-411	308C, 314C
AM-414	308C, 318C
AM-450	312C, 320C
AM-452	312C, 320C
AM-453	308C, 324C
AM-460	308C, 320C
AM-462	312C, 320C
AM-464	310C, 326C
AM-470	310C, 328C
AM-490	308C, 330C
AM-500	312C, 350C
AM-7600	308C, 334C
AM-7601	308C, 334C
AM-7611	310C, 344C
AM-7612	310C, 344C
AM-7613	310C, 344C
AM-7614	310C, 344C
AM-7615	310C, 344C
AM-8510	310C, 352C
AM-8520	310C, 352C
AM-8530	310C, 352C

## INSTRUMENTATION AMPLIFIERS

AM-201	364C, 382C
AM-435	364C, 366C
AM-542	364C, 378C
AM-453	364C, 378C
AM-7605	364C, 368C
AM-7606	364C, 368C

## SPECIAL FUNCTIONS

AMC-8013	388C, 392C
FLT-U2	388C, 404C
LA-8048	388C, 396C
LA-8049	388C, 396C
TT-590	388C, 410C
VFQ-IC	388C, 412C
VFV-10K	388C, 416C
VFV-100K	388C, 416C
VI-7760	388C, 422C, 549C
VR-182	388C, 428C
VR-8069	388C, 430C
WG-8038	442C, 444C

## ANALOG SWITCHES

AS-5040 to AS-5051	442C, 444C
AS-5140 to AS-5145	442C, 454C

## COUNTERS AND DISPLAY

### DRIVERS

CD-7216	464C, 466C*
CD-7217	464C, 481C
CD-7224	464C, 493C
CD-7225	464C, 493C
CD-7226	464C, 501C
CD-7227	464C, 481C
DD-7211	464C, 513C
DD-7212	464C, 513C
DD-7218	464C, 523C

## POWER SUPPLIES

### LINE OPERATED POWER

#### SUPPLIES

BCM-15/60	540C
BCM-15/100	540C
BCM-15/200	540C
BCM-15/300	540C
BPM-5/250	538C
BPM-5/500	538C
BPM-12/60	538C
BPM-12/100	538C
BPM-12/200	538C
BPM-12/300	538C
BPM-15/60	538C
BPM-15/100	538C
BPM-15/200	538C
BPM-15/300	538C
BPM-120/25	544C
BPM-150/20	544C
BPM-180/16	544C
MPD-12/1	550C
MPD-12/1.5	550C
MPD-12/3	550C
MPD-15/1	550C
MPD-15/1.5	550C
MPD-15/3	550C
MPS-5/3	550C
MPS-5/6	550C
MPS-5/12	550C
MPS-5/18	550C
MPT-12/1-5/3	550C
MPT-12/1.5-5/6	550C
MPT-12/1.5-5/12	550C
MPT-15/1-5/3	550C
MPT-15/1.5-5/6	550C
MPT-15/1.5-5/12	550C

OV-1	548C
OV-2	548C
PCD-12/1	546C
PCD-12/2	546C
PCD-12/3	546C
PCD-15/1	546C
PCD-15/2	546C
PCD-15/3	546C
PCS-5/3	546C
PCS-5/6	546C
PCS-5/12	546C
PCS-5/18	546C
PCT-5/3-12/1	546C
PCT-5/3-15/1	546C
PCT-5/6-12/2	546C
PCT-5/6-15/2	546C
PCT-5/12-12/2	546C
PCT-5/12-15/2	546C
TPM-12/100-5/500	542C
TPM-15/100-5/500	542C
TPM-12/200-5/500	542C
TPM-15/200-5/500	542C
TPM-12/150-5/1000	542C
TPM-15/150-5/1000	542C
UCM-5/250	540C
UCM-5/500	540C
UCM-5/1000	540C
UCM-5/1000B	540C
UCM-5/2000	540C
UPA-5/500	545C
UPM-5/250	536C
UPM-5/500	536C
UPM-5/1000	536C
UPM-5/1000B	536C
UPM-5/2000	536C
UPM-6/150A	536C
UPM-9/100A	536C
UPM-12/100A	536C
UPM-15/100A	536C
USM-5/3	543C
USM-5/5	543C

#### DC-DC CONVERTER MODULES

BPM-12/25-D5	552C
BPM-12/25-D12	552C
BPM-12/25-D28	552C
BPM-12/40-D48	556C
BPM-12/100-D5	552C
BPM-12/100-D12	552C
BPM-12/100-D28	552C
BPM-12/125-D48	556C
BPM-12/210-D5	554C
BPM-12/210-D12	554C
BPM-12/210-D28	554C
BPM-12/210-D48	556C
BPM-12/420-D5	554C
BPM-12/420-D12	554C
BPM-12/420-D28	554C
BPM-12/420-D48	556C
BPM-15/25-D5	552C
BPM-15/25-D12	552C
BPM-15/25-D28	552C
BPM-15/30-D48	556C
BPM-15/100-D5	552C
BPM-15/100-D12	552C

BPM-15/100-D28	552C
BPM-15/100-D48	556C
BPM-15/150-D5	558C
BPM-15/150-D24	558C
BPM-15/150-D28	558C
BPM-15/165-D5	554C
BPM-15/165-D12	554C
BPM-15/165-D28	554C
BPM-15/165-D48	556C
BPM-15/330-D5	554C
BPM-15/330-D12	554C
BPM-15/330-D28	554C
BPM-15/330-D48	556C
BPM-18/25-D5	552C
BPM-18/25-D12	552C
BPM-18/25-D28	552C
BPM-18/100-D5	552C
BPM-18/100-D12	552C
BPM-18/100-D28	552C
BPM-18/140-D5	554C
BPM-18/140-D12	554C
BPM-18/140-D28	554C
BPM-18/280-D5	554C
BPM-18/280-D12	554C
BPM-18/280-D28	554C
UPM-5/200-D5	559C
UPM-5/200-D12	552C
UPM-5/200-D28	552C
UPM-5/200-D48	556C
UPM-5/500-D5	559C
UPM-5/500-D12	552C
UPM-5/500-D28	552C
UPM-5/600-D48	556C
UPM-5/1000-D5	559C
UPM-5/1000-D12	554C
UPM-5/1000-D28	554C
UPM-5/1000-D48	556C
UPM-5/2000-D5	559C
UPM-5/2000-D12	554C
UPM-5/2000-D28	554C
UPM-5/2000-D48	556C
UPM-12/80-D5	552C
UPM-12/80-D28	552C
UPM-12/80-D48	556C
UPM-12/250-D5	552C
UPM-12/250-D28	552C
UPM-12/250-D48	556C
UPM-12/420-D5	554C
UPM-12/420-D28	554C
UPM-12/420-D48	556C
UPM-12/840-D5	554C
UPM-12/840-D28	554C
UPM-12/840-D48	556C
UPM-15/60-D48	556C
UPM-15/200-D48	556C
UPM-15/330-D48	556C
UPM-15/660-D48	556C
UPM-24/40-D5	552C
UPM-24/40-D12	552C
UPM-24/125-D5	552C
UPM-24/125-D12	552C
UPM-24/210-D5	554C
UPM-24/210-D12	554C
UPM-24/420-D5	554C
UPM-24/420-D12	554C

UPM-28/25-D5	552C
UPM-28/25-D12	552C
UPM-28/100-D5	552C
UPM-28/100-D12	552C
UPM-28/180-D5	554C
UPM-28/180-D12	554C
UPM-28/360-D5	554C
UPM-28/360-D12	554C
VI-7660	422C,549C

#### INSTRUMENTS AND SYSTEMS SECTION

##### Digital Panel Meters

DM-3100L	11S-14S
DM-3100B	15S-18S
DM-3100N	19S-22S
DM-31	23S-30S
DM-3100U1	31S-34S
DM-3100X	35S-38S
DM-3100U2, U3	39S-42S
DM-LX3	43S-45S
DM-4100L,N	46S-49S
DM-4100D	50S-58S
UPA-5/500	59S
DM-2115	60S
DM-350	61S
DM-2000AR	62S

##### Digital Voltage Calibrator

DVC-8500	64S-66S
----------	---------

##### SineTrac A/D-D/A

##### Computer Analog Boards

ST-711, ST-732	71S-75S
ST-711RLY	76S-80S
ST-724	81S-87S
ST-800	88S-99S
ST-LSI	100S-111S
ST-LSI2	112S, 113S
ST-LSI-RLY	114S-121S
ST-6800	122S-130S

##### Panel-Mount Thermal Printers

Parallel APP-20	133S-146S
APP-20D	147S
Serial APP-20	148S-157S
CDPP-Q7/CAPP-20	158S, 159S
APP-48	160S, 163S
DPP-Q7	164S, 174S

##### A/D-D/A Computer Data Systems

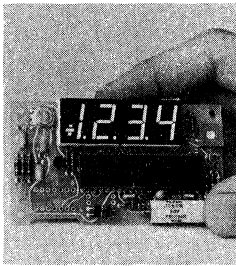
DAS-256	176S-189S
PDAS-250	190S-196S
Interface Panel	197S, 198S

##### Low-Power Digital Cassette Data Loggers

DL-2	201S-204S
Uncased DL-2	205S
DL-2T	206S
DL-2R	207S, 208S
LPS-16	209S-211S
LPS-16 Inst. Ampl.,	
Start Clock	212S, 213S
LPR-16	214S-217S
ICT	218S-226S

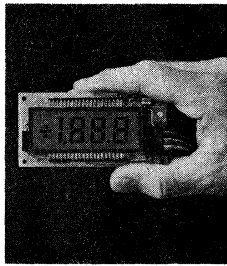
# New Products

## INSTRUMENTS AND SYSTEMS



### DM-31 Ultra-Low Cost 3 1/2 Digit Single Board OEM Digital Panel Meter

- Miniature 2" x 3 1/2" (50.8 x 88.9 mm) single board DPM features fully differential autozeroed input.
- Tiny 5 pA bias current, super high 1000 Megohm input impedance won't load down sensitive circuits.
- Large 0.56" LED display with HOLD function.
- +5 Vdc power at 280 mA.
- Ratiometric internal/external reference.
- Accepts user attenuators and shunts for 2A, 300V ranges. See page 23S for full information.



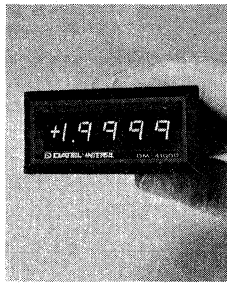
### DM-LX3 3 1/2 Digit Micro-Powered LCD Single Board OEM Digital Panel Meter

- Tiny 5 pA bias current, super high 1000 Megohm input impedance.
- Ratiometric internal/external reference.
- Accepts user attenuators and shunts for 2A, 300V ranges. See page 43S for full information.
- Miniature 4" x 2" (102 x 51 mm) single board DPM features fully differential autozeroed input.
- Uses only 3.5 mA from a 5 Vdc source.
- Very large 3/4-inch high (19.1 mm) liquid crystal digits easily viewed from many feet away. Includes HOLD function.



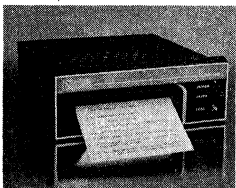
### DM-3100B Miniature 3 1/2 Digit Differential Dual-AC Powered Digital Panel Meter

- Includes internal regulated AC power supply with pin-selected 115/230 VAC, 47-440 Hz power inputs.
- LED display 0.56" high.
- Fully differential autozeroed input.
- Tiny 5 pA bias current, super high 1000 Megohm input impedance, won't load down sensitive circuits.
- Ratiometric internal/external reference.
- ±5 Vdc regulated output power available (several mA) for low-power external preamps, etc. See page 15S for full information.



### DM-4100D Miniature Digital Panel Meter with 3-State Gatable Computer Bussable BCD Data Outputs

- 4 1/2 digit resolution.
- LED display with 0.3" High digits.
- Output data is enabled in 4-bit nibbles. May share bus with other 4, 8, 12 or 16 bit devices.
- May also be enabled in full parallel for older equipment.
- +5 Vdc power at 380 mA.
- Ratiometric internal/external reference.
- Lower cost than many full parallel-only, non-gatable DPM's. See page 50S for full information.



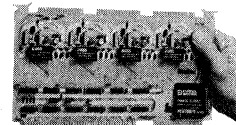
### APP-48 Panel-Mount 48-Column Alphanumeric Full Serial Thermal Printer

- Includes both 20 mA TTY current loop and RS-232-C full serial data inputs for teletypewriters, computer serial I/O ports and CRT terminals.
- Complete with all serial data electronics and regulated AC power supply built in.
- Non-moving thermal printhead—no ink, no ribbons, no hammers, super quiet, no mess.
- See page 106S
- Prints inverted text mode by software (STX/ETX) command.
- Internal microprocessor with 48-character data buffer.
- Optoisolated 2-wire 20 mA data input operates 100's of feet from data source and eliminates ground loop errors.
- Prints full 96-character upper/lower case ASCII text plus 96 extra characters.



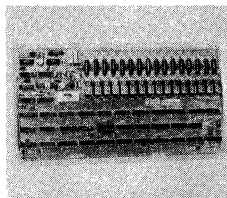
### Serial APP-20 Miniature Panel-Mount 20-Column Alphanumeric Full Serial Thermal Printer

- Includes both 20 mA TTY current loop and RS-232-C full serial data inputs for teletypewriters, computer serial I/O ports and CRT terminals.
- Complete with all serial data electronics and regulated AC power supply built in.
- Non-moving thermal printhead—no ink, no ribbons, no hammers, super quiet, no mess.
- Prints inverted text mode by logic input.
- Internal microprocessor with 20-character data buffer.
- Optoisolated 2-wire 20 mA data input operates 100's of feet from data source and eliminates ground loop errors.
- Prints full 96-character upper/lower ASCII text. See page 148S for full information.



### ST-724 Sinetrac 4-Channel Analog Output D/A Current Loop Board for SBC-80/Multibus Microcomputers

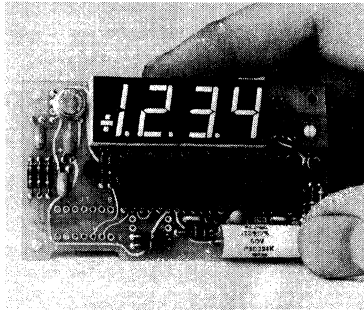
- Exact replacement for SBC-724.
- Includes 4-20 mA externally-powered current loop amplifiers for industrial process controllers.
- Includes D/A voltage outputs with 4 microsecond settling time and 12-bit binary resolution.
- Selectable voltage ranges, base address, and coding.
- Completely controlled by computer program. Works directly from RMX-80 Executive software.
- Includes on-board ±15V DC/DC Power Converter.
- Includes Diagnostic Program and Manual.
- RMX-80 and MULTIBUS are INTEL Corp. trademarks. See page 81S for full information.



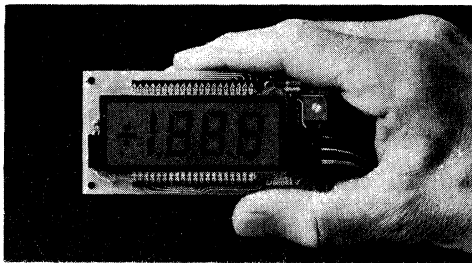
### ST-LSI-RLY Sinetrac Half-Quad Relay-Input Industrial A/D Board for LSI-11, -11/2 Q-Bus Computers

- Flying capacitor Relay MUX for 250 VRMS isolation and 126 dB CMR noise rejection.
- 8 Differential A/D Channels, 12 bit binary resolution.
- Programmable gain amplifier, X1, 2, 5, 10.
- Resistor-selected hi-gain instrumentation, 10 mV to 2V range.
- EOC interrupt, external trigger start.
- Includes Diagnostic program and manual.
- Selectable A/D coding and memory-mapped base address.
- Includes +5, -12V DC/DC Converter.
- LSI-11 is a Digital Equipment Corp. trademark. See page 114S for full information.

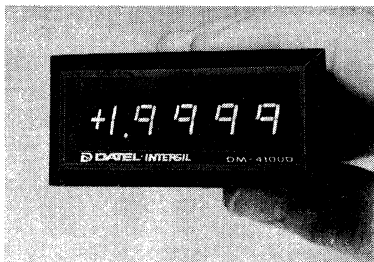
# Digital Panel Meters



DM-31



DM-LX3



DM-4100D



DM-3100B

## IN THIS SECTION:

INTRODUCTION	6S, 7S
SELECTION GUIDE	8S, 9S
DM-3100L	11S-14S
DM-3100B	15S-18S
DM-3100N	19S-22S
DM-31	23S-30S
DM3100UI	31S-34S
DM-3100X	35S-38S
DM-3100U2,U3	39S-42S
DM-LX3	43S-45S
DM-4100L,N	46S-49S
DM-4100D	50S-58S
UPA-5/500	59S
DM-2115	60S
DM-350	61S
DM-2000AR	62S

# Digital Panel Meters

## Introduction

Digital Panel Meters (DPM's) accept a dc or slowly-varying input signal, convert that signal to digital form and display it on decimal digits. DPM's combine an Analog to Digital (A/D) Converter, display decoder-drivers, decimal display and a DC/DC power converter in one assembly. Both fully encased and uncased single board panel-mounting DPM's are offered. DPM's are intended for test and measurement applications, instrumentation systems, analytical instruments, data acquisition and logging systems, portable equipment, automatic test equipment, vehicles, medical, chemical, and biological instruments, physical sensors (temperature, pressure, flow rate, etc.) and industrial process control instruments, to name a few.

Datel-Intersil's DM-3100 and DM-4100 series DPM's employ modern CMOS operational amplifier type front ends for extraordinarily-high input impedance (typically 1000 Megohms) and tiny bias currents (5 pA average). These features avoid errors caused by loading down sensitive measurement circuits. The dual-slope integrating A/D conversion technique is used. This method compares the input to a stable, internal voltage reference diode or user-supplied external ratiometric reference. Dual-slope conversion rejects higher frequency noise and the displayed accuracy is virtually unaffected by internal clock frequency drift.

A choice of power supplies and displays is offered. Most of the DPM's with red, solid-state self-illuminated Light Emitting Diode (LED) displays are powered by +5 Vdc regulated. The Liquid Crystal Displays (LCD) are battery-powered at extremely low current (down to 3 mA). Several models are AC-powered.

DPM's are sampling instruments which measure the input and display readings a few times a second. User-added internal circuits easily adapt the DPM to higher voltage, current and resistance ranges. Other circuits will adapt the DPM to measure temperature, pressure, RPM, frequency, AC and RMS inputs, sound levels, signal strength, angular position, weight, etc.

Most of Datel-Intersil's DPM's are for display-only application with no data outputs. However, the recently introduced model DM-4100D includes BCD data outputs so that the DM-4100D may be used in data acquisition and data logging systems. Unlike older competitive DPM's with full parallel data outputs which could not be directly connected to a shared data bus without requiring interface circuits supplied by the user, the DM-4100D can be connected directly to a microprocessor bus shared with other devices such as other DM-4100D's.

## How to Select Your DPM

Selecting a DPM is a series of decisions and analysis of the needs of your application or the product the DPM will be used in. Datel-Intersil manufactures a broad range of DPM's, each of which emphasizes certain features over others. Some features are related to others, such as LCD digits with ultra-low power.

The first step is to thoroughly determine your needs. The major considerations are:

1. Display
2. Input Type
3. Power Supply
4. Cost
5. Data Output

These are discussed in detail:

1. Display

**Resolution**—The DM-3100 series DPM's have 3½ digits (Full count 1999) of displayed resolution. 3½ digit DPM's are lower cost than the DM-4100N series 4½ digit models (Full count 19999). With equivalent  $\pm 2$  Vdc input ranges, the DM-4100 series will resolve 100  $\mu$ V steps in the least significant digit compared to 1 mV steps in the DM-3100's.

**Count range**—A second reason to use a 4½ digit DPM is for total count range. If a weighing application called for display of 15000 pounds maximum for example, a 3½ digit could not display all the required digits.

**Display Type**—The lowest cost meters are supplied with LED red, self-illuminated displays which require regulated +5 Vdc power. For portable, battery-powered applications, Liquid Crystal (LCD) meters may be used. LCD's are not self-illuminated and require external light for viewing. LED DPM's include models DM-3100L,N,B, DM-31 and DM-4100L,N. LCD models include DM-3100X,U1,U2,U3 and DM-LX3. The DM-3100U series include display descriptor labels which may be electronically controlled or pin-programmable to indicate labels "A, mA, V, mV,  $\Omega$ , K $\Omega$ , AC, DC".

**Case Style**—Two case styles are offered plus two new very low cost DPM's (DM-31, LX3) which are a single board and omit the case. The low profile case offers minimal front panel area and includes models DM-3100N,U1,U2,U3, DM-4100N,B. The short depth case occupies more front panel area but extends back the least from the front panel surface. Both case styles include a second set of internally molded rails for optional user-supplied circuit boards. Access to the boards is to the rear on low profile cases (and includes a punch-out connector slot) and through the front on short depth models (with no connector slot).

## 2. Input Type

**Configuration**—Inputs are either single-ended or differential and isolated or non-isolated. Because of circuit design, all DM-3100's are differential and all DM-4100's are single-ended. The single-board DM-31 and DM-LX3 are both differential. Differential circuits are employed to solve certain application problems such as high common mode voltages, ground loop noise and bridge inputs. Differential circuits are easily converted to single-end. Isolation is provided through an AC transformer power supply as on DM-3100B,U2,U3 and solves large common mode problems or safety requirements such as leakage currents. All modern Datel-Intersil DPM's are autozeroed and ratiometric to correct drift. CMOS inputs are 1000 M $\Omega$  impedance and 5 pA bias currents to avoid loading down sensitive circuits.

## 3. Power Supply

Most LED DPM's are +5 Vdc-powered and require regulated supplies of up to ½ amp. A low cost AC power adapter (Model UPA-5/500) supplies regulated 5 Vdc to any Datel-Intersil DPM. The LCD meters may be battery powered. Several DPM's (DM-3100B,U2,U3) include built-in AC power supplies to minimize external wiring and mounting.

## 4. Cost

The lowest cost DPM is the single-board DM-31. However, the cased DM-3100L,N are also very inexpensive and offer additional protection from dust and contaminants.

## 5. Data Output

Finally, the DM-4100D may be used in a data acquisition system or microprocessor since it supplies BCD Data Outputs which are 3-state gateable in 4,8,12, or 16-bit or full parallel bus widths. Users preferring a blind data acquisition function should refer to Datel-Intersil's selection of bussable A/D converters.



## DPM Selection Summary

- For the lowest cost, choose the single-board 3½ digit LED DM-31. For 4½ digits, you'll find that the DM-4100L and N have very reasonable costs.
- For differential inputs required to reject common noise, for ground loop problems or bridge inputs, use any of the 3½ digit DM-3100's or the DM-31 or DM-LX3.
- For battery power portable applications, select any of the 3½ digit LCD meters, models DM-3100X, U1 or DM-LX3.
- For minimal front panel area choose any low profile case model, DM-3100N, U1, U2, U3 or DM-4100N, D.
- For short panel depth, use any short depth case DPM, models DM-3100L, X, B and DM-4100L. The single board encased DM-31 and DM-LX3 are about 5/8" deep.
- For 4½ digit resolution, select models DM-4100L, N or D.
- For BCD digital data output, choose the DM-4100D. It can be directly connected to 4, 8, 12, 16-bit or full parallel computer and microprocessor busses using 3-state gatable outputs.

## Quick Model Guide

### 3½ Digit, Differential Input (No Data Output)

		CASE STYLE		
		LOW PROFILE	SHORT DEPTH	NO CASE, SINGLE-BOARD
Power Supply And Display	5 Vdc Regulated LED	DM-3100N	DM-3100L	DM-31
	Battery Power LCD	DM-3100U1	DM-3100X	DM-LX3
	AC Power LED	—	DM-3100B (115/230 VAC)	—
	AC Power LCD	DM-3100U2 (115 VAC) DM-3100U3 (230 VAC)	—	—

### 4½ Digit, Single-Ended Input

Display Only	5 Vdc Regulated LED	DM-4100N	DM-4100L	—
BCD Data Output	5 Vdc Regulated LED	DM-4100D	—	—

See Next Page for Detailed Selection Guide.

# Digital Panel Meters Selection Guide

								SPECIAL
MODEL	PAGE NUMBER	NO. OF DIGITS	INPUT TYPE	DISPLAY TYPE & HT.	REQUIRED POWER	CASE STYLE	STD. INPUT RANGE	OTHER F.S.* VOLTAGE RANGES
► 3½ DIGIT DPM's ► DISPLAY ONLY-LED DM-3100L	11S	3½	Balanced Differential 80dB CMR	Red LED; .56"H	+ 5Vdc reg. @ 280mA Typ.	Short Depth	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-3100B	15S	3½	Balanced Differential 80dB CMR	Red LED; .56"H	Dual-Voltage 115/230 VAC 47-440 Hz	Short Depth	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-3100N	19S	3½	Balanced Differential 80dB CMR	Red LED; .56"H	+ 5Vdc reg. @ 280mA Typ.	Low Profile	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-31	23S	3½	Balanced Differential 80dB CMR	Red LED; .56"H	+ 5Vdc reg. @ 280mA Typ.	Single Board Meter; No case	± 1.999Vdc	± 20Vdc ± 200Vdc ± 300Vdc
► DISPLAY ONLY-LCD DM-3100U1	31S	3½	Balanced Differential 80dB CMR	Liquid Xtal., 5"H	+ 5Vdc reg. @ 15mA or + 9 to + 15Vdc @ 6mA	Low Profile	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-3100X	35S	3½	Balanced Differential 80dB CMR	Liquid Xtal., 5"H	+ 5Vdc reg. @ 15mA or + 9 to + 15Vdc @ 6mA	Short Depth	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-3100U2 DM-3100U3	39S	3½	Balanced Differential 80dB CMR	Liquid Xtal., 5"H	115 VAC (- U2) or 230 VAC (- U3) or + 9 to + 15Vdc @ 6mA	Low Profile	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-LX3	43S	3½	Balanced Differential 80dB CMR	Liquid Xtal., 75"H	+ 5Vdc reg. @ 3.5mA	Single Board Meter; No Case	± 1.999Vdc	± 20Vdc ± 200Vdc ± 300Vdc
► 4½ DIGIT DPM's ► DISPLAY ONLY-LED DM-4100L	46S	4½	Single- ended, High Impedance	Red LED; .56"H	+ 5Vdc reg. @ 350mA Typ.	Short Depth	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
DM-4100N	46S	4½	Single- ended, High Impedance	Red LED; 0.3"H	+ 5Vdc reg. @ 350mA Typ.	Low Profile	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
► DISPLAY WITH BCD OUTPUT DM-4100D	50S	4½	Single- ended, High Impedance	Red LED; 0.3"H	+ 5Vdc reg. @ 380mA Typ.	Low Profile	± 1.999Vdc	± 20Vdc ± 200Vdc ± 1000Vdc
► SPECIAL PERFORMANCE DPM's DM-2115A1 <sup>1</sup> DM-2115A2 DM-2115D1 DM-2115D2	60S	3½	Single- ended, Floating Xfrmr isolated	Red LED; 0.43"	+ 5Vdc reg. @ 400mA (- D1, - D2) or 100, 115, or 230 VAC (- A1, - A2)	Short Depth	± 1.999Vdc	None
DM-350D1 <sup>2</sup> DM-350D2 <sup>2</sup> DM-350A1 <sup>2</sup> DM-350A2 <sup>2</sup>	61S	3½	Single- ended, High Impedance	Red LED; 0.43"H	+ 5Vdc reg. @ 300mA max. (- D1, - D2) 115/230 VAC (- A1, - A2)	Short Depth	0 to + 1.999 VDC (- D1, - A1) ± 1.999Vdc (- D2, - A2)	None
DM-2000AR DM-2000AR-2	62S	3½	Single- Ended, 1MΩ imp. Optional Optoisol.	Red LED; 0.3"H	+ 5Vdc reg. @ 800mA max.	Short Depth	± 1.999Vdc ± 1.999Vdc ± 19.99Vdc Auto- Ranging	None

**FEATURES** (\* Features with an asterisk require internal components supplied by the user.)

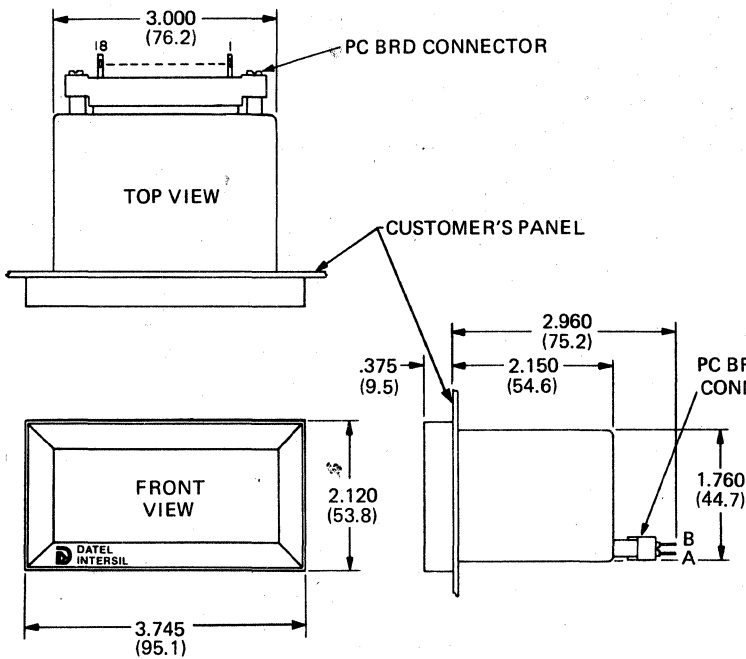
CURRENT RANGES	OFFSET	RATIO-METRIC	OHMMETER F.S. RANGES	AUTOZEROING	BCD OUTPUT	OTHER FEATURES AND NOTES	PRICES (1-9)	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in	\$50.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in + 5Vdc out @ 100mA - 5Vdc out @ 5mA	\$70.00	
± 20μA to ± 2A	<input type="checkbox"/> Yes (Pot*)	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in	\$50.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	200Ω to 20mΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	Single Board Meter 5pA bias current 1000MΩ Z in	<input type="checkbox"/> \$38.50	
± 20μA to ± 2A	<input type="checkbox"/> Yes (Pot*)	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in	\$60.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in	\$66.00	
± 20μA to ± 2A	<input type="checkbox"/> Yes (Pot*)	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in	U2: \$69.00 U3: \$69.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	200Ω to 20MΩ (ref. resistor*)	<input type="checkbox"/> Yes	No	Single Board Meter 5pA bias current 1000MΩ Z in - 5Vdc out @ 20mA	\$55.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	None	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in	\$88.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	None	<input type="checkbox"/> Yes	No	5pA bias current 1000MΩ Z in ± 15Vdc out, @ ± 5mA	\$93.00	
± 20μA to ± 2A	No	<input type="checkbox"/> Yes	None	<input type="checkbox"/> Yes	<input type="checkbox"/> BCD 3-State Outputs use w/4, 8, 12 & 16-bit buses	5pA bias current 1000MΩ Z in ± 13.5Vdc out, @ ± 20mA max.	<input type="checkbox"/> \$129.00	
None	No	No	None	No	<input type="checkbox"/> BCD Latched, full parallel output (-2 models only)	Variable int./ext. Start clock	A1 (also E1, J1): \$209.00 A2 (also E2, J2): \$230.00 D1: \$167.00 D2: \$188.00	
None	No	No	None	No	No		A1: \$125.00 A2: \$139.00 D1: \$109.00 D2: \$119.00	(5 pc. <sup>2</sup> minimum order)
None	No	No	None	No	<input type="checkbox"/> BCD full parallel output	Optional Optoisolation ± 100V (- 2 models only). Var. int./ext. start clk.	AR: \$236.00 AR-2: \$310.00	

**NOTES:**

Prices and specifications subject to change without notice.  
 DM-350 and DM-2115 are still available, but are not recommended for new designs.  
 features are product highlights.  
 UPA-5/500 5V @ 500mA Adapter, \$15.75 option.

### OUTLINE DIMENSIONS

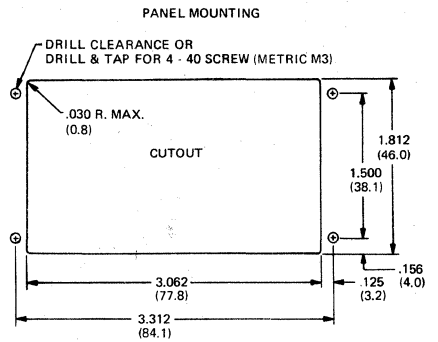
INCHES (MILLIMETERS)



### SHORT DEPTH CASE

Models: DM-3100L, X, B,  
DM-4100L  
DM-2115  
DM-2000AR  
DM-350

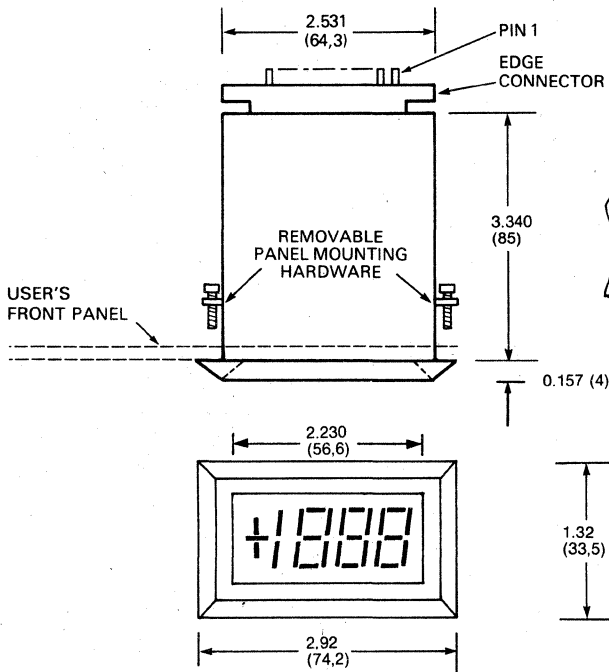
### PANEL CUTOUT DIMENSIONS



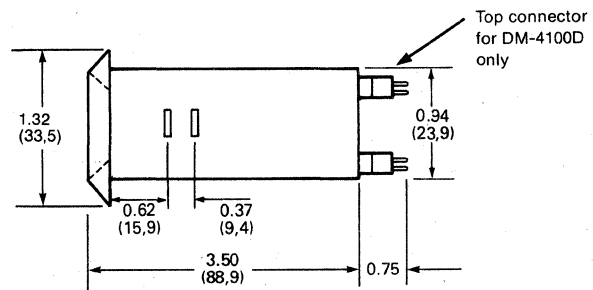
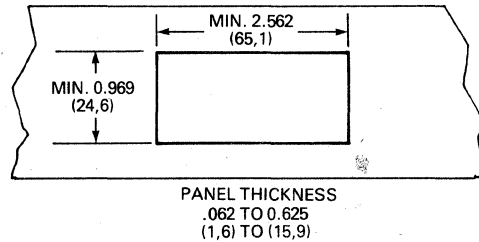
DWG. C-1561-4

### LOW PROFILE CASE

Models: DM-3100N  
DM-3100U1, U2, U3  
DM-4100N  
DM-4100D



### SINGLE MOUNTING CUT OUT



# DM-3100L Low Cost 3½-Digit LED DPM in Short Depth Case

## FEATURES

- Balanced differential inputs, 5 pA bias current, autozeroing with 80 dB CMR noise rejection
- 1000 M $\Omega$  CMOS high impedance inputs,  $\pm 1.999$  V dc FS range
- 3½ digits, 56" high LED displays, 5V-powered, ratiometric reference for drift correction
- Internal user-options:
  1. Accepts shunts for  $\pm 20$   $\mu$ A to  $\pm 2$ A FS ranges
  2. Accepts attenuators for  $\pm 2$ V to  $\pm 1$ KV FS ranges
  3. Digital ohmmeter, 200 $\Omega$  to 10 M $\Omega$ , FSR
- Compact, short depth case measures only 3.00"W  $\times$  2.15"D  $\times$  1.76"H (76,2  $\times$  54,6  $\times$  44,7 mm).



NOTE: DPM's are normally supplied without Bezel Labels or Logos.

## GENERAL DESCRIPTION

The DM-3100L is a 3½ digit Digital Panel Meter which uses solid-state self-illuminated, light-emitting diode (LED) displays. Its large size (0.56" high) and brilliant red light make it easily readable from many feet away. This DPM is contained in a very small short depth case (3.00"W  $\times$  2.15"D  $\times$  1.76"H) which makes for easy installation in shallow test panels. Besides measuring DC voltages, the user may install internal components to make resistance and current readings. The decimal point can also be externally selected by jumpering selected pins together. The versatility of this meter is further enhanced by its autozeroing capabilities.

The DPM DM-3100L accepts a dc or slowly-varying input voltage between  $-1.999$ V and  $+1.999$  and displays that input on front panel numerical indicators. It employs a conventional dual-slope A/D converter plus 7 segment display decoder-drivers all in one LSI microcircuit. Since this microcircuit requires approximately 10V to power the A/D section, an internal DC/DC converter generates  $-5$ VDC from  $+5$ V power input to form a bipolar power supply.

Another feature of the DM-3100L is that it employs a bal-

anced differential input. When used with a bridge or transducer input, it offers high noise immunity and can accurately measure very small signals in the presence of much larger common mode signals.

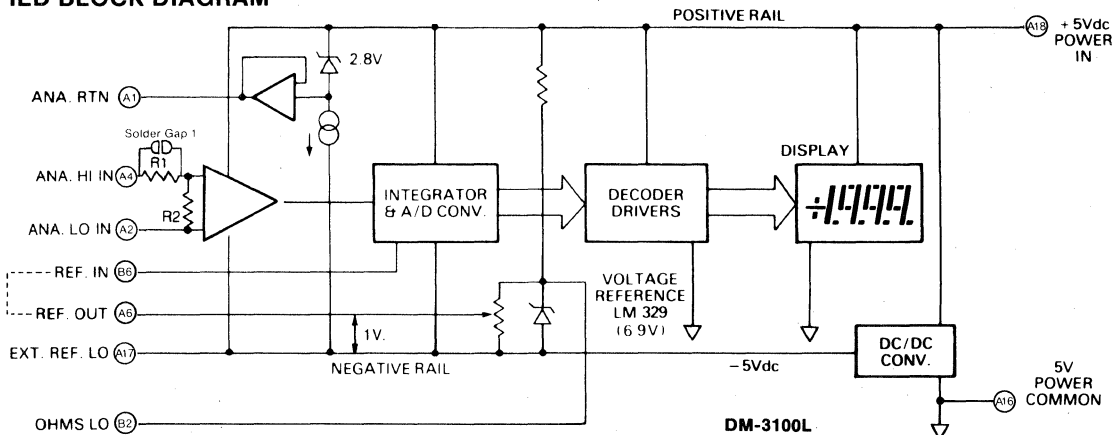
Another characteristic of this balanced differential input is that, due to the high input impedance, 1000 megohms, the DPM will not load down sensitive input circuits.

A very noteworthy feature of this meter is that it can be operated ratiometrically. This means that it has internal circuits that can automatically compensate for reference drifts in the supplies of balanced bridge or transducer sensors.

The DM-3100L finds use in analytical instruments, industrial process controllers, portable diagnostic instruments, automatic test equipment, medical and patient monitoring instruments, airborne, marine and ground vehicles and data acquisition/data logging systems.

Open PC board pads are provided to accept user-supplied input voltage attenuators, current shunts or digital ohmmeter components.

## SIMPLIFIED BLOCK DIAGRAM



## SPECIFICATIONS DM-3100L (Typical @ +25°C unless noted)

### ANALOG INPUT

<b>Configuration</b> .....	True, balanced differential bipolar
<b>Full Scale Input Range</b> .....	-1.999 Vdc to +1.999Vdc Input pad area will accept user-installed range change
<b>Input Bias Current</b> .....	5 pA typical, 50 pA maximum
<b>Displayed Accuracy @ +25°C</b> .....	Adjustable to ±0.1% of reading, ±1 count
<b>Resolution</b> .....	1 mV
<b>Temperature Drift of Zero</b> .....	Autozeroed ±1 count over 0 to +50°C
<b>Temperature Drift of Gain</b> .....	±50 ppm of Reading/°C typ. ±100 ppm of Reading/°C max.
<b>Input Impedance</b> .....	100 Megohms, minimum
<b>Input Overvoltage</b> .....	±250 Volts dc 175 VRMS continuous max. ±300 Volts intermittent max.
<b>Common Mode Rejection</b> .....	80 dB, DC to 60 Hz, 1 Kilohm unbalance
<b>Common Mode Voltage Range</b> .....	Within +Vs -5V and -Vs +1V where +Vs is the positive rail (Pin A18) and -Vs is the negative rail (Pin A17) -Vs is approximately equal to -5V below PWR. COM.
<b>Warm-up Time Reference</b> .....	Within 10 minutes Internal, referred to the negative rail (-Vs). External, user-supplied reference optional for ratiometric operation.
<b>External Ref. Range</b> .....	+100 mV to +2V, referred to Vs
<b>Ramp-up Time (Integration Period)</b> .....	83.3 mS.

<b>Display Enable (Pin B18)</b> .....	Connect to +5 Vdc power to illuminate display. Disconnect to blank display but keep A/D converter cycling.
<b>Display Test (Pin B14)</b> .....	Connect this input to +5Vdc to light all display segments.
<b>Polarity Enable (Pin B16)</b> .....	Ground this input to automatically display a minus sign for negative inputs.
<b>Ohms Lo (Pin B2)</b> .....	This connection is used in the ohmmeter configuration, otherwise do not use.

### POWER CONNECTIONS

<b>+5 VDC Power IN (Pin A18)</b> ..	Connect this pin to +5 Vdc regulated to power the A/D converter and displays.
<b>5V Power Common (Pin A16)</b> ..	This pin may be used as a bias current return path for some inputs. Connect to Power Ground.

### POWER REQUIREMENTS

.....	External +5, ±0.25 Vdc regulated required at 280 mA typical, 450 mA max. Logic spikes must not exceed 50 mV. Power current varies rapidly so that unregulated supplies cannot be used.
<b>Calibration</b> .....	A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

### PHYSICAL-ENVIRONMENTAL

<b>Short-Depth Case</b> .....	Interchangeable with other Datel-Intersil cases
<b>Outline Dimensions</b> .....	3.00"W × 2.15"D × 1.76"H (76.2 × 54.6 × 44.7 mm)
<b>Cutout Dimensions</b> .....	1.812"H × 3.062"W (46.0 × 77.7 mm)
<b>Mounting Method</b> .....	Through a front panel cutout secured by (4) 4-40 front access screws which are concealed by the bezel.
<b>Weight</b> .....	Approximately 5 ounces (142g)
<b>Connector</b> .....	Double-sided edgeboard PC type, solder tab, gold-plated fingers. Dual 18-pin, 0.100" centers, Datel-Intersil #58-2075010, (not included)
<b>Mounting Position</b> .....	Any
<b>Operating Temperature Range</b> ..	0 to +50 °C
<b>Storage Temperature Range</b> ..	-25 to +85°C
<b>Altitude</b> .....	0 to 15,000 feet (4900m)
<b>Relative Humidity</b> .....	20% to 80% non-condensing

### DISPLAY

<b>Number of Digits</b> .....	3 decimal digits and most significant "1" digit (3½ digits)
<b>Decimal Points</b> .....	Selectable decimal points are included for scale multipliers.
<b>Display Type</b> .....	Red, light-emitting diode (LED) self illuminated.
<b>Display Height</b> .....	0.56 inches (14.2 mm)
<b>Overscale</b> .....	Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign
<b>Autopolarity</b> .....	A minus sign is automatically displayed for negative inputs, and may also be blanked
<b>Sampling Rate</b> .....	Factory set at 3 conversions per second. May be rewired up to 20 conversions/second.

### I/O CONNECTIONS

<b>Analog HI Input (Pin A4)</b> .....	Differential input voltages are connected between these inputs. A bias current path to POWER COMMON (if 5V-powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.
<b>Analog LO Input (Pin A2)</b> .....	
<b>Analog Return (Pin A1)</b> .....	This pin may be used as a low-noise bias current for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if 5V-powered). Analog Return is approximately -2.8V below +Vs and can sink 30 mA to -Vs.
<b>Reference In/Out (Pins B6/A6)</b> .....	Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin A17) may be substituted for ratiometric operation.
<b>Decimal Points</b> .....	Connected selected pin to DECIMAL POINT COMMON (Pin B15)

### DM-3100L ORDERING INFORMATION

MODEL	DESCRIPTION
DM-3100L	3½ Digit LED DPM in Short Depth Case
58-2075010	Connector, dual 18-pin, 0.100" centers; one required (not supplied with meter).
UPA-5/500	+5Vdc @ 500mA Power Supply; permits DM-3100L to run from 115 VAC power.
RN-DM-3000	Attenuation Resistor Set; matched, tracking units for 10:1 and 100:1 Attenuation Ratios.

DM-3100L COMPONENT LOCATIONS

FOR OTHER VOLTAGE AND CURRENT RANGES			
F.S. RANGE	1, 2 R1	R2	DECIMAL POINT
±2V	Short SG1	Ohm	A10 to B15
±20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1MΩ	1.1 MΩ <sup>4</sup> or 1 MΩ	A11 to B15
±200V <sup>3</sup>	10 MΩ	100 KΩ	A12 to B15
±1000V	10 MΩ <sup>4</sup>	10 KΩ	A13 to B15
±200 mA	Short SG1	100.1W	A12 to B15
±20 mA	Short SG1	100Ω.1/4W	A11 to B15
±2 mA	Short SG1	1 KΩ	A10 to B15
±200 μA	Short SG1	10 KΩ	A12 to B15
±20 μA	Short SG1	100 KΩ	A11 to B15

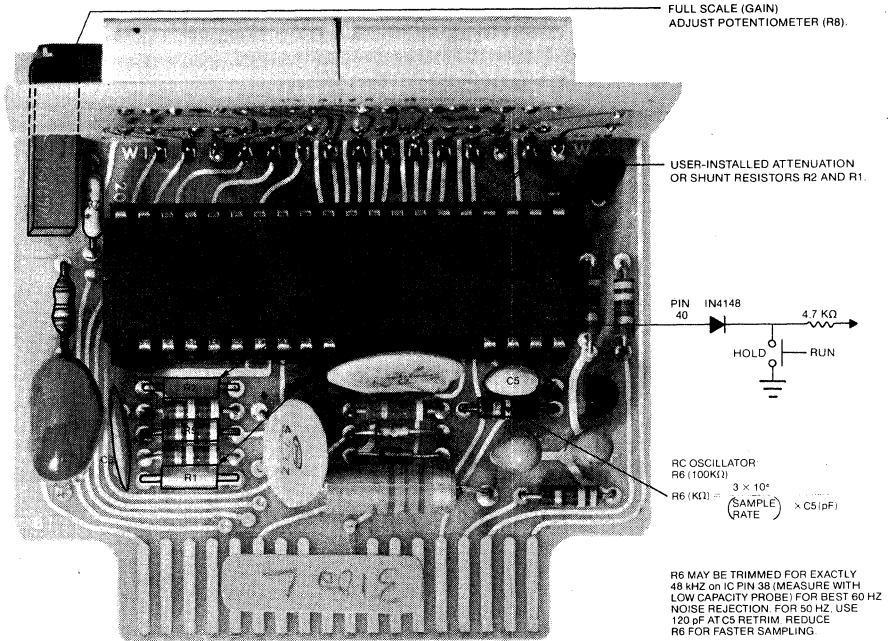
NOTES:

(1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.

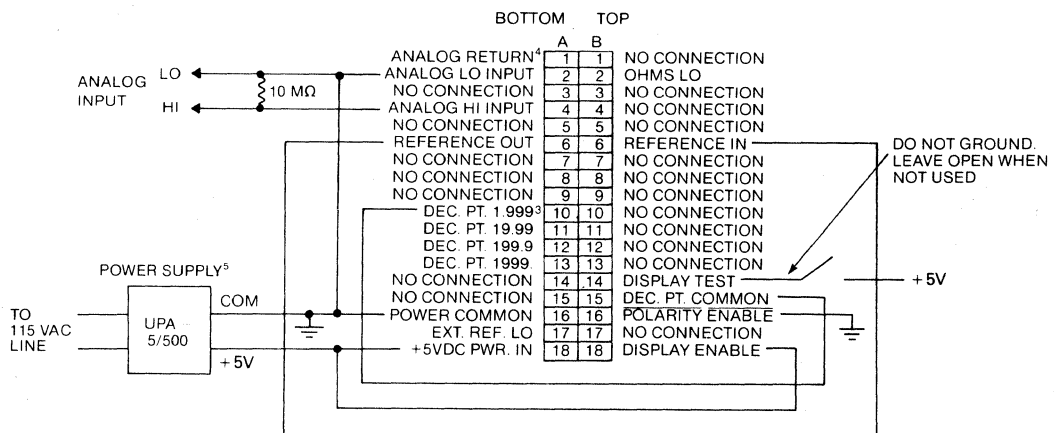
(2) R1 AND R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.

(3) THESE RANGES REQUIRE ADJUSTMENT OF R8 FOR ACCURATE READINGS.

(4) IF 10 MΩ IS NOT AVAILABLE, USE R1 = 2 MΩ, R2 = 220 KΩ. A MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, and 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.



INPUT/OUTPUT CONNECTIONS WITH SINGLE-ENDED INPUT



NOTES:

- This shows the connector rear view with the DPM tilted on its side.
- CAUTION: This DPM employs high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, this DPM will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle the DPM with ground protection.
- DO NOT CONNECT DECIMAL POINT TO POWER COMMON as this will destroy the decimal point.
- ANALOG RETURN = +V<sub>s</sub> - 2.8 Vdc. DO NOT CONNECT TO POWER COMMON.
- The UPA-5/500 Power Supply is a user-supplied, user installed DATEL-INTERSIL accessory.

**DIFFERENTIAL INPUT WITH SAMPLE RATIOMETRIC CONNECTIONS**

The DM-3100L has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Bridge's external excitation source. The input gain on the DM-3100L varies inversely with voltage at Reference In — as REF IN voltage increases, meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO).

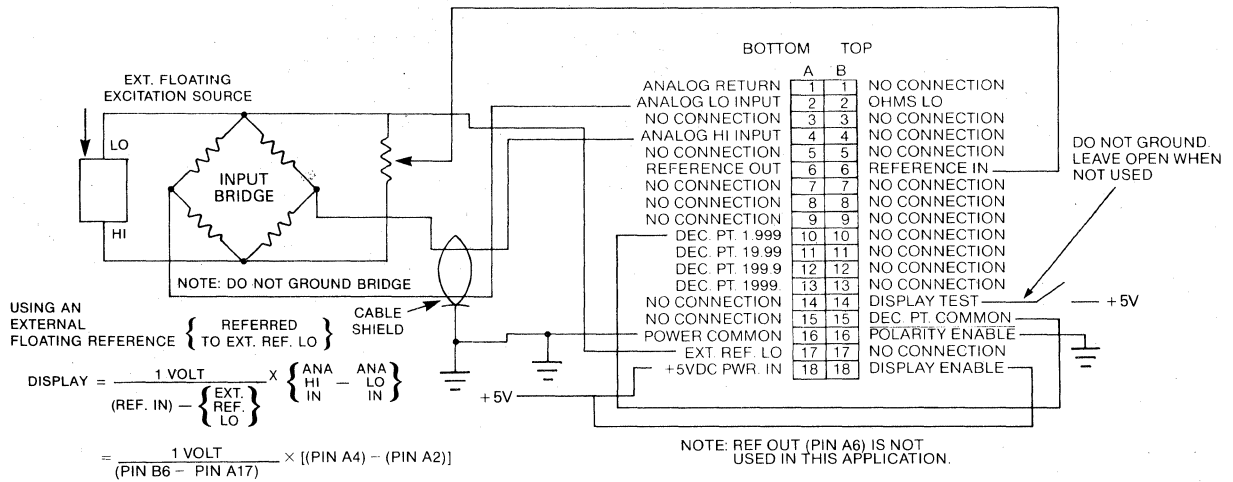
For all applications,  $V_{IN} = 2 V_{REF}$  at full scale (1999 counts). For small values of  $V_{REF}$  (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid  $V_{REF}$  inputs beyond about 2V to prevent integrator satu-

ration with full scale inputs. Variable  $V_{REF}$  is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.

A note on grounding: The DM-3100L's internal voltage reference source is biased against the internal negative supply rail (EXT. REF. LO). Note that this is *not* the same electrical connection as the 5V Power Common connection. Refer to the Simplified Block Diagram.

Because of this configuration, external reference sources should be isolated from the 5V Power Common and should have the Reference Lo Output from the external source connected to the negative supply rail.

**DM-3100L**

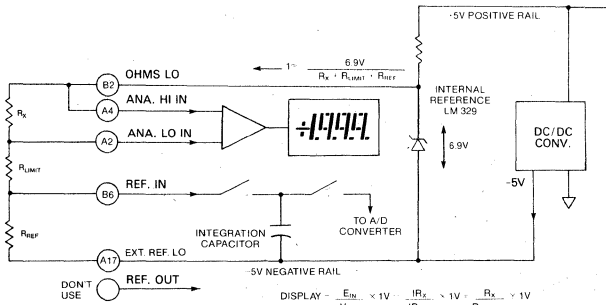


**DIGITAL OHMMETER CONNECTIONS**

The digital ohmmeter circuit uses the DM-3100L's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable voltage from

the DPM's internal reference diode is applied to the resistor pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.

The chart below lists recommended  $R_{REF}$  and  $R_{LIMIT}$  resistance values corresponding to different ohmmeter ranges. Values of  $R_{LIMIT}$  were selected to limit the current through  $R_{REF}$  and  $R_X$  to 1 milliampere maximum.



RANGE	RESOLUTION	$R_{LIMIT}$	$R_{REF}$	DECIMAL POINT
19.99 M $\Omega$	10 k $\Omega$	22 M $\Omega$	10 M $\Omega$	A11 to B15
1.999 M $\Omega$	1 k $\Omega$	3.6 M $\Omega$	1 M $\Omega$	A10 to B15
199.9 k $\Omega$	100 $\Omega$	360 k $\Omega$	100 k $\Omega$	A12 to B15
19.99 k $\Omega$	10 $\Omega$	36 k $\Omega$	10 k $\Omega$	A11 to B15
1.999 k $\Omega$	1 $\Omega$	6.2 k $\Omega$	1 k $\Omega$	A10 to B15

1.  $R_{LIMIT}$  and  $R_{REF}$  should be metal film, High Stability Resistors (AS RN60C).



# DM-3100B AC-Powered, 3½ Digit LED Digital Panel Meter

## FEATURES

- **Dual Voltage Power** - 115/230 VAC, pin-selected
- **Balanced Differential Inputs, 80 dB CMR Noise Rejection**
- **Autozeroing, Ratiometric Reference for Drift Correction**
- **1000 M $\Omega$  CMOS High Impedance Inputs**
- **Display** - .56" High Numerals Red LED
- **Compact, Short Depth Case** - 3.00"W x 2.15"D x 1.76"H (76,2 x 54,6 x 44,7 mm)

## APPLICATIONS

- **Ammeter** - Accepts user-supplied shunts for  $\pm 20 \mu\text{A}$  to  $\pm 2\text{A}$  Full Scale Ranges
- **Voltmeter** - Accepts user-supplied attenuators for  $\pm 2\text{V}$  to  $\pm 1\text{ kV}$  Full Scale Ranges
- **Ohmmeter** - 200 $\Omega$  to 10M $\Omega$  Full Scale Range



Note: DPM's are normally supplied without Bezel Labels or Logos

## DESCRIPTION

The DM-3100B is a very low cost, dual AC-powered Digital Panel Meter. Analog voltages over the range of  $\pm 1.999\text{ Vdc}$  are displayed with 3½ digits of resolution. The DM-3100B is powered from the AC line; 115 or 230 VAC is pin-selectable. The unit can provide +5V and -5 Vdc (@ 100 milliamps and 5 milliamps respectively) to power customer-supplied external circuitry.

The DM-3100B uses a self-illuminated red LED display with .56" high numerals. It is clearly visible from many feet away in normal or dim light.

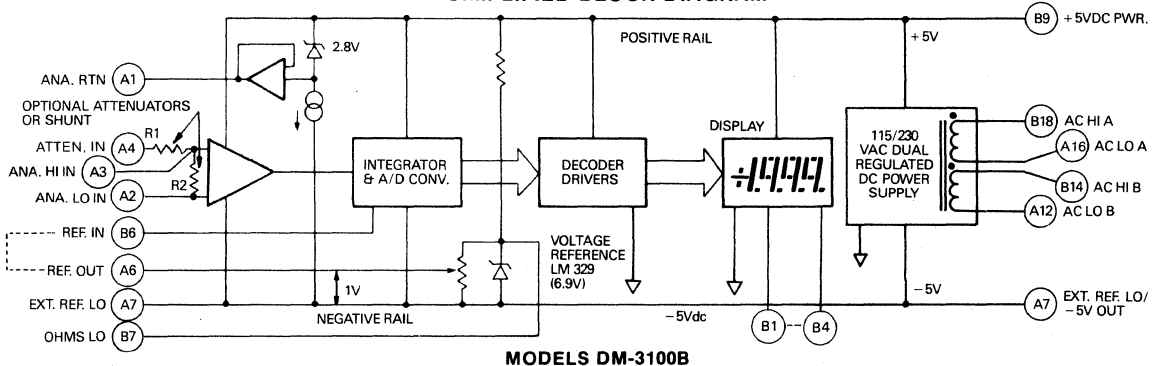
Inputs to the DM-3100B are balanced differential (80 dB Common Mode Rejection) so the meter will accurately display small signals even in electrically noisy industrial environments. CMOS circuitry results in an extremely high input impedance (1000 Megohms, typically) and a very low bias current of 5 picoamps - inputs with a source impedance as high as 100 kilohms can be displayed with accuracy. The input circuitry will also safely tolerate over-voltages up to  $\pm 250\text{ Vdc}$  (155 VRMS). Inputs are sampled and displayed about four times per second.

Autozeroing and a ratiometric reference in-out loop permit the DM-3100B to be used for drift correction in bridge-type measurement systems. Meter accuracy is adjustable to  $\pm 1/10\%$  ( $\pm 1$  count). Temperature drift of zero is  $\pm 1$  count from 0 to 50°C, while temperature drift of gain runs typically  $\pm 50$  ppm of Reading/°C.

The AC-powered DM-3100B was designed for installations where existing dc supplies are noisy, inaccessible, or overloaded. This meter may be used wherever a voltage, or a unit which can be made proportional to voltage, must be displayed with accuracy and clarity. The basic input range of  $\pm 1.999\text{ Vdc}$  can be expanded with a simple voltage divider to display voltages up to  $\pm 1\text{ kV}$  or up to  $\pm 2\text{A}$  using current shunts. Blank pads on the meter's circuit board can accept user-supplied voltage attenuator resistors, current shunts, or digital ohmmeter components.

The DM-3100B is supplied in Datel's standard short depth black polycarbonate case, measuring only 3.00"W x 2.15"D x 1.76"H. All connections are made on the back panel to an optional 18-pin edge connector. Cutout dimensions are 1.812"H x 3.062"W (46,0 x 77,8 mm), minimum.

## SIMPLIFIED BLOCK DIAGRAM



DATEL-INTERASIL, INC., 11 CABOT BOULEVARD, MANSFIELD, MA 02048/TEL. (617) 339-9341/TWX 710-346-1953/TLX 951340

## SPECIFICATIONS, DM-3100B

(Typical @ +25°C, unless noted)

### ANALOG INPUT

<b>Configuration</b> .....	True, balanced differential bipolar -1.999 Vdc to +1.999 Vdc Input pad area will accept user- installed range change
<b>Input Bias Current</b> .....	5 pA typical, 50 pA maximum
<b>Displayed Accuracy @ +25°C</b> .....	Adjustable to ±0.1% reading, ±1 count
<b>Resolution</b> .....	1 mV
<b>Temperature Drift of Zero</b> .....	Autozeroed ±1 count over 0 to +50°C
<b>Temperature Drift of Gain</b> .....	±50 ppm of Reading/°C typ. ±100 ppm of Reading/°C max.
<b>Input Impedance</b> .....	100 Megohms, minimum
<b>Input Overvoltage</b> .....	±250 Volts dc, 155 VRMS con- tinuous max. ±300 Volts intermittent max.
<b>Common Mode Rejection</b> .....	80 dB, DC to 60 Hz, 1 Kiloohm un- balance
<b>Common Mode Voltage Range</b> .....	Within +Vs - .5V and -Vs +1V where +Vs is the positive rail (Pin B9) and -Vs is the negative rail (Pin A7)). -Vs is approximately equal to -5V below PWR. COM. (Pin A9)
<b>Warm-Up Time</b> .....	Within 10 minutes
<b>Reference</b> .....	Internal, referred to the negative rail (-Vs). External, user-supplied reference optional for ratiometric operation.
<b>External Ref. Range</b> .....	+100 mV to 2V, referred to -Vs
<b>Ramp-up Time</b> .....	83.3 mS
<b>(Integration Period)</b>	

### DISPLAY

<b>Number of Digits</b> .....	3 decimal digits and most significant "1" digit (3½ digits)
<b>Decimal Points</b> .....	Selectable decimal points are in- cluded for scale multipliers.
<b>Display Type</b> .....	Red, light-emitting diode (LED) self illuminated.
<b>Display Height</b> .....	0.56 inches (14.2 mm)
<b>Overscale</b> .....	Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign.
<b>Autopolarity</b> .....	A minus sign is automatically dis- played for negative inputs, and may also be blanked
<b>Sampling Rate</b> .....	Factory set at 3 conversions per second. May be rewired up to 20 conversions/second.

### I/O CONNECTIONS

<b>Analog HI Input (Pin A3)</b> .....	Differential input voltages are con- nected between these inputs. A bias current path to POWER COMMON (if ±5V-powered) or ANALOG RETURN from both these inputs must be exter- nally provided. External circuits must constrain these inputs to be within the common mode voltage range.
<b>Analog LO Input (Pin A2)</b> .....	
<b>Attenuator IN (Pin A4)</b> .....	Connected in series through R1 (Optional attenuator resistor) to Ana- HI In (Pin A3). Supplied with a jumper in place of R1.
<b>Analog Return (Pin A1)</b> .....	This pin may be used as a low-noise bias current return for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if ±5V-powered). Analog Return is approximately -2.8V below +Vs and can sink 30 mA to -Vs.
<b>Reference In/Out (Pins B6/A6)</b> .....	Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin A7) may be sub- stituted for ratiometric operation.

<b>Decimal Points</b> .....	Connect selected pin to DECIMAL POINT COMMON (Pin B5)
<b>Display Test (Pin A5)</b> .....	Connect this input to +5 Vdc (Pin B9) to light all display segments.
<b>Polarity Enable (Pin A8)</b> .....	Ground this input to Pin A9 to auto- matically display a minus sign for negative inputs.
<b>Ohms Lo (Pin B7)</b> .....	This connection is used in the ohm- meter configuration, otherwise do not use.

### POWER CONNECTIONS

- For 115 VAC input: (parallel both windings)
1. Connect AC LINE HI A (Pin B18) to AC LINE HI B (Pin B14). Connect both to the hot side of the AC line (mains).
  2. Connect AC LINE LO A (Pin A16) to AC LINE LO B (Pin A12). Connect both to the neutral side of the AC line (mains).
- For 230 VAC input: (Series both windings)
1. Connect AC LINE HI B (Pin B14) to AC LINE LO A (Pin A16). Make no other connections to these two leads.
  2. Connect AC LINE HI A (Pin B18) to the the hot side of the AC line (mains).
  3. Connect AC LINE LO B (Pin A12) to the neutral side of the AC line (mains).
- DC Power Ground (Pin A9) may be connected to earth ground if input circuits permit.
- For DC-Power Only:  
A bipolar ±5V power supply or two isolated single supplies are required. Connect +5V to Pin B9, -5V to Pin A7 and Power Ground to Pin A9

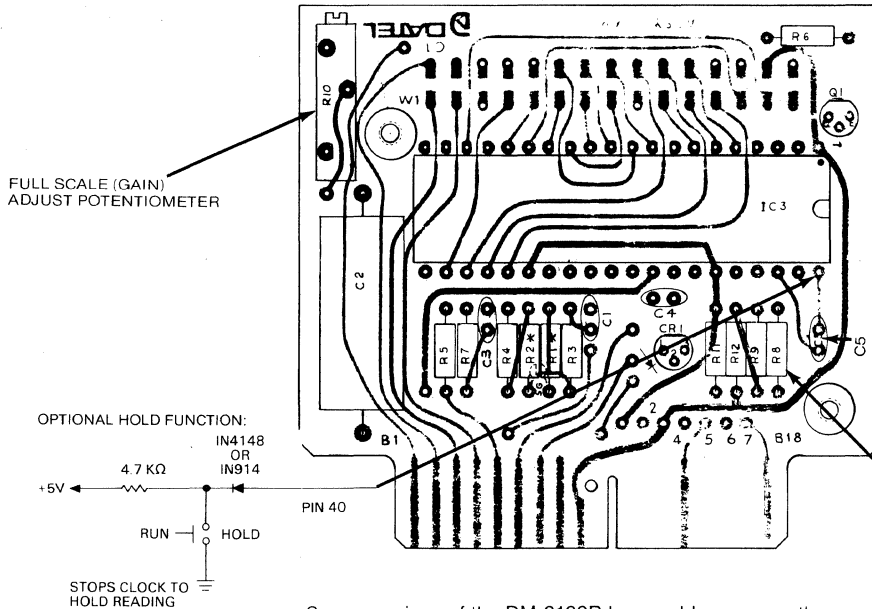
### POWER REQUIREMENTS

<b>AC Power</b> .....	115 or 230 VAC, ±10%, 47 to 440 Hz, 4 watts typical
<b>DC Power</b> .....	+5V ±0.25 Vdc @ 250 mA typical, 400 mA max. and -5V Vdc @ 5 mA typ, 25 mA max. Logic spikes must be less than 50 mV. Bypass supplies externally if necessary.
( Users will normally power from AC-only. DC-only power is optional. )	
<b>Calibration</b> .....	A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

### PHYSICAL-ENVIRONMENTAL

<b>Short-Depth Case</b> .....	Interchangeable with other Dattel cases.
<b>Outline Dimensions</b> .....	3.00"W x 2.15"D x 1.76"H (76.2 x 54.6 x 44.7 mm)
<b>Cutout Dimensions</b> .....	1.812"H x 3.062"W (46.0 x 77.7 mm)
<b>Mounting Method</b> .....	Through a front panel cutout secured by (4) 4-40 front access screws which are concealed by the bezel.
<b>Weight</b> .....	Approximately 5 ounces (142g)
<b>Connector</b> .....	Double-sided edgeboard PC type, solder tab, gold-plated fingers, Dual- 18-pin, 0.100" centers, Dattel #58-2075010, (not included)
<b>Mounting Position</b> .....	Any
<b>Operating Temperature Range</b> .....	0 to +50°C
<b>Storage Temperature Range</b> .....	-25 to +85°C
<b>Altitude</b> .....	0 to 15,000 feet (4600m)
<b>Relative Humidity</b> .....	20% to 80% non-condensing

## DM-3100B COMPONENT LOCATIONS



### FOR HIGHER RANGES

FS Range	R1	R2	DECIMAL POINT
±2V	Jumper	Omit	B1 to B5
±20V <sup>1</sup>	10 MΩ	1.1 MΩ	B2 to B5
±20V <sup>2</sup>	9.1 MΩ	1 MΩ	B2 to B5
±200V <sup>1</sup>	10 MΩ	100 kΩ	B3 to B5
±1 kV	10 MΩ <sup>2</sup>	10 kΩ	B4 to B5
±200mA	Jumper	10Ω, 1W	B3 to B5
±20mA	Jumper	100Ω, 1/4W	B2 to B5
±2mA	Jumper	1 kΩ	B1 to B5
±200μA	Jumper	10 kΩ	B3 to B5
±20μA	Jumper	100 kΩ	B2 to B5

R1, R2 ARE USER-INSTALLED ATTENUATION OR SHUNT RESISTORS (R2).  
 A JUMPER NORMALLY REPLACES R1.  
 R1, R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C.  
 NOTE 1:  
 THESE RANGES REQUIRE ADJUSTMENT OF POT. R10 FOR ACCURATE READING.

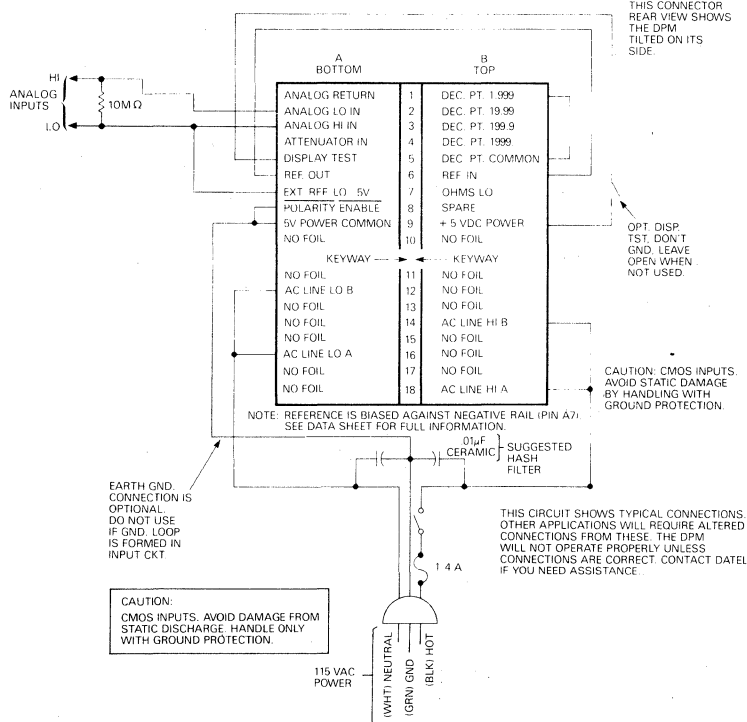
### RC OSCILLATOR R8 (100KΩ)

$$R8 (K\Omega) = \frac{3 \times 10^4}{\text{SAMPLE RATE}} \times C5 (pF)$$

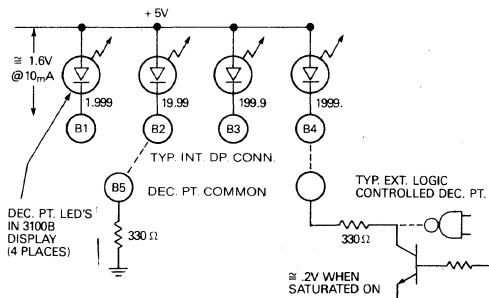
R8 MAY BE TRIMMED FOR EXACTLY 48 KHZ ON IC PIN 38 (MEASURE WITH LOW CAPACITY PROBE) FOR BEST 60 HZ NOISE REJECTION; FOR 50 HZ, USE 120 pF AT C5 RETRIM. REDUCE R8 FOR FASTER SAMPLING.

Some versions of the DM-3100B have solder gaps on the bottom of the converter board, rather than a jumper at R1. Before attenuating resistors can be added to the DM-3100B, this solder gap must be opened with a soldering iron.

## INPUT/OUTPUT CONNECTIONS WITH SINGLE-ENDED INPUT



## DECIMAL POINT WIRING



## ORDERING INFORMATION

MODEL	DESCRIPTION
DM-3100B	DPM, AC-Powered
58-2075010	Dual 18-pin connector, .100" ctrs., solder-tabs (not included)

## APPLICATIONS

### RATIOMETRIC CONNECTIONS WITH BRIDGE INPUTS

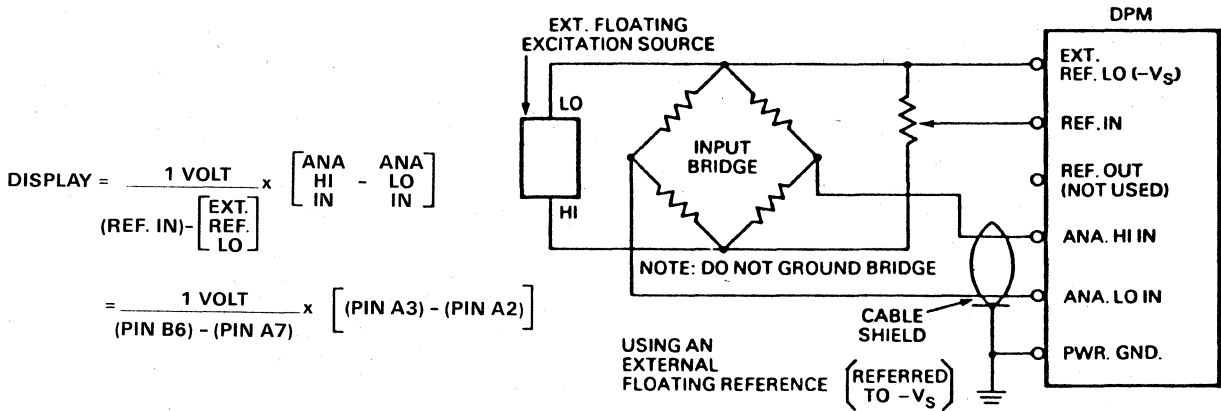
The DM-3100B has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Bridge's external excitation source. The input gain on the DM-3100B varies inversely with voltage at Reference In — as REF IN voltage increases, meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO).

For all applications,  $V_{IN} = 2 V_{REF}$  at full scale (1999 counts). For small values of  $V_{REF}$  (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid  $V_{REF}$  inputs beyond about 2V to prevent inte-

grator saturation with full scale inputs. Variable  $V_{REF}$  is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.

A note on grounding: The DM-3100B's internal voltage reference source is biased against the internal negative supply rail (EXT. REF. LO). Note that this is *not* the same electrical connection as the 5V Power Common connection. Refer to the Simplified Block Diagram.

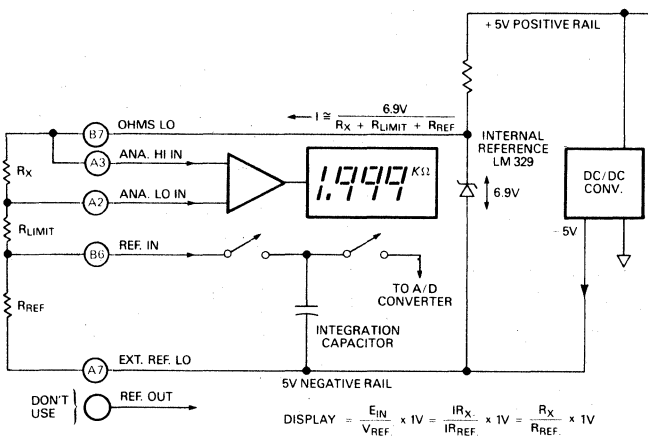
Because of this configuration, external reference sources should be isolated from the 5V Power Common and should have the Reference Lo Output from the external source connected to the negative supply rail.



### DIGITAL OHMMETER CONNECTIONS

The digital ohmmeter circuit uses the DM-3100B's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable volt-

age from the DPM's internal reference diode is applied to the resistor pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.



The chart below lists recommended  $R_{REF}$  and  $R_{LIMIT}$  resistance values corresponding to different ohmmeter ranges. Values of  $R_{LIMIT}$  were selected to limit the current through  $R_{REF}$  and  $R_X$  to 1 milliamper maximum.

RANGE	RESOLUTION	$R_{LIMIT}$	$R_{REF}$	DECIMAL POINT
19.99 MΩ	10 kΩ	22 MΩ	10 MΩ	B2 to B5
1.999 MΩ	1 kΩ	3.6 MΩ	1 MΩ	B1 to B5
199.9 kΩ	100 Ω	360 kΩ	100 kΩ	B3 to B5
19.99 kΩ	10 Ω	36 kΩ	10 kΩ	B2 to B5
1.999 kΩ	1 Ω	6.2 kΩ	1 kΩ	B1 to B5
199.9 Ω	1 Ω	6.8 kΩ	100 Ω	B3 to B5

# DM-3100N

## Low Cost 3½-Digit LED DPM in Low Profile Case

### FEATURES

- Lowest cost
  - Balanced differential inputs, 5pA bias current, autozeroing with 80 db CMR noise rejection
  - 1000 M $\Omega$  CMOS high impedance inputs,  $\pm 1.999$  Vdc FS range
  - 3½ digits, .56" high LED displays, 5V-powered, ratiometric reference for drift correction
  - Low Profile Case measures 2.53" W  $\times$  3.25" D  $\times$  0.94" H (64,3  $\times$  82,5  $\times$  23,8 mm)
  - Low profile model accepts optional 4-20 mA inputs
- Internal user-options:
1. Offset pot for 4-20 mA and other applications
  2. Accepts shunts for  $\pm 20\mu$ A to 24A FS ranges
  3. Accepts attenuators for  $\pm 2$ V to  $\pm 1$ KV FS ranges
  4. Digital ohmmeter, 200 $\Omega$  to 10 M $\Omega$ , FSR



NOTE: DPM's are normally supplied without Bezel Labels or Logos

### GENERAL DESCRIPTION

The DM-3100N is a 3½ digit Digital Panel Meter which uses a solid-state self-illuminated, light-emitting diode (LED) display. Their large size (0.56" high) and brilliant red light make them easily readable from many feet away. This DPM is contained in a compact low profile case which makes for higher packing density on test panel faces. Besides measuring DC voltages, components can be internally installed by the user to make resistance and current readings. The decimal point can also be externally selected by jumpering appropriate pins.

The versatility of this meter is further enhanced by its auto-zeroing capabilities, or if the customer desires, a pot can be internally installed by the user so that an offset can be obtained with a zero input to the meter, or a zero reading with an offset input.

This DPM accepts a DC or slowly-varying input voltage between  $\pm 1.999$ V and displays that input on front panel numerical indicators. It employs a conventional dual-slope A/D converter plus 7 segment display decoder-drivers all in one LSI microcircuit. Since this microcircuit requires approximately 10V to power the A/D section, an internal DC/DC converter generates -5V from +5V power input to form a bipolar supply.

The DM-3100N is identical to the DM-3100L, except that a low-

profile case style is used and there is PC board room to accept the optional offset pot.

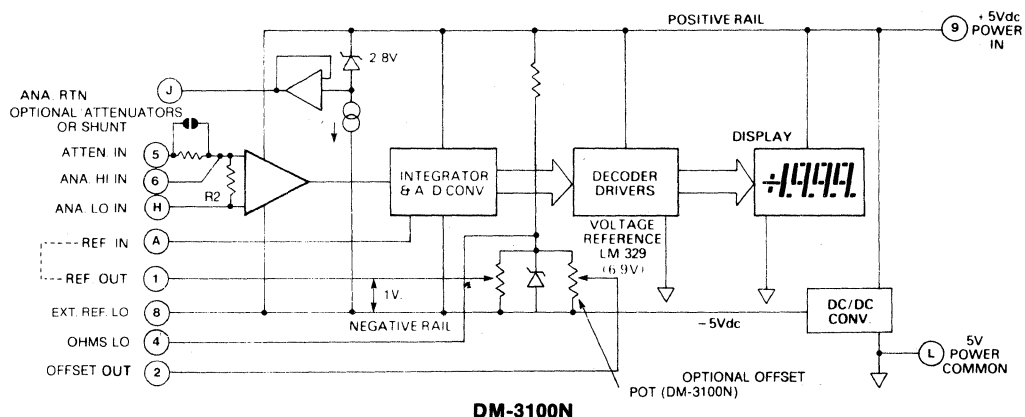
Open PC board pads are provided on the DM-3100N to accept user-supplied input voltage attenuators, current shunts, digital ohmmeter components or an offset pot for applications such as 4-20 mA process control measurement.

Another feature of the DM-3100N is that a balanced differential input is used. When used with bridge or transducer inputs, it offers high noise immunity and can accurately measure very small signals in the presence of much larger common mode signals. Another characteristic of this balanced differential input is that they will not load down sensitive input circuits, due to its high input impedance, 100 megohms, and low 5 pA bias current.

A very noteworthy feature of this meter is that it can be operated ratiometrically. This means that it has internal circuits that can automatically compensate for reference drifts in the supplies of balanced bridge or transducer sensors.

The DM-3100-N finds use in analytical instruments, industrial process controllers, portable diagnostic instruments, automatic test equipment, medical and patient monitoring instruments, airborne, marine and ground vehicles and data acquisition/data logging systems.

### SIMPLIFIED BLOCK DIAGRAM



**SPECIFICATIONS (Typical @ +25° C unless noted)****ANALOG INPUT**

<b>Configuration</b> .....	True, balanced differential bipolar
<b>Full Scale Input Range</b> .....	-1.999 Vdc to +1.999Vdc Input pad area will accept user-installed range change
<b>Input Bias Current</b> .....	5 pA typical, 50 pA maximum
<b>Displayed Accuracy @ +25° C</b> .....	Adjustable to ±0.1% of reading, ± 1 count
<b>Resolution</b> .....	1 mV
<b>Temperature Drift of Zero</b> .....	Autozeroed ±1 count over 0 to +50° C
<b>Temperature Drift of Gain</b> .....	±50 ppm of Reading/°C typ. ±100 ppm of Reading/°C max.
<b>Input Impedance</b> .....	100 Megohms, minimum
<b>Input Overvoltage</b> .....	±250 Volts dc 175 VRMS continuous max. ±300 Volts intermittent max.
<b>Common Mode Rejection</b> .....	80 dB, DC to 60 Hz, 1 Kiloohm unbalance
<b>Common Mode Voltage Range</b> .....	Within +Vs, -5V and -Vs +1V where +Vs is the positive rail (Pin A18) and -Vs is the negative rail (Pin A17) -Vs is approximately equal to -5V below PWR. COM.
<b>Warm-up Time</b> .....	Within 10 minutes
<b>Reference</b> .....	+100mV to +2V, referred to -Vs
<b>External Ref. Range</b> .....	
<b>Ramp-up Time (Integration Period)</b> .....	83.3 mS.

**DISPLAY**

<b>Number of Digits</b> .....	3 decimal digits and most significant "1" digit (3½ digits)
<b>Decimal Points</b> .....	Selectable decimal points are included for scale multipliers.
<b>Display Type</b> .....	Red, light-emitting diode (LED) self illuminated.
<b>Display Height</b> .....	0.56 inches (14,2 mm)
<b>Overscale</b> .....	Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign
<b>Autopolarity</b> .....	A minus sign is automatically displayed for negative inputs, and may also be blanked
<b>Sampling Rate</b> .....	Factory set at 3 conversions per second. May be reviewed up to 20 conversions/second.

**I/O CONNECTIONS**

<b>Analog HI Input (Pin 6)</b> .....	Differential input voltages are connected between these inputs. A bias current path to POWER COMMON (if 5V-powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.
<b>Analog L.O. Input (Pin H)</b> .....	
<b>Analog Return (Pin J)</b> .....	This pin may be used as a low-noise bias current for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if 5V-powered). Analog Return is approximately -2.8V below +Vs and can sink 30 mA to -Vs.
<b>Reference In/Out (Pins A/1)</b> .....	Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin 8) may be substituted for ratiometric operation.
<b>Decimal Points (Pins B-E)</b> .....	Connected selected pin to DECIMAL POINT COMMON (Pin F)
<b>Offset Out (Pin 2)</b> .....	0 to +6.9V referred to -Vs (Pin 8) requires installation of optional offset pot supplied by user.

<b>Display Enable (Pin K)</b> .....	Connect to +5 Vdc power to illuminate display. Disconnect to blank display but keep A/D converter cycling.
<b>Display Test (Pin 3)</b> .....	Connect this input to +5Vdc to light all display segments.
<b>Polarity Enable (Pin 10)</b> .....	Ground this input to automatically display a minus sign for negative inputs.
<b>Ohms Lo (Pin 4)</b> .....	This connection is used in the ohmmeter configuration, otherwise do not use.

**POWER CONNECTIONS**

<b>+5 VDC Power IN (Pin 9)</b> .....	Connect this pin to +5 Vdc regulated to power the A/D converter and displays.
<b>5V Power Common (Pin L)</b> .....	This pin may be used as a bias current return path for some inputs. Connect to Power Ground.
<b>POWER REQUIREMENTS</b> .....	External +5, ±0.25 Vdc regulated required at 280 mA typical, 450 mA max. Logic spikes must not exceed 50 mV. Power current varies rapidly so that unregulated supplies cannot be used.
<b>Calibration</b> .....	A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

**PHYSICAL-ENVIRONMENTAL**

<b>Low Profile Case</b> .....	Interchangeable with other Datel-Intersil cases
<b>Outline Dimensions</b> .....	2.53"W × 3.25"D × 0.94"H (64,3 × 82,5 × 23,8 mm)
<b>Cutout Dimensions</b> .....	2.56"W × 0.97"H min. (65,1 × 24,6 mm)
<b>Mounting Method</b> .....	Through a front panel cutout secured by 2 side case "L" brackets and screws (supplied). Panel thickness up to 0.62" (15,9 mm)
<b>Weight</b> .....	Approximately 5 ounces (142g)
<b>Connector</b> .....	Double-sided edgeboard PC type, solder tab, gold-plated fingers. Dual 10-pin, 0.156" centers, Datel-Intersil #58-2073082 (not included).
<b>Mounting Position</b> .....	Any
<b>Operating Temperature Range</b> .....	0 to +50° C
<b>Storage Temperature Range</b> .....	-25 to +85° C
<b>Altitude</b> .....	0 to 15,000 feet (4900m)
<b>Relative Humidity</b> .....	20% to 80% non-condensing

**DM-3100N ORDERING INFORMATION**

MODEL	DESCRIPTION
<b>DM-3100N</b>	3½-Digit LED DPM in low Profile Case.
<b>58-2073082</b>	Connector, dual 10-pin, 0.156" centers; one required (not supplied with meter).
<b>UPA-5/500</b>	+5Vdc @ 500mA Power Supply; permits DM-3100N to run from 115 VAC power.
<b>RN-DM-3000</b>	Attenuation Resistor Set; matched, tracking units for 10:1 and 100:1 Attenuation Ratios.
<b>TP-50K</b>	Optional Offset Pot, R16

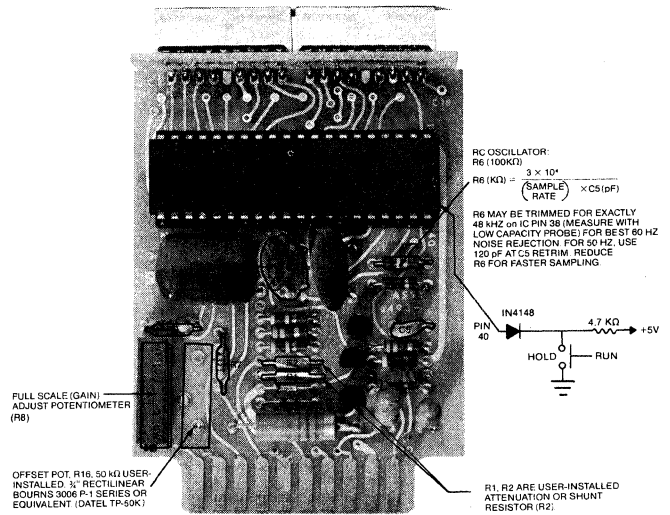
DM-3100N COMPONENT LOCATIONS

FOR OTHER VOLTAGE AND CURRENT RANGES

F.S. RANGE	R1 <sup>1,2</sup>	R2 <sup>1,2</sup>	DECIMAL POINT
±2V	Short SG1	Omit	E to F
±20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1 MΩ	1.1 MΩ <sup>4</sup> or 1 MΩ	D to F
±200V <sup>3</sup>	10 MΩ	100 KΩ	C to F
±1000V	10 MΩ <sup>4</sup>	10 KΩ	B to F
±200 mA	Short SG1	10Ω, 1W	C to F
±20 mA	Short SG1	100Ω, 1/4W	D to F
±2 mA	Short SG1	1 KΩ	E to F
±200 μA	Short SG1	10 KΩ	C to F
±20 μA	Short SG1	100 KΩ	D to F

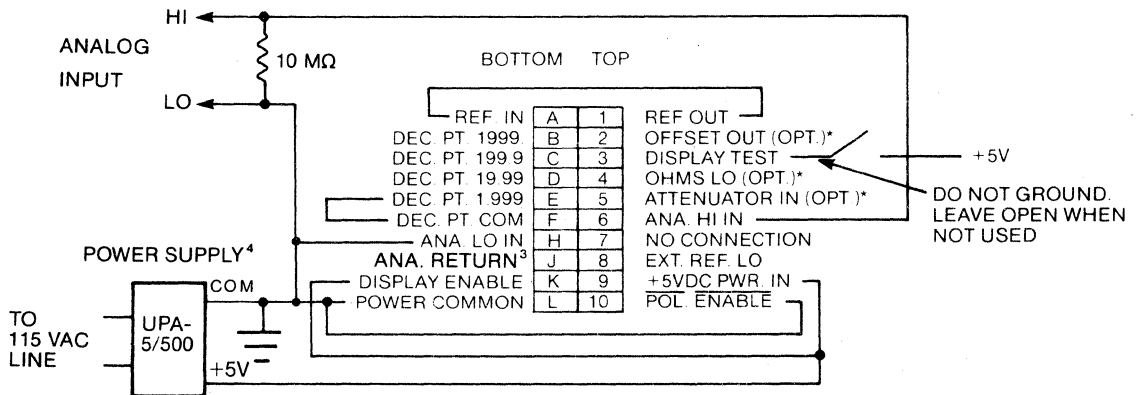
NOTES:

- (1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT, IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.
- (2) R1 AND R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.
- (3) THESE RANGES REQUIRE ADJUSTMENT OF R8 FOR ACCURATE READINGS.
- (4) IF 10 MΩ IS NOT AVAILABLE, USE R1 = 2 MΩ, R2 = 220 KΩ. A MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, and 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.



INPUT/OUTPUT CONNECTIONS WITH SINGLE-ENDED INPUT

DM-3100N



NOTES:

1. This shows the connector rear view with the DPM tilted on its side.
2. CAUTION: This DPM employs high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, this DPM will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle the DPM with ground protection.
3. ANALOG RETURN = +Vs - 2.8 Vdc. DO NOT CONNECT TO POWER COMMON.
4. UPA-5/500 is a user-supplied and user-installed DATTEL-INTERSIL accessory.

**DIFFERENTIAL INPUT WITH SAMPLE RATIO-METRIC CONNECTIONS**

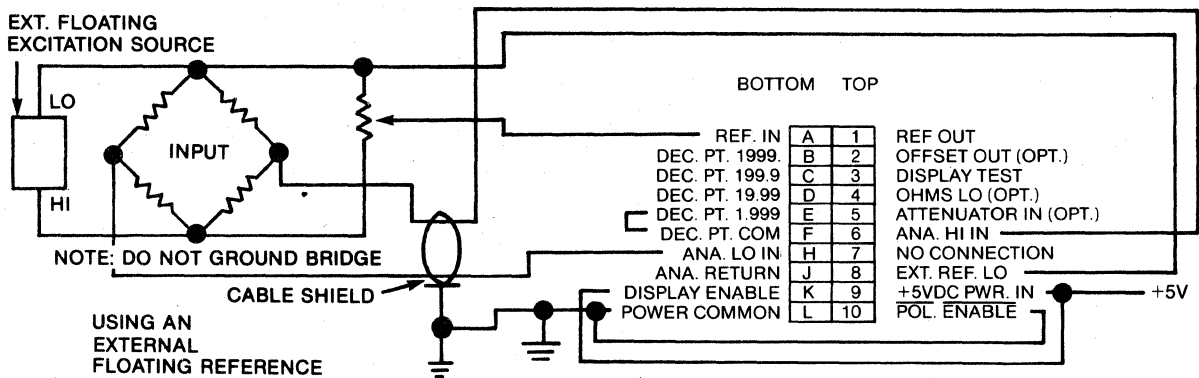
The DM-3100N has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Bridge's external excitation source. The input gain on the DM-3100N varies inversely with voltage at Reference In — as REF IN voltage increases meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO).

For all applications,  $V_{IN} = 2 V_{REF}$  at full scale (1999 counts). For small values of  $V_{REF}$  (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid  $V_{REF}$  inputs beyond about 2V to prevent integrator satu-

ration with full scale inputs. Variable  $V_{REF}$  is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.

A note on grounding: the DM-3100N's internal voltage reference source is biased against the internal negative supply rail (EXT. REF. LO). Note that this is not the same electrical connection as the 5V Power Common connection. Refer to the Simplified Block Diagram.

Because of this configuration, external reference sources should be isolated from the 5V Power Common and should have the Reference Lo Output from the external source connected to the negative supply rail.



NOTE: DO NOT GROUND BRIDGE

USING AN EXTERNAL FLOATING REFERENCE

$$\text{DISPLAY} = \frac{1 \text{ VOLT}}{(\text{REF. IN}) - \text{EXT. REF. LO}} \times \left[ \text{ANA HI IN} - \text{ANA LO IN} \right]$$

$$= \frac{1 \text{ VOLT}}{(\text{PIN A}) - (\text{PIN 8})} \times [(\text{PIN 6}) - (\text{PIN H})]$$

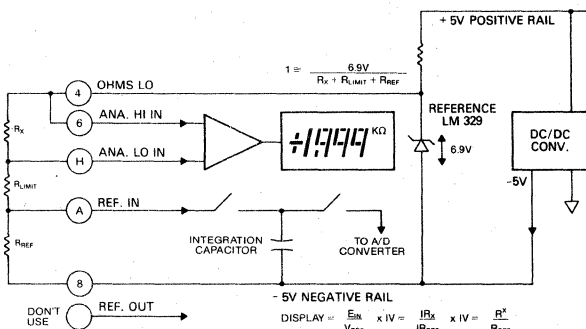
NOTE: Ref Out (PIN 1) is not used in this application.

**DIGITAL OHMMETER CONNECTIONS**

The digital ohmmeter circuit uses the DM-3100N's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable voltage from the DPM's internal reference diode is applied to the resistor

pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.

The chart below lists recommended  $R_{REF}$  and  $R_{LIMIT}$  resistance values corresponding to different ohmmeter ranges. Values of  $R_{LIMIT}$  were selected to limit the current through  $R_{REF}$  and  $R_x$  to 1 milliampere maximum.



RANGE	RESOLUTION	$R_{LIMIT}^1$	$R_{REF}^1$	DECIMAL POINT
19.99 MΩ	10 kΩ	22 MΩ	10 MΩ	D to F
1.999 MΩ	1 kΩ	3.6 MΩ	1 MΩ	E to F
199.9 kΩ	100 Ω	360 kΩ	100 kΩ	C to F
19.99 kΩ	10 Ω	36 kΩ	10 kΩ	D to F
1.999 kΩ	1 Ω	6.2 kΩ	1 kΩ	E to F

1.  $R_{LIMIT}$  and  $R_{REF}$  should be metal film, High Stability Resistors (AS RN60C).



# DM-31 Single Board Differential 3½ Digit Digital Panel Meter

## FEATURES

- Ultra-low cost yet retains outstanding performance
- Miniature 2" x 3.5" single board 3½ digit meter uses large 0.56" high red LED displays. Rear panel depth only 5/8"
- True balanced noise-rejecting differential inputs
- Tiny 5 pA bias current and very high 1000 Megohm input impedance won't load down sensitive input circuits
- Accepts external ratiometric reference and is autozeroing to correct drifts
- Hold function to freeze last reading
- Accepts user-supplied components for higher voltage ranges, current ranges, and digital ohmmeter (to 20 MΩ)
- 5 Vdc powered at 280 mA

## APPLICATIONS\*

- Digital Thermometer, Digital Ohmmeter
- Audio dB sound level meter
- Digital Pressure Meter, Tachometer
- Flow Rate Meter, Bridge Nulling Meter
- Digital Scale or Strain Gauge Meter
- Laboratory and Analytical Instruments
- R&D and Test Instrumentation
- Industrial Process Indicators
- Data Loggers and Data Acquisition Systems

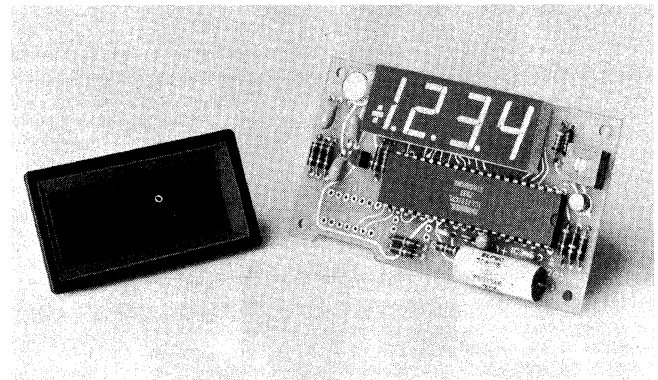
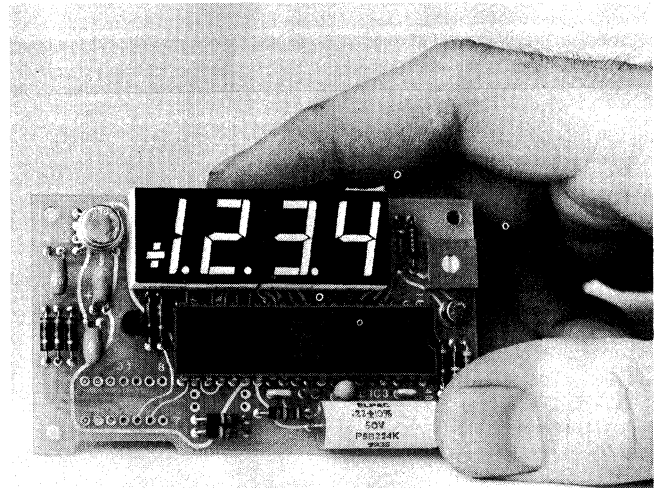
\*Each application requires external circuits supplied by the user.

## DESCRIPTION

The DM-31 is a digital panel meter (DPM) with 3½ digits of resolution (the maximum full scale count is plus or minus 1999). It employs red self-illuminated solid-state Light Emitting Diode (LED) displays which measure 0.56 inches (14.2 mm) high. The DM-31 is constructed on a single printed circuit board measuring 2"H x 3.5"W x 0.5" Thk (88.9 x 50.8 x 12.7 mm). The DM-31 accepts DC or slowly-varying electrical inputs and converts them to displayed decimal values on its LED digits. The basic fixed input range of the DM-31 is -1.999 Volts dc to +1.999 Vdc. However, the user may add internal or external components to change the voltage range from ±2V up to ±300 Vdc, or to current ranges from ±20 microamps, dc up to ±2 Amps, dc or to resistance ranges of 0 to 2 Kiloohms up to 0 to 20 megohms.

## APPLICATIONS

The DM-31 may be used for any application where a physical or electrical parameter needs to be measured and can be converted with user-supplied external circuits into the basic dc voltage, current or resistance ranges which the DM-31 will accept and display. Such parameters include temperature, pressure, flow rate, RPM, noise, weight, velocity, frequency and many



others. The DM-31 is intended for applications in analytical instruments, test and measurement equipment, data acquisition systems, research and development instrumentation, laboratory analyzers and other devices. Industries served by the DM-31 include petrochemical, power utilities, batch and continuous processing, telecommunications, paper, glass, metals and chemical manufacturing, photographic, automotive and medical services and much else.

Continued

### In This Brochure —

Features, Description	Page 23S
Introduction, Continued	Page 24S
Specifications	Pages 25, 26S
Ordering Guide	Page 26S
Block Diagram, I/O Connections	Page 27S
Mounting Methods, Mechanical Dimensions	Pages 28, 29S
Typical Applications Circuits, Warranty	Page 30S

## INTRODUCTION Continued

**MOUNTING**

The DM-31 is designed as a very general purpose panel-mounting component which may be stocked in one version to be used in multiple applications. Normal mounting techniques include four half-inch standoffs, either behind a front panel display cutout or on the front of a panel. An alternate method is to directly mount the DM-31 on a full-size board cutout using the four mounting holes punched in the corner of the DM-31's PC board.

**PERFORMANCE**

Despite its low cost, the DM-31 has excellent performance specifications which are normally seen only in more expensive instruments. The DM-31 requires regulated +5 Vdc input power (@ .28 Amp), which is commonly used by digital logic circuits. A low-cost optional accessory AC power adapter is available in case the user's equipment has no regulated 5 Vdc power. Input signals may be bipolar and the DM-31 will automatically switch its polarity display (autopolarity) to indicate whether signals are positive or negative. Three LED decimal points are included in the display and may be selected on the 14-pin input/output connector either by a jumper, a user-supplied external relay or logic control. These programmable decimal points are to display input scale multipliers or conversion to units other than the electrical range of the input. For example, the user may add external circuits to accept a  $\pm 2$  Vdc input but display 0 to +150.0 PSI.

Analog input specifications are outstanding. The basic input configuration is true balanced differential, non-isolated, for high noise rejection and for connections to bridge-type inputs found in many industrial transducers such as strain gauges. The common mode rejection is 80 dB (dc to 60 Hz) and the common mode voltage range is approximately  $\pm 2$ V to Power Common. By using a transformer input power supply such as the optional UPA-5/500 AC Power Adapter, DC isolation will be achieved.

By using CMOS electronic technology, input impedance is extraordinarily high, typically 1000 Megohms. Input bias currents are very small, typically 5 picoamps, many orders of magnitude below older DPM's. These two features mean that the DM-31 may be safely connected to high source resistance inputs (up to 100 K $\Omega$ ) and will not cause errors by loading down sensitive circuits. Yet the DM-31's inputs are fully protected against normal overloads ( $\pm 250$  Vdc or 155 VAC).

Displayed accuracy is adjustable to  $\pm 0.1\%$  of reading,  $\pm 1$  count and temperature drift is typically within  $\pm 50$  ppm of reading/ $^{\circ}$ C over the  $0^{\circ}$ C to  $+50^{\circ}$ C operating range ( $+32^{\circ}$ F. to  $+122^{\circ}$ F.).

**APPLICATION FEATURES**

The DM-31 includes autozeroing circuits to correct zero drift. A ratiometric input accepts external dc voltages for limited gain change. These two features correct drift and reference errors in measurement circuits. An external +1 Volt dc reference may be substituted for the internal reference.

The basic  $\pm 1.999$  Vdc input range may be altered very easily. PC board pads have been left for the user to add attenuator resistors (for higher voltage ranges) or a shunt resistor for current ranges. Resistance ranges require a few more components external to the board. A simple digital thermometer may also be made using a few user-supplied external components. These inexpensive components are not supplied by Datel-Intersil but are readily available from electronic parts distributors.

The DM-31 includes a HOLD input which will latch the last A/D sample and freeze the display. This input may be connected to a switch for an operator to momentarily copy down a reading.

A DISPLAY ENABLE input may be used to blank the display and save power but keep the A/D converter sampling to reduce turn-on drift in portable applications. An automatic overscale indication is also included. All segments of the display may be checked by using the DISPLAY TEST input which displays "1888". The polarity sign may be blanked using the POLARITY ENABLE Input for non-polarized applications. This pin may also be controlled by an external relay, transistor or digital logic. Flashing the polarity sign may be used to indicate special conditions such as exceeding an alarm limit (this would require external, user-supplied circuits). Finally, an ANALOG RETURN output is provided as an optional bias return for differential inputs and for use as reference common when an external reference is employed or for digital ohmmeter circuits.

A single-turn adjustment pot is included on the front of the DM-31 PC board to calibrate full scale gain. Many users will mount the DM-31 behind their own front panel filter which may have legends screened on it as well as other indicators behind the panel filter besides the DM-31. If preferred, users may separately purchase a snap-in bezel/filter as part of an optional accessory kit which includes a solder-tab DIP-plug connector, 4 standoffs and mounting hardware. Some type of red filter is recommended to improve viewing contrast of the display and for aesthetics to conceal the components on the PC board. For users who prefer a fully cased DPM, refer to Datel-Intersil's DM-3100 and DM-4100 series at additional cost.

**If you are unfamiliar with DPM's** but feel that a low-cost DM-31 would be an important asset to your product, we have a few suggestions. Many manufacturers with limited electronics experience have recognized the important sales appeal to their customers of a modern DPM on the front panel of their product.

While the DM-31 is not at all difficult to use, those who are unfamiliar with electronics may wish to seek the assistance of a staff electronics engineer or a consultant or contracting engineer. If such a person is not available at your facility, your local Datel Sales Office will be happy to discuss your requirement and may be able to direct you to such assistance. More comprehensive technical assistance is available from Datel's Applications Engineering Department at the Mansfield, Mass. home office and from Datel's direct sales people.

The DM-31 is a very versatile, general purpose instrument with a wealth of operating features to be used in a large range of applications. However, no one universal connection scheme can be recommended to serve all requirements. Each user will obtain the best performance from the DM-31 by designing the unique right connections for his application.

The DM-31 does not directly measure temperatures, pressures, RPM, frequencies and many other physical parameters. External devices supplied by the user are required to convert such parameters into electrical inputs usable by the DM-31. A competent engineer will be able to specify and fabricate a complete system to your needs.

## PRELIMINARY SPECIFICATIONS (Typical at +25° C and +5 Vdc power unless noted)

### ANALOG INPUT

<b>Configuration</b> .....	True, balanced differential bipolar inputs
<b>Full Scale Input Range</b> .....	-1.999 Vdc to +1.999 Vdc
<b>Optional Ranges</b> .....	Up to $\pm 300$ Vdc, or $\pm 19.99 \mu\text{A}$ to $\pm 1.999$ Amps or 0 to 1.999 K $\Omega$ up to 0 to 19.99 megohms. These optional ranges require connection of external components supplied by the user.
<b>Displayed Accuracy at +25° C</b> .....	Adjustable to within $\pm 0.1\%$ of reading, $\pm 1$ count
<b>Resolution</b> .....	1 mV
<b>Input Bias Current</b> .....	5 pA typical, 50 pA maximum
<b>Temperature Drift of Gain</b> .....	Within $\pm 50$ ppm of Reading/ $^{\circ}\text{C}$ typical Within $\pm 100$ ppm of Reading/ $^{\circ}\text{C}$ max.
<b>Temperature Drift of Zero</b> .....	Autozeroed, $\pm 1$ count max over $0^{\circ}\text{C}$ to $+50^{\circ}\text{C}$
<b>Input Impedance</b> .....	100 Megohms, min., 1000 Megohms, typical to Analog Return or Power Common
<b>Input Overvoltage</b> .....	$\pm 250$ Vdc or 155 VRMS, continuous max. $\pm 300\text{V}$ intermittent max.
<b>Common Mode Rejection</b> .....	80dB to Analog Return, DC to 60 Hz, 1 Kilohm unbalance
<b>Common Mode Voltage Range</b> .....	Both inputs must remain within +4.5V and -4V of Power Common
<b>Warm-Up Time Reference</b> .....	1 minute to rated accuracy Choice of internal or user-supplied external reference. The internal reference is referred to Analog Return (pin 10). The DPM is calibrated when a one volt dc drop exists from pin 11 (+) to pin 10 (-).
<b>External Ratiometric Reference Range</b> .....	Pin 11 +2V to +.5V (Relative to pin 10)
<b>Ratiometric Gain Equation</b> .....	Display = $1000 \times V_{IN} / V_{REF}$ (no decimal points)
<b>Calibration</b> .....	Front panel single-turn screwdriver pot adjusts full scale gain. Zeroing is automatic. Suggested recalibration in stable conditions is 90 days

### DISPLAY

<b>Number of Digits</b> .....	3 decimal digits and most significant "1" digit ( $3\frac{1}{2}$ digits)
<b>Decimal Points</b> .....	3 Selectable decimal points are included for scale multipliers
<b>Luminous Intensity per Average Digit</b> .....	125 microcandelas, typical
<b>Display Type</b> .....	Red, light-emitting diode (LED) self-illuminated
<b>Display Height</b> .....	0.56 inches (14.2 mm)

<b>Overscale</b> .....	Inputs exceeding full scale blank the 3 least significant digits leaving a "1" MSD and sign displayed
<b>Autopolarity</b> .....	+ & - sign are automatically displayed if pin 5 is grounded. Disconnecting pin 5 will blank sign display for non-polarized applications
<b>Sampling Rate</b> .....	3 samples per second

### INPUT/OUTPUT CONNECTIONS

<b>Analog HI Input (pin 8)</b> <b>Analog LO Input (pin 9)</b> .....	Differential input signals are connected between these pins. A bias current path to either Analog Return or Power Common must be externally provided by the user to constrain these inputs not to exceed the common mode voltage range.
<b>Analog Return Input (pin 10)</b> .....	This pin may be used as a low-noise bias current return path for certain types of isolated inputs. If preferred, Analog Return may be left disconnected and Power Common may be used as a bias return. Analog Return is approximately -2.8 Vdc below +5V Power (pin 7) and can sink approximately 5 mA. Analog Return may be connected to Power Common if required. <i>Do not connect Analog Return to +5V (pin 7). Will destroy DPM.</i> Analog Return is also used as Reference Common when an external ratiometric reference is used in place of the internal reference.
<b>Reference Out (pin 12)</b> <b>Reference In (pin 11)</b> .....	Normally Ref. In and Ref. Out should be jumpered together. Ref. Out is approximately +1 Volt above Analog Return. Output impedance (pin 12) is approx. 3 K $\Omega$ . Recommended external reference source resistance should be less than 10 K $\Omega$ into pin 11. Ref. Out adjustment range is approx. $\pm 5\%$ . For ratiometric operation, where DPM gain is changed inversely to an external user-supplied reference, Ref. Out is not used and the external reference is connected to Ref. In + (pin 11) and biased against Analog Return (pin 10). If the external reference is single-ended, connect Analog Return to Power Common. The DPM is calibrated when a one volt dc drop exists between pin 11 (+) and pin 10 (-).

Continued on page 4

**PRELIMINARY SPECIFICATIONS Continued**

- Decimal Point Inputs (Pins 2, 3, 4)** ..... Ground the appropriate pin to display the selected decimal point. The decimal points may be externally controlled by an NPN transistor or open collector TTL gate. Sink 10mA
- Display Test Input (pin 1)** .. Connect to +5V to display "1888". Make no connection when not in use.
- Polarity Enable Input (pin 5)** ..... Ground this pin for normal autopolarity operation. Leave this pin open to blank the +/- sign for unipolar applications.
- Display Enable Input (pin 6)** ..... Tie to +5V for normal operation. Disconnect to blank the display and save power but keep the A/D converter sampling to reduce turn-on drift in portable applications. May be wired as "press to read."
- +5 VDC Power Input (pin 7)** ..... Connect this pin to the positive leg of an external, user-supplied +5V regulated power source.
- Hold Input (pin 13)** ..... Ground this pin for normal use. Open this pin to latch the last A/D conversion and stop the display from changing. May be used by an operator to momentarily copy down the last reading.
- Power Common (pin 14)** .. Connect the common of the external +5V power source to this pin. Power Common may also be used as a bias current return path for signal inputs.
- Power Requirement** ..... +5 Vdc nominal, -1, +2V regulated required. Logic spikes must not exceed 50 mV. Use an external bypass capacitor or other means to attenuate noise. Current @ 5V: 280 mA average, 450 mA max. Current varies rapidly as digits switch so that unregulated supplies cannot be used. Current is approximately 5 mA with displays blanked.

**PHYSICAL-ENVIRONMENTAL**

- Outline Dimensions** ..... 3.5"W x 2"H x .5" Thk depth behind front panel (88,9 x 50,8 x 12,7 mm) Max. height on component side of board is 0.315" (8mm)
- Mounting Method** ..... Using a front panel cutout, 4 holes for .5" mounting standoffs and 1 hole for the gain pot.
- Mounting Kit** ..... Optional, includes filter/bezel DIP connector, standoffs, and hardware; see ordering guide.

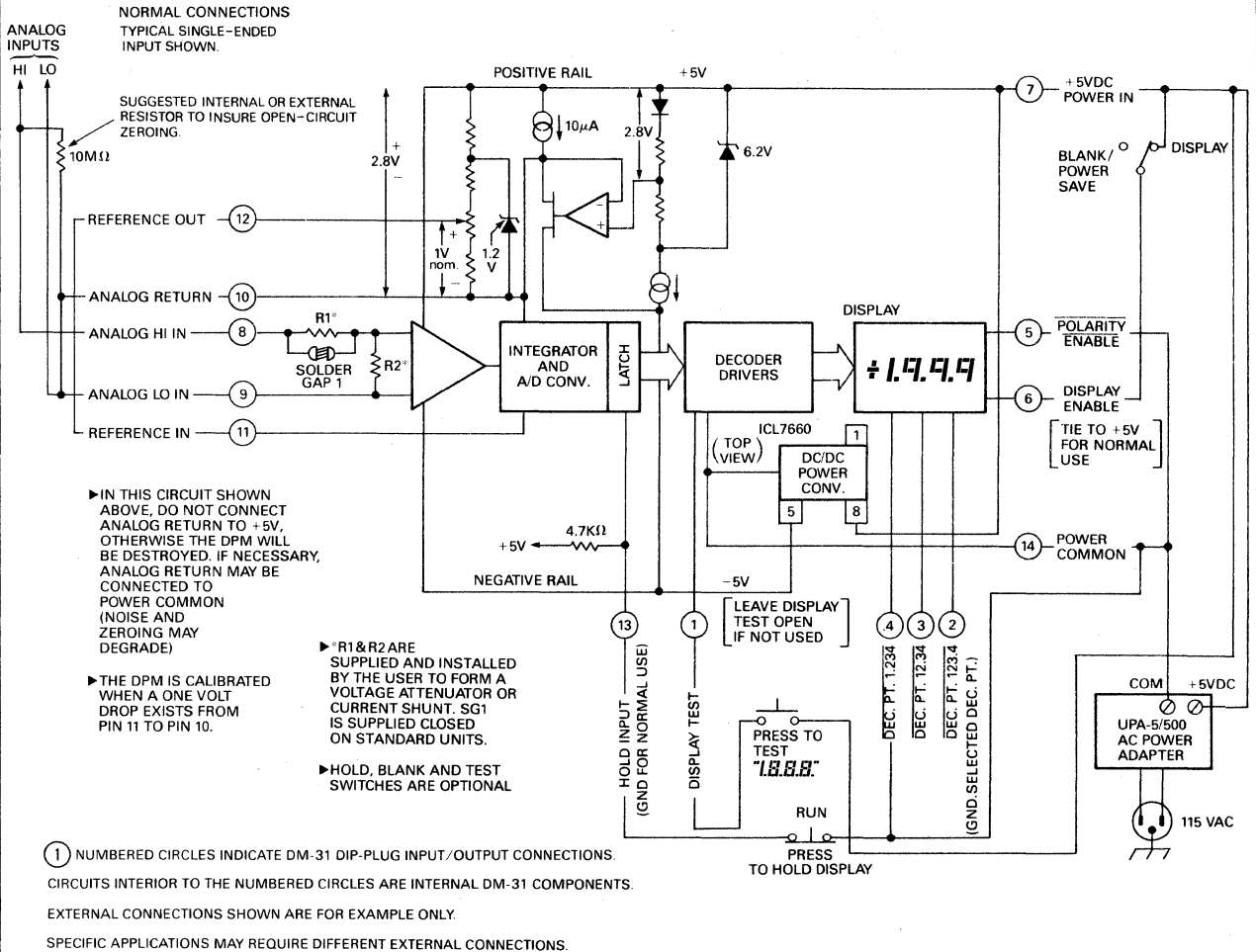
- Cutout Dimensions (For optional bezel/filter)** ... 1.156"H x 2.375"W (29,36 x 60,33 mm) Bezel/filter panel thickness range: .040 to 0.062" (snug fit at 0.062") 1,0 to 1,6 mm.
- Optional Snap-In Bezel/Filter Dimensions** ..... Outside Dimensions: 1.343"H x 2.531"W (34,1 x 64,3 mm)  
Display Opening: 0.812"H x 2.0"W (20,6 x 50,8 mm)  
Front Panel Bezel Relief Height: 0.062" (1,6 mm)
- Weight** ..... 1.2 ounces (35g)
- Connector** ..... 14 pin sockets mounted on board for Dual-Inline Package (DIP-spaced) plugs. Consists of two rows, spaced 0.300" (7,62 mm) between rows and 0.100" (2,5 mm) between sockets. Accepts .020" dia. (0,5 mm) pins. Solder tab plug connector included in optional Model 39-7249-1 Accessory Kit.
- Mounting Position** ..... Any
- Operating Temperature Range** ..... 0 to +50°C (+32° to +122°F)
- Storage Temperature Range** ..... -25° to +85°C (-13°C to +185°F)
- Altitude** ..... 0 to 15,000 feet (4900m)
- Relative Humidity** ..... 10% to 90%, non-condensing

**ORDERING GUIDE**

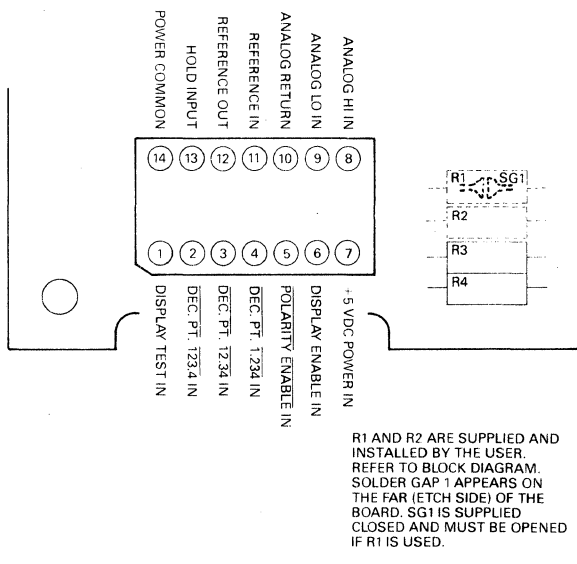
Model Number	Description
<b>DM-31</b>	Single-board Digital Panel Meter
<b>39-7249-1</b>	Optional Accessory Kit, consists of: (1) Snap-In Red Filter & Bezel (1) 14-Pin DIP Solder Tab Plug (4) ¼" Hex x ½" Long Threaded Standoffs (8) 4-40 x ¼" Screws
<b>UPA-5/500</b>	Optional AC to +5 Vdc Wall Plug Power Adapter, 500 mA max., 115 VAC ±10%, 60 Hz input, 1500 VAC isolation, 8 mV ripple and noise, 0.3% typ. line and load regulation

**Contact your local Datel-Intersil sales office for quantity prices.**

**BLOCK DIAGRAM WITH TYPICAL EXTERNAL CONNECTIONS**



**INPUT/OUTPUT CONNECTIONS**

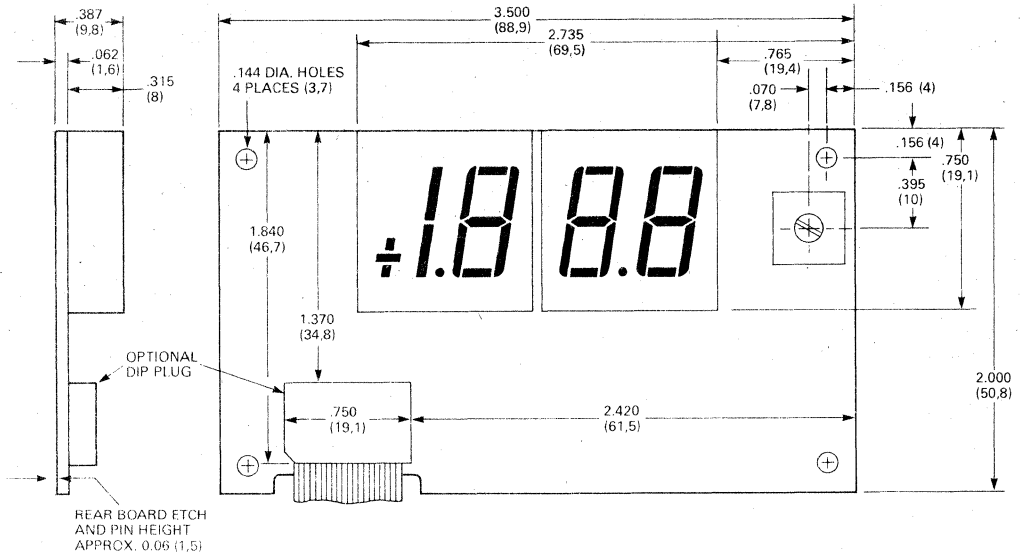


**ARE YOU ALREADY A DM-3100 SERIES USER?**

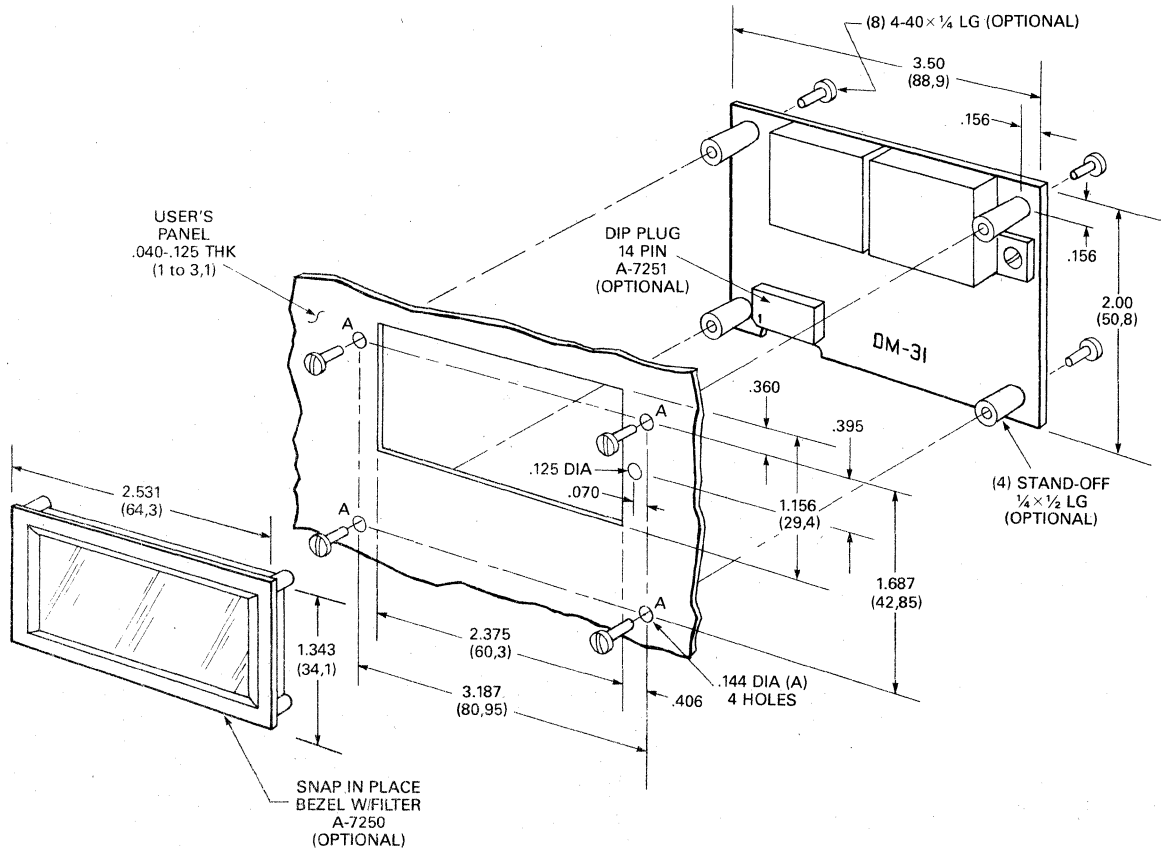
Note: For users familiar with Datel's DM-3100 series DPM's the DM-31 circuit is nearly identical to the DM-3100L or N except for the following:

1. The internal ICL8069 bandgap reference diode is biased against Analog Return, which is also internally connected (in the ICL7117 converter) to what was formerly Ohms LO, the cathode of the DM-3100 series reference. If desired, external ratiometric references can be single ended by connecting Analog Return to Power Common. Formerly, DM-3100 external references had to be biased against the negative rail.
2. A HOLD input (pin 13) is provided.
3. The -5V negative rail is not provided on the I/O DIP-plug connector (no room) but can be readily found on pin 5 of the ICL7660 voltage converter for users who wish to steal a few milliamps for external signal conditioners.

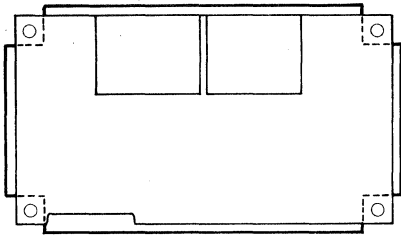
**MECHANICAL DIMENSIONS  
INCHES (MM)**



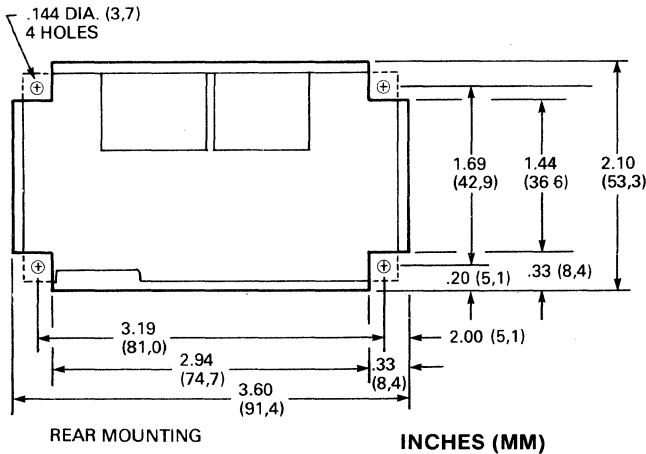
**PANEL MOUNTING WITH OPTIONAL BEZEL/FILTER  
INCHES (MM)**



**ALTERNATE FULL-BOARD-CUTOUT MOUNTING METHOD**



FRONT MOUNTING



REAR MOUNTING

**INCHES (MM)**

There are several suggested mounting methods for the DM-31. The standard method requires the optional accessory kit which includes a snap-in bezel/filter, DIP plug connector, 4 standoffs and mounting hardware. This method mounts the DM-31 PC board behind a front panel cutout sized for the optional bezel/filter. Four screw holes are required for the half-inch standoffs and a fifth hole provides screwdriver access to the full scale gain adjust pot.

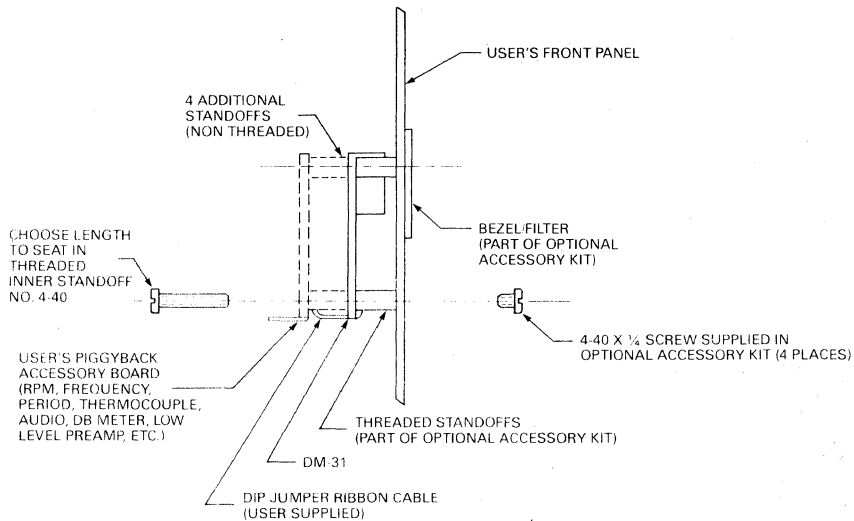
In test and laboratory applications where aesthetics may have little importance, the DM-31 board can be mounted on the *outside front* of a test panel using only the four standoff holes. Some sort of red filter will enhance viewing contrast.

Many users will mount the DM-31 behind their own front panel filter which may have legends or units silkscreened on it. Other LED or incandescent indicators may be positioned to display through this filter as well as the DM-31. Several DM-31's for different functions may share a common large red front panel filter. For these applications, an alternate flush mounting is shown either in front of or behind the mounting surface. No standoffs are used but the cutout is slightly more complex.

Appropriate filter materials would include: —

- Rohm & Haas Plexiglass #2423
- Panelgraphic 60 or 65 (Red) or 90 (Purple)
- 3M Panelfilm #6310
- Homalite H100-LR72-1600
- These can be supplied with anti-reflective/anti-scratch coatings

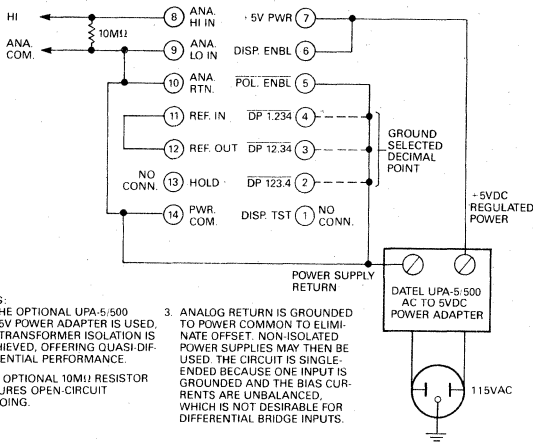
**SUGGESTED ACCESSORY BOARD MOUNTING**



SUGGESTED ACCESSORY BOARD MOUNTING (FOR USER-FABRICATED SIGNAL CONDITIONING ACCESSORY BOARDS PLUS THE OPTIONAL MOUNTING KIT AND BEZEL FILTER.)

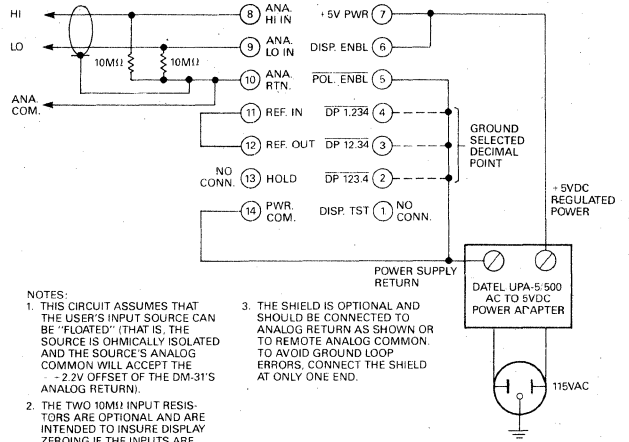
**TYPICAL APPLICATIONS CIRCUITS**

**SINGLE-ENDED INPUT CONNECTION**



- NOTES:**
- IF THE OPTIONAL UPA-5/500 AC 5V POWER ADAPTER IS USED, DC TRANSFORMER ISOLATION IS ACHIEVED, OFFERING QUASI-DIFFERENTIAL PERFORMANCE.
  - THE OPTIONAL 10MΩ RESISTOR INSURES OPEN-CIRCUIT ZEROING.
  - ANALOG RETURN IS GROUND TO POWER COMMON TO ELIMINATE OFFSET. NON-ISOLATED POWER SUPPLIES MAY THEN BE USED. THE CIRCUIT IS SINGLE-ENDED BECAUSE ONE INPUT IS GROUND AND THE BIAS CURRENTS ARE UNBALANCED, WHICH IS NOT DESIRABLE FOR DIFFERENTIAL BRIDGE INPUTS.

**ISOLATED DIFFERENTIAL INPUT CONNECTIONS**



- NOTES:**
- THIS CIRCUIT ASSUMES THAT THE USER'S INPUT SOURCE CAN BE "FLOATED" (THAT IS, THE SOURCE IS OHMICALLY ISOLATED AND THE SOURCE'S ANALOG COMMON WILL ACCEPT THE -2.2V OFFSET OF THE DM-31'S ANALOG RETURN).
  - THE TWO 10MΩ INPUT RESISTORS ARE OPTIONAL AND ARE INTENDED TO INSURE DISPLAY ZEROING IF THE INPUTS ARE OPEN-CIRCUITED.
  - THE SHIELD IS OPTIONAL AND SHOULD BE CONNECTED TO ANALOG RETURN AS SHOWN OR TO REMOTE ANALOG COMMON TO AVOID GROUND LOOP ERRORS, CONNECT THE SHIELD AT ONLY ONE END.

**FOR OTHER INPUT RANGES,** you may install resistors which you supply on the DM-31 PC board using the chart below. Refer to the I/O Connections diagram on page 5 to locate where the resistors are installed. The 2 Amp shunt must be remotely mounted.

Full Scale Range, dc	R1 <sup>(2)</sup>	R2 <sup>(2)</sup>
±1.999V (Std. range)	Short Solder Gap 1	Omit
±19.99V <sup>(3)</sup>	10 MΩ <sup>(2)</sup> (1 MΩ)	1.1 MΩ (110 KΩ)
±199.9V <sup>(3)</sup>	10 MΩ <sup>(2)</sup> (1 MΩ)	100 KΩ (10 KΩ)
±300V <sup>(3)</sup>	10 MΩ <sup>(2)(4)</sup> (1 MΩ)	10 KΩ (1 KΩ)
±19.99 μA	Short Solder Gap 1	100 KΩ
±199.9 μA	Short Solder Gap 1	10 KΩ
±1.999 mA	Short Solder Gap 1	1 KΩ
±19.99 mA	Short Solder Gap 1	100Ω
±199.9 mA	Short Solder Gap 1	10Ω <sup>(5)</sup> , 2W.W.W.
±1.999 Amps	Short Solder Gap 1	1Ω <sup>(6)</sup> , 5W.W.W.

**NOTES**

- These ranges will require recalibration. There is sufficient range in the full scale gain pot for this.
- These ranges give 10 MΩ input impedance. If 10 MΩ resistors are unavailable, use 1 MΩ resistors with the same ratio shown for R2. Input impedance reduces to about 1 MΩ.
- The ±300V range will display up to ±1999V but the safe limit for the board and connector is ±300V.
- R1 for the ±300V range is RN70C.
- R2 for the ±200 mA range is 2 watts, wirewound and must be externally mounted (not on the board).
- R2 for the ±2A range is 5 watts, wirewound and must be externally mounted (not on the board or connector.)
- Displayed accuracy is dependent on resistor quality. Economical metal film resistors ±1%, ±50 ppm/°C are suggested except for 200 mA and 2A ranges (see notes 5 and 6).

**CAUTION:** If you are unfamiliar with electronic assembly, we recommend that you obtain competent assistance when installing any component internally on these DPM PC boards. This will prevent possible damage or loss of performance from improperly installed or incorrect types of components. Components may be mounted externally on the connector if board insertion is not preferred.

These additional components are generally readily available from most electronic distributors. However, Dattel will preassemble components at extra cost for OEM quantity orders.

**CAUTION:** These DPMs employ high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, these DPMs will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle these DPMs with ground protection.

**WARRANTY INFORMATION**

**NOTE:** Dattel's Digital Panel Meters are warranted to be free from defects in materials and workmanship when operated as described in this brochure for a period of one year from the date of shipment. A number of suggested operating modes shown in this brochure show components which must be installed by the user. Since the selection of these components and the manner of installation is beyond Dattel's control, Dattel's warranty extends only to standard unmodified products. This means that Dattel will honor warranties on products which have been restored to their original condition (that is, added or modified components will have been removed by the customer before returning the product to Dattel for repair). Further, the customer must insure that the product was not damaged by the addition and removal of components. Such damage would void the original product warranty.

As a practical matter, users have several alternatives to insure warranty protection. A thorough incoming inspection by the customer is suggested before DPM's are modified. Those original components of the DPM (displays, IC's, etc.) will be honored under warranty if found to be defective (and not subject to catastrophic user damage).

Users may also partially remove components (one lead of a shunt resistor, for example) to restore the DPM to original condition while expediting return to the user's modified condition, once Dattel has repaired the product.

The intent of all these procedures is to allow rapid diagnosis and repair on Dattel's test fixtures to return the product as soon as possible to the user. Because of the variety of possible DPM modifications, Dattel test fixtures can only test unmodified products.

**NOTICE**

This applications information shows typical suggested circuits to illustrate design examples. Since Dattel-Intersil has no control over the selection, mounting, interconnection, fabrication and environmental factors of external apparatus and components to this product, specific performance cannot be warranted. This information is believed to be accurate and reliable. No responsibility is assumed for any errors or omissions. Nor does Dattel-Intersil, Inc. assume responsibility for the use of such information or for any infringement of present or future patents or other third party rights resulting from such use. No license is granted by implication or otherwise under any patent, patent rights, or otherwise of Dattel-Intersil, Inc. Prices and specifications are subject to change without notice.



# LCD Micropowered DPM with Programmable Descriptors

### FEATURES

- Ultra-low power, 3 mA from 9V battery
- .5" high Liquid Crystal Display
- 3½ digits, 5V or 9-15V powered, ratiometric reference for drift correction
- Programmable Descriptor Labels: A, mA, V, mV, Ω, KΩ, AC, DC
- Balanced differential inputs, 5 pA bias current, autozeroing with 80 dB CMR noise rejection
- Low profile model accepts optional 4-20 mA inputs
- Internal user-options:
  1. Offset pot for 4-20 mA and other applications
  2. Accepts shunts for ±20 μA to ±2A FS ranges
  3. Accepts attenuators for ±2V to ±1KV FS ranges
  4. Digital ohmmeter, 200Ω to 10 MΩ, FSR



NOTE: DPM's are normally supplied without Bezel Labels or Logos.

### GENERAL DESCRIPTION

The DM-3100U1 is a 3½ Digit Liquid Crystal Display (LCD) Digital Panel Meter that uses extremely low power (+5V @ 6 mA or +9V @ 3 mA) and has a power voltage range of +4V to +15 Vdc. The large 0.5" display can be seen from many feet away under normal room lighting conditions. This DPM is contained in a very small low profile case which makes for higher packing density on test panel faces. Besides measuring dc voltages, components can be placed internally to make resistance and current readings possible, and to display descriptor labels, mA, mV, KΩ, AC or DC to indicate which function is being used. Also, the decimal point can be internally selected by jumpering appropriate pins. The user may add internal attenuators to measure higher dc voltages up to ±1 kV.

The versatility of this meter is further enhanced by its autozeroing capabilities. If the customer desires, an offset pot can be internally installed so that a desired reading can be obtained with a zero input to the meter.

This DPM accepts a dc or slowly varying input voltage between ±1.999V and displays that input on front panel numerical indicators. It employs a conventional dual-slope A/D converter plus 7 segment display decoder-drivers all in one LSI microcircuit. Since this microcircuit requires approximately 9V to power the A/D conversion,

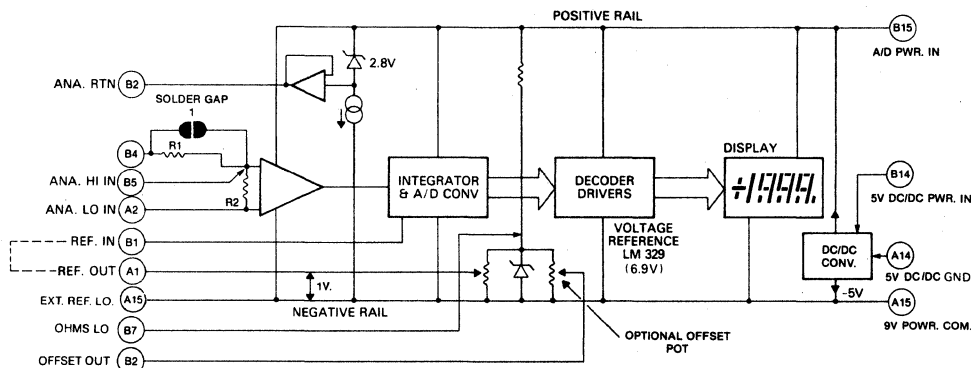
an internal DC/DC converter generates -5V from +5V power input. Together these two voltage sources form a bipolar power supply to power the A/D converter. The DM-3100U1 may also be powered directly from a single 9V battery @ 3 mA without using the DC/DC converter.

Another feature of the DM-3100U1 is that it employs a balanced differential input. When used with a bridge or transducer input, it offers high noise immunity and can accurately measure very small signals in the presence of much larger common mode noise. Another characteristic of this balanced differential input is that it will not load down sensitive input circuits due to its high input impedance of 1000 megohms, and low 5 pA bias current.

A very noteworthy feature of this meter is that it can be operated ratiometrically. This means that it has internal circuits that can automatically compensate for reference drifts in the supplies of balanced bridge or transducer sensors and still give accurate readings.

The DM-3100U1 finds use in analytical instruments, industrial process controllers, portable diagnostic instruments, automatic test equipment, medical and patient monitoring instruments, airborne, marine and ground vehicles, and data acquisition/data logging systems.

### SIMPLIFIED BLOCK DIAGRAM



## SPECIFICATIONS, (Typical @ +25°C unless noted)

### ANALOG INPUT

#### Configuration

True, balanced differential bipolar

#### Full Scale Input Range

-1.999 Vdc to +1.999 Vdc Input pad area will accept user-installed range change

#### Input Bias Current

5 pA typical, 50 pA maximum

#### Displayed Accuracy @+25°C

Adjustable to  $\pm 0.1\%$  of reading,  $\pm 1$  count

#### Resolution

1 mV

#### Temperature Drift of Zero

Autozeroed  $\pm 1$  count over 0 to +50°C

#### Temperature Drift of Gain

$\pm 50$  ppm of Reading/°C typ.

$\pm 100$  ppm of Reading/°C max.

#### Input Impedance

100 Megohms, minimum

#### Input Overvoltage

$\pm 250$  Volts dc 175 VRMS continuous max.

$\pm 300$  Volts intermittent max.

#### Common Mode Rejection

80 dB, dc to 60 Hz, 1 Kilohm unbalance

#### Common Mode Voltage Range

Within +Vs - .5V and -Vs +1V where +Vs is the positive rail (Pin B15) and -Vs is the negative rail (Pin A15) -Vs is approximately equal to -5V below PWR. COM.

#### Reference

Internal, referred to the negative rail (-Vs).

External, user-supplied reference optional for ratiometric operation

#### External Ref. Range

+100 mV to +2V, referred to -Vs

#### Ramp-up Time

#### (Integration Period)

83.3 ms

### DISPLAY

#### Number of Digits

3 decimal digits and most significant "1" digit (3½ digits)

#### Decimal Points

Selectable decimal points are included for scale multipliers.

#### Display Type

Field effect liquid crystal displays (LCD) requiring room light for viewing. Black digits against a light background.

#### Display Height

0.5 inches (12.7 mm)

#### Overscale

Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign

#### Autopolarity

A minus sign is automatically displayed for negative inputs, and may also be blanked

#### Sampling Rate

Factory set at 3 conversions per second. May be rewired up to 20 conversions/second

#### Descriptors

k $\Omega$ , mA, mV, ACDC

This field of function labels is positioned to the right of the decimal digits. Individual unit descriptors may be selected for display.

### I/O CONNECTIONS

#### Analog HI Input (Pin B5)

#### Analog LO Input (Pin A2)

Differential input voltages are connected between these inputs. A bias current path to POWER COMMON (if 5V-powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.

### Analog Return (Pin B2)

This pin may be used as a low-noise bias current return for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if 5V-powered). Analog Return is approximately -2.8V below +Vs and can sink 30 mA to -Vs. Do not connect Analog Return to +5V or +9V power. Analog Return may be connected to 5V Power Common (not 9V Pwr Com/-Vs!!) for single-ended input

#### Reference In/Out (Pins B1/A1)

Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin A15) may be substituted for ratiometric operation.

#### Decimal Points (Pins B8,9,10)

Connected selected pin to DECIMAL POINT COMMON (Pin B11) Connect unused decimal points or Descriptors to Backplane Out (Pin All)

#### Offset Out (Pin B3)

0 to +6.9V referred to -Vs (pin A15) requires installation of optional offset pot supplied by user

#### Display Test (Pin B6)

Connect this input to pin B15 to test all display segments

#### Horizontal Polarity In (Pin A12)

#### Horizontal Polarity Out (Pin B12)

Normally these inputs are jumpered together to continuously display the horizontal portion of the polarity sign. Omit the jumper for applications not requiring sign display. See Backplane Out.

#### Vertical Polarity In (Pin A12) (Pin B12)

#### Horizontal Polarity Out

Normally these inputs are jumpered together to continuously display the horizontal portion of the polarity sign. Omit the jumper for applications not requiring sign display. See Backplane Out.

#### Vertical Polarity In (Pin A13) Vertical Polarity Out (Pin B13)

Jumper these inputs when HORIZ. POL. is jumpered for automatic sign display with bipolar inputs. For reverse sensing applications, VERT. POL. OUT may be jumpered to HORIZ. POL. IN (no other connections). This will display a minus sign with positive inputs and no sign (implied positive) inputs. See Backplane Out.

#### Ohms Lo (Pin B7)

This connection is used in the ohmmeter configuration, otherwise do not use.

#### Backplane Out (Pin All)

Connect all unused Polarity, Decimal Points and Descriptors to Backplane Out. For VOM or DVM applications, a 470 k $\Omega$  resistor may be used for each Decimal Point or Descriptor to All. A rotary switch pole to B11 will then select the desired Descriptor and/or Decimal Point.

#### Descriptors

Electrical units are displayed by connecting to the Descriptor Common. Descriptors displayed are as follows:

"mA" (Pin A3)- "m" portion only

"k $\Omega$ " (Pin A4)- "k" portion only

"k $\Omega$ " (Pin A5)- "k" portion only

"mA" (Pin A6)- "A" portion only

"mV" (Pin A7)- "V" portion only

"DC" (Pin A8)

"AC" (Pin A9)

"mV" (Pin A10)-"m" portion only

**IMPORTANT NOTE:** The descriptors display labels only. They do not select functions. This meter does not directly measure ohms, mA, AC, etc. without first adding user-installed internal or external components.

### POWER CONNECTIONS

#### A/D Power IN (Pin B15)

Connect this pin to +5 Vdc regulated to power the A/D converter and displays. Connect to +9V for 9V configuration.

#### 5V DC/DC Power Common (Pin A14)

Use only for the 5V power configuration. This provides power return for the DC/DC converter.

#### 5V DC/DC Power IN (Pin B14).

Connect to the +5V supply if a single +5V supply is to be used. This will power the DC/DC converter to generate -5V. Don't use this pin in the 9V power configuration.

### POWER REQUIREMENTS

5V between B14/B15 and A14 (A15 no connection): 6 mA typ., 15 mA max. OR 9 to 15 Vdc between B15 and A15 (B14, A14 no connection): 3 mA typ, 6 mA max.

#### Calibration

A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

### PHYSICAL-ENVIRONMENTAL

#### Low Profile Case Outline Dimensions

2.53"W  $\times$  3.25"D  $\times$  0.94"H (64.3  $\times$  82.5  $\times$  23.8 mm)

#### Cutout Dimensions

2.56"W  $\times$  0.97"H min. (65.1  $\times$  24.6 mm)

#### Mounting Method

Through a front panel cutout secured by 2 side case "L" brackets and screws (supplied). Panel thickness up to 0.62" (15.9 mm)

#### Weight

Approximately 5 ounces (142g)

#### Connector

Double-sided edgeboard PC type, solder tab, gold-plated fingers. 15-pin, 0.1" Datel-Intersil #58-2073083 (not included).

#### Mounting Position

Any

#### Operating Temperature Range

0 to +50°C

#### Storage Temperature Range

-25 to +85°C

#### Altitude

0 to 15,000 feet (4900m)

#### Relative Humidity

20% to 80% non-condensing

## DM-3100U1 ORDERING INFORMATION

### DM-3100U1

3½-digit LCD DPM,

### 58-2073083

Connector, dual 15-pin, 0.1" spacing; one required (not supplied with meter).

### RN-DM-3000

Attenuation Resistor Set; matched, tracking units for 10:1 and 100:1 Attenuation Ratios.

### TP-50K

Optional Offset Pot, R16.

DM-3100U1 COMPONENT LOCATIONS

FOR OTHER VOLTAGE AND CURRENT RANGES

F.S. RANGE	R1 <sup>1,2</sup>	R2 <sup>1,2</sup>	DECIMAL <sup>5</sup> POINT	DESCRIPTORS <sup>5</sup>
±2V	Short SG1	Omit	B10 to B11	A7 to B11
±20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1 MΩ	1.1 MΩ <sup>4</sup> or 1 MΩ	B 9 to B11	A7 to B11
±200V <sup>3</sup>	10 MΩ	100 KΩ	B 8 to B11	A7 to B11
±1000V	10 MΩ*	10 KΩ	_____	A 7 to B11
±200 mA	Short SG1	10Ω, 1W	B 8 to B11	A3 & A6 to B11
±20 mA	Short SG1	100Ω, 1/4W	B 9 to B11	A3 & A6 to B11
±2 mA	Short SG1	1 KΩ	B10 to B11	A3 & A6 to B11
±200 μA	Short SG1	10 KΩ	B 8 to B11	_____
±20 μA	Short SG1	100 KΩ	B 9 to B11	_____

RC OSCILLATOR:  
R8 (100KΩ)

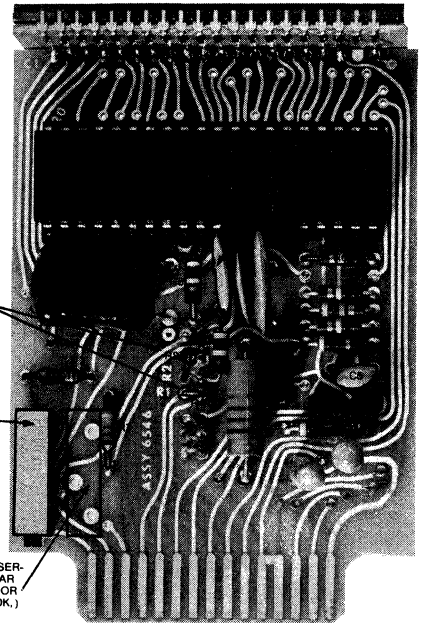
$$R8 (KΩ) = \frac{3 \times 10^4}{(\text{SAMPLE RATE}) \times C5 (pF)}$$

R8 MAY BE TRIMMED FOR EXACTLY 48 MHz ON IC PIN 38 (MEASURE WITH LOW CAPACITY PROBE) FOR BEST 80 HZ NOISE REJECTION. FOR 50 HZ, USE 120 pF AT C5 RETRIM. REDUCE R8 FOR FASTER SAMPLING.

R1, R2 ARE USER-INSTALLED ATTENUATION OR SHUNT RESISTOR (R2).

FULL SCALE (GAIN) ADJUST POTENTIOMETER (R8)

OFFSET POT, R16, 50 KΩ USER-INSTALLED. 3/4" RECTILINEAR BOURNS 3006 P-1 SERIES OR EQUIVALENT. (DATEL TP-60K.)



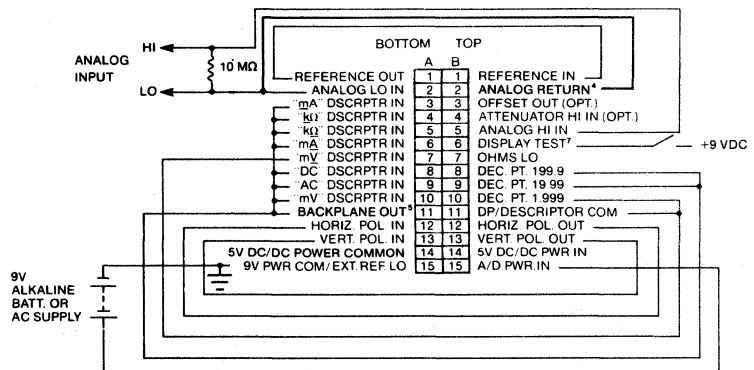
NOTES:

- (1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT, IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.
- (2) R1 AND R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.
- (3) THESE RANGES REQUIRE ADJUSTMENT OF R8 FOR ACCURATE READINGS.

- (4) IF 10 MΩ IS NOT AVAILABLE, USE R1 = 2 MΩ, R2 = 220 KΩ. A MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, and 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.
- (5) ALL UNUSED DESCRIPTORS AND DECIMAL POINTS MUST BE CONNECTED TOGETHER TO A11 (BACKPLANE OUT).

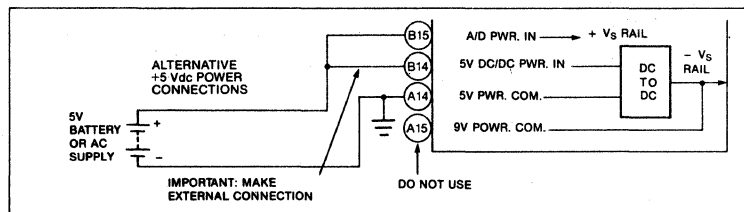
INPUT/OUTPUT CONNECTIONS WITH SINGLE-ENDED INPUT

DM-3100U1



NOTES:

1. This shows the connector rear with the DPM tilted on its side.
2. CAUTION: CMOS inputs. Avoid damage from static discharge. Handle only with ground protection.
3. ANALOG RETURN = +Vs - 2.8 Vdc. DO NOT CONNECT TO POWER COMMON.
4. Connect all unused Decimal Points, Descriptors and Signs to BACKPLANE OUT (PIN A11).
5. Descriptors A3 through A10 DO NOT select functions. Users must install additional components to measure Ohms, mA, etc.
6. Hold meter in DISPLAY TEST no longer than 1 minute to prevent damage to display.



**DIFFERENTIAL INPUT WITH SAMPLE RATIOMETRIC CONNECTIONS.**

The DM-3100U1 has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Bridge's external excitation source. The input gain on the DM-3100U1 varies inversely with voltage at Reference In — as REF IN voltage increases meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO.)

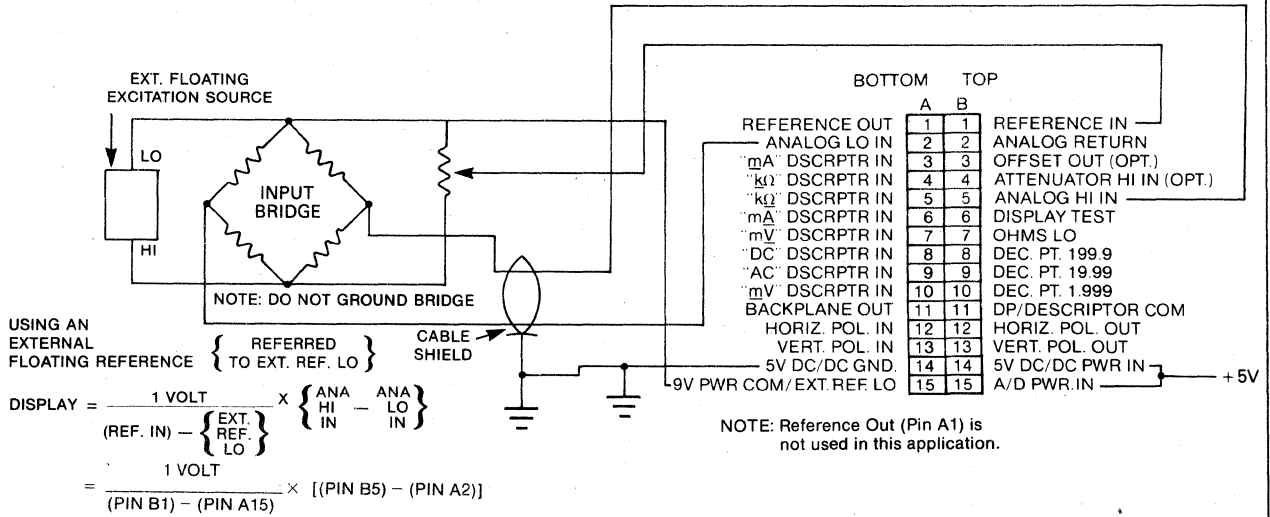
For all applications,  $V_{IN} = 2 V_{REF}$  at full scale (1999 counts). For small values of  $V_{REF}$  (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid  $V_{REF}$  inputs beyond about 2V to prevent integrator satu-

ration with full scale inputs. Variable  $V_{REF}$  is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.

A note on grounding: The DM-3100U1's internal voltage reference source is biased against the internal negative supply rail (EXT. REF. LO). Note that this is not the same electrical connection as the 5V Power Common connection. Refer to the Simplified Block Diagram.

Because of this configuration, external reference sources should be isolated from the 5V Power Common and should have the Reference Lo Output from the external source connected to the negative supply rail.

DM-3100U1

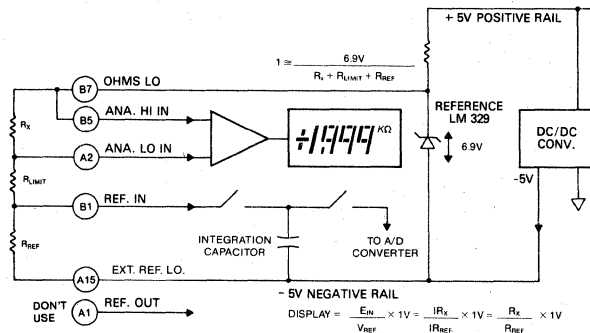


**DIGITAL OHMMETER CONNECTIONS**

The digital ohmmeter circuit uses the DM-3100U1's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable voltage from the DPM's internal reference diode is applied to the resistor pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional

only to the ratio of the resistances since the current through them is identical.

The chart below lists recommended  $R_{REF}$  and  $R_{LIMIT}$  resistance values corresponding to different ohmmeter ranges. Values of  $R_{LIMIT}$  were selected to limit the current through  $R_{REF}$  and  $R_x$  to 1 milliampere maximum.



RANGE	RESOLUTION	$R_{LIMIT}^1$	$R_{REF}$	DECIMAL POINT
19.99 MΩ	10 kΩ	22 MΩ	10MΩ	B9 to B11
1.999 MΩ	1 kΩ	3.6 MΩ	1 MΩ	B10 to B11
199.9 kΩ	100 Ω	360 kΩ	100 kΩ	B8 to B11
19.99 kΩ	10 Ω	36 kΩ	10 kΩ	B9 to B11
1.999 kΩ	1 Ω	6.2 kΩ	1 kΩ	B10 to B11

- $R_{LIMIT}$  and  $R_{REF}$  should be metal film, High Stability Resistors (AS RN60C).
- All unused decimal points must be connected together to All (BACKPLANE OUT).

# DM-3100X 3½-Digit LCD 5V/9V Micropowered Digital Panel Meter

## FEATURES

- Ultra-low power, 3 mA from 9V battery, short depth case
- .5" high Liquid Crystal Display
- 3½ digits, 5V or 9-15V powered, ratiometric reference for drift correction
- Balanced differential inputs, 5 pA bias current, autozeroing with 80 db CMR noise rejection
- 1000 MΩ CMOS high Impedance Inputs, ±1.999 Vdc FS range

### Internal user-options:

1. Accepts shunts for ±20 μA to ±2A FS ranges
2. Accepts attenuators for ±2V to ±1KV FS ranges
3. Digital ohmmeter, 200Ω to 10 MΩ. FSR



## GENERAL DESCRIPTION

The DM-3100X is a 3½ Digit Liquid Crystal Display (LCD) Digital Panel Meter that uses extremely low power (+5V @ 6 mA or +9V @ 3 mA) and has a power voltage range of +4V to +15 Vdc. The large 0.5" display can be seen from many feet away under normal room lighting conditions. This DPM is contained in a short depth case which measures only 2.15" (54.6 mm) deep. Besides measuring dc voltages, components can be internally placed to make ohm and current readings possible along with attenuators to measure higher voltages.

Also, the decimal point can be internally selected by jumpering appropriate pins.

The versatility of this meter is further enhanced by its autozeroing circuits which eliminate zero drift.

This DPM accepts a dc or slowly varying input voltage between +1.999V and displays that input on front panel numerical indicators. It employs a conventional dual-slope A/D converter plus 7 segment display decoder-drivers all in one LSI microcircuit. Since this microcircuit requires approximately 9V to power the A/D section, an internal DC/DC converter generates -5V from +5V power input. Together these two voltage sources form a bipolar power supply to

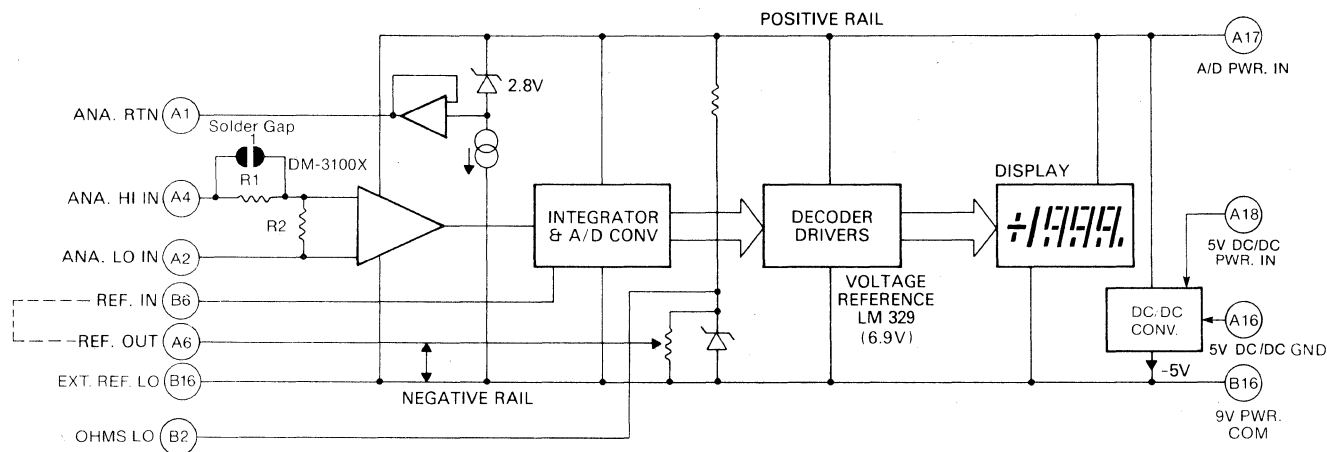
power the A/D converter. The DM-3100X may also be powered directly from a single 9V battery @ 3 mA without using the DC/DC converter.

Another feature of the DM-3100X is that it employs a balanced differential input. When used with a bridge or transducer input, it offers high noise immunity and can accurately measure very small signals in the presence of much larger common mode noise. Another characteristic of this balanced differential input is that it will not load down sensitive input circuits due to its high input impedance of 1000 megohms, and low 5 pA bias current.

A very noteworthy feature of this meter is that it can be operated ratiometrically. This means that it has internal circuits that can automatically compensate for reference drifts in the supplies of balanced bridge or transducer sensors and still give accurate readings.

The DM-3100X finds use in analytical instruments, industrial process controllers, portable diagnostic instruments, automatic test equipment, medical and patient monitoring instruments, airborne, marine, and ground vehicles, and data acquisition/data logging systems.

## SIMPLIFIED BLOCK DIAGRAM



**SPECIFICATIONS (Typical at +25° C, unless noted)****ANALOG INPUT****Configuration**

True-balanced differential bipolar

**Full Scale Input Range**

-1.999 Vdc to +1.999 Vdc. Input pad area will accept user-installed range change

**Input Bias Current**

5 pA typical, 50 pA maximum

**Displayed Accuracy @ +25° C**

Adjustable to  $\pm 0.1\%$  of reading,  $\pm 1$  count

**Resolution**

1 mV

**Temperature Drift of Zero**

Autozeroed  $\pm 1$  count over 0 to +50° C

**Temperature Drift of Gain**

$\pm 50$  ppm of Reading/°C typ.  $\pm 100$  ppm of Reading/°C max.

**Input Impedance**

100 Megohms, minimum

**Input Overvoltage**

$\pm 250$  Volts dc 175 VRMS continuous max.

$\pm 300$  Volts intermittent max.

**Common Mode Rejection**

80 dB, DC to 60 Hz, 1 Kiloohm unbalance

**Common Mode Voltage Range**

Within +Vs - .5V and -Vs +1V where +Vs is the positive rail (Pin A 17) and -Vs is the negative rail (Pin B16). -Vs is approximately equal to -5V below PWR. COM.

**Reference**

Internal, referred to the negative rail (-Vs).

External, user-supplied reference optional for ratiometric operation.

**External Ref. Range**

+100 mV to +2V, referred to -Vs.

**Ramp-up Time (Integration Period)**

83.3 mS

**DISPLAY****Number of Digits**

3 decimal digits and most significant "1" digit (3½ digits)

**Decimal Points**

Selectable decimal points are included for scale multipliers.

**Display Type**

Field effect liquid crystal displays (LCD) requiring room light for viewing. Black digits against a light background

**Display Height**

0.5 inches (12.7 mm)

**Overscale**

Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign

**Autopolarity**

A minus sign is automatically displayed for negative inputs, and may also be blanked

**Sampling Rate**

Factory set at 3 conversions per second. May be rewired up to 20 conversions/second.

**I/O CONNECTIONS****Analog HI Input (Pin A4)****Analog LO Input (Pin A2)**

Differential input voltages are connected between these inputs. A bias current path to POWER COMMON (if 5V-powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.

**Analog Return (Pin A1)**

This pin may be used as a low-noise bias current for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if 5V-powered). Analog Return is approximately -2.8V below +Vs and can sink 30 mA to -Vs.

**Reference In/Out (Pins B6/A6)**

Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin B16) may be substituted for ratiometric operation.

**Decimal Points**

Connected selected pin to DECIMAL POINT COMMON (Pin B13). See Backplane Out.

**Display Test (Pin B14)**

Connect this input to Pin A17 or +Vs to test all display segments.

**Horizontal Polarity In (Pin B15)****Horizontal Polarity Out (Pin B9)**

Normally these inputs are jumpered together to continuously display the horizontal portion of the polarity sign. Omit the jumper for applications not requiring sign display. See Backplane Out

**Vertical Polarity In (Pin B17)****Vertical Polarity Out (Pin B18)**

Jumper these inputs when HORIZ. POL. is jumpered for automatic sign display with bipolar inputs. For reverse sensing applications, VERT. POL. OUT may be jumpered to HORIZ. POL. IN (no other connections). This will display a minus sign with positive inputs and no sign (implied positive) with negative inputs. See Backplane Out

**Ohms Lo (Pin B2)**

This connection is used in the ohmmeter configuration, otherwise do not use.

**Backplane Out (Pin A13)**

Connect all unused Polarity, and Decimal Points to Backplane Out. For VOM or DVM applications, a 470 kΩ resistor may be used for each Decimal Point. A rotary switch pole to B13 will then select the desired Decimal Point.

**POWER CONNECTIONS****A/D Power IN (Pin A17)**

Connect this pin to +5 Vdc regulated to power the A/D converter and displays. Connect to +9V for 9V configuration.

**5V DC/DC Power Common (Pin A16)**

Use only for the 5V power configuration. This provides power return for the DC/DC converter.

**5V DC/DC Power IN (Pin A18)**

Connect to +5V if a single +5V supply is to be used. This will power the DC/DC converter to generate -5V. Don't use this pin in the 9V power configuration.

**POWER REQUIREMENTS**

5V between A17/A18 and A16 (B16 no connection): 6 mA typ., 15 mA max. OR 9 to 15 Vdc between A17 and B16 (A16, A18, no connection): 3 mA typ, 6 mA max.

**Calibration**

A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

**PHYSICAL-ENVIRONMENTAL****Short-Depth Case**

Interchangeable with other Datel-Intersil cases.

**Outline Dimensions**

3.00"W × 2.15"D × 1.76"H (76.2 × 54.6 × 44.7 mm)

**Cutout Dimensions**

1.812"H × 3.062"W (46.0 × 77.7 mm)

**Mounting Method**

Through a front panel cutout secured by (4) 4-40 front access screws which are concealed by the bezel.

**Weight**

Approximately 5 ounces (142g)

**Connector**

Double-sided edgeboard PC type, solder tab, gold-plated fingers, Dual 18-pin, 0.100" centers, Datel-Intersil #58-2075010, (not included)

**Mounting Position**

Any

**Operating Temperature Range**

0 to +50° C

**Storage Temperature Range**

-25 to +85° C

**Altitude**

0 to 15,000 feet (4600m)

**Relative Humidity**

20% to 80% non-condensing

**ORDERING INFORMATION**

MODEL	DESCRIPTION
DM-3100X	3½-Digit LCD DPM.
58-2075010	Connector, dual 18-pin, 0.100" centers; one required (not supplied with meter).
RN-DM-3000	Attenuation Resistor Set; matched, tracking units for 10:1 and 100:1 Attenuation Ratios.

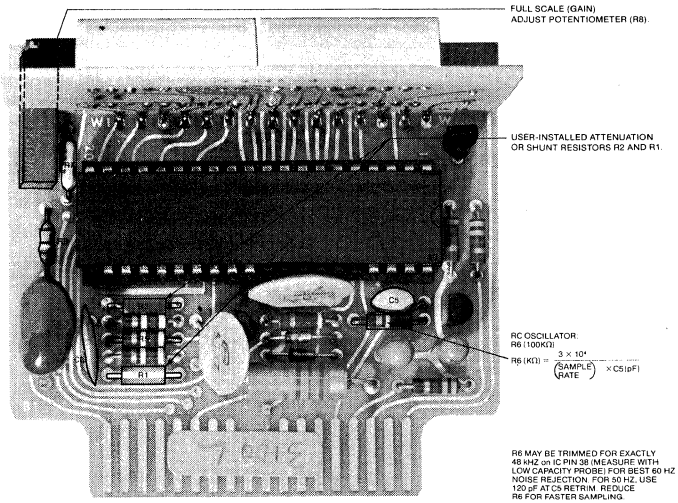
DM-3100X COMPONENT LOCATIONS

FOR OTHER VOLTAGE AND CURRENT RANGES

F.S. RANGE	R1 <sup>1,2</sup>	R2 <sup>1,2</sup>	DECIMAL <sup>5</sup> POINT
±2V	Short SG1	Omit	A12 to B13
±20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1 MΩ	1.1 MΩ <sup>4</sup> or 1 MΩ	A11 to B13
±200V <sup>3</sup>	10 MΩ	100 KΩ	A10 to B13
±1000V	10 MΩ	10 KΩ	
±200 mA	Short SG1	10Ω, 1W	A10 to B13
±20 mA	Short SG1	100Ω, 1/4W	A11 to B13
±2 mA	Short SG1	1 kΩ	A12 to B13
±200 μA	Short SG1	10 KΩ	A10 to B13
±20 μA	Short SG1	100 KΩ	A11 to B13

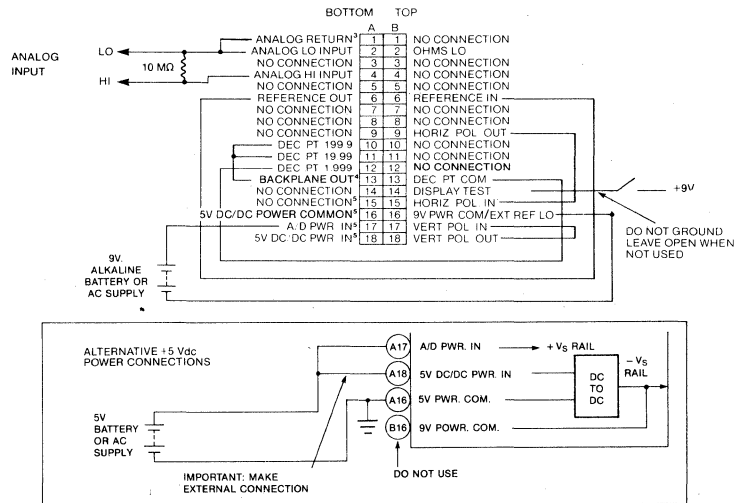
NOTES:

- (1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT, IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.
- (2) R1 AND R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.
- (3) THESE RANGES REQUIRE ADJUSTMENT OF R8 FOR ACCURATE READINGS.
- (4) IF 10 MΩ IS NOT AVAILABLE, USE R1 = 2 MΩ, R2 = 220 KΩ. A MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, and 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.
- (5) CONNECT ALL UNUSED DECIMAL POINTS TO BACKPLANE OUT (PIN A13).



R8 MAY BE TRIMMED FOR EXACTLY 48 KHZ ON IC PIN 38 (MEASURE WITH LOW CAPACITY PROBE). FOR BEST 60 HZ NOISE REJECTION, FOR 50 HZ, USE 120 pF AT C5. RETRIM, REDUCE R8 FOR FASTER SAMPLING.

INPUT/OUTPUT CONNECTIONS WITH SINGLE-ENDED INPUT



NOTES:

1. This shows the connector rear view with the DPM tilted on its side.
2. CAUTION: This DPM employs high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, this DPM will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle the DPM with ground protection.
3. ANALOG RETURN = +Vs - 2.8 Vdc. DO NOT CONNECT TO POWER COMMON.
4. Connect all unused Decimal Points to BACKPLANE OUT (Pin A13).
5. A17 and A18 are internally connected.
6. Hold Meter in DISPLAY TEST no longer than 1 minute to prevent damage to display.

**DIFFERENTIAL INPUT WITH SAMPLE RATIOMETRIC CONNECTIONS**

The DM-3100X has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Bridge's external excitation source. The input gain on the DM-3100X varies inversely with voltage at Reference In — as REF IN voltage increases, meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO).

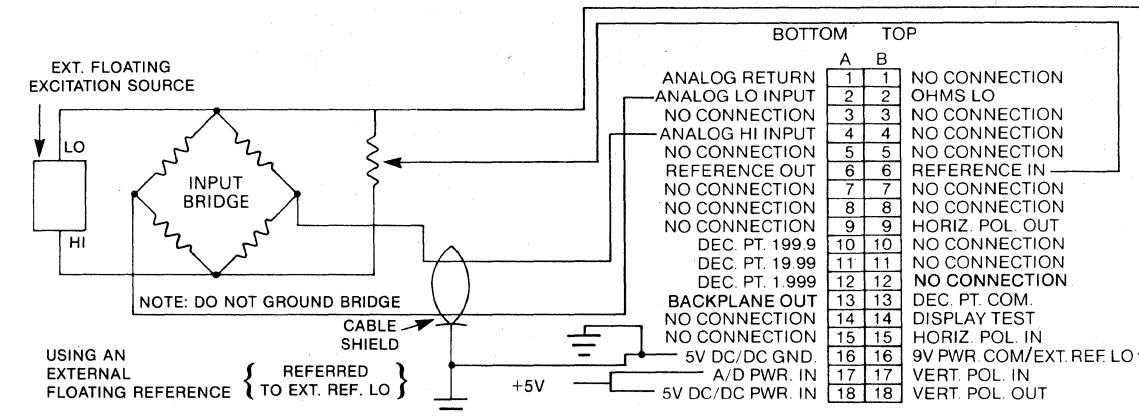
For all applications,  $V_{IN} = 2 V_{REF}$  at full scale (1999 counts). For small values of  $V_{REF}$  (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid  $V_{REF}$  inputs beyond about 2V to prevent integrator satu-

ration with full scale inputs. Variable  $V_{REF}$  is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.

A note on grounding: the DM-3100X's internal voltage reference source is biased against the internal negative supply rail (EXT. REF. LO). Note that this is *not* the same electrical connection as the 5V Power Common connection. Refer to the Simplified Block Diagram.

Because of this configuration, external reference sources should be isolated from the 5V Power Common and should have the Reference Lo Output from the external source connected to the negative supply rail.

**DM-3100X**



		BOTTOM	TOP	
		A	B	
ANALOG RETURN		1	1	NO CONNECTION
ANALOG LO INPUT		2	2	OHMS LO
NO CONNECTION		3	3	NO CONNECTION
ANALOG HI INPUT		4	4	NO CONNECTION
NO CONNECTION		5	5	NO CONNECTION
REFERENCE OUT		6	6	REFERENCE IN
NO CONNECTION		7	7	NO CONNECTION
NO CONNECTION		8	8	NO CONNECTION
NO CONNECTION		9	9	HORIZ. POL. OUT
DEC. PT. 199.9		10	10	NO CONNECTION
DEC. PT. 19.99		11	11	NO CONNECTION
DEC. PT. 1.999		12	12	NO CONNECTION
BACKPLANE OUT		13	13	DEC. PT. COM.
NO CONNECTION		14	14	DISPLAY TEST
NO CONNECTION		15	15	HORIZ. POL. IN
5V DC/DC GND		16	16	9V PWR. COM/EXT. REF. LO
A/D PWR. IN		17	17	VERT. POL. IN
5V DC/DC PWR. IN		18	18	VERT. POL. OUT

$$\text{DISPLAY} = \frac{1 \text{ VOLT}}{(\text{REF. IN}) - \left\{ \begin{matrix} \text{EXT. REF. LO} \end{matrix} \right\}} \times \left\{ \begin{matrix} \text{ANA HI IN} \\ \text{ANA LO IN} \end{matrix} \right\}$$

$$= \frac{1 \text{ VOLT}}{(\text{PIN B6}) - (\text{PIN B16})} \times (\text{PIN A4}) - (\text{PIN A2})$$

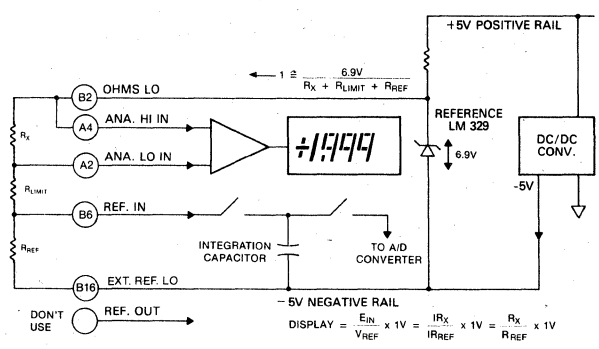
NOTE: Reference Out (PIN A6) is not used in this application.

**DIGITAL OHMMETER CONNECTIONS**

The digital ohmmeter circuit uses the DM-3100X's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable voltage from the DPM's internal reference diode is applied to the resistor

pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.

The chart below lists recommended  $R_{REF}$  and  $R_{LIMIT}$  resistance values corresponding to different ohmmeter ranges. Values of  $R_{LIMIT}$  were selected to limit the current through  $R_{REF}$  and  $R_x$  to 1 milliampere maximum.



RANGE	RESOLUTION	$R_{LIMIT}^1$	$R_{REF}^1$	DECIMAL POINT
19.99 MΩ	10 kΩ	22 MΩ	10 MΩ	A11 to B13
1.999 MΩ	1 kΩ	3.6 MΩ	1 MΩ	A 12 to B13
199.9 kΩ	100 Ω	360 kΩ	100 kΩ	A10 to B13
19.99 kΩ	10 Ω	36 kΩ	10 kΩ	A11 to B13
1.999 kΩ	1 Ω	6.2 kΩ	1 kΩ	A12 to B13

1.  $R_{LIMIT}$  and  $R_{REF}$  should be metal film, High Stability Resistors (AS RN60C).

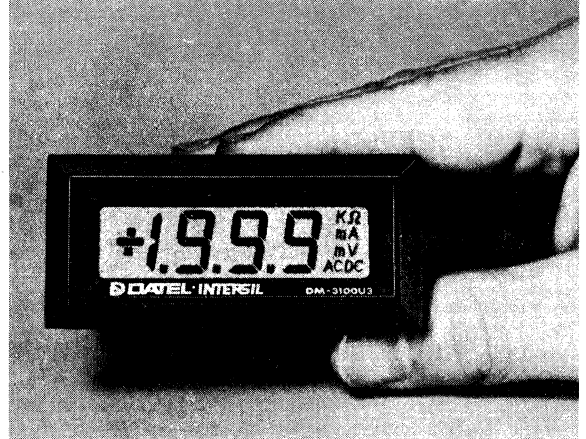




# DM-3100U2 and DM-3100U3 3½-Digit, LCD, AC/DC - Power DPM's with Programmable Descriptors

## FEATURES

- Dual-powered, 9-15 Vdc or AC (115 VAC DM-3100U2, 230 VAC DM-3100U3)
  - .5" High Liquid Crystal Display
  - 3½ digits, ratiometric reference for drift correction
  - Programmable Descriptor Labels: A, mA, V, mV,  $\Omega$ , K $\Omega$ , AC, DC
  - Balanced Differential Inputs, 5 pA bias current, autozeroing with 80 dB CMR noise rejection, transformer-isolated 300V
  - Low profile model accepts optional 4-20 mA inputs
- Internal user-options:
1. Offset pot for 4-20 mA and other applications
  2. Accepts shunts for  $\pm 20 \mu\text{A}$  to  $\pm 2\text{A}$  FS ranges
  3. Accepts attenuators for  $\pm 2\text{V}$  to  $\pm 1\text{KV}$  FS ranges
  4. Digital Ohmmeter,  $200\Omega$  to  $10\text{M}\Omega$ , FSR
  5.  $\pm 200\text{mV}$  Full Scale Range



NOTE: DPM's are normally supplied without Bezel Labels or Logos.

## GENERAL DESCRIPTION

The DM-3100U2 and DM-3100U3 Digital Panel Meters use 3½ Liquid Crystal Display Digits and accept either AC or dc power inputs. The DM-3100U2 uses 115 VAC power, 47 to 440 Hz or 9 to 15 Vdc at 3 to 7 mA. The DM-3100U3 is identical to the DM-3100U2 but uses 230 VAC power, 47 to 440 Hz or 9 to 15 Vdc at 3 to 7 mA.

Both models use .5" high LCD's and use Datel-Intersil's low profile DPM case. The input section is balanced differential for excellent noise rejection and uses a high impedance ( $1000\text{M}\Omega$ ) CMOS front end with low 5 pA bias currents.

The standard voltage range is  $\pm 1.999\text{Vdc}$  with autopolarity, but may be changed with user-supplied internal components to  $\pm 1000\text{Vdc}$ . The user may also install an internal shunt resistor to measure from  $\pm 20\mu\text{A}$  to  $\pm 2\text{A}$  FSR. Digital ohmmeter operation is also a user-option

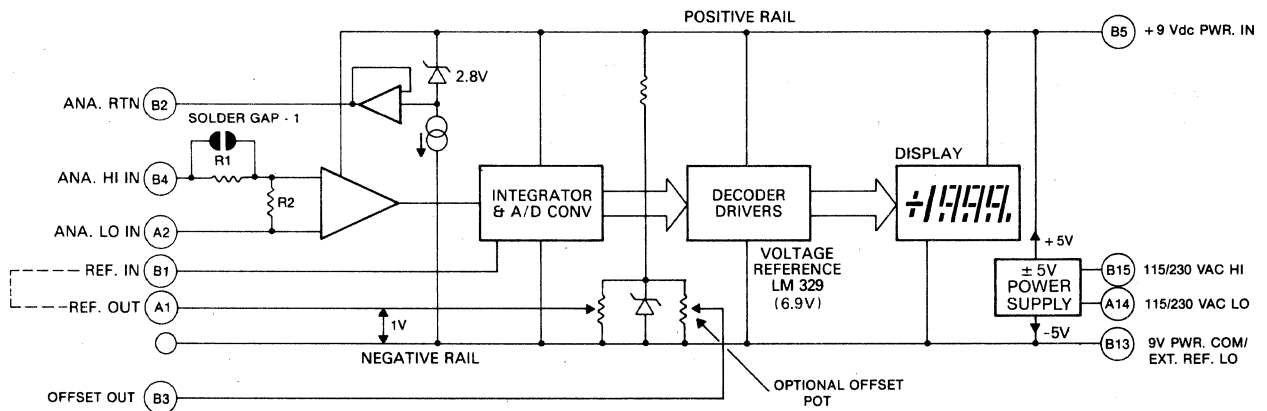
from  $199.9\Omega$  FSR to  $10\text{M}\Omega$  FSR. Finally, the user may install an internal offset pot for 4-20 mA and other applications.

Both meters are autozeroed and accept external ratiometric reference inputs to reduce drift errors in instrumentation systems.

The LCD display on both meters contains Descriptor unit labels (A, mA, V, mV,  $\Omega$ , K $\Omega$ , AC, DC) which are pin-programmable for dedicated VOM, DVM applications.

The AC supply in both meters produces an additional filtered DC output of approximately 12 Vdc @ 5 mA for customer use. A suggested application is to charge standby NiCad batteries. Since this power output pin is also used for power input when dc-powered, the NiCads may be left continuously connected so the meter will continue operating if there is an AC power failure.

## SIMPLIFIED BLOCK DIAGRAM



DM-3100U2 and DM-3100U3 3½-Digit, LCD, AC/DC - Pwr'd, with Programmable Descriptors

DPM

## SPECIFICATIONS (Typical at +25°C, unless noted)

## ANALOG INPUT

## Configuration

True, balanced differential bipolar

## Full Scale Input Range

-1.999 Vdc to +1.999 Vdc. Input pad area will accept user-installed range change

## Input Bias Current

5 pA typical, 50 pA maximum

## Displayed Accuracy @ +25°C

Adjustable to  $\pm 0.1\%$  of reading,  $\pm 1$  count

## Resolution

1 mV

## Temperature Drift of Zero

Autozeroed  $\pm 1$  count over 0 to +50°C

## Temperature Drift of Gain

$\pm 50$  ppm of Reading/ $^{\circ}$ C typ.  $\pm 100$  ppm of Reading/ $^{\circ}$ C max.

## Input Impedance

100 Megohms, minimum

## Input Overvoltage

$\pm 250$  Volts dc 175 VRMS continuous max.  $\pm 300$  Volts intermittent max.

## Common Mode Rejection

80 dB, DC to 60 Hz, 1 Kiloohm unbalance

## Common Mode Voltage Range

Within +Vs - .5V and -Vs +1V where +Vs is the positive rail (Pin B5) and -Vs is the negative rail (Pin B13). -Vs is approximately equal to -5V below PWR. COM.

## Reference

Internal, referred to the negative rail (-Vs).

External, user-supplied reference optional for ratiometric operation

## External Ref. Range

+100mV to +2V referred to -Vs.

## Ramp-up Time (Integration Period)

83.3 ms

## DISPLAY

## Number of Digits

3 decimal digits and most significant "1" digit (3 $\frac{1}{2}$  digits)

## Decimal Points

Selectable decimal points are included for scale multipliers

## Display Type

Field effect liquid crystal displays (LCD) requiring room light for viewing. Black digits against a light background

## Display Height

0.5 inches (12.7 mm)

## Overscale

Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign

## Autopolarity

A minus sign is automatically displayed for negative inputs, and may also be blanked

## Sampling Rate

Factory set at 3 conversions per second. May be rewired up to 20 conversions/second

## Descriptors

k $\Omega$ , mA, mV, ACDC. This field of function labels is positioned to the right of the decimal digits. Individual unit descriptors may be selected for display

## I/O CONNECTIONS

## Analog HI Input (Pin B4)

## Analog LO Input (Pin A2)

Differential input voltages are connected between these inputs. A bias current path to POWER COMMON (if 5V-powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.

## Analog Return/Ohms LO (Pin B2)

This pin may be used as a low-noise bias current return for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if 9V powered). Analog Return is approximately -2.8V below +Vs and can sink 30 mA to -Vs. Do not connect Analog Return to +5V or +9V power. Analog Return may be connected to 5V Power Common (not 9V Pwr Com/-Vs!) for single-ended input

## Reference In/Out (Pins B1/A1)

Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin B13) may be substituted for ratiometric operation.

## Decimal Points

Connected selected pin to DECIMAL POINT COMMON (Pin B11). Connect unused decimal points or Descriptors to Backplane Out (Pin B10)

## Offset Out (Pin B3)

0 to +6.9V referred to -Vs (Pin B13) requires installation of optional offset pot supplied by user.

## Display Test (Pin B6)

Connect this input to Pin B5 to test all display segments

## Horizontal Polarity In (Pin A11)

## Horizontal Polarity Out (Pin B11)

Normally these inputs are jumpered together to continuously display the horizontal portion of the polarity sign. Omit the jumper for applications not requiring sign display. See Backplane Out.

## Vertical Polarity In (Pin A12)

## Vertical Polarity Out (Pin B12)

Jumper these inputs when HORIZ. POL. is jumpered for automatic sign display with bipolar inputs. For reverse sensing applications VERT. POL. OUT may be jumpered to HORIZ. POL. IN (no other connections). This will display a minus sign with positive inputs and no sign (implied positive) with negative inputs. See Backplane Out

## Backplane Out (Pin B10)

Connect all unused Polarity, Decimal Points and Descriptors to Backplane Out. For VOM or DVM applications, a 470 k $\Omega$  resistor may be used for each Decimal Point or Descriptor to A11. A rotary switch pole to B11 will then select the desired Descriptor and/or Decimal Point.

## Descriptors

Electrical units are displayed by connecting to the Descriptor Common. Descriptors displayed are as follows:

"mA" (Pin A3)-"m" portion only  
 "k $\Omega$ " (Pin A4)-"k" portion only  
 "k $\Omega$ " (Pin A5)-" $\Omega$ " portion only  
 "mA" (Pin A6)-"A" portion only  
 "mV" (Pin A7)-"V" portion only  
 "DC" (Pin A8)  
 "AC" (Pin A9)  
 "mV" (Pin A10)-"m" portion only

**IMPORTANT NOTE:** The descriptors display labels only. They do not select functions. This meter does not directly measure ohms, mA, AC, etc. without first adding user-installed internal or external components.

## POWER CONNECTIONS

## AC Power

## 115 VAC (Model DM-3100U2) or 230 VAC (Model DM-3100U3)

Connect AC Hot to Pin B15. Connect AC Neutral to Pin A14. Earth ground may be connected to Pin B13 if the input is isolated from earth ground. Make no connection to Pin B13 if input ground loops will result.

## DC Power

## (Both DM-3100U2 and U3)

Connect +9 to 15 Vdc to Pin B5. Connect Power Common to Pin B13. When AC-powered, Pins B9/B13 produce +12 Vdc @ 5 mA max., filtered for optional customer external use.

## POWER REQUIREMENTS

## AC

1/4 watt, max.

## DC

+9 to +15 Vdc, filtered @ 3 to 6 mA typ., 12 mA max. Logic spikes must be less than 50 mV.

## Calibration

A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

## PHYSICAL-ENVIRONMENTAL

## Low Profile Case Outline Dimensions

2.53"W x 3.25"D x 0.94"H (64.3 x 82.5 x 23.8 mm)

## Cutout Dimensions

2.56"W x 0.97"H min. (65.1 x 24.6 mm)

## Mounting Method

Through a front panel cutout secured by 2 side case "L" brackets and screws (supplied). Panel thickness up to 0.62" (15.9 mm)

## Weight

Approximately 5 ounces (142g)

## Connector

Double-sided edgeboard PC type, solder tab, gold-plated fingers. 15-pin, 0.1" Datel-Intersil #58-2073083 (not included).

## Mounting Position

0 to +50°C

## Storage Temperature Range

-25 to +85°C

## Altitude

0 to 15,000 feet (4900m)

## Relative Humidity

20% to 80% non-condensing

DM-3100U2, DM-3100U3  
ORDERING INFORMATION

MODEL	DESCRIPTION
DM-3100U2	3 $\frac{1}{2}$ -Digit, LCD Digital Panel Meter, 115 VAC or +9 to +15Vdc powered.
DM-3100U3	3 $\frac{1}{2}$ -Digit, LCD Digital Panel Meter, 230 VAC or +9 to +15Vdc powered.
58-2073083	Connector, dual 15-pin, 0.1" centers; one required (not supplied with meter).
RN-DM-3000	-Attenuation Resistor Set; matched, tracking units for 10:1 and 100:1 Attenuation Ratios.
TP-50K	Optional Offset Pot, R16.

DM-3100U2, DM-3100U3 COMPONENT LOCATIONS

FOR OTHER VOLTAGE AND CURRENT RANGES

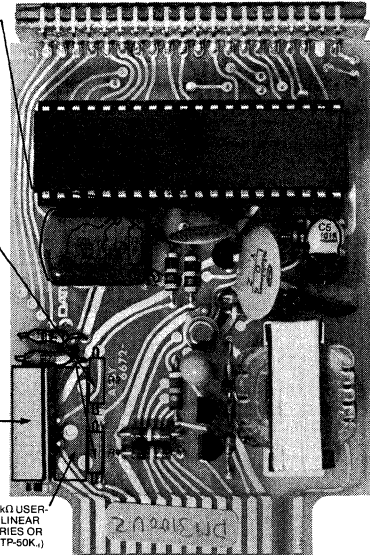
F.S. RANGE	R1 <sup>1,2</sup>	R2 <sup>1,2</sup>	DECIMAL <sup>3</sup> POINT	DESCRIPTORS <sup>4</sup>
±2V	Short SG1	Omit	B9 to B11	A7 to B11
±20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1MΩ	1.1MΩ <sup>4</sup> or 1 MΩ	B8 to B11	A7 to B11
±200V <sup>3</sup>	10 MΩ	100 KΩ	B7 to B11	A7 to B11
±1000V	10 MΩ	10 KΩ	B7 to B11	A7 to B11
±200 mA	Short SG1	10Ω, 1W	B7 to B11	A3 & A6 to B11
±20 mA	Short SG1	100Ω, 1/4W	B8 to B11	A3 & A7 to B11
±2 mA	Short SG1	1 KΩ	B9 to B11	A3 & A6 to B11
±200 μA	Short SG1	10 KΩ	B7 to B11	_____
±20 μA	Short SG1	100 KΩ	B8 to B11	_____

RC OSCILLATOR:  
R6 (100KΩ)  
 $R6 (KΩ) = \frac{3 \times 10^4}{(\text{SAMPLE RATE}) \times C5 (\mu F)}$   
R6 MAY BE TRIMMED FOR EXACTLY 48 KHZ ON IC PIN 38 (MEASURE WITH LOW CAPACITY PROBE) FOR BEST 50 HZ NOISE REJECTION. FOR 50 HZ, USE 120 pF AT C5 RETRIM. REDUCE R6 FOR FASTER SAMPLING.

R1, R2 ARE USER-INSTALLED ATTENUATION OR SHUNT RESISTOR (R2)

FULL SCALE (GAIN) ADJUST POTENTIOMETER SUPPLIED (R8)

OFFSET POT. R16, 50 KΩ USER-INSTALLED. 1/4" RECTILINEAR BOURNS 3006 P-1 SERIES OR EQUIVALENT. (DATEL TP-50K.)

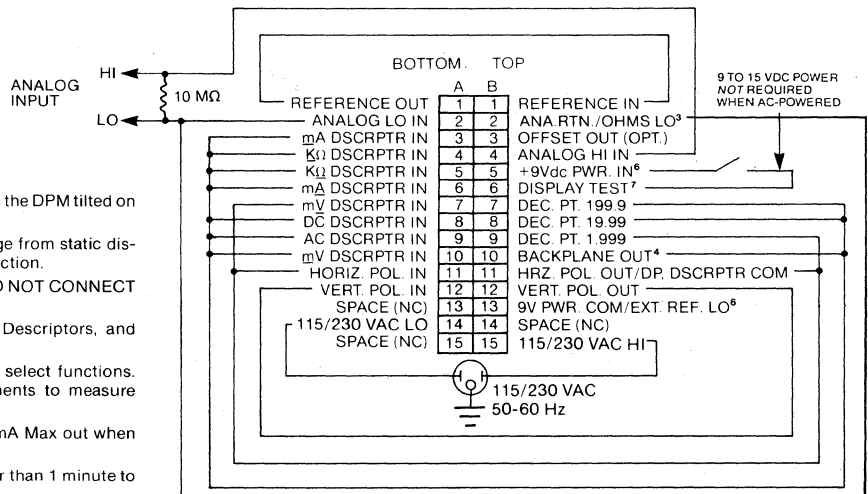


NOTES:

- (1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT, IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.
- (2) R1 AND R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.
- (3) THESE RANGES REQUIRE ADJUSTMENT OF R6 FOR ACCURATE READINGS.
- (4) IF 10 MΩ IS NOT AVAILABLE, USE R1 = 2 MΩ, R2 = 220 KΩ. A MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, and 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.
- (5) ALL UNUSED DESCRIPTORS AND DECIMAL POINTS MUST BE CONNECTED TOGETHER TO B10 (BACKPLANE OUT).

INPUT/OUTPUT CONNECTIONS WITH SINGLE-ENDED INPUT

DM-3100U2, DM-3100U3



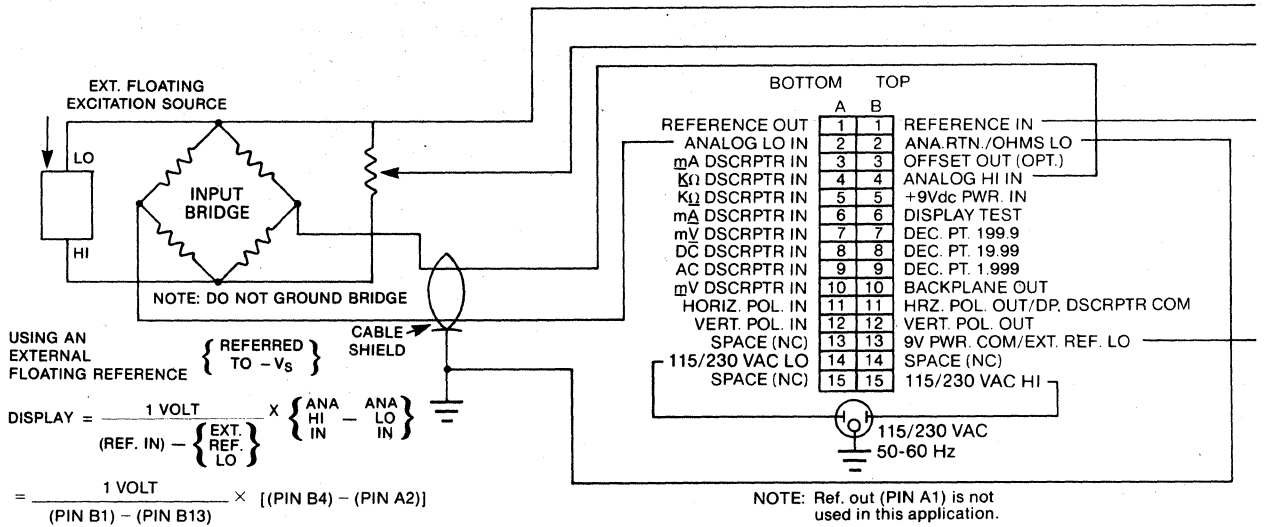
NOTES:

1. This shows the connector rear view with the DPM tilted on its side.
2. CAUTION: CMOS inputs. Avoid damage from static discharge. Handle only with ground protection.
3. ANALOG RETURN = +Vs - 2.8 Vdc. DO NOT CONNECT TO POWER COMMON.
4. Connect all unused Decimal Points, Descriptors, and Signs to BACKPLANE OUT (Pin B10).
5. Descriptors A3 through A10 DO NOT select functions. Users must install additional components to measure Ohms, mA, etc.
6. 5B/13B = Approximately 12 Vdc. @ 5mA Max out when AC powered.
7. Hold meter in DISPLAY TEST no longer than 1 minute to prevent damage to display.

**DIFFERENTIAL INPUT WITH SAMPLE RATIOMETRIC CONNECTIONS**

The DM-3100U2, -U3 has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Birdge's external excitation source. The input gain on the DM-3100U2, -U3 varies inversely with voltage at Reference In—as REF IN voltage increases meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO).

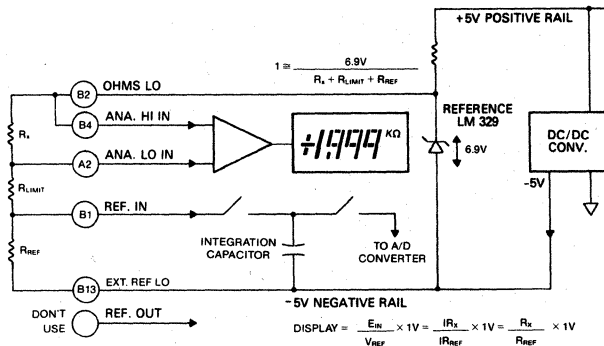
For all applications,  $V_{IN} = 2 V_{REF}$  at full scale (1999 counts). For small values of  $V_{REF}$  (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid  $V_{REF}$  inputs beyond about 2V to prevent integrator saturation with full scale inputs. Variable  $V_{REF}$  is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.



**DIGITAL OHMMETER CONNECTIONS**

The digital ohmmeter circuit uses the DM-3100U2, -U3's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable voltage from the DPM's internal reference diode is applied to the resistor pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.

age from the DPM's internal reference diode is applied to the resistor pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.



RANGE	RESOLUTION	<sup>1</sup> R <sub>LIMIT</sub>	<sup>1</sup> R <sub>REF</sub>	DECIMAL POINT <sup>2</sup>
19.99 MΩ	10 kΩ	22 MΩ	10 MΩ	B8 to B11
1.999 MΩ	1 kΩ	3.6 MΩ	1 MΩ	B9 to B11
199.9 kΩ	100 Ω	360 kΩ	100 kΩ	B7 to B11
19.999 kΩ	10 Ω	36 kΩ	10 kΩ	B8 to B11
1.999 kΩ	1 Ω	6.2 kΩ	1 kΩ	B9 to B11

1. <sup>1</sup>R<sub>LIMIT</sub> and <sup>1</sup>R<sub>REF</sub> should be metal film. High Stability Resistors (AS RN60C).  
 2. All unused decimal points must be connected together to B11 (BACKPLANE OUT).

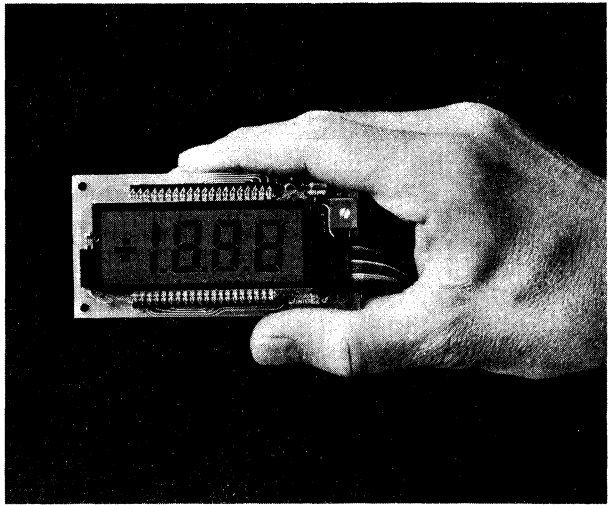
# DM-LX3 Single Board Differential LCD 3½ Digit Digital Panel Meter

## FEATURES

- Ultra-low power — 3.5 mA @ 5V in; can be powered from 4 AA alkaline batteries
- Ultra-compact — tiny single board circuit measures only 4.0" W × 2.0" H × .56" D (102 × 51 × 14 mm)
- 3½ digits, Liquid Crystal Display (LCD)
- Balanced Differential Inputs, 80 dB CMR Noise Rejection
- 1000 MΩ input impedance, 5 pA input bias current
- Autozeroed, Ratiometric Reference for Drift Correction
- Low Cost

## APPLICATIONS

- Voltmeter — Accepts user-supplied attenuators for ±2V to ±300 Vdc Full Scale Ranges
- Ammeter — Accepts user-supplied shunts for ±20 μA to ±2A Full Scale Ranges
- Ohmmeter — 200Ω to 10 MΩ Full Scale Range
- Digital Thermometer — requires a few user-supplied components



## GENERAL DESCRIPTION

The DM-LX3 is a high performance, compact Digital Panel Meter (DPM) which displays analog input voltages from -1.999 to +1.999 Vdc on .75" high numerals. Its single board construction results in a very thin assembly (.56" or 14 mm deep) which is only slightly larger than its display — the DM-LX3 can fit into many test instruments, data acquisition systems, and process control panels which could previously accommodate only analog meters. The meter's Liquid Crystal Display (LCD — not self-illuminated) draws only 3.5 mA at +5 Vdc — it can operate from 4 "AA" alkaline batteries, or can optionally be powered from a computer's +5V power bus, or an inexpensive AC power adapter, (Datel-Intersil's UPA-5/500). Pin-selectable decimal points, for factor-of-ten scaling of the display, combined with user-installed range change components permit the meter to display full scale ranges to ± 300 Vdc. User-supplied current shunts (from 20 mA to 2A full scale) and digital ohmmeter components (from 200Ω to 10 MΩ full scale) are also easily installed.

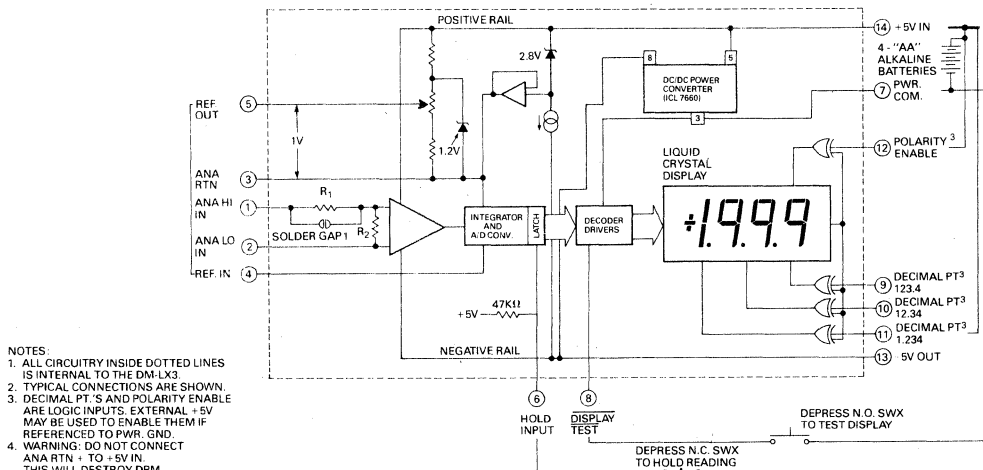
Despite its small size and low cost, the DM-LX3 offers very high instrument performance. CMOS circuitry provides 1000 Megohm input

impedance and 5 picoamp input bias current; the meter will not "load down" sensitive input signals. Analog inputs to the meter are balanced differential, and offer 80 dB Common Mode Rejection. Over-voltages to ± 250 Vdc (175 VRMS) are handled without damage.

A significant feature is an externally-accessible Reference In-Out loop which sets the meter's gain. This permits the DM-LX3 to be used in ratiometric applications such as a digital ohmmeter — an external reference voltage, derived from a bridge-type input circuit, causes the meter's gain to compensate for voltage drift in the bridge excitation source.

Other circuit features include autopolarity, a Display Hold circuit, and a selectable Display Test. Autozeroing holds the meter's zero drift to ± 1 count maximum over the 0° C to +50° C operating range. Temperature drift of gain is typically within ± 50 ppm of reading/° C. The meter's on-board DC-to-DC converter can also be used to supply -5V out at 20 mA maximum, to power user-supplied signal conditioning components. (Note that current taken out at -5V OUT must be added to current required to power the meter at +5V IN).

DM-LX3 Simplified Block Diagram



## PRELIMINARY SPECIFICATIONS (Typical @ +25° unless noted)

**ANALOG INPUT****Configuration**

True, balanced differential bipolar inputs

**Full Scale Input Range**

-1.999 Vdc to +1.999 Vdc

**Optional Ranges**

Up to  $\pm 300$  Bdc or  $\pm 19.99 \mu\text{A}$  to  $\pm 1.999$  Amps or 0 to 1.999 k $\Omega$  up to 0 to 19.99 Megohms. These optional ranges require connection of additional components supplied by the user.

**Input Bias Current**

5pA typical, 50pA maximum

**Displayed Accuracy @ +25° C**

Adjustable to  $\pm 0.1\%$  FSR,  $\pm 1$  count

**Resolution**

1 mV in Least Significant Digit

**Temperature Drift of Gain**

Within  $\pm 50$  ppm of FSR/°C typical, within  $\pm 100$  ppm of FSR/°C max.

**Temperature Drift of Zero**

Autozeroed  $\pm 1$  count over 0° to +50° C

**Input Impedance**

100 Megohms minimum 1000 Megohms typical to Analog Return or Power Common

**Input Overvoltage**

$\pm 250$  Vdc, 175 VRMS continuous maximum  $\pm 300$ V dc intermittent maximum

**Common Mode Rejection**

80 dB to Analog Return, DC to 60Hz, 1 kilohm unbalance

**Common Mode Voltage Range**

Both inputs must remain within +4V and -4V of Power Common

**Warm-Up Time**

1 minute to rated accuracy

**Reference**

Internal, referred to Analog Return. External user-supplied reference optional for ratiometric operation

**External Reference Range**

Pin 4 +5V to +2V (relative to Pin 3)

**Ramp-Up Time (Integration Period)**

83.3mS

**DISPLAY****Number of Digits**

3 decimal digits and most significant "1" digit (3½ digits)

**Decimal Points**

3 selectable decimal points are included for scale multipliers

**Display Type**

Liquid crystal display (LCD), requires external room light for viewing.

**Display Height**

.75" (19mm)

**Overscale**

If input exceeds + Full Scale, display shows "+1" MSD with zeros blanked

**Underscale**

If input goes below Full Scale, display shows "-1" MSD with zeros blanked.

**Autopolarity**

A "+" is displayed for positive inputs, a "-" for negative inputs. It is also possible to disable all polarity signs

**Sampling Rate**

3 samples per second

**INPUT/OUTPUT CONNECTIONS****Analog HI Input (pin 1)****Analog LO Input (pin 2)**

Differential input voltages are connected between these inputs. A bias current path to ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.

**Analog Return Input (pin 3)**

This pin may be used as a low-noise bias current return for some floating inputs. Analog Return is approximately 2.8V below +V<sub>s</sub> (+V<sub>s</sub> - 2.8V).

**Reference In (pin 4)****Reference Out (pin 5)**

Normally REFERENCE IN and REFERENCE OUT should be jumpered together. An external high quality reference, referenced to ANALOG RETURN, may be connected to REFERENCE IN or used for ratiometric applications.

**Hold Input (pin 6)**

Ground this Pin for normal use. Open this pin to latch the last A/D conversion and stop the display from changing. May be used by an operator to copy down the last reading.

**+5V Input (pin 14) and Power Common (pin 7)**

Power input connections for the meter; requires +5 Vdc @ 3.5mA to power meter alone. (May require up to 23.5 mA, if user powers external circuitry from -5V OUT).

**-5V Output (pin 13)**

A voltage output may be used from the internal DC-to-DC converter to power user-supplied external circuitry (as a C.A.Z. amplifier to provide gain). Maximum current out is 20mA, all current out must be added to 3.5 mA current in (Pin 14, +5VIN) to determine total current draw of meter.

**Polarity Enable Input (pin 12)**

A CMOS logic input which enables or disables the polarity symbols on the display. A +5V in voltage (grounded at DISPLAY TEST) causes a "+" to be displayed with positive inputs and a "-" to be displayed with negative inputs. Connect Pin 12 to DISPLAY TEST (Pin 8) to disable polarity. WARNING: POLARITY ENABLE INPUT SHOULD NOT BE LEFT OPEN.

**Decimal Point Inputs (pins 10, 11, and 12)**

These are CMOS logic inputs to enable in disable decimal points. Connect to +5 Vdc (grounded at DISPLAY TEST) to light the desired decimal point. Connect all others to DISPLAY TEST. WARNING: DECIMAL POINT INPUTS SHOULD NOT BE LEFT OPEN.

**Display Test Input (pin 8)**

Connect this pin to POWER COMMON to display 1888 and test all display segments. CAUTION: TO PREVENT DAMAGE TO THE LIQUID CRYSTAL DISPLAY, HOLD DPM IN "TEST" NO LONGER THAN 1 MINUTE.

**POWER CONNECTIONS****D.C. Power In**

+5 Vdc (+3.5 to +7.0 Vdc) at 3.5mA nominal (up to 23.5mA if current taken from -5V OUT (Pin 13)). May be supplied from four "AA" alkaline batteries in series, or a regulated ( $\pm 5\%$ ) power supply (Datel-Intersil UPA-5/500)

**D.C. Power Out**

-5 Vdc (-3.5 to -7.0 Vdc, depending on input) @ 20mA max.

**Calibration**

A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (auto-zeroing). Suggested recalibration in stable conditions is 90 days.

**PHYSICAL-ENVIRONMENTAL****Outline Dimensions**

4.0"W x 2.0"H x .56"D (102 x 51 x 14 mm)

**Cutout Dimensions**

Display requires 2.88" x 1.13" (72 x 29 mm) cutout, also, separate .125" (3.2 mm) diameter hole to access gain adjust pot.

**Mounting Method**

Front or rear panel mounting possible; for rear mounting, four ¼" (11,1 mm) standoffs required. For front mounting, four .125" (3,2 mm) standoffs required.

**Weight**

1.8 oz. (52g).

**Connector**

14-pin DIP plug with cover (Datel-Intersil 39-7251-1).

**Mounting Position**

Any

**Operating Temperature Range**

0° to +50° C  
(+32° to +122° F)

**Storage Temperature Range**

-25° to +60° C (LCD display is damaged if stored above +60° C)  
(-13° to +140° F)

**Altitude**

0 to 15,000 feet (4600 M)

**Relative Humidity**

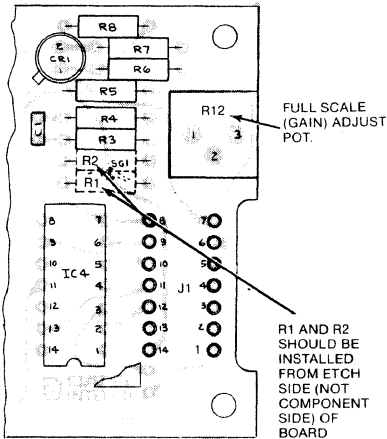
20% to 80% non-condensing

**ORDERING INFORMATION**

MODEL	DESCRIPTION
DM-LX3	3½-Digit Single Board DPM with Liquid Crystal Display (P1 Connector not included).
39-7251-1	P1 Connector for J1 Jack; 14-pin DIP Connector and Cover.
UPA-5/500	115 VAC in, +5Vdc (@ 500mA) out, Power Adapter; permits DM-LX3 to run from 115V line.

NOTE: The top of the DM-LX3 display is made of a plastic material which can be scratched easily. It is recommended that a clear plexiglas filter be installed with the meter. Care should also be taken in cleaning the display.

**DM-LX3 COMPONENT LOCATIONS**

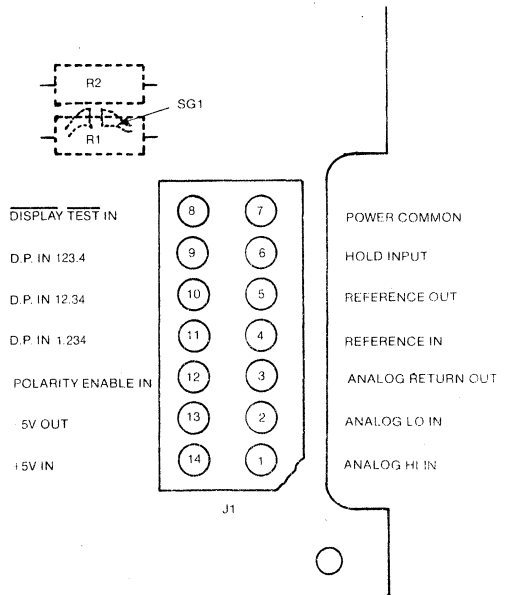


- NOTES:
- (1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.
  - (2) R1 AND R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.
  - (3) THESE RANGES REQUIRE ADJUSTMENT OF R12 FOR ACCURATE READINGS.
  - (4) IF 10 MΩ IS NOT AVAILABLE, USE R1 = 2 MΩ, R2 = 220 KΩ. A MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, AND 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.
  - (5) THE ±300V RANGE WILL DISPLAY ±1999V BUT THE SAFE LIMIT FOR THE BOARD AND CONNECTOR IS ±300V.
  - (6) CONNECT ALL UNUSED DECIMAL POINTS TOGETHER TO DISPLAY TEST (PIN 8).

**FOR OTHER VOLTAGE AND CURRENT RANGES**

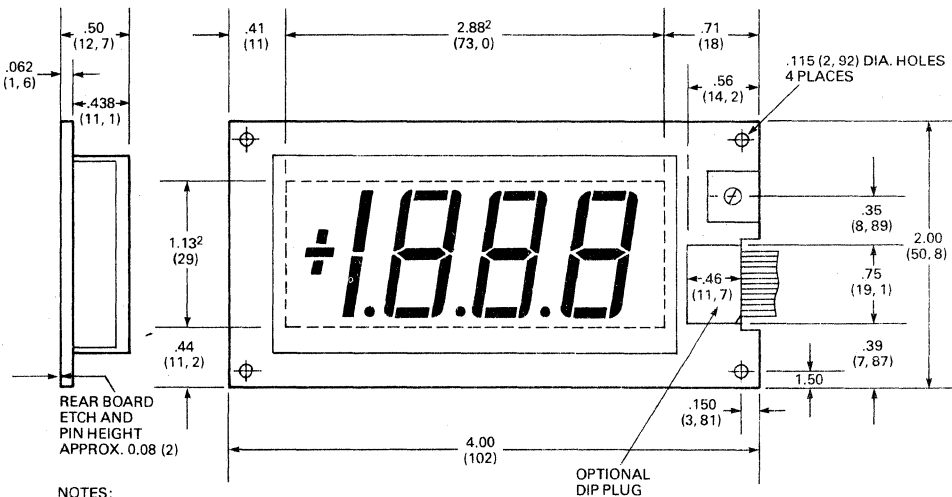
F.S. RANGE	R1 <sup>1,2</sup>	R2 <sup>1,2</sup>	DECIMAL <sup>6</sup> POINT
±2V	Short SG1	Omit	pin 11 to 14
±20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1MΩ	1.1 MΩ <sup>4</sup> or 1 MΩ	pin 10 to 14
±200V <sup>3</sup>	10 MΩ	100 KΩ	pin 9 to 14
±300V <sup>5</sup>	10 MΩ	10 KΩ	
±200 mA	Short SG1	10Ω, 1W	pin 9 to 14
±20 mA	Short SG1	100Ω, 1/4W	pin 10 to 14
±2 mA	Short SG1	1 KΩ	pin 11 to 14
±200 μA	Short SG1	10 KΩ	pin 9 to 14
±20 μA	Short SG1	100 KΩ	pin 10 to 14

**INPUT/OUTPUT CONNECTIONS**



**MECHANICAL DIMENSIONS**

INCHES (MM)

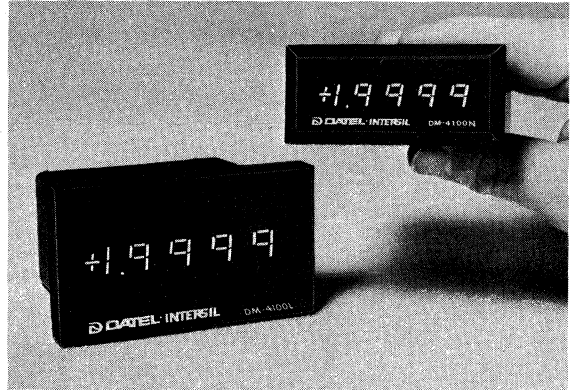


- NOTES:
1. USE 1/4" x 1/2" LG STAND-OFFS (NOT SUPPLIED WITH METER) TO REAR MOUNT DM-LX3.
  2. THESE ARE NOT OUTLINE DIMENSIONS FOR THE DISPLAY. THEY ARE PANEL CUTOUT DIMENSIONS USED WHEN REAR MOUNTING THE METER.

# DM-4100L and DM-4100N Low Cost 4½-Digit LED Digital Panel Meters

## FEATURES

- Low-cost 4½ digit DPM
- LED displays, .56" high, (DM-4100L) and .3" (DM-4100N), ±1.9999 V dc FS range, 100 μV resolution
- 100 MΩ CMOS high impedance single-ended input, 5 pA bias currents
- Autozeroing with ratiometric reference for drift correction
- +5Vdc-powered, short depth case (DM-4100L) or low profile case (DM-4100N).
- Internal user-options:
  1. Accepts shunts for ±20 μA to ±2A FS ranges
  2. Accepts attenuators for ±2V to ±1KV FS ranges
  3. External ratiometric reference input



DPM's are normally supplied without Bezel Logos or Labels.

## GENERAL DESCRIPTION

The DM-4100L and DM-4100N are 4½ digit light emitting diode (LED) Digital Panel Meters that use +5Vdc @ .35A for power. The LED displays emit a brilliant red light that can be seen from many feet away in dimly lit rooms. Besides measuring DC voltages, a shunt may be installed by the user to make direct current readings. Additionally, the user may install attenuator resistors to measure higher voltages up to ±1 KV. The versatility of this meter is further enhanced by its autozeroing capabilities for drift reduction.

This DPM accepts a DC or slowly varying input voltage between ±2V and displays that input on front panel numerical indicators. It employs a conventional dual-slope A/D converter and a 7 segment display decoder-driver. Since the A/D section requires +15 and -15 volts for operation, an internal DC/DC converter generates these voltages from the +5V power input.

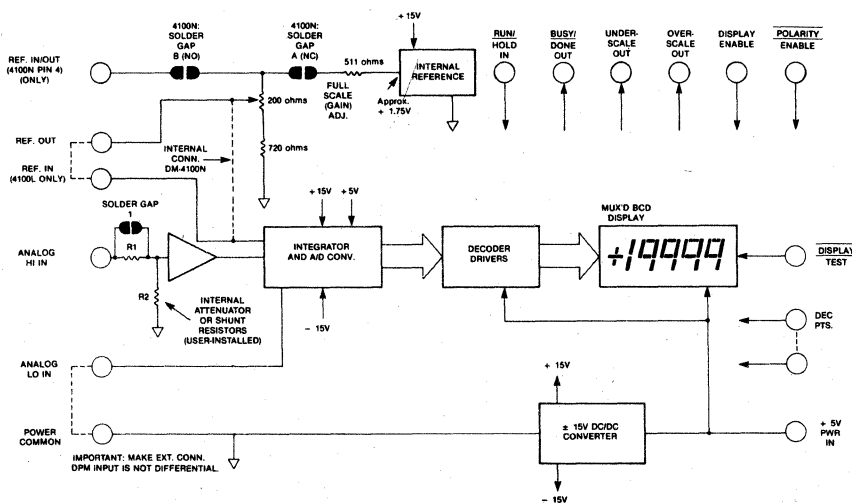
The DM-4100L and N are identical except for case style and display size. The DM-4100L has a short depth case which takes more front panel area than the DM-4100N but has .56" high displays. The DM-4100N is supplied in a low profile case which is deeper than the DM-4100L but takes less front panel area. Display size on the DM-4100N is .3" high.

This DPM is also designed for use with automatic test equipment. Included are features such as the Busy/Done Output which may be used with automatic equipment to prevent changing the input voltage during conversion, and an Overscale and Underscale Output function which indicates an out of range condition for external autoranging circuits. Also included is a Run/Hold function which will hold and display the last sample for temporary single sample storage or to copy down a reading.

A very noteworthy feature of this meter is that it can be operated ratiometrically. This means that it can automatically compensate for reference drifts in the supplies of bridge or transducer sensors.

The DM-4100L and DM-4100N find use in analytical instruments, industrial process controllers, portable diagnostic instruments, automatic test equipment, medical and patient monitoring instruments, airborne, marine ground vehicles, and data acquisition/data logging systems.

## SIMPLIFIED BLOCK DIAGRAM



DM-4100L and DM-4100N, Low Cost 4½-Digit LED

DPM's



**SPECIFICATIONS (Typical at +25°C, unless noted).****ANALOG INPUT****Configuration**

Single-ended bipolar

**Full Scale Input Range**

-1.9999 Vdc to +1.9999 Vdc

**Optional Ranges\***

Up to ±1000 Vdc

**Ammeter Ranges (Optional\*)**

±199.99 microamps to ±1.999 Amps

**Input Bias Current**

5 pA typical, 50 pA maximum

**Displayed Accuracy @ +25°C**

Adjustable to ±0.02% of reading, ±2 counts

**Resolution**

100 μV

**Temperature Drift of Zero**

Autozeroed ±1 count over 0 to +50°C

**Temperature Drift of Gain**

±50 ppm of Reading/°C typ.

±100 ppm of Reading /°C max.

**Input Impedance**

100 Megohms, minimum, 1000 Megohms, typ.

**Input Overvoltage**

±250 Volts dc, 175 VRMS continuous max.

±300 Volts intermittent max. (Resistor and diode clamp protected)

**Warm-up Time**

Within 10 minutes

**Reference**

Internal, referred to Power Common. An External, user-supplied reference is optional for ratiometric operation.

**External Ref. Range**+100mV to +2V, referred to -V<sub>s</sub>.**Ramp-up Time (Integration Period)**

83.3 ms

**DISPLAY****Number of Digits**

4 decimal digits and most significant "1" digit (4½ digits)

**Display Type**

Red, light-emitting diode (LED), self illuminated

**Display Height**

0.56 inches (14.2 mm) DM-4100L

0.3 inches (7.6 mm) DM-4100N

**Overscale**

Inputs exceeding the full scale range cause the display to blink

**Autopolarity**

A polarity sign is automatically displayed for bipolar inputs, and may also be blanked

**Sampling Rate**

Factory set at 3 conversions per second

**Decimal Points**

Right-of-digit selectable decimal points are included for scale multipliers

**I/O CONNECTIONS (DM-4100L only)****Analog HI Input (B3)****Analog LO Input (A2, A3)**

Analog LO IN and PWR. COMM. are connected internally. The DPM is not differential.

**Reference IN/OUT (A1/B1)**

Normally, Ref. IN and Ref. OUT are jumpered together. An external ref. returned to Power Common may be used ratiometrically.

**Busy/Done Out (B10)**

This output may be used in automatic equipment to prevent changing the input voltage during conversion.

**Overscale Out (B13)****Underscale Out (B12)**

A logic "HI" on either output indicates an out of range input for autoranging applications.

**Decimal Point Common (A4)**

Connect this pin to the selected decimal point pin.

**Display Enable (B18)**

Connect to +5 Vdc power to illuminate display. Disconnect to blank display but keep A/D converter cycling.

**RUN/HOLD IN (B11)**

A TTL "HI" or open pin enables continuous sampling. A TTL "LO" or ground will hold and display the last sample for temporary single sample storage.

**Display Test (B15)**

Ground this input to light all display segments.

**Polarity Enable IN (A18)**

Ground this input to automatically display a minus sign.

**I/O CONNECTIONS (DM4100N only)****Analog HI input (Pin H)****Analog LO Input (Pin 5)**

Analog LO IN must be connected externally to POWER COMMON. The DPM is not differential.

**Reference IN/OUT (Pin 4)**

Normally make no connection. Solder gaps must be altered to use an external reference.

$$\text{Display} = \frac{+1.75V \times E_{IN}}{\text{Ref. In}}$$

Display =

Ref. In

**Busy/Done Out (Pin 2)**

This output is logic "HI" during A/D conversion and logic "LO" when conversion is complete. It may be used in automatic equipment to prevent changing the input voltage during conversion.

**Overscale Out (Pin 6)****Underscale Out (Pin 7)**

A logic "HI" on either output indicates an out of range input for autoranging applications.

**Decimal Points**

Connect selected pin to DECIMAL POINT COMMON (Pin 1).

**Display Enable (Pin 8)**

Connect to +5 Vdc power to illuminate display. Disconnect to blank display but keep A/D converter cycling.

**Run/Hold In (Pin 3)**

A TTL "HI" or open pin enables continuous sampling. TTL "LO" or ground will hold and display the last sample for temporary single storage or to copy down a reading.

**Display Test (Pin J)**

Ground this input to light all display segments.

**Polarity Enable IN (Pin 10)**

Ground this input to automatically display a minus sign for negative inputs.

**POWER REQUIREMENTS**

External +5, ±0.25 Vdc regulated required at 350 mA typical, 400 mA max. Logic spikes must not exceed 50 mV. Power current varies rapidly so that unregulated supplied cannot be used.

**PHYSICAL-ENVIRONMENTAL****Short-Depth Case (DM-4100L)****Outline Dimensions**

3.00"W × 2.15"D × 1.76"H (76.2 × 54.6 × 44.7 mm).

**Cutout Dimensions**

1.812"H × 3.062"W (46.0 × 77.7 mm).

**Mounting Method**

Through a front panel cutout secured by (4) 4-40 front access screws which are concealed by the bezel.

**Low Profile Case (DM-4100N)****Outline Dimensions**

2.53"W × 3.25"D × 0.94"H (64.3 × 82.5 × 23.8 mm).

**Cutout Dimensions**

2.562"W × 0.97"H min. (65.1 × 24.6 mm).

**Mounting Method**

Through a front panel cutout secured by brackets and two removable side case screws. Panel thickness up to 0.62" (15.9 mm).

**Weight**

Approximately 5 ounces (142g).

**Connector**

DM-4100L: Dual 18-pin, 0.100" centers, Datel-Intersil #58-2075010, (not included).

DM-4100N: Dual 10-pin, 0.156" centers, Datel-Intersil #58-2073082, (not included).

**Mounting Position**

Any

**Operating Temperature Range**

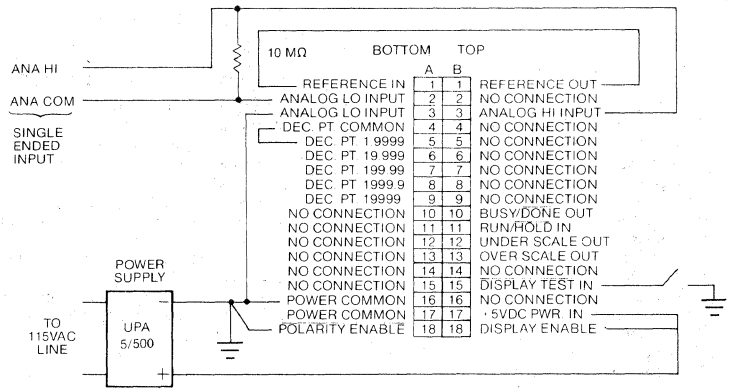
0 to +50°C.

\*Note - The optional ranges require installation of extra components by the user inside the DPM. This is also available on special order in OEM quantities from Datel-Intersil.

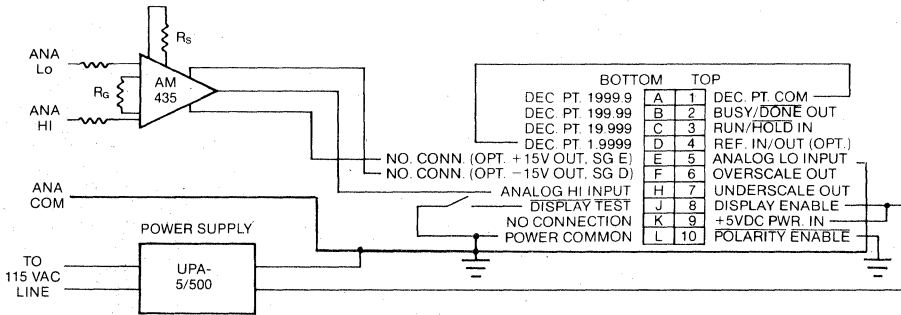
## DM-4100L INPUT/OUTPUT CONNECTIONS

**NOTES:**

1. The UPA-5/500 is a user-supplied and installed DATEL-INTERSIL accessory.
2. ANALOG LO and POWER COMMON are connected internally on the DM-4100L.
3. This shows the connector rear view with the DPM tilted on its side.
4. CAUTION: This DPM employs high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, this DPM will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle the DPM with ground protection.
5. The DM-4100L is not differential.



## DM-4100N INPUT/OUTPUT CONNECTIONS WITH DIFFERENTIAL INPUT



**NOTES:**

1. The UPA-5/500 and AM-435 are user-supplied and installed DATEL-INTERSIL accessories.
2. ANALOG LO and POWER COMMON are not internally connected, and must be externally connected by the user.
3. On the DM-4100N, REF IN and REF OUT are normally internally connected. To input an external reference on Pin 4, open Solder Gap A and connect Solder Gap B (both on back of converter board).

4. The DM-4100N is not differential.
5. CAUTION: This DPM employs high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, this DPM will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle the DPM with ground protection.
6. This shows the connector rear view with the DPM tilted on its side.
7. ±15 Vdc out at 5mA max. may be drawn from pins E and F by connecting SOLDER GAPS D and E on the DC/DC converter board.

### DM-4100N ORDERING INFORMATION

MODEL	DESCRIPTION
DM-4100N	4½-Digit LED Digital Panel Meter, Low Profile Case.
58-2073082	Connector, dual 10-pin, 0.156" centers; one required (not supplied with meter).
UPA-5/500	+5 Vdc @ 500 mA Power Supply; permits DM-4100N to run from 115 VAC power.
RN-DM-3000	Attenuation Resistor Set, tracking units for 10:1 and 100:1 Attenuation Ratios.

### DM-4100L ORDERING INFORMATION

MODEL	DESCRIPTION
DM-4100L	4½-Digit LED Digital Panel Meter, Short Depth Case.
58-2075010	Connector, dual 18-pin, 0.100" centers; one required (not supplied with meter).
UPA-5/500	+5 Vdc @ 500 mA Power Supply; permits DM-4100L to run from 115 VAC power.
RN-DM-3000	Attenuation Resistor Set, tracking units for 10:1 and 100:1 Attenuation Ratios.

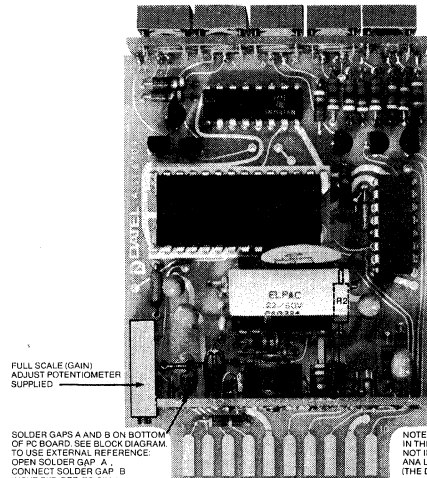
## DM-4100N COMPONENT LOCATIONS

FOR OTHER VOLTAGE AND CURRENT RANGES

F.S. RANGE	R1 <sup>1,2</sup>	R2 <sup>1,2</sup>	DECIMAL POINT (DM-4100N)	DECIMAL POINT (DM-4100L)
±2V	Short SG1	Omit	D to 1	A5 to A4
+20V <sup>3</sup>	10 MΩ <sup>4</sup> or 9.1MΩ	1.1 MΩ <sup>4</sup> or 1 MΩ	C to 1	A6 to A4
±200V <sup>3</sup>	10 MΩ*	100 KΩ	B to 1	A7 to A4
±1000V	10 MΩ*	10 KΩ	A to 1	A8 to A4
±200 mA	Short SG1	10 Ω, 1W	B to 1	A7 to A4
±20 mA	Short SG1	100Ω, 1/4W	C to 1	A6 to A4
±2 mA	Short SG1	1 KΩ	D to 1	A5 to A4
±200 μA	Short SG1	10 μΩ	B to 1	A7 to A4
±20 μA	Short SG1	100Ω	C to 1	A6 to A4

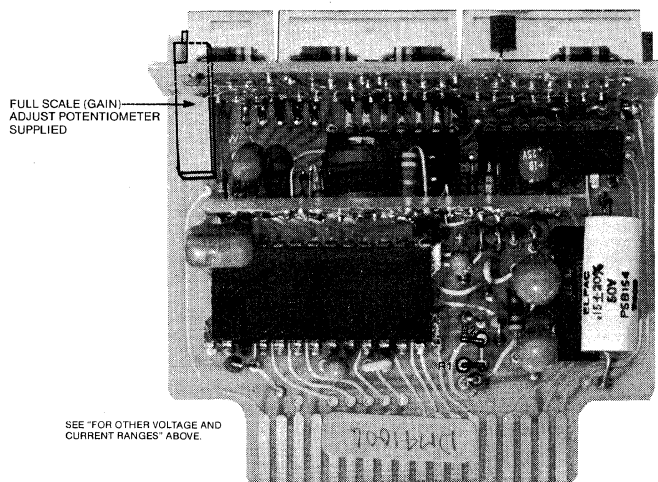
### NOTES:

- (1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON ETCH SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT, IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.
- (2) R1 and R2 FOR VOLTAGE RANGES ARE RN60C EXCEPT \*RN70C. CURRENT SHUNTS SHOULD BE 1%, 10 PPM/°C OR BETTER. 1W AND 1/4W RESISTORS MAY NOT FIT FLUSH TO BOARD.
- (3) THESE RANGES REQUIRE ADJUSTMENT OR R10 FOR ACCURATE READINGS.
- (4) MATCHED, TRACKING SET OF 10:1 AND 100:1 ATTENUATOR RESISTORS (900 KΩ, 90 KΩ, and 10 KΩ) IS AVAILABLE. ORDER MODEL RN-DM-3000 WITH YOUR DPM.



NOTE: ON DM-4100N'S WITH A 'D' SUFFIX IN THE SERIAL NUMBER ANALOG IN IS NOT INTERNALLY CONNECTED TO PWR. GND. ANALOG IN MUST BE EXTERNALLY GROUNDING (THE DM-4100N IS NOT DIFFERENTIAL)

## DM-4100L COMPONENT LOCATIONS



SEE "FOR OTHER VOLTAGE AND CURRENT RANGES" ABOVE.

# DM-4100D Micro-Bussable 4 1/2-Digit DPM with 3-State BCD Outputs

## FEATURES

- Micro-bussable meter provides BCD data outputs for compatibility with microprocessors.
- BCD data out is 3-state-gated, to share bus with other devices.
- Data gated in 4-bit groups for use with 4-, 8-, 12-, or 16-bit data bus widths.
- Full parallel output selectable.
- "Data Ready" output pulse is ideal for interrupt or print command.
- DPM has super high impedance (1000 megohms), super low bias current (5 pA).
- Ultra-compact, low profile case—2.53"W × 3.25"D × 0.94"H (64,3 × 82,5 × 23,8 mm)
- 5V powered @ 500 mA
- Bright 0.30"H LED digits
- Autozeroed, ratiometric, single-ended input



Note: DPMs are normally supplied without Bezel Labels or Logos.

## APPLICATIONS

- **Signal Monitor and A/D**—Use meter to monitor voltage, current, temp; BCD outputs permits CPU control or printout.
- **Data Logger**—Simple interconnection with Datal-Intersil's DPP-Q7 Thermal Printer (see p.9)
- **Ammeter**—Accepts user-supplied shunts for  $\pm 20 \mu\text{A}$  to  $\pm 2\text{A}$  Full Scale Ranges.
- **Voltmeter**—Accepts user-supplied attenuators for  $\pm 2\text{V}$  to  $\pm 1\text{kV}$  Full Scale Ranges.

## DESCRIPTION

The DM-4100D combines full 4 1/2 digit DPM performance with 3-state BCD outputs, an ultra-compact size, and a very low price. The meter has single-ended analog inputs which are both ultra high in impedance (1000 megohms) and ultra low in bias current (5 picoamperes)—the DM-4100D will not load down sensitive input signals. The unit is accurate to within .02% FSR ( $\pm 2$  counts). Input circuitry is autozeroed on each conversion cycle to reduce zero drift. All this performance has been packed into a low-profile black polycarbonate case only 2.53" wide × 3.25" deep × 0.94" high (64,3 × 82,5 × 23,8 mm). The price of the meter is small as well: it costs no more than a few less sophisticated, display-only DPM's.

The DM-4100D's 3-state BCD outputs take it beyond many so-called "microprocessor compatible" DPM's. 3-state outputs mean that the meter can be connected directly to a microcomputer's data bus. They also permit multiple DM-4100D's to be daisy-chained to a single set of computer or printer input connections—the computer inputs "see" only those meter outputs which have been enabled. And, since each 4-bit group (corresponding to a single BCD-encoded numeral) may be gated separately, a single rear-panel change makes the DM-4100D compatible with processors using 4-, 8-, 12-, or 16-bit data words. Digital outputs for the Display Polarity Under-range, Out of Range, E.O.C., "Data Ready" (a 10  $\mu\text{sec}$  pulse occurring 10  $\mu\text{sec}$  after the digital data is valid), and meter Run/Hold status make microcomputer control of the meter possible with minimal external hardware. Sufficient control circuitry is already built into the DM-4100D that it can interface directly with Datal-Intersil's DPP-Q7 thermal printer (or a similar printer) to become a functional data logger.

The DM-4100D's input CMOS circuitry can safely handle over-voltages to  $\pm 250 \text{Vdc}$ . The meter's converter board contains blank circuit pads to accept input attenuation resistors or current shunts. Temperature drift of the autozeroed input amplifier is  $\pm 1$  count from 0 to  $+50^\circ\text{C}$ . Temperature drift of gain measures  $\pm 50 \text{ppm}$  of FSR/ $^\circ\text{C}$  (typical) and  $\pm 100 \text{ppm}$  of FSR/ $^\circ\text{C}$  maximum.

The DM-4100D uses a dual slope integrating converter which provides normal mode rejection of AC power line noise. It provides an input-to-output conversion linearity to within  $\pm 0.2\%$  of reading, or  $\pm 2$  counts. The standard sampling

rate is 3 conversions per second, but a rear pin connector may be used to disable the Least Significant Digit. In the 3 1/2 digit mode, the DM-4100D provides 30 conversions/second.

Power to the meter is +5 Vdc @ 380 mA typical (500 mA max), and may be supplied directly from a microcomputer bus. A built-in dc-dc converter (to power the meter's analog input circuitry) provides  $\pm 13.5 \text{Vdc} \pm 5\%$  (@  $\pm 20 \text{mA}$  max.) to power user-supplied circuitry. The  $\pm 13.5\text{V}$  output was specifically intended to power an external instrumentation or CAZ amp, to provide the DM-4100D with a differential analog input. Datal-Intersil's UPA-5/500, 5V @ 500 mA AC power supply is available as an accessory.

## IN THIS DATA SHEET

Specifications  
Ordering Information  
Outline Dimensions  
Panel Mounting  
Block Diagram  
Input-Output Connections  
Component Locations  
Other Voltage and Current Ranges  
Differential Input  
Decimal Point Wiring  
Timing Diagram  
Applications  
Introduction  
DM-4100D Bus Interface  
Bus Interface Block Diagram  
Motorola 6800/6502 P.I.A. Interface  
DM-4100D Interface with DPP-Q7 Thermal Printer

**SPECIFICATIONS, DM-4100D**  
 (typical @ +25°C, unless noted)

**ANALOG INPUT**

<b>Configuration</b> .....	Single-ended bipolar; -1.9999 Vdc to +1.9999 Vdc Input pad area will accept user-installed range change.
<b>Input Bias Current</b> .....	5 pA typical, 50 pA maximum
<b>Displayed Accuracy @ +25°C</b> .....	Adjustable to ±0.02% of reading, ±2 counts
<b>Resolution</b> .....	100 μV in Least Significant Digit
<b>Temperature Drift of Zero</b> .....	Autozeroed; ±1 count over 0 to +50°C
<b>Temperature Drift of Gain</b> .....	± 50 ppm of Reading/°C typical ±100ppm of Reading/°C maximum
<b>Input Impedance</b> .....	1000 megohms, typical, 100 megohms, minimum
<b>Input Overvoltage</b> .....	±250 Volts dc, 155 VRMS continuous max. ±300 Volts intermittent max.
<b>Warm-Up Time</b> .....	Within 10 minutes
<b>Reference</b> .....	Internal, referred to Power Common. External, user-supplied reference optional for ratiometric operation.
<b>External Ref. Range</b> .....	+100 mV to +2V, referred to Analog Common
<b>Ramp-up Time (Integration Period)</b> .....	83.3 mS

**DISPLAY**

<b>Number of Digits</b> .....	4 decimal digits and most significant "1" digit (4½ digits)
<b>Decimal Points</b> .....	Selectable decimal points are included for scale multipliers.
<b>Display Type</b> .....	Red, light-emitting diode (LED), self-illuminated
<b>Display Height</b> .....	0.3" (7.6 mm)
<b>Overscale</b> .....	Inputs exceeding the full scale range cause the display to blink
<b>Autopolarity</b> .....	A polarity sign is automatically displayed for bipolar inputs, and may be disabled.
<b>Sampling Rate</b> .....	Factory set at 3 conversions per second. Meter may be short-cycled in 3½ digit mode for 30 conversions per second.

NOTE: The DM-4100D's display is not latched; the display may not track the meter's BCD data out.

**I/O CONNECTIONS**
**J2 ANALOG CONNECTOR (LOWER)**

<b>Reference In (Pin B1)/ Reference Out (Pin A1)</b> .....	Normally REFERENCE IN and REFERENCE OUT should be jumpered together. An external high quality reference, grounded to ANALOG COMMON may be connected to REFERENCE IN or used for ratiometric applications.	
<b>Analog Common (Pins B2/A2)</b> .....	ANALOG COMMON is <i>not</i> internally connected to POWER COMMON, but <i>must</i> be connected externally.	
<b>Analog HI Input (Pin B5)</b> .....	Signal input Normal voltage range is -1.9999 to +1.9999 Vdc, but an internal attenuator or current shunt resistors may be installed (R1 and R2)	
<b>Display Test Input (Pin A7)</b> .....	Connect this to POWER COMMON, displays 18888 to test display segments.	
<b>Decimal Points (Pins A8 to A11)</b> .....	Connect selected pin to DECIMAL POINT COMMON (Pin A12). <i>Do not connect D.P. to POWER COMMON as this will destroy D.P.</i>	
<b>Polarity Enable Input (Pin B8)</b> .....	Ground to POWER COMMON (Pin A14) to enable +/- sign on display.	
<b>3½/4½ Mode Input (Pin B9)</b> .....	Leave open or high for 4½ digit mode. Logic low (connected to POWER COMMON) causes Least Significant Digit to read permanent zero, and causes	meter to operate in 3½ digit mode. Conversions in 3½ digit mode occur at <i>10 times usual speed</i> , i.e. 30 conversions per second.
		<b>+5V In (Pin B14)</b> .....
		Power input to the meter; connections made between +5V IN and POWER COMMON (pins A14 and B13); requires regulated supply (±5%), capable of supplying 500 mA max.
		<b>Display Enable Input (Pin B15) (Not a Logic Input)</b> .....
		Connect to +5V (B14) to enable all display segments and decimal points. (Disabling display reduces power consumption to 250 mA, typically).
		<b>Power Common (Pins A14/B13)</b> .....
		Power supply common must be connected externally to ANALOG COMMON.
		<b>+13.5Vout (Pin B12)</b>
		<b>-13.5Vout (Pin B11)</b> .....
		These voltage outputs provide +20 mA and -20 mA respectively to power user-supplied external circuitry. May be used to power an instrumentation or C.A.Z. amplifier to provide a differential input to the meter. <b>Caution:</b> these outputs are <i>not</i> short-circuit-proof. Shorting either of them to ground, or drawing more than the ±20 mA specified, can damage the meter's DC-DC converter.
		<b>Pins A3 to A6; A13, A15; B3, B4, B6, B7, B10</b> .....
		No internal connection

**SPECIFICATIONS (Cont'd):**

**I/O CONNECTIONS (Cont'd)**

**J1 DATA CONNECTOR (UPPER)**

**Digit Enable Input** ..... These are active high, and operate on data in groups of 4 bits (e.g., Enable 10's controls BCD 10, 20, 40 and 80; Enable 10,000's controls BCD 10,000 (overrange), PLUS/MINUS, OUT OF RANGE, and UNDERRANGE. For full parallel output, all Enables should be left open or connected to +5V. 74LS295 are used as latches, and timing is as specified for these devices.

**Enable 1's (Pin A1)**  
**Enable 10's (Pin A6)**  
**Enable 100's (Pin B1)**  
**Enable 1000's (Pin B6)**  
**Enable 10,000's (Pin A11)**

**Run/Hold Input (Pin B13)** .... When open or high the D.P.M. will run continuously at its maximum rate (3 readings/second). When low, the D.P.M. will hold a reading after completion of any conversion in process. Momentarily bringing the RUN/HOLD high (for a minimum of 300  $\mu$ S) will initiate a conversion, after which the D.P.M. will remain in hold until receipt of another RUN/HOLD pulse. This provides a means of externally triggering the D.P.M.

**BCD Data Outputs** ..... 1,2,4,8 (and 10,20,40,80, etc) BCD data is fully latched. Outputs are 3-state and controlled in groups of 4. Outputs are DTL/TTL compatible, positive true, and sink 4.0 mA @ 0.4V (2 1/2 TTL loads).

**BCD 1 (Pin A2), 2 (Pin A3), 4 (Pin A4), 8 (Pin A5)**  
**BCD 10 (Pin A7), 20 (Pin A8), 40 (Pin A9), 80 (Pin A10)**  
**BCD 100 (Pin B2), 200 (Pin B3), 400 (Pin B4), 800 (Pin B5)**  
**BCD 1000 (Pin B7), 2000 (Pin B8), 4000 (Pin B9), 8000 (Pin B10)**  
**BCD 10,000 (Pin A12)**

**Plus/Minus Polarity Out (Pin A13)** ..... This is true for positive input. 3-state latch enabled by pin A11.

**Out of Range Output (Pin A14)** ..... This is true when reading is greater than +1.9999 Vdc or less than -1.9999 Vdc. 3-state latch enabled by pin A11.

**Underrange Output (Pin A15)** ..... This is true when the magnitude of the reading is less than 1800. OUT OF RANGE and OVERRANGE may be used to drive auto-ranging circuitry external to the D.P.M. Three-state latch enabled by pin A11.

**E.O.C. Output (Pin B11)** ..... The E.O.C. output is high during a conversion (fan out 2 1/2 TTL loads).

**Data Ready (Pin B12)** ..... The DATA READY is a short pulse (10  $\mu$ S) which is produced 10  $\mu$ S after the data is valid in the D.P.M. latches. It may be used to trigger a printer, to load external latches, or to interrupt a computer.

**+5V (Pin B14) and Digital Common (Pin B15)** ..... These connections duplicate +5V IN and POWER COMMON on the Analog Connector.

**BCD OUTPUT**

**Format** ..... BCD outputs 3-state, gatable in 4-bit groups, full parallel output available.

**Fanout** ..... 2 1/2 TTL loads

**Logic Controls** ..... E.O.C. pulse, "Data Ready" (Print Pulse), Overage, Underrange, Out of Range, PLUS/MINUS Polarity OUT, and RUN/HOLD.

**POWER CONNECTIONS**

**D.C. Power In** ..... +5Vdc, regulated ( $\pm$ 5%), @380 mA typical, 500 mA maximum

**D.C. Power Out** .....  $\pm$ 13.5 Vdc,  $\pm$ 5%, @  $\pm$ 20 mA, unregulated, for external signal conditioning.

**Calibration** ..... A multiturn screwdriver pot (rear-panel mounted) adjusts the full scale reading (gain). Zero is automatic (autozeroed). Suggested recalibration in stable conditions is 90 days.

**PHYSICAL-ENVIRONMENTAL**

**Low-Profile Case** ..... Interchangeable with other Datel-Intersil cases.

**Outline Dimensions** ..... 2.53"W  $\times$  3.25"D  $\times$  0.94"H (64,3  $\times$  82,5  $\times$  23,8 mm)

**Cutout Dimensions** ..... 2.562"W  $\times$  0.969"H (minimum) (65,1  $\times$  24,6 mm)

**Mounting Method** ..... Through a front panel cutout secured by brackets and two removable side case screws. Panel thickness 0.62" (15,9 mm).

**Weight** ..... 4.1 oz. (116 grams)

**Connectors (2 Required)** ..... Dual 15 pin, 0.1" centers, Datel-Intersil #58-2073083,

**Mounting Position** ..... Any

**Operating Temperature Range** ..... 0 to +50°C

**Storage Temperature Range** ..... -25 to +85°C

**Altitude** ..... 0 to 15,000 feet (4600m)

**Relative Humidity** ..... 20% to 80%, non-condensing

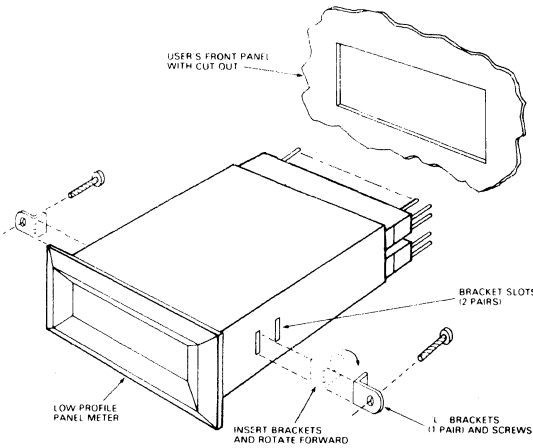
**ORDERING INFORMATION**

MODEL	DESCRIPTION
DM-4100D	Micro-bussable 4 1/2 Digit DPM
58-2073083	Dual 15-pin connector, .100" ctrs., solder-tabs (not included with meter, 2 required)

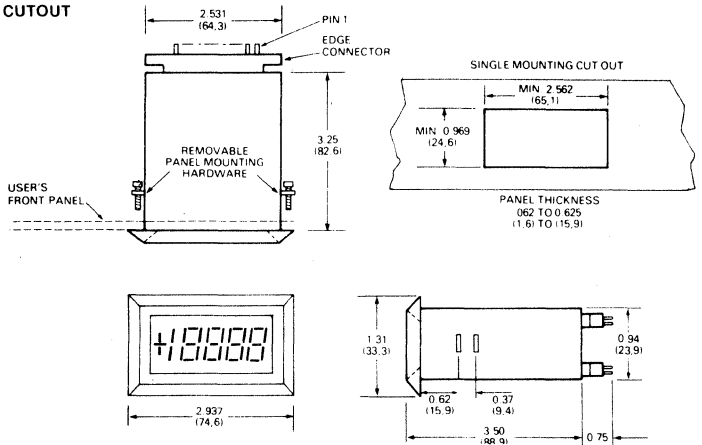
PANEL MOUNTING

OUTLINE DIMENSIONS

LOW PROFILE CASE

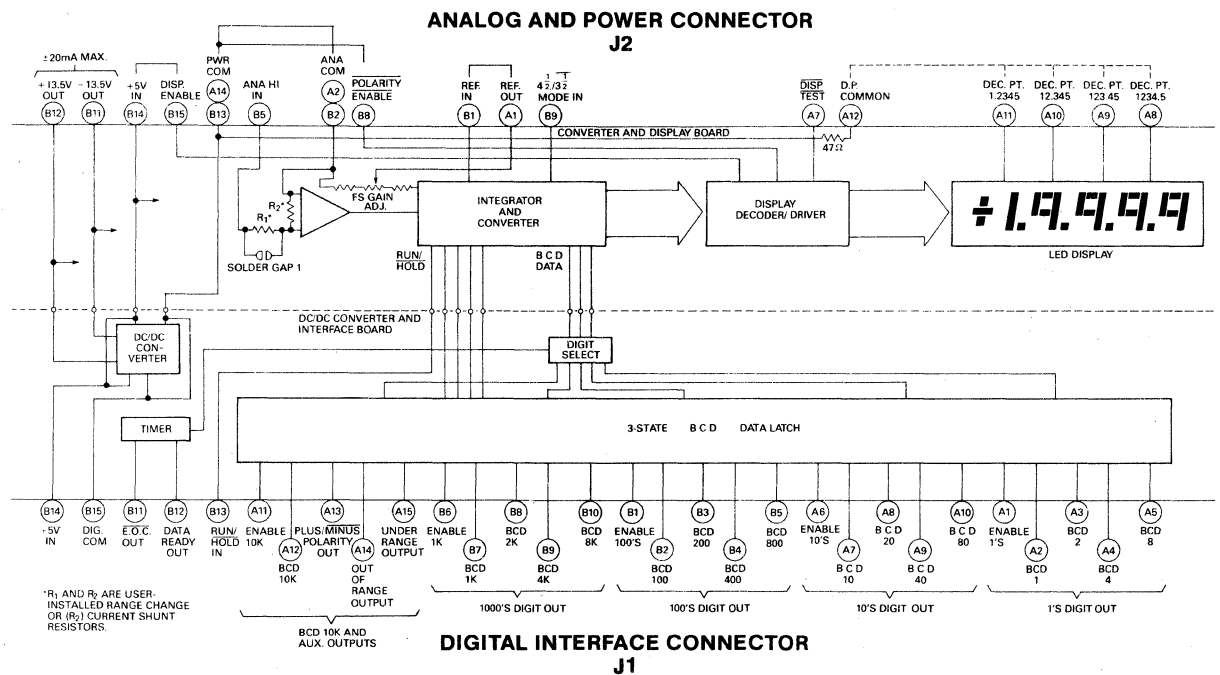


FRONT PANEL CUTOUT



INCHES (MM)

BLOCK DIAGRAM



\*R<sub>1</sub> AND R<sub>2</sub> ARE USER INSTALLED RANGE CHANGE OR (R<sub>2</sub>) CURRENT SHUNT RESISTORS.

**DM-4100D INPUT-OUTPUT CONNECTIONS  
(REAR VIEW)**

(This view shows DPM turned on its side.)

**BOTTOM BOARD (J2)  
ANALOG AND POWER CONNECTOR**

A (Lower)	Pin #	B (Upper)
Ref. Out	1	Ref. In
Analog Common	2	Analog Common
No Etch	3	No Etch
No Etch	4	No Etch
Keyway	5	Keyway
No Etch	6	Ana. Hi In
No Etch	7	No Etch
Display Test	8	No Etch
D.P. 1234.5	9	Polarity Enable
D.P. 123.45	10	4 1/2/3 1/2 Mode
D.P. 12.345	11	No Etch
D.P. 1.2345	12	-13.5V Out (20mA)
D.P. Common	13	+13.5V Out (20mA)
No Etch	14	Power Common
Power Common	15	+5V In
No Etch		Display Enable

Bottom of Meter

User must externally wire Analog Common to Power Common

**TOP BOARD (J1)  
DIGITAL INTERFACE CONNECTOR**

A (Lower)	Pin #	B (Upper)
Enable 1's	1	Enable 100's
BCD 1	2	BCD 100
Keyway	3	Keyway
BCD 2	4	BCD 200
BCD 4	5	BCD 400
BCD 8	6	BCD 800
Enable 10	7	Enable 1K
BCD 10	8	BCD 1K
BCD 20	9	BCD 2K
BCD 40	10	BCD 4K
BCD 80	11	BCD 8K
Enable 10K	12	E.O.C.
BCD 10K	13	Data Ready
Plus/Minus Out	14	Run/Hold
Out of Range	15	+5V In
Underrange		Digital Common

Top of Meter

Input Voltage, ±1.9999V, Across B2 and B5

User-supplied connection to Power Common necessary to enable "±" on Display

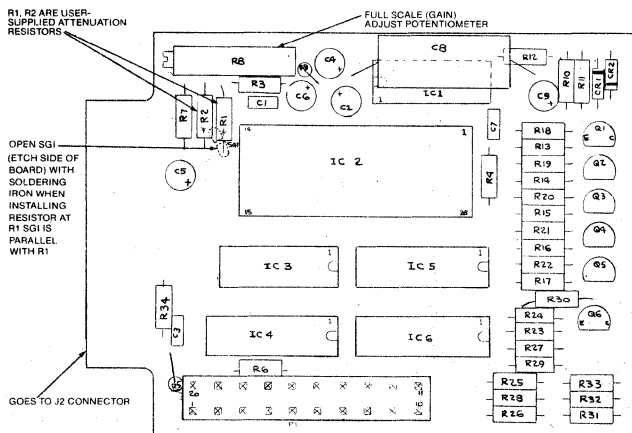
User-supplied jumper, B14 to B15, necessary to Enable Display

**CAUTION:** CMOS Inputs. Avoid damage from static discharge. Handle only with ground protection.

**Normal External Connections Are Shown**

- NOTES:**
1. Dashed lines indicate connections internal to the DPM.
  2. All BCD outputs are 3-state, enabled high, and can drive 2 1/2 TTL loads. 74LS295 3-state latches are used.
  3. ±13.5V OUT are ±20 mA max., and are not current limited. Sustained overloads or short circuits can result in damage to the meter's DC-DC converter.

**COMPONENT LOCATIONS, CONVERTER AND DISPLAY BOARD  
(Bottom Board; J2 Connector)**



**OTHER VOLTAGE AND CURRENT RANGES**

FS RANGE	R1	R2	DECIMAL POINT (ALL ON LOWER J2 CONNECTOR)
±2V	Short Solder Gap	Omit	A11 to A12
±20V <sup>1</sup>	10 MΩ	1.1 MΩ	A10 to A12
±20V <sup>1</sup>	9.1 MΩ	1 MΩ	A10 to A12
±200V <sup>1</sup>	10 MΩ	100 KΩ	A9 to A12
±1000V	10 MΩ <sup>2</sup>	10 KΩ	A8 to A12
±20 μA	Short Solder Gap	100 KΩ	A10 to A12
±200 μA	Short Solder Gap	10 KΩ	A9 to A12
±2 mA	Short Solder Gap	1 KΩ	A11 to A12
±20 mA	Short Solder Gap	100Ω, 1/2W <sup>2</sup>	A10 to A12
±200 mA	Short Solder Gap	10Ω, 1W <sup>2</sup>	A9 to A12

R1 and R2 are user-installed attenuation or (R2) shunt resistors. Before installing resistors at R1, open solder gap with a hot soldering iron on etch side of board. Note that, if R1 is later removed, user must close solder gap by soldering across it.

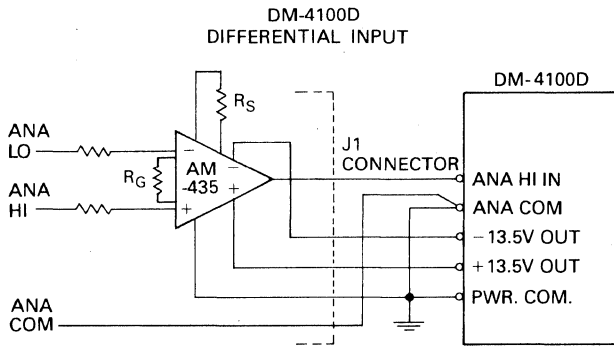
R1 and R2 for voltage ranges are RN60C except \*RN70C.

Note 1:  
These ranges require adjustment of pot, R8, for accurate reading.

Note 2:  
100Ω 1/2W and 10Ω 1W resistors should be 1% tolerance, metal film, or wire wound with tempco better than 100ppm/°C. These may not fit flush to the board.

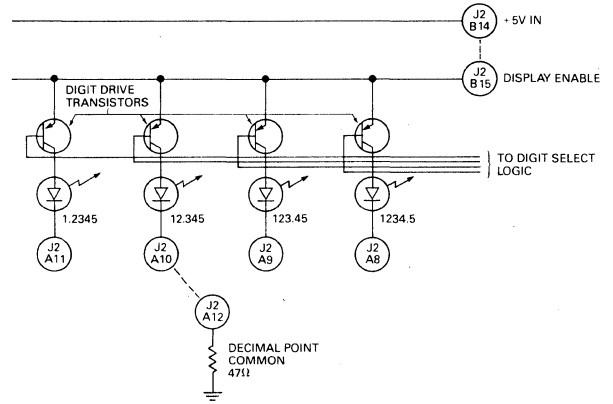


**DIFFERENTIAL INPUT**

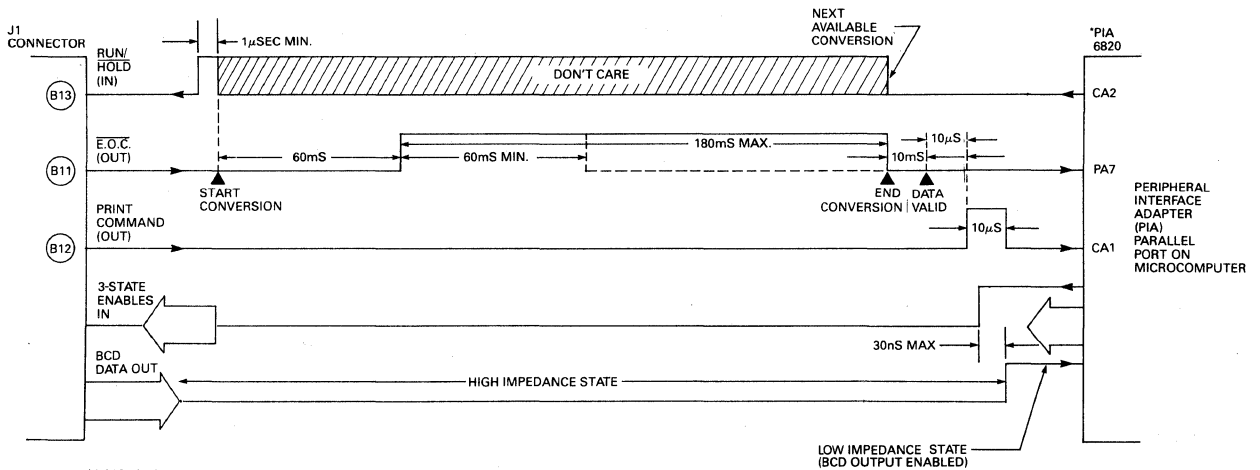


The DC/DC converter in the DM-4100D can power external circuits, as shown above. The addition of an instrumentation amplifier permits the meter to handle differential inputs, with an attendant rejection of common mode noise. The external amplifier may be wired to provide input gain or polarity inversion, and permits the DM-4100D to be used in bridge-type circuits, or as a digital ohmmeter. Please note that external circuitry should draw no more than  $\pm 20$  mA, total maximum.  $\pm 13.5$  V<sub>out</sub> should not be shorted to ground, or to each other, or damage to the voltage converter can result.

**DECIMAL POINT WIRING**



**TIMING DIAGRAM**



\*A MOTOROLA 6820 PIA IS SHOWN FOR ILLUSTRATION  
OTHER INTERFACE METHODS MAY ALSO BE USED.

## APPLICATIONS

### INTRODUCTION

The DM-4100D may be used to interface with a variety of microcomputers, thermal printers, data loggers and so on. The discussion below of DM-4100D BUS INTERFACING provides the general information necessary to any application in which the BCD data from the DM-4100D will be used. Reference should also be made to the BUS INTERFACE BLOCK DIAGRAM

A specific interface is also given, as an example: the Motorola 6800/6502 P.I.A. INTERFACE. The diagram and notes describe interconnection of the meter with this particular Motorola microcomputer.

Similar connections with other microcomputers are possible, but are beyond the scope of this data sheet.

### DM-4100D BUS INTERFACE

In order to fully implement a typical interface between the DM-4100D and a microcomputer, three functions must be considered. The first function is to start A/D conversion in the DPM. The second function is to recognize that the DPM is ready to transfer valid output data. The third function is to transfer this data.

The microcomputer has two common methods to output start signals to the DPM and two methods to input End of Conversion (Data Valid) signals into the computer. The DPM's start signal can be supplied from a parallel port output on the computer. This port output line is latched and separated from the other busses of the computer and has TTL drive. If the port method is not desired, the start input may be derived from the address decoder technique to be used later in the data transfer section.

The two methods to input the EOC signal from the DPM are the parallel port and an interrupt input line to the computer. The port method is straightforward in that the user's operating program for the computer periodically scans ("polls") an input bit on the computer's parallel port which is connected to the DPM's EOC output. When the EOC port bit goes low (true), and the polling routine discovers this, the program jumps to a routine which transfers the DPM's BCD data. The only problem with the polling routine method is that excessive computer time (and lost efficiency) might be dedicated to sampling the port bit. If sampling is done less often, valid BCD data could sit ready for an excessive time, thereby lowering the total data acquisition throughput, if that is important (it may not be important in many applications with slowly-varying data).

The interrupt method is more efficient if throughput is at a premium. Interrupt involves a separate line or lines to the CPU which get immediate attention when the interrupt is set. There are two types of interrupts found on microcomputers. The less common type found on some controller-type microprocessors requires only a momentary pulse to set the interrupt. This interrupt type is ideal for a pulse version of the EOC Output called the Data Ready Output (pin B12) which is supplied on the DM-4100D.

The more conventional interrupt input requires a handshake procedure as follows: The interrupt input is set and the CPU detects it as fast as possible, given the preselected priority which you, the programmer have written into the software. The CPU responds with an Interrupt Acknowledge (INTA) Output which is intended to clear the original interrupt and avoid retriggering that same interrupt until its function is performed. Since INTA must clear the interrupt, an additional external flip flop is required or other method since the DPM's EOC Output cannot be externally reset. Some external interface circuitry may be needed in any event, so the flip flop will be easy to add.

Once the EOC is detected, either through the polled port or interrupt, it is time to take the data. If the user has persisted with a parallel port so far it may be tempting to tie all 20-odd bits to the rest of the parallel port, assuming a Peripheral Interface device or Peripheral Interface Adapter (Intel 8255 or Motorola 6820) are used. This simplifies matters but sacrifices the great advantage of the 3-state BCD data outputs which is that one data bus can *share* several DM-4100D's, depending on distance, loading, etc.

A more elegant method is to wire up the DM-4100D's data outputs in three parallel groups of eight bits (assuming an 8-bit microcomputer). Thus, two decades (8 bits) of BCD data may be strobed onto the bus simultaneously by wiring their 2 Enable Inputs together and by toggling these paired Enables in 1-2-3 sequence to strobe out each 2-digit byte. Using this method, three 8-bit bytes completely transfer  $4\frac{1}{2}$  decimal digits plus signs and flags.

The Enable inputs are supplied by the computer's CPU and are derived from the memory bus. The Enables may be treated either as I/O Addresses or as Memory Read locations (so called memory-mapped architecture). In either case, the CPU sends an address down the memory bus. An external address decoder is used to create a single pulse input to each Enable input pair by first ANDING the decoder output with either the I/O Read Command output or Memory Read Command Output from the CPU. While this pulse input enables the BCD data gates, the CPU's data bus reads these BCD data bits and routes them to the accumulator. From there they are routed to memory for further processing according to the user's program. If this decoder method is used, it will be noted that the program instruction which moves BCD data from the DPM to the CPU is an I/O Read command: IN N, in 8080 assembly language, for example. It will use the I/O Read Command Output line (IORC) from the computer. The complementary instruction, OUT N may be used with the identical address to start A/D conversion in the DPM, as discussed earlier. If start is used this way, the I/O Write Command (IOWC) Output will be ANDed with the decoder's output to create a start pulse.

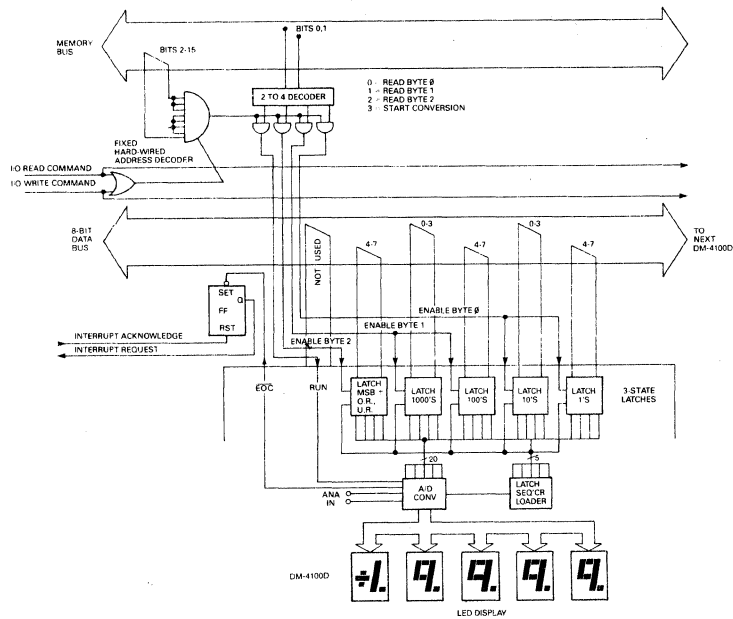
With the appropriate address decoder circuit, successive IN N instructions will be physically routed to ascending sets of paired Enable inputs. For example, (in 8080 language)

```
IN N+0
STA M+0
IN N+1
STA M+1
IN N+2
STA M+2
```

will completely strobe out  $4\frac{1}{2}$  digits, signs and flags into three successive memory locations. Since the next data sample will write over the previous data, M+0, M+1 and M+2 should be thought of as temporary scratchpad intersample storage and full data manipulation should occur between samples.

**BUS INTERFACE BLOCK DIAGRAM**

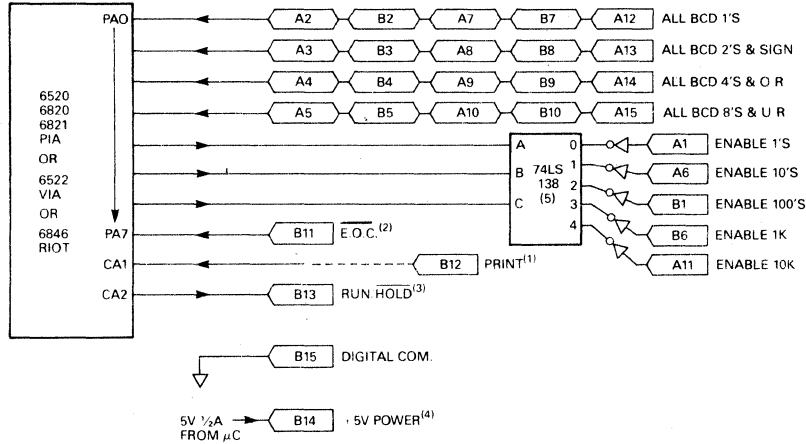
**APPLICATIONS (Cont'd)**



**MOTOROLA 6800/6502 P.I.A. INTERFACE**

The diagram below indicates wiring between the DM-4100D and a Motorola Peripheral Interface Adapter. Please note that an external 74LS138 decoder is specified:

this permits both 3-state control lines, and BCD data lines, to interface on a single port of the P.I.A. If preferred, the P.I.A.'s B port may be used, and the decoder omitted.



**Notes**

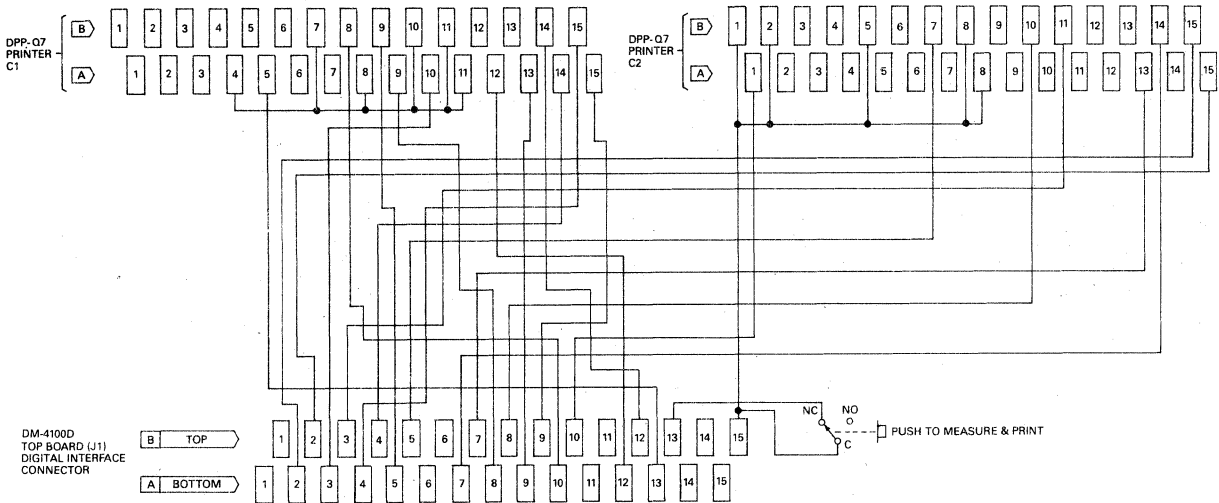
- 1) For interrupt at end of conversion, connect B12 to CA1 & program PIA to negative or positive edge.
- 2) Due to auto-zero,  $\overline{E.O.C.}$  will go high approx. 60mS after initiation of conversion of RUN/HOLD.  $\overline{E.O.C.}$  will remain high for a minimum of 60mS for zero analog input, to 180mS for  $\pm$  full scale. If polling of the  $\overline{E.O.C.}$  is used as check on valid data, the polling sequence should not commence until 100mS after initiation of conversion. (If the DM-4100D is operating in 3 1/2 digit mode these times are  $\div$  10.) Due to demultiplexing of data internally in the DM-4100D approximately 10mS (1mS) should be allowed after  $\overline{E.O.C.}$  goes low before transferring data.

- 3) To initiate a conversion RUN/HOLD should be pulsed high for a minimum of 1 $\mu$ s. Additional RUN/HOLD pulses after initiation of conversion until  $\overline{E.O.C.}$  goes low will have no effect. If RUN/HOLD is held high continuously, DM-4100D will perform conversions continuously at about 3 conversions/sec. (4 1/2 mode) or 30 conversions/sec. (3 1/2 mode).
- 4) 5V @ 1/2 A may be derived from the  $\mu$ C buss if power supplies have capacity. The DM-4100D in turn provides  $\pm$ 13.5V power which may be used to power input signal conditioning circuitry e.g. Datel AM-435 instrumentation amp &/or input multiplexer e.g. Datel MX1606/MXD807.

APPLICATIONS (Cont'd)

DM-4100D INTERFACE WITH DPP-Q7 THERMAL PRINTER

The DM-4100D may be connected directly to Dattel-Intersil's DPP-Q7 Miniature Printer to form a functional data logger. The required connections are shown below.



Notes:

1. Leading zero suppression on the printer may be activated by grounding printer pin B4 on connector C1 (join B4 to A4 on C1).
2. To select the desired decimal point on the printer, ground all unused decimal points to C1 pin A4. Only the unconnected decimal point is enabled.
3. The Run/Hold input on the D.P.M. can be used to trigger a Measure/Print cycle. A logic input or contact opening can be used (no debounce is necessary). Leaving the Run/Hold open or high will cause the system to free run at about 3 measurements per second.

This applications information shows typical suggested circuits to illustrate design examples. Since Dattel-Intersil has no control over the selection, mounting, interconnection, fabrication and environmental factors of external apparatus and components to this product, specific performance cannot be warranted. This information is believed to be accurate and reliable. No responsibility is assumed for any errors or omissions. Nor does Dattel-Intersil, Inc. assume responsibility for the use of such information or for any infringement of present or future patents or other third party rights resulting from such use. No license is granted by implication or otherwise under any patent, patent rights, or otherwise of Dattel-Intersil, Inc. Prices and specifications are subject to change without notice.

PLUG-IN REGULATED POWER ADAPTER FOR DM-4100D

MODEL UPA-5/500

FEATURES

- 115 VAC ( $\pm 10\%$ ), provides +5 VDC out ( $\pm 6\%$ ) @ 500 mA
- Line and load regulated to within 0.3% of rated output
- Ripple and noise measure less than 8 mV RMS

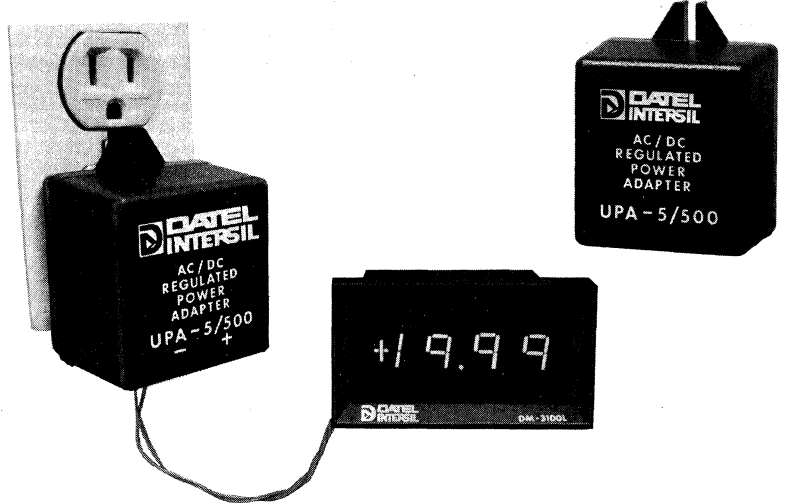




# UPA-5/500 Plug-In, +5V Regulated Power Adapter for Digital Panel Meters

## FEATURES:

- ▶ 115 VAC ( $\pm 10\%$ ) line power provides +5 Vdc Out ( $\pm 6\%$ ) @ 500 mA
- ▶ Line and Load regulated to within 0.3% of rated output
- ▶ Ripple and noise measure less than 8 mV RMS
- ▶ Plugs directly into U.S. power outlets
- ▶ Provides isolated, low voltage operation of meter
- ▶ Designated for U.L. and C.S.A. Listing
- ▶ Low Cost

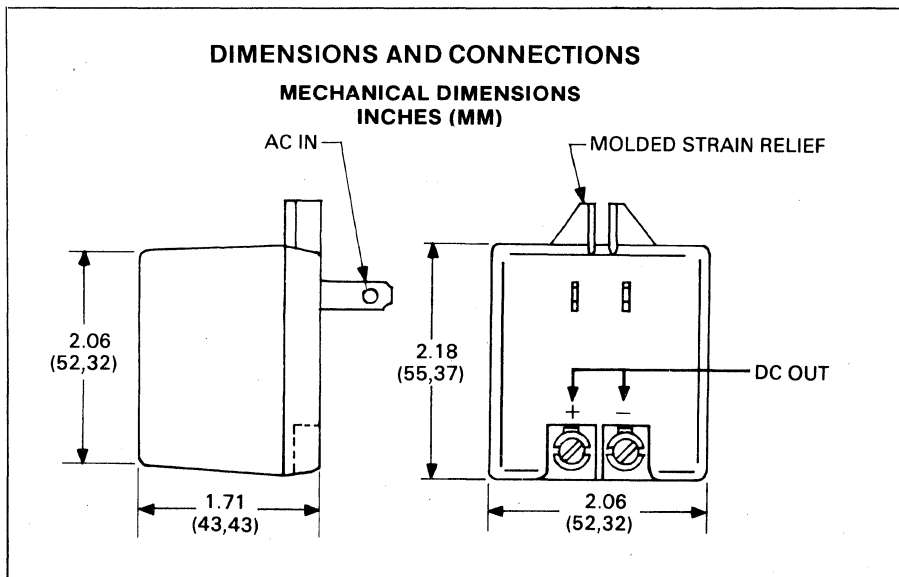


## COMPATIBLE WITH

- ▶ DM-3100L, DM-3100N, DM-3100U1, DM-3100X, DM-2115, DM-350, DM-31, DM-LX3, DM-4100L, DM-4100N, DM-4100D.
- ▶ Any DPM which requires +5 Vdc power at 500 mA or less.

## SPECIFICATIONS

Input Voltage .....	115VAC $\pm 10\%$
Input Frequency .....	60 HZ
Output Voltage .....	+4.8 to +5.3Vdc
Output Current .....	0-500 mA
Regulation (0 to 500mA)	
Line and Load .....	0.3%typ.
Ripple/Noise .....	8mV RMS max.
Breakdown Voltage .....	1500 VAC min.



UPA-5/500 Plug-In, +5V Regulated POWER ADAPTER

# DM-2115

## 3 1/2-Digit LED Digital Panel Meter with optional AC Power/BCD Outputs

### FEATURES

- Choice of AC line or +5VDC power
- Compact, short depth case measures only 3.00" W x 2.15" D x 1.76" H (76,2 x 54,6 x 44,7 mm).
- Large, Bright, 0.43" High Red LED Displays
- Automatic Polarity and Overflow Display
- 5V/400mA Optional Power Input — Ideal for Portable Use
- Differential Input
- Optional Parallel BCD/TTL Output

### SPECIFICATION HIGHLIGHTS

#### INPUTS

Input Voltage Range	±1.999 Volts DC
Input Impedance	100 Megohms, min.
Type of Input	True Differential
Input Bias Current	Analog HI Input 3nA Typ, 7nA Max. Analog LO Input 45nA Typ, 500nA Max.
Input Polarity	Bipolar-Automatic
Common Mode Rejection	70 dB, DC-60 Hz
Common Mode Range	(E <sub>IN</sub> + E <sub>CM</sub> ) Must be within ±3.0V to logic or Analog Ground, ±300V to AC line
Input Overvoltage	±50V Max. continuous ±200V Max. 5 sec. duration

#### PERFORMANCE

Accuracy @ 25°C	±0.05% of reading ± 1 count
Resolution	1mV
Temperature Coefficient	±50ppm/°C Max.
Conversion Speed	0 to 40 conversions/sec. max. (ext. trigger required at max. rate) 4 samples/sec. normal from Int. Clock. (adjustable)

BCD Outputs	12 latched parallel lines 8-4-2-1 positive true binary coded decimal. Loading 2 TTL loads. BCD not valid until 400 μsec after EOC trailing edge.
-------------	--

Operating Temperature Range	0 to +50°C
Storage Temperature Range	-20°C to +85°C
Warm Up Time	5 minutes to specified accuracy.

Adjustments	Diff. Amp. Balance and Full Scale located behind snap on front Bezel and filter.
-------------	--

Power Supply	(J) (A) (E) 100, 115 or 230VAC, ±10%, 47 to 440 Hz @ 3.5 Watts or +5VDC ±5%, regulated at 400mA max.
--------------	---



NOTE: DPM's are supplied without Bezel Labels or Logos

#### DISPLAY OUTPUT

Display Type	Solid State 0.43" Red LED. 100% overrange.
Overload Scale	Indicated by alternating flashing of center bars and zeroes.
Decimal Points	3 left-hand decimal points selectable at rear connector. Ground appropriate pin for desired decimal point.
Polarity	Minus sign only displayed for negative input. Sign blanks for positive inputs.

#### PHYSICAL

Case Size	3" W x 1.75" H x 2.25" D (76,2 mm x 44,4 mm x 57,2 mm)
Case Material	Black polycarbonate plastic
Weight	Line Power Units — 10 oz. (284g) 5V Units — 5 oz. (141g)
Mounting	1.812" x 3.062" cut out attached by four 4-40 flat-head countersunk screws.
Connector	DUAL 18-pin PC edge-board type on 0.1" centers (Viking 3VH18/1JN-5 or 1JHD-5 equiv. w/keys).

#### ORDERING INFORMATION

MODEL	DESCRIPTION
DM-2115D1	DM-2115, +5 Vdc powered, no BCD.
DM-2115D2	DM-2115, +5 Vdc powered, with BCD.
DM-2115A1	DM-2115, +5 Vdc powered (USA), no BCD.
DM-2115J1	DM-2115, 100 VAC powered (Japan), no BCD.
DM-2115E1	DM-2115, 230 VAC powered (Europe), no BCD.
DM-2115A2	DM-2115, 115 VAC powered (USA), with BCD.
DM-2115J2	DM-2115, 100 VAC powered (Japan), with BCD.
DM-2115E2	DM-2115, 230 VAC powered (Europe), with BCD.
58-2075010	Connectors, dual 18-pin, 0.100" centers, one required (not supplied).

DM-2115 3 1/2 Digit LED, Optional AC Pwr., BCD Out DPM

## FEATURES

- ▶ Large 0.43" (11mm) LED Display.
- ▶ Choice of Unipolar or Bipolar 1.999 Vdc ranges.
- ▶ Choice of AC or +5 Vdc Power Supply.
- ▶ Very Low Power Consumption, +5 Vdc @ 300mA typ.
- ▶ Compact, short depth case measures only 3.00"W × 2.15"D × 1.76"H. (76,2 × 54,6 × 44,7 mm).

## SPECIFICATIONS (Typical at +25°C unless noted).

### DISPLAY

- Number of Digits** ..... 3-1/2 digits with sign and 3 decimal points (+1.999)
- Display Type** ..... Red, Light Emitting Diode (LED)
- Display Size** ..... 0.43 inches (11 mm high)
- Overscale** ..... Inputs greater than 1.999V indicated by steady horizontal bars and a "one"
- Polarity** ..... Plus and minus sign automatically displayed on bipolar models. No sign on unipolar models.
- Lamp Test** ..... All display segments may be tested (using 888) by grounding pin 9.
- Sampling Rate** ..... 2 samples per second, may be varied using ext. resistors
- Underscale** ..... Reads all zero's

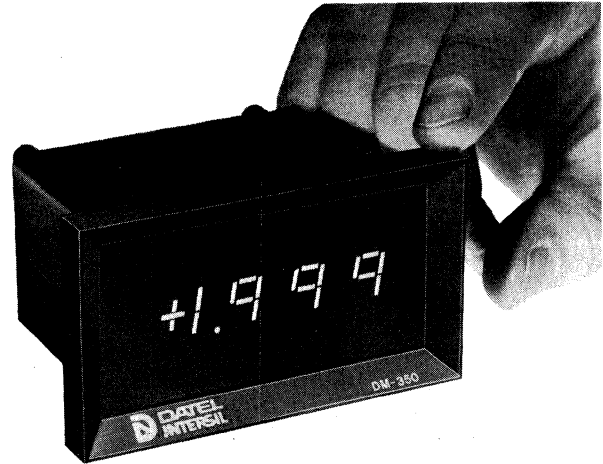
### ANALOG INPUT

- Configuration** ..... Single-ended referenced to ground and common or single-ended transformer isolated (AC models)
- Full Scale Input Ranges** ..... 0 to +1.999 Volts (unipolar) or -1.999 Volts to +1.999 Volts (bipolar)
- Input Bias Current** ..... 45nA, typical 500nA, maximum
- Displayed Accuracy** ..... Within 2mV of correct reading after calibration at steady operating temperature. (±0.05% of F.S. ±1 count)
- Temp. Drift** ..... Within 10mV between 0 and +50°C (±100ppm of F.S./°C)
- Operating Temp. Range** ..... 0 to +50°C
- Storage Temp. Range** ..... -25°C to +85°C
- Input Overvoltage** ..... ±50V continuous maximum for no damage
- Input Impedance** ..... 100 Megohms minimum
- Common Mode Voltage** ..... ±300 VDC to AC pwr gnd (AC models only)

- Common Mode Rejection** ..... 70dB @ DC (AC models only)
- Warm Up Time** ..... Essentially None

### DIGITAL INPUTS (Disregard These Inputs If Not Required)

- Lamp Test** ..... (Pin 9) Ground this pin to illuminate the three '8's' in the display. 1 TTL load (Sink 1.6mA)
- Hold Display** ..... (Pin 10) Switch this input to +5VDC to freeze the last displayed reading. 10 Kilohm load to ground.
- Sample Rate Adjust** ..... (Pin 11) Sampling rate is 2 samples per second with no connection on pin 11. Connect a 680 Kohms resistor to +5V for 4 samples/second. Connect a 1µF, 10V capacitor to ground for 1 sample/second. (Plus lead of cap to pin 11).
- Decimal Points** ..... (Pins 5, 6, and 7) Ground each pin to illuminate corresponding decimal points. Sink 20mA.



NOTE: DPM's are supplied without Bezel Labels or Logos.

### ADJUSTMENTS

- Zero, Full Scale Balance** ..... Screwdriver trim pots for calibration adjustable by removing front panel bezel and filter.

### POWER SUPPLY

- +5VDC** ..... (Pin 13) +5VDC power ±.25VDC @ 300 mA max. Noise and spikes must be less than 50mV. Approximately 50mA may be used from pin 13 for external circuitry on AC models. Avoid errors by using a regulated supply.
- AC** ..... (Pins 15 thru 18) 115 or 230 VAC, ±10%, 47 to 440 Hz 5W max. required at these pins. Externally pin-strapped by the user

### PHYSICAL

- Case Size** ..... 3"W × 1.75"H × 2.25"D (76,2 × 54,6 × 44,7 mm)
- Case Material** ..... Black polycarbonate plastic
- Weight** ..... Approx. 10 oz. (280 g) AC Models  
Approx. 5 oz. (140 g) DC Models
- Mounting** ..... Panel mounted through a 1.812" × 3.062" (46,0 × 77,7 mm) cutout with 4-40 flathead screws.
- Connector** ..... Dual 18-pin, PC edgeboard type 0.1" centers, Datal 58-2075010

### ORDERING INFORMATION

#### MODEL

#### DESCRIPTION

DM-350D1	DM-350, +5 Vdc Power, Unipolar Input.
DM-350D2	DM-350, +5 Vdc Power, Bipolar Input.
DM-350A1	DM-350, 115/230 VAC Power, Unipolar Input.
DM-350A2	DM-350, 115/230 VAC Power, Bipolar Input.
58-2075010	Connector, dual 18-pin, 0.100" centers; one required (not supplied with meter).



# DM-2000AR Autoranging 3½-Digit LED DPM with BCD Outputs

## FEATURES

- ▶ 3 Full-Auto Ranging-Scales:  $\pm 19.99V$ ,  $\pm 1.999V$ ,  $\pm 199.9mV$
- ▶ 3½ Digit Solid State LED Display
- ▶ Automatic Polarity and Overflow Display
- ▶ Operates From Single +5V DC Supply
- ▶ Optional Optically Isolated Differential Input
- ▶ Optional External Ranging Control
- ▶ Adjustable Internal/External Start Clock
- ▶ Includes Full-Parallel BCD Data Outputs
- ▶ Compact short depth case measures only 3.00"W x 2.15"D x 1.76"H (76,2 x 54,6 x 44,7 mm).

## GENERAL DESCRIPTION

The DM-2000AR is a miniature 5V-powered Digital Panel Meter featuring automatic X10 and X100 gain ranging over 3 full scale input ranges of  $\pm 19.99 V_{dc}$ ,  $\pm 1.999 V_{dc}$  and  $\pm 199.9 mV$ .

The 0.43" high self-illuminated LED displays have 3½ digits of resolution and the DM-2000AR automatically shifts the decimal point to indicate the selected range. Polarity and overscale indication are also automatic and the sampling interval may be adjusted up to 30 samples per second, making the DM-2000AR ideal for an industrial data logging system.

Autoranging offers important advantages including lower costs because a front panel range switch is eliminated. Also, autoranging reduces operator display misinterpretation errors.

BCD digital data at the rear connector also includes the range code, polarity, overscale, and data valid indication.

The 1 Megohm single-ended input has optional optoisolation for virtual differential characteristics. The DM-2000AR is powered by +5 Vdc regulated at 800 mA max.

The internal start clock rate may be externally adjusted or an external start pulse may be substituted to synchronize with process events.

## SPECIFICATIONS

(Typical @ 25°C, 15 minutes warm-up)

### ANALOG INPUT (single ended)

#### Full Scale Input Ranges (automatic ranging)

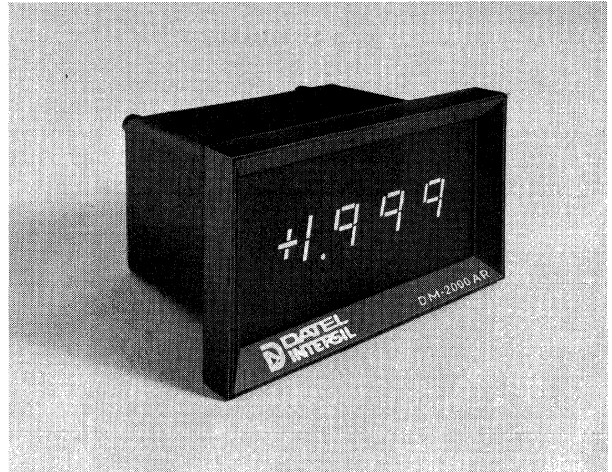
$\pm 19.99V$   
 $\pm 1.999V$   
 $\pm 199.9mV$

Input Bias Current ..... 2nA (all ranges)  
Input Overvoltage .....  $\pm 100V$  max.  
Input Impedance ..... 1 MEGOHM

Additional specifications (available only with optical isolation option):

Input Configuration ..... Single ended Bipolar Floating  
Common Mode Voltage .....  $\pm 100V_{CM}$  max.  
to digital output common  
Common Mode Rejection ..... 70dB @ 60 Hz

Note: Display reads in volts on high ranges, millivolts on low range.



NOTE: DPM's are supplied without bezel labels or Logos.

## PERFORMANCE

Accuracy	$\pm 1\%$ of F.S. $\pm 1$ count
Resolution	$\pm 1$ count ( $\pm 100\mu\text{volts}$ )
Temperature Coefficient of Full Scale	$\pm 100$ PPM/ $^{\circ}C$
Zero Drift (referred to the input)	$30\mu V/^{\circ}C$ (199.9mV and 1.999V range) $150\mu V/^{\circ}C$ (19.99V range)
Conversion Time	33 msec max
Input Settling Time	1 m sec for F.S. change
Operating Temperature Range	$0^{\circ}C$ to $+50^{\circ}C$
Storage Temperature Range	$-20^{\circ}C$ to $+85^{\circ}C$
Warm-up Time	15 min to specified accuracy
Input Power	$+5 \pm .25VDC$ at 800mA (max), $<50mV$ spikes

## PHYSICAL

Case Size	3"W x 1.75"H x 2.25"D
Case Material	Black polycarbonate plastic
Weight	6 oz. approx.
Mounting	Panel mounted through a 1.812" x 3.062" cutout with four 4-40 screws.
Connector	Dual 18-pin, PC Edgeboard Type, (not included with DPM, add to order) 0.1" centers (Viking #3VH18/IJN-5 or equal) with key between pins 4 and 5

## ORDERING INFORMATION

MODEL	DESCRIPTION
DM-2000AR	no optoisolation, less connectors
DM-2000AR-2	with optoisolation, less connectors
58-2075010	Connector, dual 18-pin, 0.100" ctrs; one required.

DM-2000AR Auto-Ranging, 3½ Digit, BCD

DPM



# Digital Voltage Calibrator



DVC-8500

## IN THIS SECTION

DVC-8500

PAGE 64S-66S

## FEATURES

- -19.999 to +19.999 Volts Full Scale Output Range Set from Front Panel Lever Switches
- 1 Millivolt Settability with Accuracy of  $\pm 25$ ppm of setting  $\pm \frac{1}{2}$ LSB
- Continuous Front Panel  $\pm 1.5$ mV Vernier Control
- Rated Accuracy up to 25mA Output
- Current from Short-Circuit-Proof Output Transfer-Isolated  $\pm 300$  Volts to AC Line
- Miniature Aluminum Case Includes Bench-top Stand or Can Be Panel-Mounted

## DESCRIPTION

Dattel's low-cost miniature Digital Voltage Calibrator, model DVC-8500, is a  $4\frac{1}{2}$  digit voltage reference source with a full scale output range of -19.999 Volts to +19.999 Volts in 1 millivolt steps. An active buffered output amplifier provides very low output impedance and up to 25 milliamps output current at the rated accuracy of  $\pm 25$  ppm of setting,  $\pm 500\mu\text{V}$ . This short-circuit proof output is selected by front panel digital lever switches. Voltage outputs may be continuously varied within  $\pm 1.5$  millivolts of selected readings by using the front panel vernier control. The DVC-8500 output is available from front panel banana jacks and a parallel rear panel 36-pin gold-plated PC connector or lug terminals.

The DVC-8500 Digital Voltage Calibrator is small enough for bench-top use or panel mounting. It fulfills many laboratory needs such as calibrating A/D and D/A Converters, Digital Panel Meters, Operational and Instrumentation Amplifiers, Voltage/Frequency Converters and Digital Voltmeters. The small size and light weight design of the DVC-8500 make it an ideal portable instrument for a technician's repair kit. When mounted on its bench top tilt stand, the DVC-8500 uses very little space and can be positioned close to test circuits.

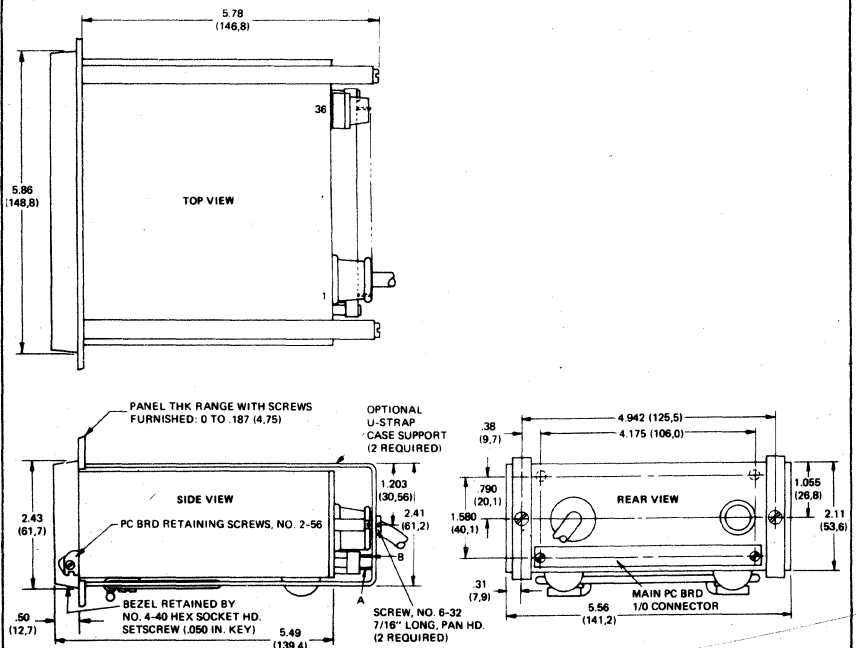
The miniature calibrator features high performance for such a small, low-cost instrument. An oven-stabilized zener diode internal reference provides an overall accuracy of  $\pm 500\mu\text{V}$  and  $\pm 25$  ppm of the setting with zero drift of  $\pm 5\mu\text{V}/^\circ\text{C}$  and full scale drift of  $4\text{ppm}/^\circ\text{C}$  max.

Rear connector sense feedback inputs reduce errors caused by cable resistance. A front panel LED overload lamp lights if the output exceeds 25mA and current limiting occurs at 70mA output. The output circuit can accept up to  $\pm 25$ mA source or sink current at rated accuracy. The rear connector also includes a low-Z output of the +10 Volt reference source with 5mA maximum drive for external reference tracking. Wide-band output noise is 25 microvolts, pk-pk max.

Powered by a choice of 100, 115 or 230 VAC  $\pm 10\%$ , and 47 to 440 Hz at 10 watts, the DVC-8500 offers transformer isolation up to  $\pm 300$  VDC. Output line rejection is within  $\pm 50$  microvolts of zero and within  $\pm 25$ ppm of full scale range. The black-anodized extruded aluminum housing provides excellent shielding to electrical noise. The housing is identical to other instruments in Dattel's 8000 series including Counter, Timer, Clock and Comparator models for a uniform appearance and compatibility when these instruments are used together.



## MECHANICAL DIMENSIONS Inches—(mm)



**SPECIFICATIONS: (Typical between 0°C and +50° at steady ambient temperature after 5 minute warm-up)**

**VOLTAGE OUTPUT**

**Output Type:** . . . . Shielded transformer isolated, active low impedance DC voltage output, current limited.

**Output Voltage Range:** . . . . . 0 to +19,999 Volts DC or 0 to -19,999 Volts DC, lever switch selected, 1mV steps.\*

**Output Current Range:** . . . . . 0 to 25mA (source current) to rated voltage output accuracy.

**Output Overload:** . . . . . Greater than 25mA (source current) will illuminate front panel LED overload lamp. Output is current limited (continuous short-circuit proof) to 70mA (source current) at any voltage up to ±20VDC.

**Output Impedance:** . . . . . Less than 10 milliohms.

**Capacitive Load:** . . . . . \*Range ±20.0005 Volts using vernier control. no limitation

**PERFORMANCE**

**Accuracy @ +25°C With Vernier:** . . . . . Within ±25ppm of setting, ±500µV when Control at Zero: calibrated.

**Resolution:** . . . . . Set within ±1mV increments. A front panel vernier control provides ±1.5mV continuous offset with 100µV graduations.

**Temperature Drift of Zero:** . . . . . Within ±5µV/°C

**Temperature Drift of Calibration:** . . . . . Within ±4ppm of setting /°C

**Operating Temperature Range:** . . . . . 0°C to +50°C

**Storage Temperature Range:** . . . . . -25°C to +85°C

**Warm-Up Time:** . . . . . 5 minutes to rated accuracy

**Output Noise:** . . . . . 25µV pk-pk, wideband (no cap load)

**Reference Source:** . . . . . 6.4V oven-stabilized low TC zener reference diode

**AC Line Voltage Rejection:** . . . . . Zero: ±50µV over full line range  
Calibration: ±25ppm of setting over full line range

**Power Transformer Isolation:** . . . . . 1000 Megohms. Transformer primary has a grounded shield for capacitive isolation. Breakdown: 300 VRMS, min.

**FRONT PANEL**

**Output Selector Switches:** . . . . . Six lever-operated detented switches are set in millivolts (±19999mV range)

**Polarity:** . . . . . 2 positions, + or -

**Leading Digit:** . . . . . 2 positions, 0 or 1

**4 Digits:** . . . . . 10 positions, 0 thru 9

**Output Vernier:** . . . . . Rotary potentiometer, range ±1.5mV of selected output. Graduated in 100µV divisions. Clockwise rotation labeled "INCR" (increase) will increase the absolute value of the selected output. "INCR" will make a negative output more negative or positive output more positive. Counterclockwise rotation labeled "DECR" (decrease).

**Overload Light:** . . . . . Red LED lamp illuminates if output exceeds ±25mA.

**Power Switch:** . . . . . Toggle switch, AC power on or off

**Power Light:** . . . . . Red LED lamp illuminates when AC power is on.

**INPUT/OUTPUT CONNECTORS**

**Front Panel:** . . . . . Voltage output (blue) and output common (black) available from two (2) gold plated brass deep banana jacks, 0.166" (4,22mm) i.d., 0.56" (14,2mm) deep, 0.75" (19,05mm) between centers. (Pomona model 2854 jack or equivalent, suitable for U.S. or European plugs).

**Rear Connections:**

**Voltage Output:** . . . . . Parallel connection with front panel jack.

**Output and Reference Common:** . . . . . Parallel connection with front panel jack. Transformer isolated ±300V from case ground.

**Reference Output:** . . . . . Low impedance ±10 Volt DC output from +6.4V ref. diode. Drain must not exceed ±5mA maximum. Ref. output is opposite polarity of calibrator output.

**Sense Input:** . . . . . Connect to remote load to compensate for cable resistance voltage drops. See diagram. This input must be tied to voltage output if not used.

**Sense Common:** . . . . . Return for sense inputs. Tie to output common if sense is not used.

Rear connections are arranged as dual 36-pin PC edgeboard connections on 0.1" centers. Individual connections consist of 4 gold-plated fingers on a common pad area in parallel with the 4-finger pad on the bottom. Each dual-pad (8 fingers total) is drilled and plated through for optional lug connection using 4-40 hardware. Shorting bars and 4-40 hardware are included to short sense and common connections if not used. Rear connections may use a Datal 56-2076050, (Viking#3VH36/1JN-5) PC connector.

**ADJUSTMENTS**

Calibration adjustment trim pots are accessible by partially removing circuit board from case. Refer to calibration procedure.

**POWER SUPPLY**

**Power Required:** . . . . . Choice of 100, 115 or 230 VAC, ±10% 47 to 440Hz, 10 watts. 3-prong U.S. captive line cord installed. Ground wire connected to case, but transformer-isolated ±300VRMS from output common. Fuses AGC Slo-Blo, .15A (115V), .1A (230V)

**MECHANICAL DIMENSIONS**

**Case:** . . . . . 5.56" W X 2.11" H X 5.78" D (141,2 X 53,6 X 146,8mm) (Bench-top stand retracted)

**Bezel:** . . . . . 5.86" W X 2.25" H X 0.50" THK (148,7 X 57,0 X 12,7 mm)

**Servicing:** . . . . . Bezel, front panel and mother board are removable from front while unit remains secured in panel. Bezel is lifted off by removing the two 0.050 - inch (4-40) Allen hex key set screws on the bottom side edges. PC boards may be removed by loosening the PC board guide track retaining screws on the lowest position on the panel mounting seats.

**Weight:** . . . . . 2.25 pounds (1,0Kg)

**MOUNTING:**

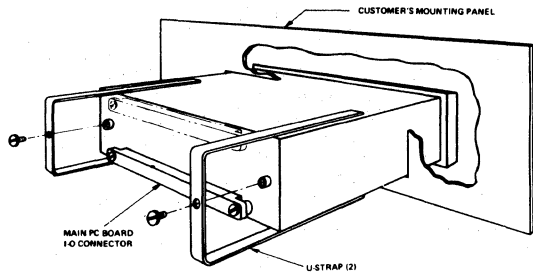
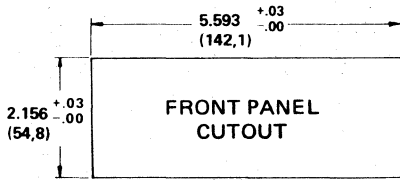
. . . . . Choice of bench-top mounting or panel mounting through a cutout measuring 2.16" H X 5.59" W (54,8 X 142,1 mm) and secured by 2 U-Straps. See ordering guide for optional panel-mount kit.

## OPTIONAL FRONT PANEL MOUNTING

Standard DVC-8500 Calibrators are supplied for bench-top use including a tilt-up stand and rubber feet. The DVC-8500 may be converted for panel-mounting using the mounting kit, model 38-A-3022-1. The required panel cutout dimensions are shown below. The tilt-up bench-top

wire bail stand and rubber feet must be removed from the case so the instrument will fit through the panel cutout. The rubber feet are held on with a strong adhesive and require pliers for removal. Secure the instrument into the panel cutout by using the two U-straps and hardware.

### MOUNTING DETAILS DIMENSIONS IN INCHES (MM)



## ORDERING GUIDE

Model Number

**DVC-8500**

AC POWER SUPPLY\*

A = 115VAC

E = 230VAC

J = 100VAC

\*±10%, (47 to 440 Hz)

**DVC-8500** .....

Panel-Mount Kit, P/N 38-A-3022-1 .....

(Consists of (2) U-Straps, rear PC board connector and hardware)

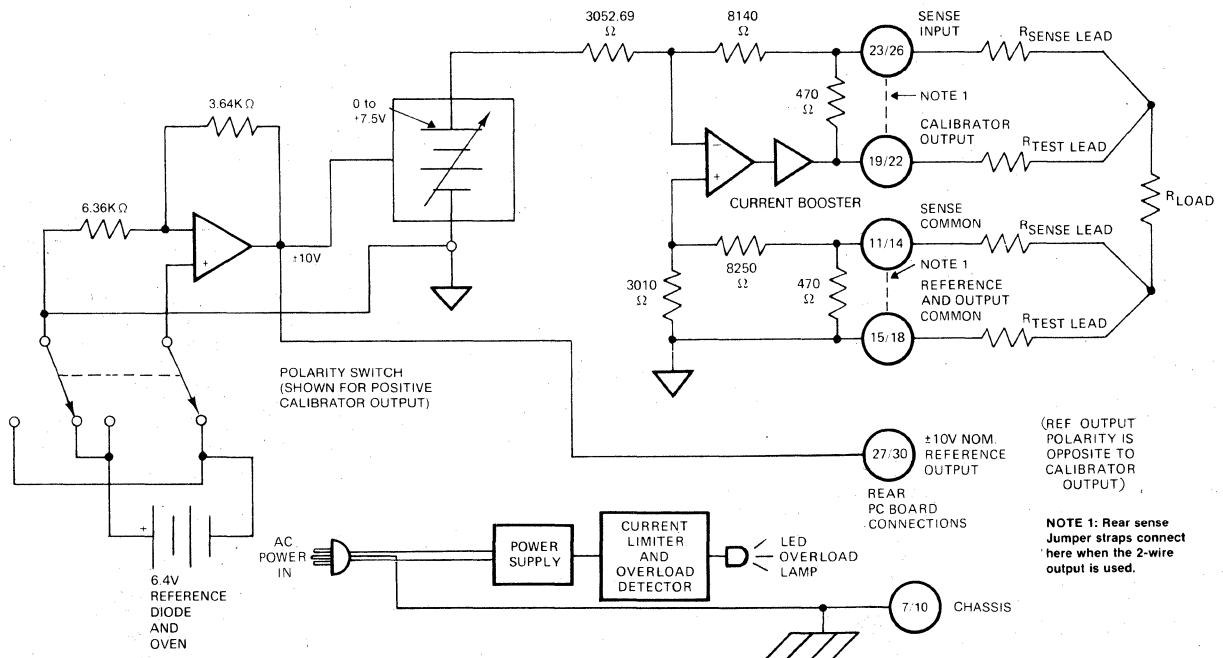
Test Lead Set, 38-3902 .....

(Consists of (2) 3-foot, 20 gauge leads, red and black. Stackable banana plugs and retracting hook clips)

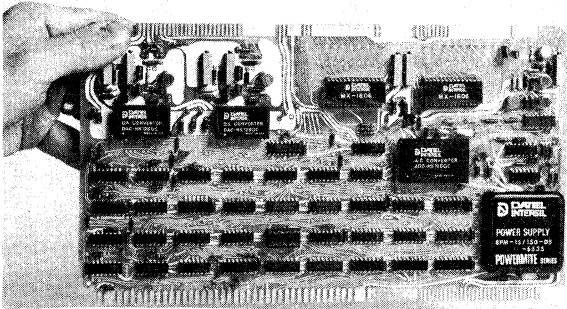
10:1 Attenuator, 38-3900-1 .....

100:1 Attenuator, 38-3901-1 .....

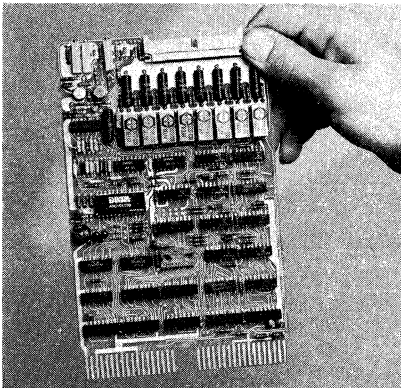
## EQUIVALENT CIRCUIT



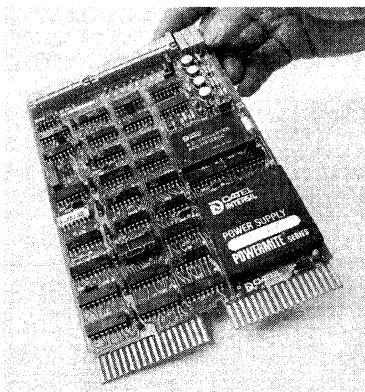
# SineTrac<sup>TM</sup> A/D-D/A Computer Analog Boards



ST-732



ST-LSI-RLY



ST-LSI2

## IN THIS SECTION

SELECTION GUIDE	68S, 69S
INTRODUCTION, HIGHLIGHTS	70S
ST-711, ST-732	71S-75S
ST-711RLY	76S-80S
ST-724	81S-87S
ST-800	88S-99S
ST-LSI	100S-111S
ST-LSI2	112S, 113S
ST-LSI-RLY	114S-121S
ST-6800	122S-130S

# SineTrac Selection Guide

## High Performance A/D-D/A Peripheral Boards

MODEL SERIES	COMPATIBLE COMPUTER	COMPUTER MFR.	NO. OF A/D CHANS.	LOW LEVEL INPUTS	CURRENT I/O	PROG. GAIN AMPL.	NO. OF D/A CHANS
<b>ST-800 Master Board</b> (See pg. 88S)	iSBC-80 Series iSBC-86 Series	Intel Corp.	32 SE or 16 Diff. (Module Change)	None	Optional 16 D A/D Chans.	No	None, use ST-800DA
<b>ST-800DA</b>	"	"	None, use ST-800	N/A	No	N/A	4 or 8 chans.
<b>ST-800ADX</b>	"	"	Adds 32/48 SE or Diff.	None	Opt. 32D or 48D	No	None
<b>ST-711 (No D/A's)</b> <b>ST-732 (2 D/A's)</b> (See pg. 71S)	"	"	32SE or 16 Diff. (Jumper change)	Resistor change for 10mV FSR	Opt. 16 A/D Chans., Opt. 2 D/A current amp	Included X1, 2, 4, 8 Gains	Optional 2 chans. on-board
<b>ST-711RLY (Relay Input 250V CMV)</b> (See pg. 76S)	"	"	8 Diff. or (ST-711RLY8D) 16 Diff. (ST-711RLY 16D)	Included std. 10 mV—2V	Opt. 8 or 16 A/D chans.	Included X1, 2, 5, 10 Gains	None, Use ST-800DA
<b>ST-724</b> (See pg. 81S)	SBC-80 Series SBC-86 Series	Intel Corp.	None, use ST-711 ST-732	N/A	Yes, (requires external excitation source)	N/A	4
<b>ST-6800 Master Board</b> (See pg. 122S)	M6800 EXORciser	Motorola Semi-conductor Products	32SE or 16 Diff. (Module Change)	None	Optional 8D A/D Chans. no D/A	No	Optional 2 on-board
<b>ST-6800DA</b>	"	"	None, Use Master	N/A	No	N/A	4 or 8 Chans.
<b>ST-6800ADX</b>	"	"	Adds 48S/D	None	No	No	None
<b>ST-LSI Master Brd.</b> (See pg. 100S)	LSI-11, PDP-11/03 PDP-11/23 (Full Quad)	Digital Equipment Corp.	32SE or 16 Diff.	Opt. 10 mV FSR (Resistor Change)	Opt. 8 Diff A/D Chans. Opt. 2 D/A current amp)	Opt. X1, 2, 4, 8 or 1, 2, 5, 10 Gains	Optional 2 chans.
<b>ST-LSI-DA</b>	LSI-11 and LSI-11/2 (Half Quad)	"	None	N/A Master	None, use Master	N/A	4 chans.
<b>ST-LSI-ADX</b>	LSI-11 (Half Quad)	"	Adds 32S/16 D	None	16D A/D Ch. Optional	None	None
<b>ST-LSI2 Master Brd.</b> (See pg. 112S)	LSI-11/2 (Half Quad)	"	16SE or 8 Diff.	None, (use ST-LSI)	Opt. 8D A/D Ch.	None, (use ST-LSI)	None, (use ST-LSI-DA)
<b>ST-LSI2-ADX</b>	LSI-11/2 (Half Quad)	"	Adds 48S/24D	None	Opt. 24D Ch.	None	None
<b>ST-LSI2-DMA</b>	LSI-11/2 (Half Quad)	"	N/A	N/A	N/A	N/A	N/A
<b>ST-LSI-RLY</b> (See pg. 114S)	LSI-11 and LSI-11/2 (Half Quad)	Digital Equipment Corporation	8 Diff., relay-isolated	Opt. 10mV FSR (Resistor Change)	No	Opt. X 1, 2, 5, 10 Gains	None, Use ST-LSI-DA

INTERFACE TYPE	INTER-RUPTS	DIRECT MEMORY ACCESS	PACER/ START CLOCK	DC/DC POWER CONV.	NOTES	TYPICAL PRICING (SINGLES)
Program I/O (Register Transfer)	EOS, EOC, DMA	Yes, requires DMA controller	RC one-shot DMA clock	Included	Includes Diagnostic program tape, listing and manual	16 SE Chans - \$625
Program I/O (Reg. Trans)	No	No	No	Opt. on 4 ch; NA 8 ch.	12 TTL output bits optl.	8 D/A Chans - \$780.
Slave to Master Brd.	See Master	See Master	See Master	± 15V from Master	Expdbble 128D/256S. Takes over-voltage clamps	48 SE A/D Chans. - \$430.
Memory-mapped, 16 reserved addresses relocatable	Included EOS, EOC, Int./Ext. Pacer Clk.	No	Included, 10 Binary steps, jumper-sel.	Included	Operates from Intel RMX-80 software. 2nd source to SBC-711/732	A/D Only - \$625 16 Diff Chans - \$788
Memory-mapped, 16 reserved addresses relocatable	Included, EOS, EOC, Int./Ext. Pacer Clk.	No	Included, 10 Binary steps, jumper-sel.	Not Required	Operates from Intel RMX-80 software	8 Diff Chans - \$683 16 Diff Chans - \$1045
Memory-mapped, 8 reserved addresses relocatable	No	No	No	Included	Operates from Intel RMX-80 software; 2nd source for SBC-724	\$595
Memory-mapped, 512-byte block relocatable	No	No	No	Optional	Includes Diagnostic Program Tape	16 SE A/D Chans. only - \$462
Memory-mapped, 16-byte block	No	No	No	Opt. 4 ch; Not Avail. 8 ch.	Incl. 12-bit TTL port	8 D/A Chans. - \$651
Slave to Master Brd	No	No	No	± 15V from Master	128S/112D Addressable	48 SE A/D Chans. - \$385.
Memory-mapped, 4 R/W addr. relocatable	3 Vector addresses: EOC, EOS, Pacer Clk. relocatable	Optional, requires ½ quad ST-LSI2-DMA	Software-Prog. 16 Binary steps Opt. Xtal	Optional	Int./Ext. Start	16 SE A/D Chans. - \$657 (No DC/DC) 16S A/D plus 2 D/A - \$846 (No DC/DC)
Memory-mapped 2 addr. reloc.	None	NA	No	Optional	Incl. 12 TTL output bits	No DC/DC Conv. - \$499 With DC/DC Conv. - \$562
Slave to Master Brd.	See Master	See Master	See Master	± 15V from Master	Master-Slave pairs expdbble. indefinitely	32S or 16D - \$310
Memory-mapped 4 R/W addr. relocatable	Included (See ST-LSI)	Opt., See ST-LSI2-DMA	Programmable, 16 steps no Xtal	Included	Xpdbble 64S/32D See ST-LSI2-ADX Soft. Prog. Clk.	\$625
Slave to Master Brd.	See Master	See Master	See Master	± 15V from Master	64S/32D on 2 Brds., Expdbble.	\$358.
Slave to Master Brd.	EOC, End DMA Cyc.	32K Words	Use Master Brd.	Not req'd	50 KHz Block Xfer.	\$350.
Memory-mapped 2 addr. reloc.	1 Vector Address: EOC; relocatable	No See ST-LSI2-DMA	No	Included (Generates - 12V from + 12V bus)	Relay-isolated inputs; 126dB CMR, CMV to 250 RMS.	\$695

(Refer to data sheets & brochures for ordering information.)

For detailed pricing, request a current price list from your Datel-Intersil Sales Office.

# SineTrac™ Computer A/D-D/A Boards

Datel-Intersil's SineTrac series A/D-D/A slide-in boards are the simplest method of connecting real-world analog signals to your microcomputer. The SineTrac boards are software compatible to the host computer's machine language programming, mechanically compatible to the backplane and card guides and electrically compatible to the computer's data, address and control busses.

SineTrac boards include a high performance multi-channel 12-bit binary successive approximation data acquisition system and/or D/A system. Also included is a hardware controller interface unique to the host computer. Other necessary features are included such as address decoders, start clocks, interrupt generators and DC/DC power converters.

SineTrac A/D-D/A boards eliminate tedious risky one-time interface design by users and offers a proven, production-volume, reliable method of handling analog signals in your microcomputer. Standard Datel-Intersil high performance hybrid data acquisition components are used with a comprehensive Diagnostic computer program and systems manual included with each board.

SineTrac boards are offered as A/D, D/A and channel expanders. Industrialized noise-rejecting relay-mux A/D boards are also offered. SineTrac boards are available for popular microcomputers including: SBC-80/MULTIBUS®, MDS-800, MM6800/Micromodules/EXORciser® and Q-Bus PDP®-11/03, LSI-11, LSI-11/23® and LSI-11/2.

## Quick Selection Guide

COMPUTER OR BOARD FAMILY	A/D AND/OR D/A MODELS	CHANNEL EXPANDER MODELS, ETC.	INDUSTRIALIZED RELAY-MUX A/D MODELS
SBC-80 MDS-800 MULTIBUS®  <small>(INTEL CORP. TRADEMARK)</small>	ST-800 (A/D) PG. 89S ST-800DA (D/A) PG. 89S ST-711 (A/D) PG. 71S ST-732 (A/D-D/A) PG. 71S ST-724 (D/A) PG. 81S	ST-800-ADX ST-800-DAX	ST-711RLY PG. 76S
LSI-11® LSI-11/2 PDP®-11/03 LSI-11/23  <small>(DIGITAL EQUIPMENT CORP. TRADEMARKS)</small>	ST-LSI (A/D-D/A FULL QUAD) PG. 100S ST-LSI2 (A/D HALF QUAD) PG. 112S ST-LSI-DA (D/A HALF QUAD) PG. 100S	ST-LSI-ADX ST-LSI2-ADX (FOR ST-LSI2) ST-LSI2-DMA PG. 112S	ST-LSI-RLY (HALF QUAD) PG. 114S
EXORCISER® MM6800 MICROMODULES  <small>(MOTOROLA SEMICONDUCTOR PRODUCTS CORP. TRADEMARK)</small>	ST-6800 (A/D-D/A) PG. 122S ST-6800DA (D/A) PG. 122S	ST-6800ADX PG. 122S	





# SineTrac<sup>TM</sup> ST-711, ST-732 32 A/D, 2 D/A Analog Boards for SBC-80 / Multibus Microcomputers

COMPATIBLE TO: SBC-80 SERIES  
MDS-800

## FEATURES

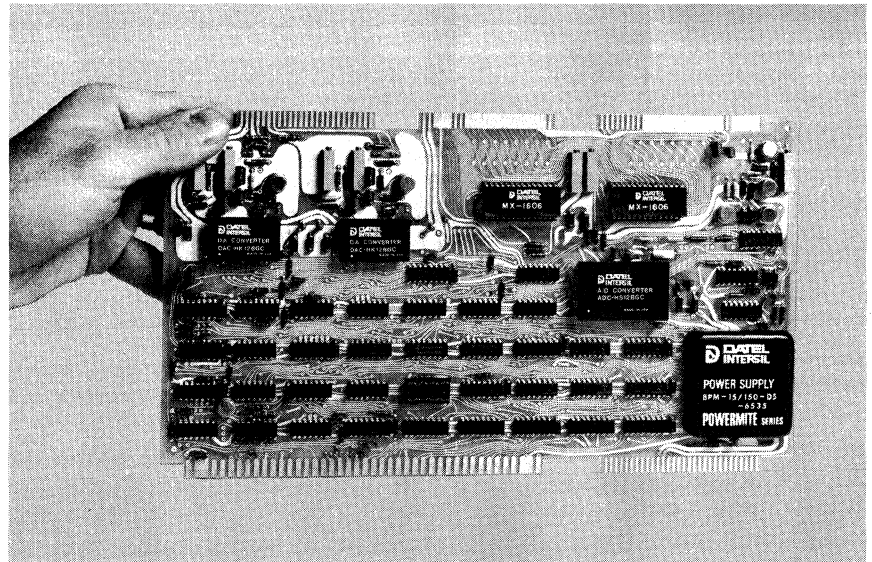
- ▶ Model ST-711: 32S/16D A/D Channels, no D/A Channels
- ▶ Model ST-732: 32S/16D A/D Channels, includes 2 D/A Channels plus current loop outputs.

## BOTH MODELS INCLUDE:

- ▶ Full mechanical, electrical, and pinout compatibility to Intel's SBC-711/732 Analog I/O Boards and Datel's ST-711RLY Board.
- ▶ Operates with all Multibus and SBC-Series compatible microcomputers including the 16-bit SBC-86/12 (except SBC-80/04).
- ▶ Works directly from Intel's RMX-80 Analog I/O Driver operating software.
- ▶ Includes 10-stage, jumper-selected, program-gatable Pacer start clock, 1 mS to 1 sec., crystal-controlled.
- ▶ A/D inputs accept up to 16 user-installed shunts for 4-20 mA etc. current inputs.
- ▶ FET-input differential amplifier accepts on-board resistor for fixed high gain up to X1000 (10 mV full scale range)
- ▶ Includes Programmable Gain Amplifier (X1, 2, 4, 8 gains)
- ▶ Includes Diagnostic Program tape for immediate TTY or CRT print-out of A/D scans. Includes selectable memory base address (16 reserved addresses).
- ▶ Includes comprehensive Systems Manual with full Diagnostic program listing.
- ▶ Includes program-gatable external A/D start trigger.
- ▶ Includes End-of-Conversion, End-of-Scan and External Start Trigger Interrupts
- ▶ Includes start and final channel address storage registers and automatic address incrementing.
- ▶ Includes DC/DC Power Converter
- ▶ 12 bit binary conversion; 23,000 samples per second.

The SineTrac ST-711 and ST-732 A/D-D/A Analog Input/Output systems extend Datel's SineTrac family concept of slide-in peripheral boards for popular mini- and micro-computers. The ST-711 and ST-732 interface to the growing Intel Single Board Computer (SBC) Series and other Multibus-compatible micro-computers. The SBC Series now has multiple sources and has been proposed as an ANSI standard. The ST-711/732 also interfaces to the 16-bit SBC-86/12 from Intel which uses the same Multibus, thus insuring present and future product compatibility for the user.

Datel's experience extends beyond the ST-711/732 series to previous SBC-80 com-



patible systems and for 6800 EXORciser, LSI-11 and -11/2, PDP-11, NOVA/ECLIPSE and microNOVA computer series.

Models ST-711 and ST-732 are second generation combination A/D-D/A peripheral board systems for the SBC-80 Series Multibus-compatible micro-computers. The ST-711/732 are sister products to Datel's earlier ST-800 series A/D-only boards and they feature functional, hardware and programming differences to the ST-800 by adding 2 D/A converters plus current loop amplifiers (ST-732 only) without sacrificing the high A/D channel density of 32 single-ended or 16 differential channels per board. Other important differences include memory-mapped interfacing (vs. conventional register transfer I/O for the ST-800), addition of a FET input programmable differential amplifier (with optional high gain operation), a jumper-programmed, 10-stage crystal Pacer clock and complete pin-for-pin form, fit, and function identity to competitive SBC-711/732 series A/D-D/A board systems. This last feature allows Datel's ST-711/732 to operate directly from Intel's RMX-80 Analog I/O Drivers (Real-time Multitasking Executive Software).

For the highest speeds and/or applications requiring interfacing through DMA, users should choose Datel's ST-800 which includes DMA logic (the ST-711/732 does not operate under DMA). When using the ST-800 under DMA, an Intel or equivalent DMA controller board is required.

And for channel expansion, the ST-800 includes addressing logic for up to 256S/128D A/D channels using multiple ST-800ADX MUX Channel Expander boards. The ST-711/732 cannot be expanded beyond 32S/16D A/D channels on one board but additional

boards may expand using different base addresses.

For D/A, either product may expand channels by using the ST-800DA series for 4 or 8 channels and ST-800DAX Slave D/A Expanders. This series is interfaced using conventional register I/O logic (not memory-mapped) therefore mixing ST-711/732 and ST-800DA/DAX systems would require a mix of programming methods.

Hardware differences include the change from an MDAS-16 data acquisition module on the ST-800 to a hybrid ADC-HS combined A/D converter and Sample/Hold Amplifier on the ST-711/732. Substantial addressing, register and DMA logic is saved on the ST-711/732, making room for the D/A's, current amplifiers and Pacer clock.

A further advantage to ST-711/732 users is complete software interchangeability to Datel's ST-711RLY Low-Level Relay Multiplexer board system for noisy, industrial or high isolation applications. (Contact Datel to receive an ST-711RLY brochure). Addressing bit assignments and I/O pin locations are identical for the ST-711/732 and ST-711RLY boards.

All of these differences are summarized in Table 1.

## INTRODUCTION

The ST-711 is a full analog input system only (use Model ST-732 for D/A outputs) including either 32 single-ended A/D input channels (standard) or 16 differential channels (jumper change). The ST-711 includes the DC/DC Power Converter to supply all on-board  $\pm 15$  VDC requirements, Programmable Gain Amplifier (X1, 2, 4, 8 gains) with

Continued

**DESCRIPTION**

optional (added resistor) gain selection up to X1000 (10mV full scale range). Also included is a 10-stage jumper-selected crystal Pacer clock, selectable base memory address, jumper-selected End of Conversion (EOC), End of Scan (EOS) and Pacer Clock/External Start Interrupts (external TTL A/D conversion starts are software-gatable). Up to 16 differential channels contain pads to accept user-installed shunt resistors for 4-20 mA, 1-5 mA, 10-50 mA and other current input ranges.

For conversion control, the ST-711 includes on-board registers to store start and final A/D channel address, status bits, conversion modes and interrupt enables.

An A/D Converter auto-increment mode, which is program-selected, automatically advances the channel address after each conversion. Successive A/D samples will continue until the program-selected last channel address is reached.

The ST-732 is identical to the ST-711 but includes two 12-bit hybrid DAC-HK D/A converters with input registers. Also included with each D/A Converter is a current loop output amplifier with a unipolar range of 4 to 20 mA, which is compatible with many industrial process transceivers and is especially suited to driving long cables in noisy industrial applications.

The A/D section of the ST-711/732 uses Datel's hybrid technology ADC-HS12B combined successive approximation A/D converter and sample/hold amplifier. The ADC-HS features 6  $\mu$ sec S/H acquisition time and 8  $\mu$ sec A/D conversion time and 12 bit binary resolution (1 part in 4096). System accuracy varies from  $\pm 0.05\%$  of FSR  $\pm \frac{1}{2}$  LSB (10V range) to  $\pm 0.3\%$  FSR  $\pm \frac{1}{2}$  LSB (10 mV range), including noise, quantization, nonlinearity and dynamic errors. The ST-711/732 employ Datel's MX-1606 series fast CMOS multiplexers which incorporate  $\pm 35$ V overvoltage protection. Input impedance is 100 megohms minimum (poweron) with 30 pA typical input bias current. Balanced inputs require 5 kilohms maximum source impedance to maintain accuracy and throughput rate.

All models include an FET input differential amplifier which is wired as single-ended for the 32-channel models. This diff. amp. will accept a fixed resistor to increase the gain to 1000, making 10 millivolt full scale ranges practical. For differential inputs, the common mode voltage is  $\pm 12$ V to analog common. Common mode noise rejection varies from 120 dB at dc with a gain of 8 to 60 dB at 60 Hz with a gain of 1000. Sample/Hold aperture delay time is 100 nanoseconds, maximum.

System temperature coefficients are  $\pm 25$  ppm of FSR/ $^{\circ}$ C (gain drift of gain = 1) and  $\pm 20 \mu$ V/ $^{\circ}$ C (RTI) zero drift. Amplifier settling time is 8 microseconds (high level) and typically 110 microseconds (low level). Overall system throughput rate for high level signals is 23,000 samples per second.

The standard A/D-D/A digital coding is off-set binary (bipolar) but jumpers may easily be changed to straight binary (unipolar) or 2's complement (bipolar). Standard A/D-D/A analog signal ranges are  $\pm 10$ V full scale but may be jumper selected to  $\pm 5$ V, or +5V or +10V unipolar.

D/A outputs include op amps for voltage outputs, giving very low output impedance (2/10's of an ohm) at 5 mA short circuit proof output current. D/A settling time is 4  $\mu$ S (FS pk-pk change). Output temperature drift is  $\pm 50$  ppm fo FSR/ $^{\circ}$ C. 4 to 20 mA current loop outputs accept a 15 to 30 Vdc voltage compliance with  $\pm 0.075\%$  FSR accuracy and  $\pm 50$  ppm FSR/ $^{\circ}$ C drift.

A Diagnostic Program on paper tape is included with all models to fully exercise the system. The Diagnostic allows A/D hex scans to be printed out on a teletypewriter or displayed on a CRT terminal within minutes after signal connections are made and the Diagnostic tape is loaded. The Diagnostic tests all data paths and registers for fault troubleshooting. The program shows examples of how the A/D-D/A sections may be controlled by the computer. A full listing of the Diagnostic is included with the supplied ST-711/732 systems manual. Selected useful portions of the Diagnostic may be extracted and written into the user's application operating program. The Diagnostic may also be used for calibration adjustments by using an interactive (prompting) teletypewriter technique.

MODEL	NO. A/D CHANS.	A/D CHANS. EXPANSION	A/D THRU-PUT RATE	PROG. GAIN AMPL.	HI-GAIN DIFF. AMPL. & RANGES	CURRENT LOOP OUTPUTS	CLOCK	EXTERNAL START	INTERFACE TYPE
ST-711 (No D/A)	32S/16D	Must use additional 711 boards with different base addresses. Infinite expansion	23,000 samples/sec.	Included X1, 2, 4, 8	User-option, up to X1000 (10mV FSR)	None, use 732 board	Included, 10-stage bin. divider 1mS to 1 sec. Xtal or jumper select. Starts A/D	Included, gatable starts A/D Conv.	Memory-mapped 16 reserved locations, any base 65K
ST-732 (2 D/A's)	"	"	"	"	"	2 Chans. Incl.	4-20mA Loops Incl.	"	"
ST-800 (No D/A)	16S, 8D, 32S or 16D	Up to 256S/128D using ST-800ADX Boards	35,000 samples/sec. (DMA Mode)	No	No	None	None	RC adj. one-shot start clk. Set status bit or interrupt	Register Transfer, Program or Interrupt I/O

MODEL	DC/DC POWER CONVERTER	NOTES	INTERRUPTS	COMPATIBLE COMPUTERS	OPERATING SOFTWARE	IDENTICAL PIN-OUTS, REGISTER BITS TO COMPET. MODELS	DIAGNOSTIC TAPE PROGRAM	DMA
ST-711 (No D/A)	Included	Uses ADC-HS Combined A/D Converter and Sample/Hold. Stores Start & Final Chan. Addr.	End of Conversion End of Scan Pacer clk. 2 of 3 may be wired to INTA, INTB or 8 Multibus Interrupts	ISBC-80/05 ISBC-80/10 ISBC-80/20 ISBC-80/30 ISBC-80/20 (-4) ISBC-86/12 & Multibus Compatible Computers	Intel RMX-80 Analog I/O Drivers	SBC-711 SBC-732	Included, plus program listing in manual	No
ST-732 (2 D/A's)	"	"	"	"	"	"	"	"
ST-800 (No D/A)	Included	Uses MDAS-16 Data Acquisition Module	EOC, EOS, Start Clock. May be wired to any or 8 Multibus Interrupts	ISBC-80/05 ISBC-80/10 ISBC-80/20 ISBC-80/30 ISBC-80/20 (-4) ISBC-86/12 & Multibus Compatible Computers	---	---	Included, plus program listing in manual	Yes, requires Intel's DMA controller board

**SPECIFICATIONS, MODELS ST-711/732**

(Typical at +25°C, dynamic conditions, unless noted)

**GENERAL**

Configurations Available  
**Model ST-711**  
 32S/16D A/D Chans, No D/A Chans.  
**Model ST-732**  
 32S/16D A/D Chans, 2 D/A Chans.

**ANALOG INPUTS**

**Number of Channels**  
 32 Single-ended or 16 Differential  
 (Jumper selected, 32S supplied standard)  
**Channel Expansion**  
 May expand indefinitely by using addi-

tional ST-711/732 boards with different base addresses. Expansion limited by board slots and power.  
**Input Type**  
 High impedance voltage input, non-isolated. Differential inputs are balanced.  
**Current Inputs**  
 Up to 16 differential voltage inputs may be converted to differential current inputs with shunt resistors provided and installed by the user. Pads on the board will accommodate 4-20 mA, 1-5 mA, 10-50 mA and other ranges. 4-20 mA ranges require

250-ohm, 1/4W, ±1% resistors, ±100 ppm/°C max.  
**Input Overvoltage**  
 ±35V sustained (no damage)  
**Input Capacitance to Ground**  
 5 pF - Off Channels, 100 pF - On Channels  
**Full Scale Input Ranges**  
 ±10V, ±5V, ±2.5V, ±1.25V (Supplied standard, selectable by 2-bit programmable gain code). Board pads are etched for the user to install a fixed gain resistor, providing down to ±10 mV full scale range.

**FULL SCALE INPUT RANGES**

Software Programmable	Programmable Gain	Unipolar		Bipolar		Low Level	
		Unipolar	Bipolar	Unipolar	Bipolar	Unipolar	Bipolar
X1	0→+5V	0→+10V	±5V	±10V	Up to +80 mV	Up to ±1V	
X2	0→+2.5V	0→+5V	±2.5V	±5V	Up to +40 mV	Up to ±500mV	
X4	0→+1.25V	0→+2.5V	±1.25V	±2.5V	Up to +20 mV	Up to ±200mV	
X8	0→+675 mV	0→+1.25V	±675 mV	±1.25V	Up to +10 mV	Up to ±100mV	

(Standard, Offset Binary)

Selected by on-board jumpers

Requires substitution by user of fixed gain resistor on the on-board differential amplifier.

**Programmable Gain Amplifier**

Supplied, X1, X2, X4, X8 gains (see ranges above) Fixed high gain X1000 optional (see above)

**Input Impedance**

100 Megohms min., differential or to ground (Power On) 1.5 Kilohms min. (Power Off)

**Input Source Resistance**

5K Ohms max. (balanced)  
 1K Ohms max. (Unbalanced)

**Input Bias Current**

30 pA typ., 200 pA max.

**Overall Accuracy at +25°C**

(Including 3-sigma noise and quantization error, dynamic response errors, referred to input, after initial calibration)

GAIN	ACC
X1	±0.05% FSR ± 1/2 LSB
X2	0.07% FSR ± 1/2 LSB
X4	0.07% FSR ± 1/2 LSB
X8	0.07% FSR ± 1/2 LSB

X100 0.1% FSR ± 1/2 LSB  
 X1000 0.3% FSR ± 1/2 LSB  
 Requires rewiring diff. ampl. for fixed high gain

**Common Mode Voltage Range**

Within ±12V of analog common (signal plus common mode)

**Common Mode Rejection**

At Gain = 1

0 Hz	100 dB
100 Hz	80 dB
1 KHz	60 dB

At Gain = 8

0 Hz	120 dB
100 Hz	100 dB
1 KHz	80 dB

At Gain = 1000 (Requires rewiring diff. ampl. for fixed high gain)  
 60 Hz 100 dB

**Nonlinearity**

± 1/2 LSB  
**Differential Nonlinearity**  
 ± 1/2 LSB

**Resolution**

12 Binary Bits (1 part in 4096)

**Multiplexer Crosstalk from Off Channels**

0.01% DC to 1 KHz

**Sample/Hold Switch Feedthrough**

0.01% max.

**Sample/Hold Aperture Time**

100 nanoseconds, max.

**System Temperature Coefficients**

Gain  
 ±25 ppm of FSR/°C (Gain X1)  
 ±30 ppm of FSR/°C (Gain X2, 4, 8)  
 Zero  
 ±20 µV/°C

**A/D Conversion Period**

20 microseconds

**Amplifier Settling Time**

(Input = ±FSR pk-pk step)

8 microseconds (HL)

110 microseconds (LL)

**System Throughput Rate**

(High Level Inputs)

23,000 samples/second

**A/D Digital Outputs**

Offset Binary (Bipolar) - Supplied standard

Two's Complement (Bipolar) } Rewired with jumpers by user  
 Straight Binary (Unipolar) }

**Output Data Format**

12 Bit Binary Group compatible to SBC-Series computers. The A/D Bit 1 (MSB) may be inverted by jumper for 2's complement coding.

**ANALOG OUTPUTS**

**VOLTAGE OUTPUTS**

**Number of Channels**

2 non-isolated

**Full Scale Voltage Output Ranges**

0 to +5V } Jumpers may be rewired by the user or by Datel  
 0 to +10V } in OEM quantities  
 -5 to +5V } (Supplied Standard)  
 -10 to +10 V }

**Digital Input Coding**

Straight Binary } Jumpers may be rewired by the user or by Datel in OEM quantities  
 2's Complement }

Offset Binary (Supplied Standard)

**Output Impedance**

200 milliohms

**Output Current**

±5 mA, short circuit proof to ground

**Slew Rate**

10V/µS (with no Ext. Cap. Load)

**Settling Time**

4 microseconds to within ± 1/2 LSB of final value

**Accuracy at +25°C**

±0.05% of FSR (Includes noise and nonlinearity)

**Temperature Coefficient**

±50 ppm of FSR/°C

**CURRENT LOOP OUTPUTS**

**Full Scale Current Output Range**

4 to 20 mA, Unipolar. (May be rewired to other ranges by the user)

**Current Loop Load Resistance**

0 to 500 ohms

**Current Loop Voltage Compliance**

18 to 30 Vdc, Unipolar, provided by the user

**Accuracy at +25°C**

±0.075% of FSR (Includes noise and nonlinearity)

**Temperature Coefficient**

±50 ppm of FSR/°C

**PHYSICAL**

**Outline Dimensions**

12W x 6.75D x 0.5H inches\*  
(305 x 171 x 13 mm)

Pin-for-pin and card guide compatible to the Multibus SBC-Series computers

**Weight**

22 ounces (0,6 kg)

**Operating Temperature Range**

0 to +70°C

**Storage Temperature Range**

-25°C to +85°C

**Relative Humidity**

10% to 90%, non-condensing.

**Altitude**

0 to 15,000 feet (4600 m)

**POWER CONSUMPTION**

+5 VDC ±5% @ 2.5 Amps. max.

An on-board DC/DC Power Converter operated from +5V, is provided to supply regulated ±15V for linear circuits

**Programming and Architecture**

**Type of Interface**

Memory-mapped interface.

The ST-711/732 appears to the CPU as 16 consecutive memory locations with 4 unused locations.

**Compatibility**

Pin-for-pin and card guide compatible to the Multibus, SBC-Series computers

**Compatible Software**

RMX-80 Analog I/O Drivers  
ASM80 8080 Assembly Language

**Compatible Computers:**

iSBC-80/10

iSBC-80/05

iSBC-80/20

iSBC-80/20 (-4)

iSBC-80/30

iSBC-86/12

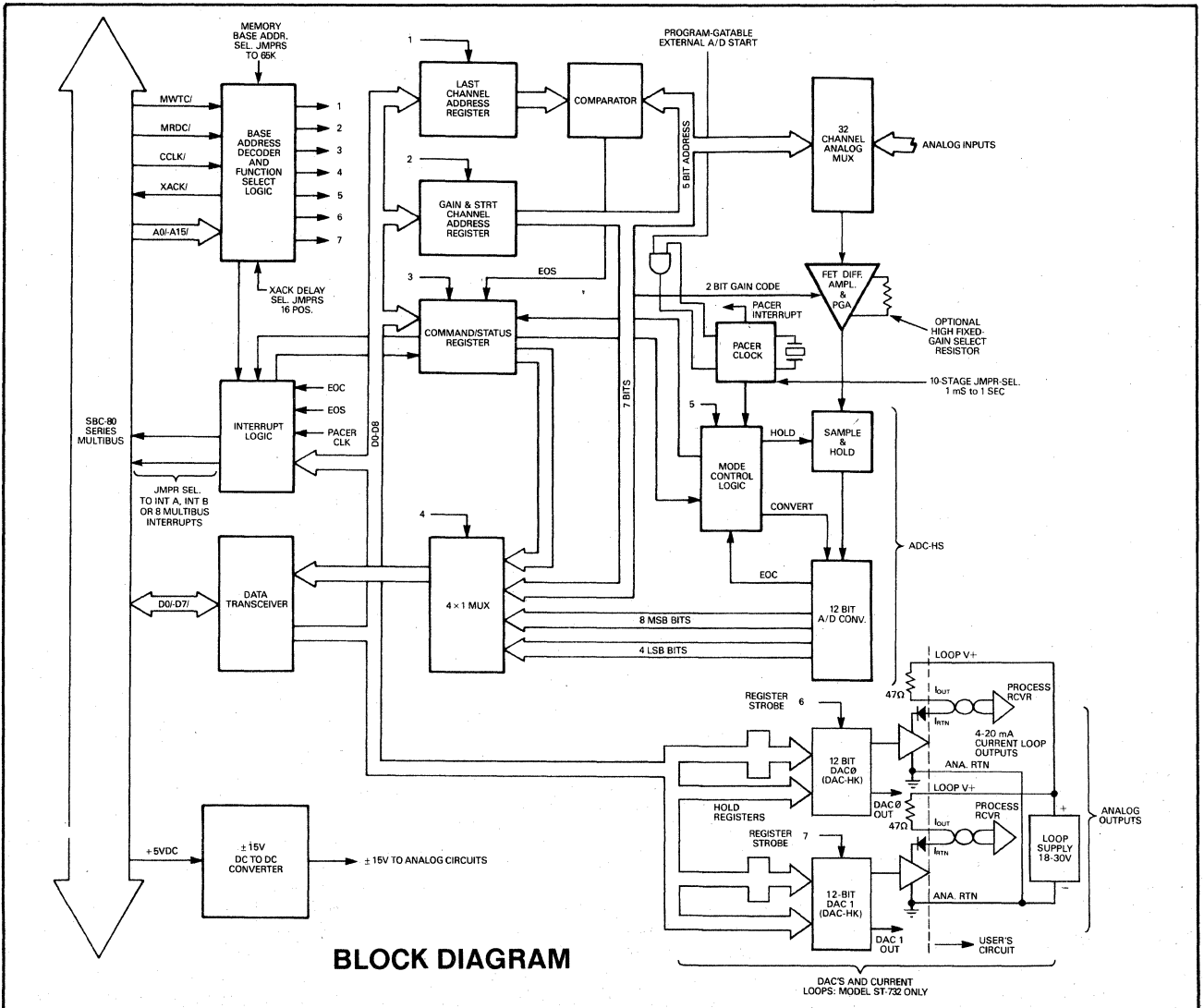
**Memory Base Address**

The 16-location starting base address is factory set at F700 (Hex) but may be reassigned anywhere in 65K memory locations by altering a supplied DIP jumper plug. However, the supplied Diagnostic program is preset to operate from base address F700.

**INTERFACE CONNECTORS**

DESIG.	FUNCTION	NO. OF PINS	PIN SPACING CENTERS (IN.)	MATING RIBBON CONNECTORS
P1	SBC Multibus Bus Connector	86	0.156	
P2	±15V Aux. Power (Bus)	60	0.1	58-2076061
J1	2 D/A Analog Output Channels	50	0.1	58-2076061
J2	1st 8D/16S A/D Input Channels	50	0.1	58-2076061
J3	Expander 8D/16S A/D Input Channels	50	0.1	58-2076061

\*Cards may be stacked adjacent if standard 0.60"-spacing cages are used



**MEMORY ADDRESS ASSIGNMENTS**

New Addr.	Datel Supplied	Command	Function
M + 0	F700	Write	Load Command Register
M + 0	F700	Read	Read Status Register
M + 1	F701	Write	Load PGA and Ch. Addr. Register
M + 1	F701	Read	Read PGA and Ch. Addr. Register
M + 2	F702	Write	Load Last Chan. Addr. Register
M + 3	F703	Write	Clear Interrupts
M + 4	F704	Read	Read A/D Data LO Byte
M + 5	F705	Read	Read A/D Data HI Byte
M + 8	F708	Write	DAC0 LO Byte → Hld. Reg.
M + 9	F709	Write	DAC0 HI Byte → DAC0 (HR → DAC0)
M + A	F70A	Write	DAC1 LO Byte → Hld. Reg.
M + B	F70B	Write	DAC1 HI Byte → DAC1 (HR → DAC1)
C → F	F70C/F		Don't Use

**LOAD COMMAND REGISTER (WRITE F700)**

Bit	Function
7	Not Used
6	Not Used
5	1 = Enable End of Convert (EOC) Interrupt
4	1 = Enable End of Scan (EOS) Interrupt
3	0 = Clear Board Busy Status
2	1 = Enable External Trigger
1	1 = Enable Automatic Ch. Addr. Increment
0	1 = Enable A/D Conversion

**READ STATUS REGISTER (READ F700)**

Bit	Function
7	1 = A/D Conversion Done
6	1 = Scan Done
5	1 = EOC Interrupt Enabled
4	1 = EOS Interrupt Enabled
3	1 = Board is Busy
2	1 = External Trigger Enabled
1	1 = Auto-increment Enabled
0	1 = A/D Conversion Enabled

**READ/LOAD PGA AND START CHAN. ADDR. (READ/WRITE F701)**

Bit	Function
7, 6	00 = Gain X1 01 = Gain X2 10 = Gain X4 11 = Gain X8
5	Not Used
4	1 = 2 <sup>4</sup>
3	1 = 2 <sup>3</sup>
2	1 = 2 <sup>2</sup>
1	1 = 2 <sup>1</sup>
0	1 = 2 <sup>0</sup>

} Start Chan. Addr. Select  
(1 of 32)

**LOAD LAST CHANNEL ADDRESS (WRITE F702)**

Bits	Function
7, 6, 5	Not Used
4	1 = 2 <sup>4</sup>
3	1 = 2 <sup>3</sup>
2	1 = 2 <sup>2</sup>
1	1 = 2 <sup>1</sup>
0	1 = 2 <sup>0</sup>

} Last Channel Address Select  
(1 of 32)

**CLEAR INTERRUPTS (WRITE F703)**

Bit	Function
7, 6	Not Used
5	0 = Clear EOC Interrupt
4	0 = Clear EOS Interrupt
3	0 = Clear Pacer Clk. Interrupt
2, 1, 0	Not Used

**LOAD HOLD REGISTER with DAC LO Byte (Write F708-DAC0, Write F70A-DAC1)**

Bit	Function
7	DAC Bit 9
6	DAC Bit 10
5	DAC Bit 11
4	DAC Bit 12 (LSB)
3, 2, 1, 0	Zeroes

**LOAD HI BYTE TO DAC: Load Hold Reg. to DAC (Write F709-DAC0, Write F70B-DAC1) Enable DAC Input Register Strobe**

Bit	Function*
7	DAC Bit 1 (MSB)
6	DAC Bit 2
5	DAC Bit 3
4	DAC Bit 4
3	DAC Bit 5
2	DAC Bit 6
1	DAC Bit 7
0	DAC Bit 8

\*A/D-D/A convention is to label the converter's Most Significant Bit as Number 1 (MSB)

**READ A/D DATA HI BYTE (Read F705)**

Bit	Function
7	ADC Bit 1 (MSB)
6	ADC Bit 2
'	'
'	'
'	'
0	ADC Bit 8

**READ A/D DATA LO BYTE (Read F704)**

Bit	Function
7	ADC Bit 9
6	ADC Bit 10
5	ADC Bit 11
4	ADC Bit 12 (LSB)
3, 2, 1, 0	Not Used

**Transfer Acknowledge Delay**

The ST-711/732 responds with a Transfer Acknowledge (XACK) with any Read or Write Command. The XACK may be delayed to suit different processors. 16 delay steps are jumper-selected from 50 nS to 1.5 μS. Standard units are set to 50 nS.

**Pacer Clock**

Adjustable timebase consisting of a 10-stage binary divider capable of starting A/D conversions in the External Trigger Mode. Time-base periods are jumper-selected and the oscillator may be either crystal or RC controlled. The standard range is 975μS to 1 second.

**Interrupts**

2 of 3 possible interrupts may be jumper-selected to one or both (INTA and INTB) interrupt lines. The interrupts are EOC, EOS and Pacer Clock. They are factory-jumpered as: INT A - EOC, INT B - EOS. Additionally, any of the 8 Multibus interrupts may be wired to any combination of the EOC, EOS, Pacer Interrupts.



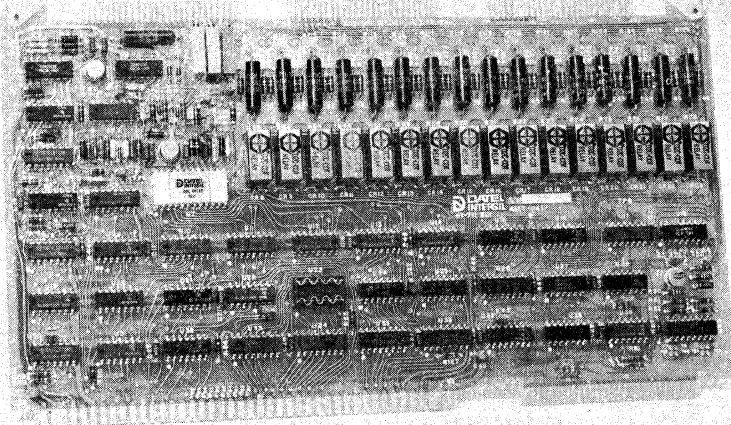
# SineTrac™ ST-711 RLY

## Relay-Input A/D Board for SBC-80 and Multibus Microcomputers

COMPATIBLE TO: SBC-80 SERIES  
MDS-800

### FEATURES

- ▶ 8 or 16 differential A/D channels using a "Flying Capacitor" relay multiplexer for high common mode noise rejection (126 dB) and high isolation (250V RMS).
- ▶ Complete hardware and software compatibility to Multibus and SBC-Series microcomputers. Uses identical programming and register assignments to SBC-711/732, and ST-711/732 A/D-D/A boards.
- ▶ 10 mV to 2V selectable input ranges including X1, 2, 5, 10 Programmable Gain Amplifier. 12 binary bit A/D resolution.
- ▶ Includes paper tape Diagnostic Program for immediate TTY or CRT printout of A/D scans. Includes selectable memory base address.
- ▶ Includes comprehensive Systems Manual with full Diagnostic listing.
- ▶ Uses computer's  $\pm 12V$ , +5V power buses; no DC/DC converter is required.
- ▶ Will accept user's selection of shunt resistors for 4-20 mA inputs.
- ▶ Will accept overload clamps and attenuators.
- ▶ Includes 10-stage Pacer Start Clock.
- ▶ Includes External A/D start trigger.
- ▶ Includes End of Conversion, End of Scan and External Start Trigger interrupts.
- ▶ Includes Start and Final Channel Address storage registers and automatic address incrementing.



lay multiplexer specifically for industrial environments with long, noisy signal leads, high common mode voltages and unwanted normal mode signals.

The ST-711RLY8D and ST-711RLY16D A/D boards join Datal's growing family of SineTrac-series analog signal peripheral boards for popular mini- and microcomputers. This ST-711RLY series is mechanically, electrically and program compatible to Intel's SBC-80 Series one-board microcomputers and slides into respective cardcages as an adjacent card to the CPU. In addition, the ST-711RLY has full program and pinout compatibility to the popular SBC-711/732 and ST-711/732 series fast A/D-D/A boards which use solid-state multiplexers.

These Relay A/D boards may be used with microcomputers in industrial process control equipment. Generally these applications measure slowly-varying parameters such as temperature, pressure, flow rate, etc. And, low level bridge-type transducer-sensors are usually employed such as thermocouples, strain gauges, load cells, etc. Thus, the 30 sample-per-second throughput of the ST-711RLY is entirely adequate. And the selectable gain ranges from 10 mV to 2 Volts full scale are ideal for low level applications.

The ST-711RLY uses the  $\pm 12$  VDC power bus from the computer to run the A/D section, thereby not requiring the DC/DC power converter normally found on A/D boards. However, if the computer's  $\pm 12V$  buses are unusable, board pads are left in place of five relay channels for a Datal BPM-12/100-D5 DC/DC Power Converter which operates from +5V. Also included are board pads for input current shunt resistors, overload clamps or attenuators. And, a Diagnostic program tape is provided for immediate startup with hex A/D scans printed out on a teletypewriter or CRT within minutes after connecting signals and loading the Diagnostic. A systems manual includes the Diagnostic listing with extensive comments. Finally, a selectable start clock combined with programmable interrupt modes and an external start are ideal for repetitive process applications.

### DESCRIPTION

The relay A/D is offered in an 8 channel, differential-input model (ST-711RLY8D) and a 16 differential channel model (ST-711RLY16D). The product achieves input voltage isolation by using the "flying capacitor" technique whereby a non-polarized input storage capacitor is switched between the input signal and the A/D converter input using a computer-controlled DPDT dry multi-

Continued

### INTRODUCTION

The convenience of having A/D conversion inside a microcomputer on slide-in analog I/O boards has led to the next generation of analog boards for industrial and process control applications. While most presently-available A/D boards are intended more for test and instrumentation applications with high throughput rates, many channels and minimal noise protection, the ST-711RLY A/D board series uses a re-

SineTrac™ ST-711 RLY Multibus Relay-MUX A/D Board

Intel, RMX-80 and Multibus are Intel Corp. Trademarks

**DESCRIPTION, Continued**

reed relay for each differential channel. The combined storage capacitor and input resistors act as a one-pole, low pass filter to attenuate normal mode noise and the integrating monolithic A/D converter (DateI's ADC-EK12B) provides further noise rejection. A/D conversion is to 12 bit binary resolution (1 part in 4096) with accuracy of .05% FSR (2V range), and .1% FSR (10 mV range).

A programmable gain amplifier is included with gains of X1, 2, 5 and 10 selected by a 2-bit program word. Further jumper-selection of supplied on-board integrator components gives a total range selection from 10 mV to 2V full scale.

In normal operation, all input relays remain connected to the input signals, so that respective storage capacitors continually track the inputs. During conversion, the capacitor is briefly disconnected from the signal and the stored voltage is switched to the A/D input for digital conversion.

Users may install their own precision shunt resistors onto the board to directly measure 4-20 mA, 1-5 mA and 10-50 mA current outputs commonly produced by process transmitters. For higher DC voltage ranges, precision attenuators may also be installed while retaining 250 VRMS common mode isolation.

Because of the balanced design, common mode noise rejection is 126 dB, from 0 to 60 Hz with 2.5 pF input capacitance and  $5 \times 10^{13}$  ohms to power ground. Temperature drift has been held to  $\pm 20 \mu\text{V}/^\circ\text{C}$  (Zero) and  $\pm 30$  ppm FSR/ $^\circ\text{C}$  (Gain) for the A/D converter and gain drift  $\pm 10$  ppm FSR/ $^\circ\text{C}$  for the PGA. Autozeroing circuits on the PGA eliminate zero drift. System throughput period is 36 mS (sample-to-sample), nonlinearity is  $\pm \frac{1}{2}$  LSB, differential input impedance is 20 megohms (capacitor leakage) for dc signals and will accept  $\pm 15\text{V}$  overvoltage (sustained). The input RC network has a 300 mS time constant.

Standard output coding is Offset Binary (bipolar) but the user may rewire the coding to Two's Complement (Bipolar) or Straight Binary (Unipolar).

The ST-711 RLY is a memory-mapped device using 6 memory addresses of 16 reserved addresses. The starting (base) address is DIP-plug jumper-selected at F700 (Hex) to be compatible with the supplied diagnostic program tape. However, the user may rewire the jumpers to any base address up to 65 K.

Various registers are provided to load and read the PGA gain code, starting

and final channel addresses, EOC, EOS and Pacer Clock interrupts, automatic channel address incrementing and the external start trigger.

A selectable Transfer Acknowledge Delay Circuit (XACK) is provided to suit different processors.

For real-time applications, a Pacer Clock timebase is included to start A/D Ext. Trigger scans or interrupts at known real times. The Pacer consists of a 10-stage binary divider chain with jumper-selected periods and may be crystal or RC controlled.

Two of the three on-board interrupts (EOC, EOS, external trigger) may be jumper-selected to one or both (INTA and INTB) computer Interrupt lines. Additionally, any of the 8 Multibus interrupts may be wired to any combination of the three on-board interrupts.

Overall board size of the ST-711RLY series is 12W x 6.75D x 0.5H inches (305 x 171 x 13 mm) and weighs 22 ounces (0.6 kg). The operating temperature range is 0 to  $+70^\circ\text{C}$  and storage is  $-25^\circ\text{C}$  to  $+85^\circ\text{C}$ . Relative humidity may be 10% to 90%, non-condensing.

The system is completely software and hardware compatible to the Multibus, and SBC-Series microcomputers.

**SPECIFICATIONS**

(Typical at  $+25^\circ\text{C}$ , dynamic conditions, unless noted)

**GENERAL**

Configurations Available:

**ST-711RLY8D**

8 Differential Channels

**ST-711RLY16D**

16 Differential Channels

Both models include full channel addressing logic for 16 channels, automatic zero correction, X1, 2, 5, 10 Programmable Gain Amplifier, and jumper programmed Pacer clock, and pads for user-installed input current shunt resistors, and overload clamps.

**ANALOG INPUTS****Number of Channels**

8 Differential (ST-711RLY8D) or

16 Differential (ST-711RLY16D)

**Channel Expansion**

May be expanded by using additional ST-711RLY Boards with different base addresses

**Input Type**

Flying capacitor differential isolated relay input, multiple (DPDT) reeds per channel for temperature tracking.

The input network (when a channel relay is de-energized) consists of 30 kilohms in series with 10 microfarads. (300 mS single-pole filter).

**Current Inputs**

Any number of inputs may be converted to differential current inputs with shunt resistors provided and installed on the board by the user. 4-20 mA, 1-5 mA, 10-50 mA process transceiver ranges and others may be accepted.

**Input Overvoltage**

$\pm 25\text{V}$  sustained, no damage

**Input Capacitance to Ground**

Approx. 2.5 pF per channel

**Full Scale Input Ranges**

10 mV to 2V, unipolar or bipolar, using combinations of gain resistor selection and the Programmable Gain Amplifier (See Chart)

**Programmable Gains**

X1, X2, X5, X10

**Input Impedance**

Dependent on input signal rate of change (Diff. cap. resistance is 20 M $\Omega$ ). Insulation resistance per channel to ground is  $5 \times 10^{13}$  ohms. See block diagram for input circuit.

**Input Bias Current**

Input must source or sink current only to charge capacitor to new value. Capacitor remains connected at all times except during A/D conversion.

**Overall Accuracy at  $+25^\circ\text{C}$** 

(Including noise, referred to input, after initial calibration)

Within  $\pm 0.05\%$  of FSR (2V Range)

Within  $\pm 0.1\%$  of FSR (10 mV Range)

**Quantization Error**

$\pm \frac{1}{2}$  LSB

**Nonlinearity**

$\pm \frac{1}{2}$  LSB

**Differential Nonlinearity**

$\pm \frac{1}{2}$  LSB

**Resolution**

12 Binary bits (1 part in 4096)

**Common Mode Voltage Range**

250V RMS to power ground

**Common Mode Rejection Ratio**

126 dB @ 50/60 Hz

**Temperature Coefficients****A/D Converter Zero**

$\pm 20 \mu\text{V}/^\circ\text{C}$

- A/D Converter Gain  
±30 ppm of FSR/°C
- Input Amplifier Zero  
±¼ µV/°C (Autozeroed)
- Input Amplifier Gain  
±10 ppm of FSR/°C
- System Throughput  
30 samples per second

**A/D DIGITAL OUTPUTS**

**Output Coding**

Offset Binary (Bipolar) supplied standard.  
Two's Complement (Bipolar) } Rewired with  
Straight Binary (Unipolar) } jumpers by user

**Output Data Format**

12 Bit Binary group compatible to SBC-80, and Multibus-compatible computers. A/D Bit 1 (MSB) may be inverted by jumper for 2's complement coding

**Programming and Architecture**

**Type of Interface**

Memory-mapped  
The ST-711RLY appears to the CPU as 16 consecutive memory locations, with 10 unused locations.

**Memory Base Address**

The 16-location starting base address is factory set at F700 (Hex) but may be reassigned anywhere in 65K memory locations by altering a supplied DIP jumper plug. However, the supplied Diagnostic program is preset to operate from base address F700

**Memory Address Assignments**

New Addr.	Datel Supplied	Command	Function
M + 0	F700	Write	Load Command Register
M + 0	F700	Read	Read Status Register
M + 1	F701	Write	Load PGA and Ch. Addr. Register
M + 1	F701	Read	Read PGA and Ch. Addr. Register
M + 2	F702	Write	Load Last Chan. Addr. Register
M + 3	F703	Write	Clear Interrupts
M + 4	F704	Read	Read A/D Data LO Byte
M + 5	F705	Read	Read A/D Data HI Byte
M + 6	F706	} Don't use	
thru	thru		
M + F	F70F		

**Load Command Register (Write F700)**

Bit	Function
7	Not Used
6	Not Used
5	1 = Enable End of Convert (EOC) Interrupt
4	1 = Enable End of Scan Interrupt (EOS)
3	0 = Clear Board Busy Status
2	1 = Enable External Trigger Start
1	1 = Enable Automatic Ch. Addr. Increment
0	1 = Enable A/D Conversion

**Read Status Register (Read F700)**

Bit	Function
7	1 = A/D Conversion Done
6	1 = Scan Done
5	1 = EOC Interrupt Enabled
4	1 = EOS Interrupt Enabled
3	1 = Board is Busy
2	1 = External Trigger Enabled
1	1 = Auto-increment Enabled
0	1 = A/D Conversion Enabled

**Note:** Input settling time and accuracy degrades with additional external source resistance and input rate of change (voltage slew rate). Contact Datel if you need applications assistance.

**Transfer Acknowledge Delay** The ST-711RLY responds with a Transfer Acknowledge (XACK) with any Read or Write command. The XACK may be delayed to suit different processors. 16 delay steps are jumper selected from 50 nS to 1.5 µS. Standard units are set to 50 nS.

**Pacer Clock** adjustable timebase consisting of a 10-stage binary divider capable of starting A/D conversions in the External Trigger Mode. Timebase periods are jumper-selected and the oscillator may be either crystal or RC controlled.

**External Trigger Start.** A negative TTL pulse 1.5 ±0.5 µS may also start A/D conversions.

**Interrupts.** 2 of 3 possible interrupts may be jumper-selected to one or both (INTA and INTB) Interrupt lines. The interrupts are EOC, EOS and Pacer Clock. They are factory-jumpered as: INT A - EOS, INT B - EOC. Additionally, any of the 8 Multibus interrupts may be wired to any combination of the EOC, EOS, Pacer Interrupts.

**Read/Load PGA and Start Chan. Addr. (Read/Write F701)**

Bit	Function
7,6	00 = Gain X1 01 = Gain X2 10 = Gain X5 11 = Gain X10
5,4	Not Used
3	1 = 2 <sup>3</sup>
2	1 = 2 <sup>2</sup>
1	1 = 2 <sup>1</sup>
0	1 = 2 <sup>0</sup>

Start Chan. Addr. Select  
(1 of 16)

**Load Last Channel Address (Write F702)**

Bits	Function
7,6,5,4	Not Used
3	1 = 2 <sup>3</sup>
2	1 = 2 <sup>2</sup>
1	1 = 2 <sup>1</sup>
0	1 = 2 <sup>0</sup>

Last Channel Address Select  
(1 of 16)

**Clear Interrupts (Write F703)**

Bit	Function
7,6	Not Used
5	0 = Clear EOC Interrupt
4	0 = Clear EOS Interrupt
3	0 = Clear Pacer Clk. Interrupt
2,1,0	Not Used

**Read A/D Data LO Byte (Read F704)**

Bit	Function
7	ADC Bit 9
6	ADC Bit 10
5	ADC Bit 11
4	ADC Bit 12 (LSB)
3,2,1,0	Not Used

**Read A/D Data HI Byte (Read F705)**

Bit	Function
7	ADC Bit 1 (MSB)
6	ADC Bit 2
,	,
,	,
,	,
0	ADC Bit 8



**PHYSICAL**

**Outline Dimensions**  
 12W x 6.75D x 0.5H inches  
 (305 x 171 x 13 mm)

**Weight**  
 22 ounces (0,6 kg)

**Operating Temperature Range**  
 0 to +70°C

**Storage Temperature Range**  
 -25°C to +85°C

**Relative Humidity**  
 10% to 90%, non-condensing

**Altitude**  
 0 to 15,000 feet (4600 m)

**POWER CONSUMPTION**

+5 VDC ±5% @ 1.5 Amps. max.  
 +12 VDC ±5% @ 70 milliamps max.  
 -12 VDC ±5% @ 30 milliamps max.

Boards may be stacked adjacent if standard .60" card-spacing cages are used

On-board pads have been left to accept a Datel BPM-12/100-D5 DC/DC power converter to generate ±12V from +5 where ±12V is unusable or unavailable from the computer. Five relay channel input component sets must be deleted or removed to use the DC/DC converter.

**Compatibility**

Pin-for-pin and card guide compatible to the Multibus, SBC-80 computers

**Compatible Software**

RMX-80 Analog I/O Drivers  
 ASM80 8080 Assembly Language

**Compatible Computers:**

iSBC-80/10  
 iSBC-80/05  
 iSBC-80/20  
 iSBC-80/20 (-4)  
 iSBC-80/30  
 iSBC-86/12

**FULL SCALE INPUT RANGES**

Software Programmable	GAIN & CODE	UNIPOLAR RANGE				BIPOLAR RANGE	
		0 → +100 mV	0 → 200 mV	0 → 1V	0 → 2V	±100 mV	±1V
	1 (00)	0 → +100 mV	0 → 200 mV	0 → 1V	0 → 2V	±100 mV	±1V
	2 (01)	0 → +50 mV	0 → +100 mV	0 → +.5V	0 → +1V	±50 mV	±500 mV
	5 (10)	0 → +20 mV	0 → +40 mV	0 → +.2V	0 → +.5V	±20 mV	±200 mV
	10 (11)	0 → +10 mV	0 → +20 mV	0 → +.1V	0 → +.2V	±10 mV	±100 mV

On-board gain resistors selected by jumpers

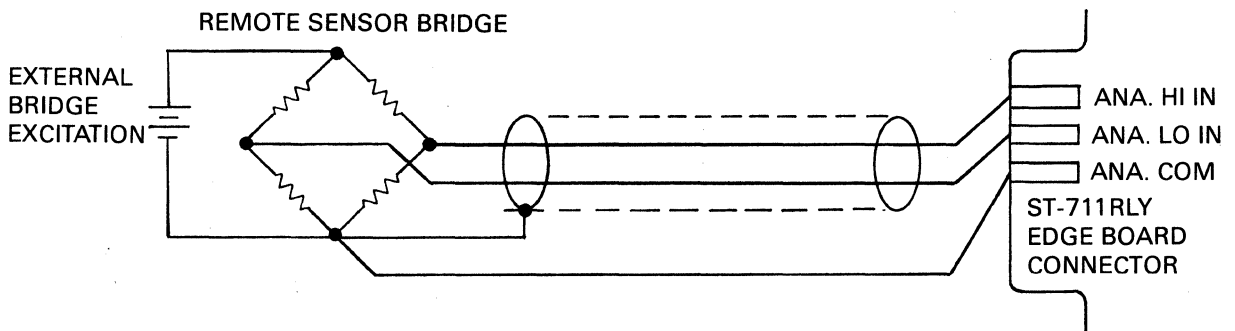
(Standard Offset Binary)

NOTE: Ranges up to ±10V may be achieved without the programmable gain amplifier

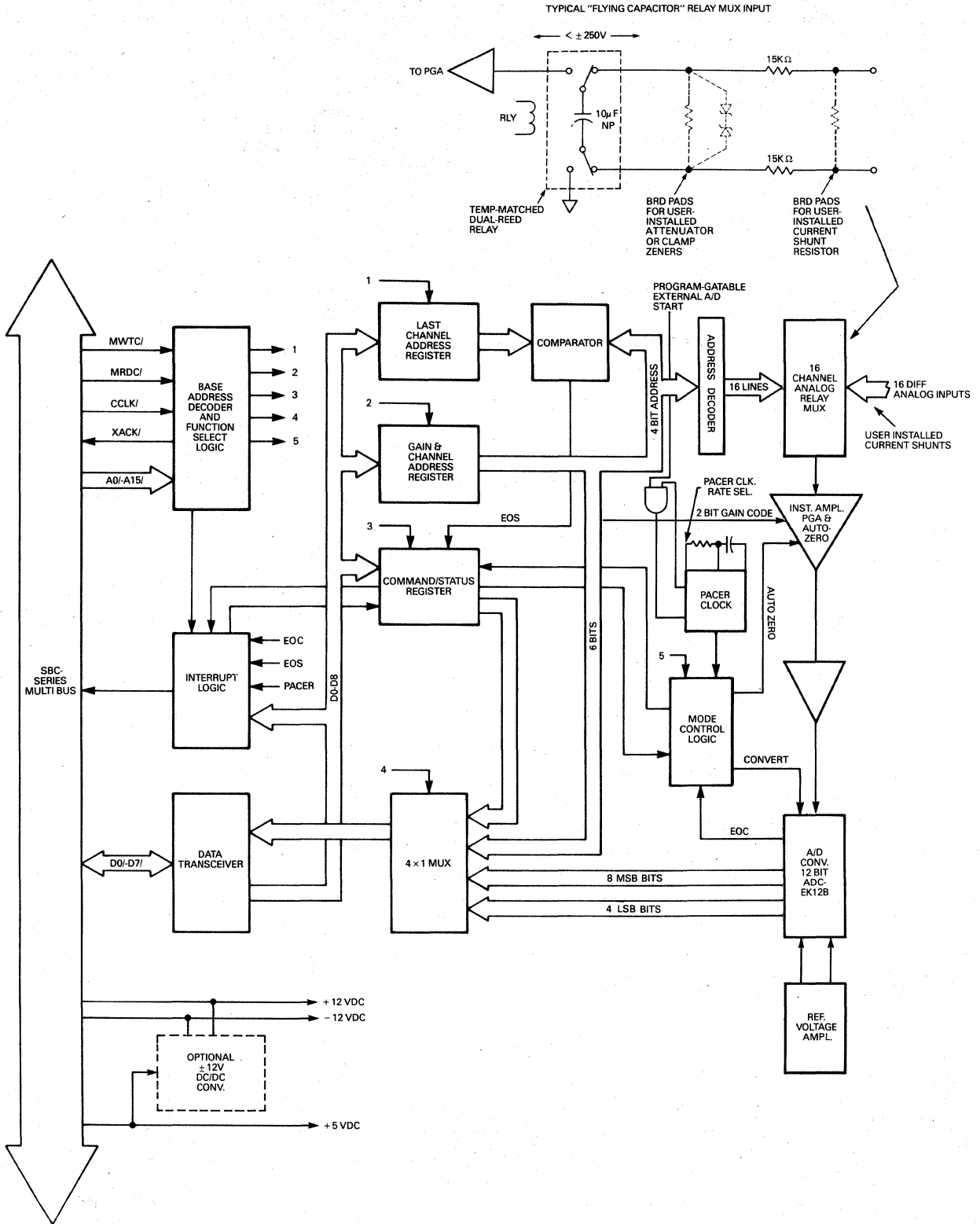
**ORDERING GUIDE**

MODEL	NO. OF A/D CHANNELS
ST-711RLY8D	8 Differential
ST-711RLY16D	16 Differential
58-12140-39	User's Manual (spare) (one included with board)
31-2076040	Dual 25-Pin 0.1" PCB/Solder Tab Connector (3 req'd)
OR: 58-2076061	PCB-to-Ribbon (0.05" spacing) (3 req'd)

**TYPICAL INPUT CONNECTIONS**



# BLOCK DIAGRAM





# SineTrac™ ST-724 4-Channel D/A and Current Loop Board for SBC-80 and Multibus Microcomputers

## FEATURES

- 4 D/A channels using 12-bit Hybrid Converters with Input Registers
- Accurate to .05% of Full Scale Reading
- Memory-mapped, with user-selectable Base Address
- Complete hardware and software compatibility with Multibus and SBC-series Microcomputers
- Pin-for-pin replacement for SBC-724. Uses identical programming and register assignments to SBC-711/732 and ST-711/732 A/D-D/A boards
- Works directly from Intel RMX-80 Software
- Includes 4 externally excited 4 to 20 mA industrial current loop amplifiers.
- Pin-selectable Transfer Acknowledge (Xack/) Delay—ensures compatibility with different memory speeds
- On-board DC/DC power converter generates  $\pm 15$  Vdc from +5 Vdc computer bus
- Includes Diagnostic Program
- Includes full systems manual with complete listing of Diagnostic

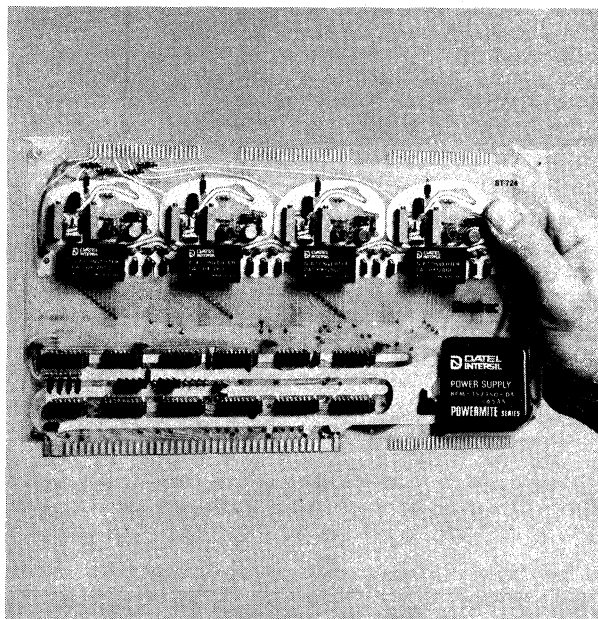
## INTRODUCTION

The ST-724 Analog Output board extends Datel-Intersil's SineTrac family of slide-in computer peripherals to a variety of industrial and instrumentation applications. It provides 4 channels of D/A conversion, each with 12 binary bits of resolution for an overall accuracy to within .05% FSR. The ST-724 is fully hardware and software compatible with the popular Multibus and SBC-80 series of microcomputers—it is a pin-for-pin replacement for the SBC-724. And, the ST-724 is significantly less expensive than other boards with comparable features.

The ST-724 is memory mapped—it appears to the host computer as eight consecutive locations in memory. The board base address is factory set to F708 but may be reassigned by the user anywhere in memory. The ST-724 also features an adjustable Transfer Acknowledge Delay (XACK/Delay). The ST-724 generates a Transfer Acknowledge signal in response to memory write commands from the system computer. The XACK/Delay circuitry permits a delay of this signal, to ensure compatibility with the host computer.

Users may wish to consider the Datel-Intersil ST-800 D/A board as an alternative to the ST-724. The ST-800 D/A is fully compatible with Multibus and SBC microcomputers, but requires different programming from that used on the ST-724. The ST-800 D/A is used as an I/O peripheral, while the ST-724 is memory-mapped. In addition, the ST-800 D/A board offers greater channel density—up to 8 D/A channels per board—and can accept slave boards for up to 256 D/A channels operating from a single address. The ST-800 D/A board has voltage outputs only. The ST-724, by comparison, offers 4 D/A channels per board, is expandable by different base address only, and provides both voltage and current outputs.

Digital inputs to the ST-724 may be set for offset binary or 2's complement (bipolar) coding or for straight binary (uni-



COMPATIBLE TO: **SBC-80 SERIES**  
**MDS-800**

polar). Outputs from  $\pm 5V$ ,  $\pm 10V$ ,  $0 \rightarrow +5V$  and  $0 \rightarrow +10V$  DC permit the ST-724 to interface with a variety of process receivers, proportional controllers, or recorders. A 4 to 20 mA current loop is also provided which permits the board to be used in electrically noisy industrial environments. All outputs may be shorted to ground without damage.

Power to the ST-724 comes from the host computer's +5V power bus. An on-board DC-to-DC converter generates  $\pm 15V$  for the analog output circuitry.

Each ST-724 board is shipped with a Diagnostic Program on paper tape, which provides a quick functional checkout of the system at the time of installation. It may also be used to calibrate the board. Also included is a systems manual, which provides a listing of the Diagnostic and complete user information on the ST-724.

## DESCRIPTION

Input to the ST-724 is from the host computer data bus. Since the Intel Multibus provides only 8 binary bits of data per memory word, and the D/A converters on the ST-724 require 12 binary bits, two memory words are required for each conversion. The 4 least significant bits are transmitted first, (for DAC 0, at the base memory address) and are latched into a 4-bit register. The next data word (base address +1) contains the 8 MSB bits, and initiates a conversion.

D/A conversion is accomplished by Datel-Intersil's DAC-HK12BGC, a 12-bit hybrid unit with an input storage register and linearity to within  $\pm \frac{1}{2}$  LSB. The output of the converter is monotonic, having a differential nonlinearity of  $\pm \frac{1}{2}$  LSB maximum. Offset zero error on each channel has been adjusted to zero prior to shipping the board; pots on the board permit recalibration of zero or offset settings using the supplied Diagnostic program.

continued

SineTrac™ ST-724 Multibus 4-Channel D/A Board

Zero temperature coefficient (unipolar outputs only) for the converter is less than  $\pm 5$  ppm/ $^{\circ}$ C of Full Scale Reading. Offset temperature coefficient (bipolar outputs only) is within  $\pm 10$  ppm/ $^{\circ}$ C of FSR. Maximum gain tempco measures  $\pm 20$  ppm/ $^{\circ}$ C of FSR. DAC settling time is 4  $\mu$ sec maximum (to within  $\frac{1}{2}$  LSB of value), and slew rate is 20V/ $\mu$ sec.

The voltage output ranges from the ST-724 board are jumper selectable and have an output impedance of 50 milliohms. Maximum available current on the voltage outputs is  $\pm 5$ mA. The ST-724 also provides voltage to current converters for each of its four D/A channels.

The current output option is jumper-selected by the user, and requires a user-supplied external excitation source (+18 to +30 Vdc).

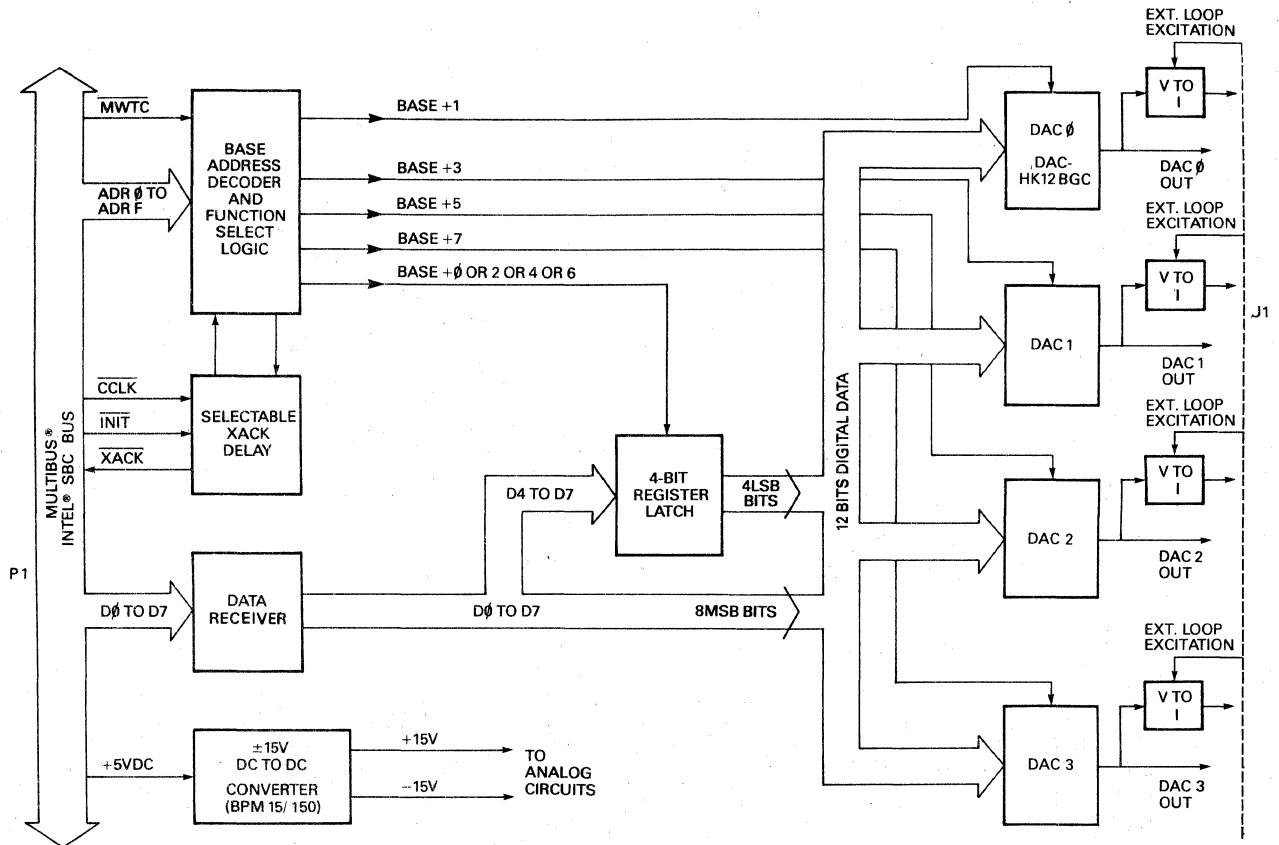
The ST-724 is a memory-mapped device which occupies 8 consecutive memory locations. The starting (base) address is set at the factory to F708, for compatibility with the in-

cluded Diagnostic Program. However, the user may reposition this base address anywhere up to FFF8 in the host computer's memory by reconfiguring jumpers on the ST-724 board.

The selectable Transfer Acknowledge Delay Circuit (XACK/Delay) provides 16 delays from .05 to 1.5  $\mu$ sec which may be jumper-programmed by the user.

The overall size of the ST-724 is 12.0"W  $\times$  6.75"D  $\times$  0.5"H (305  $\times$  172  $\times$  13 mm). Multiple ST-724 boards may be installed in adjacent card slots if used in a standard (.60" spacing) Intel card cage. The ST-724 weighs 18 ounces (.51 kg). It should be operated in an ambient temperature from 0 to +55 $^{\circ}$ C, with relative humidity from 10% to 95% (non-condensing), and from 0 to 15,000 ft (0 to 4600m) in altitude. The board may be stored at temperatures from -25 $^{\circ}$ C to +85 $^{\circ}$ C. The ST-724 is powered from the host computer bus's +5 Vdc supply, and draws 1.5A.

**ST-724**  
**BLOCK DIAGRAM**  
**4-Channel D/A**



**SPECIFICATIONS**

Typical at +25°C, dynamic conditions, unless otherwise specified

**D/A ANALOG OUTPUT**

**Number of Channels** . . . 4 D/A channels  
**Channel Expansion** . . . Indefinite channel expansion by separate, stand-alone ST-724 boards, each with a different base address; limited by available card slots, and power supply current.

**Full Scale**

**Output Ranges** . . . . ±10V (standard)  
                                   ±5V  
                                   0→+10V  
                                   0→+5V  
                                   4-20 mA  
                                   (Current Loop)

**Digital Input Coding** . . . Straight Binary  
                                   Offset Binary (standard)  
                                   2's Complement

**Output Impedance** . . . . 50 Milliohms  
**Maximum Current Available on Voltage Outputs** . . . . ±5 mA @ ±10V short-circuit-proof to ground

**ADDRESSING** Reserves a block of 8 memory locations, all successive to a jumper-selectable memory base address

**CURRENT LOOP EXTERNAL EXCITATION VOLTAGE** +18V to +30VDC, regulated, user-supplied. (25 mA maximum/DAC)

**PERFORMANCE**  
**Non-linearity** . . . . . ±½ LSB maximum  
**Differential Non-linearity** . . . . . ±½ LSB maximum  
**Offset or Zero Error** . . . Adjustable to zero using pot. Each channel individually adjustable.

**ORDERING GUIDE**

MODEL	DESCRIPTION
ST-724	4 Channel, Multibus-Compatible D/A Board
31-2076040	Edge Connector, J1, Spare (One Included with Board) (PCB to solder tab)
58-12140-41	ST-724 Manual (One Included with Board)

**Zero Temperature Drift** . . . . . (Unipolar Output only) Within ±5 ppm of FSR/°C  
**Offset Temperature Drift** . . . . . (Bipolar Output only) Within ±10 ppm of FSR/°C  
**Gain Temperature Drift** . . . . . Within ±20 ppm of FSR/°C  
**Settling Time** . . . . . Maximum, 4 μsec to within ½ LSB of final value  
**Slew Rate** . . . . . 20V/μsec  
**Power Supply Rejection** . . . . . 54 dB to DC supply bus

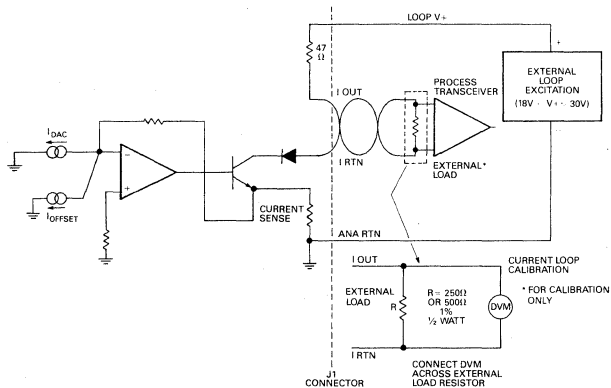
**PHYSICAL**

**Outline Dimensions** . . . 12.00"W × 6.75"D × 0.50"H (304, 8 x 171, 5 x 12, 7 mm)  
 ST-724 boards may be installed adjacent to each other in SBC card cages.  
**Weight** . . . . . 18 ounces (.510 kg)  
**Operating Temperature Range** . . . . . 0 to +55°C  
**Storage Temperature Range** . . . . . -25°C to +85°C  
**Relative Humidity** . . . . . 10% to 95%, non-condensing  
**Altitude** . . . . . 0 to 15,000 ft (4600m)

**POWER CONSUMPTION** +5Vdc ±5% @ 1.5A from computer bus (±15Vdc supplied from on-board DC/DC power converter.)

**GENERAL**  
**Compatibility** . . . . . Pin-for-pin, cardguide, and program compatible with Multibus and SBC-series microcomputers. A pin-for-pin replacement for the SBC-724.

TYPICAL CURRENT LOOP WIRING ST-724



**INPUT DATA FORMAT**

Since 12-bit D/A converters are used on the ST-724, and since the Intel Multibus provides for only 8-bits of data per memory word, two 8-bit bytes in two sequential memory words are necessary for each D/A conversion.

The LS Byte is loaded onto the board first and is stored in a 4-bit register until the MS Byte is loaded. Thus, the memory location of the LS Byte is always the lower of the two locations used for a given channel. Conversion begins as soon as the MS Byte is loaded; within 4 microseconds an analog signal appears at the board's output.

LEAST SIGNIFICANT BYTE

D7 D6 D5 D4 D3 D2 D1 D0

DAC BIT 9	DAC BIT 10	DAC BIT 11	DAC BIT 12 (LSB)	X	X	X	X
-----------	------------	------------	------------------	---	---	---	---

MOST SIGNIFICANT BYTE

DAC BIT 1 (MSB)	DAC BIT 2	DAC BIT 3	DAC BIT 4	DAC BIT 5	DAC BIT 6	DAC BIT 7	DAC BIT 8
-----------------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

X = Don't care

**REGISTERS**

The memory address bit function assignments are as follows. For an explanation of LSB and MSB Bytes, please see "Input Data Format".

**ST-724 REGISTER ASSIGNMENTS**

MEMORY ADDR.	FACTORY ASSIGNED MEM. ADDR.	FUNCTION
M+0	F708	Output LSB Byte for DAC 0 (Channel 0)
M+1	F709	Output MSB Byte for DAC 0 (Channel 0)
M+2	F70A	Output LSB Byte for DAC 1 (Channel 1)
M+3	F70B	Output MSB Byte for DAC 1 (Channel 1)
M+4	F70C	Output LSB Byte for DAC 2 (Channel 2)
M+5	F70D	Output MSB Byte for DAC 2 (Channel 2)
M+6	F70E	Output LSB Byte for DAC 3 (Channel 3)
M+7	F70F	Output MSB Byte for DAC 3 (Channel 3)

**DIAGNOSTIC PROGRAM**

A Diagnostic program formatted on paper tape is shipped with each ST-724 board. Used with a teletypewriter, the Diagnostic can perform a quick but thorough electrical checkout when the board is first installed. It can also be used to calibrate the ST-724. The names of the tests the Diagnostic can perform (each with a brief description) appear in the chart below. A complete listing of the Diagnostic, and some sample programs form part of the systems manual provided with each ST-724 board.

TEST NAME	TTY CALL KEY	DESCRIPTION
Calibration Test	C	User specifies any D/A channel through 3; enters in hex a digital input to that channel; and the corresponding analog voltage or current output appears on J1 of ST-724. Used to adjust offset and gain settings for each channel.
Sawtooth Test	S	A sawtooth waveform appears on the outputs of all 4 D/A channels simultaneously. Checks for missing or shorted bits.
Calibration Table	T	Inputs to ST-724 a program-generated range of hex codes; pauses on each for 2 to 3 seconds (to permit accurate output reading by DVM); and operates continuously without prompting. Checks output linearity.

**D/A CALIBRATION PROCEDURE**

Calibration of the ST-724 should be performed every 90 days or whenever the Analog Output Range jumpers are reconfigured. More frequent calibration may be indicated in adverse operating conditions. The Diagnostic program supplied with the ST-724 was written as part of the calibration procedure. Please see the section entitled "Diagnostic Program".

1. Set the board jumpers for the desired output range: 0→+5V, 0→+10V, 4→20 mA, ±5V, or ±10V. See "Output Range Selection" for details.
2. Connect a digital voltmeter (Fluke 8800A or equivalent) to the outputs of Channel 0 (DAC 0). For voltage ranges, measure between "V OUT" and "ANA RTN". For current ranges the user must supply a precision 250Ω or 500Ω resistor; voltage measurements are then made across this resistor (see Note 1, bottom of Calibration Table).
3. Using the Diagnostic program, select the "Calibration Test", Call Key "C".
4. The teletypewriter will respond by printing out:  
CALIBRATION TEST  
CHANNEL-
5. Enter character "0" to select Channel 0 (DAC 0)  
CHANNEL- 0  
HEX DATA
6. Making reference to the Calibration Table, enter the hex code for the -Full Scale output voltage (or current), then enter a Carriage Return. Adjust the OFFSET potentiometer, until the reading on the DVM corresponds to the -Full Scale reading from the table.
7. Refer again to the Calibration Table, and enter the hex code for + Full Scale voltage or current. Adjust the GAIN potentiometer until the reading on the DVM is the + Full Scale voltage as indicated in the table.
8. Repeat steps 6 and 7.
9. Calibration for Channels 1, 2, and 3 (DAC's 1, 2 & 3) is the same as for Channel 0.
10. The complete calibration may now be checked using the Calibration Table. Any hex value on the table may be entered followed by a carriage return. The corresponding analog output should appear on the DVM.

**CALIBRATION TABLE**

ANALOG OUTPUT				4-DIGIT HEX INPUT			
UNIPOLAR (STRAIGHT BINARY)				BIPOLAR (OFFSET OR 2'S COMPLEMENT)		STRAIGHT OR OFFSET BINARY - NO SIGN EXTENSION	2'S COMPLEMENT WITH SIGN EXTENSION
VOLTAGE		4→20 mA CURRENT <sup>1</sup>		±5V	±10V		
0→+5V	0→+10V	500Ω LOAD LOOP V+>18V	250Ω LOAD LOOP V+>15V				
4.9988V	9.9976V	9.9980V	4.9990V	4.9976V	9.9951V	FFF0	7FF0
4.9976V	9.9951V	9.9961V	4.9980V	4.9951V	9.9902V	FFE0	7FE0
4.9951V	9.9902V	9.9922V	4.9961V	4.9902V	9.9805V	FFC0	7FC0
4.9902V	9.9805V	9.9844V	4.9922V	4.9805V	9.9609V	FF80	7F80
4.9805V	9.9609V	9.9687V	4.9844V	4.9609V	9.9219V	FF00	7F00
4.9609V	9.9219V	9.9375V	4.9687V	4.9219V	9.8437V	FE00	7E00
4.9219V	9.8437V	9.8750V	4.9375V	4.8437V	9.6875V	FC00	7C00
4.8437V	9.6875V	9.7500V	4.8750V	4.6875V	9.3750V	F800	7800
4.6875V	9.3750V	9.5000V	4.7500V	4.3750V	8.7500V	F000	7000
4.3750V	8.7500V	9.0000V	4.5000V	3.7500V	7.5000V	E000	6000
3.7500V	7.5000V	8.0000V	4.0000V	2.5000V	5.0000V	C000	4000
2.5000V	5.0000V	6.0000V	3.0000V	0.0000V	0.0000V	8000	0000
1.2500V	2.5000V	4.0000V	2.0000V	-2.5000V	-5.0000V	4000	C000
0.6250V	1.2500V	3.0000V	1.5000V	-3.7500V	-7.5000V	2000	A000
0.3125V	0.6250V	2.5000V	1.2500V	-4.3750V	-8.7500V	1000	9000
0.1563V	0.3125V	2.2500V	1.1250V	-4.6875V	-9.3750V	0800	8800
0.0781V	0.1563V	2.1250V	1.0625V	-4.8437V	-9.6875V	0400	8400
0.0391V	0.0781V	2.0625V	1.0312V	-4.9219V	-9.8437V	0200	8200
0.0196V	0.0391V	2.0312V	1.0156V	-4.9609V	-9.9219V	0100	8100
0.0098V	0.0196V	2.0156V	1.0078V	-4.9805V	-9.9609V	0080	8080
0.0049V	0.0098V	2.0078V	1.0039V	-4.9902V	-9.9805V	0040	8040
0.0024V	0.0049V	2.0039V	1.0020V	-4.9951V	-9.9902V	0020	8020
0.0012V	0.0024V	2.0020V	1.0010V	-4.9976V	-9.9951V	0010	8010
0.0000V	0.0000V	2.0000V	1.0000V	-5.0000V	-10.0000V	0000	8000

Note 1: Both the 250Ω and the 500Ω resistors (.1% precision) provide 4 to 20 mA output. The current output circuit is calibrated in terms of voltage since most digital multimeters provide greater resolution and accuracy on voltage measurements than on current.

The voltages listed are those measured across a 250Ω or a 500Ω precision resistor, connected between "I RTN" and "I OUT" on any

DAC output. A user-supplied DC regulated voltage, V+ (+15V < V+ ≤ +30V for 250Ω resistor, +18V < V+ ≤ +30V for 500Ω resistor; 25 mA max) is required for current output and calibration, and should be connected to "V + LOOP". The supply providing V+ should be grounded at "ANA RTN".

**BASE ADDRESS SELECTION**

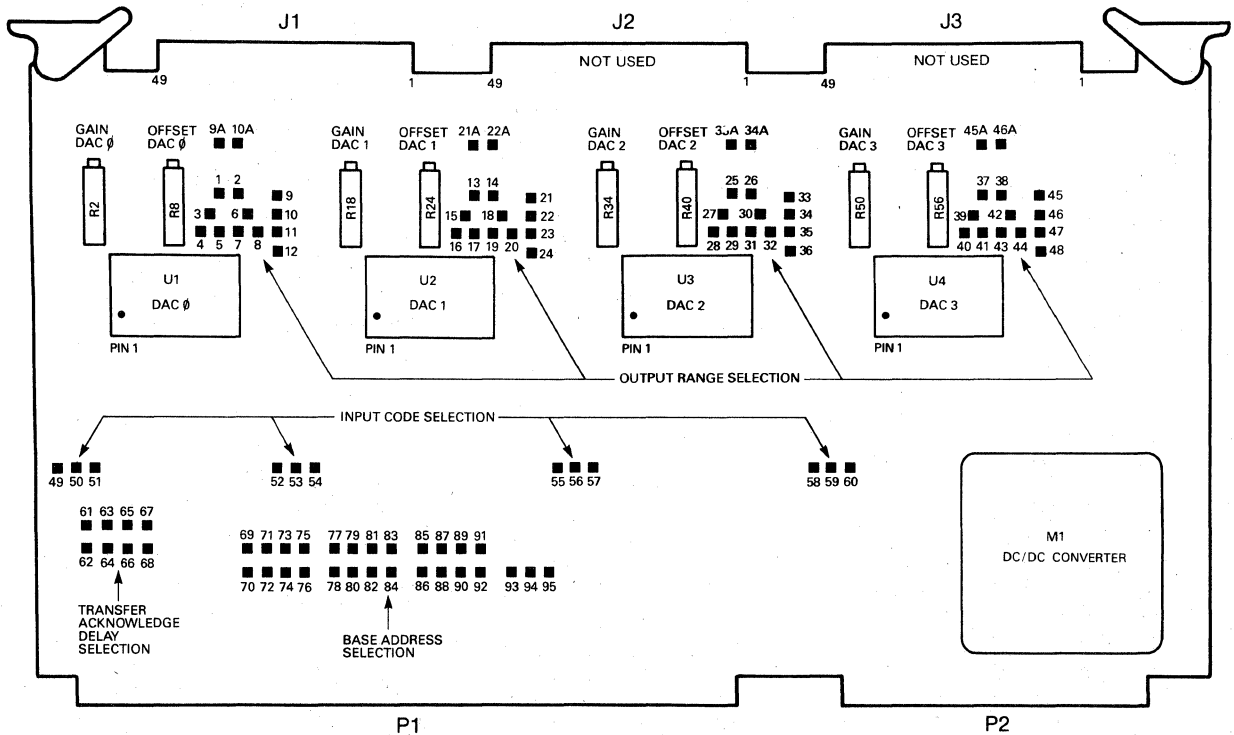
1. Select a base address, in hex, between 0000 and FFF8.
2. Write it in squares below opposite "Base Address, Hex".
3. Convert the hex code to binary by writing 1's and 0's in the appropriate boxes below (opposite "Hex Bit Weighting").
4. To set the base address, insert a jumper at each location opposite a "1". Please note that to obtain a "low" ("0") on bit 3, the jumper between 93 and 94 must be removed, and a jumper between 94 and 95 must be added.

BASE ADDRESS HEX	(0 to F)				(0 to F)				(0 to F)				(0 or 8)
HEX BIT WEIGHTING	8 4 2 1				8 4 2 1				8 4 2 1				8
ADDRESS BIT #	F	E	D	C	B	A	9	8	7	6	5	4	3
JUMPERS IN FOR "1", OUT FOR BIT "0"	69 to 70	71 to 72	73 to 74	75 to 76	77 to 78	79 to 80	81 to 82	83 to 84	85 to 86	87 to 88	89 to 90	91 to 92	93 to 94*

\*For low on bit 3, remove 93 to 93 and add 94 to 95

**BOARD LAYOUT**

COMPONENT SIDE





**OUTPUT RANGE AND INPUT CODING SELECTION**

The ST-724's 4 D/A output channels may be set independently for any of four voltage ranges or a single current output range. Full scale ranges of  $\pm 10V$ ,  $\pm 5V$ ,  $0 \rightarrow +10V$ ,  $0 \rightarrow +5V$ , or  $4 \rightarrow 20$  mA may be jumper-selected according to the chart below. Input digital coding may be offset binary, 2's complement, or straight binary on any channel. Again, refer to the chart below for details.

The ST-724 board is normally shipped with jumpers set for the  $\pm 10V$  output, and an offset binary input coding. Please note that whenever there is a change in output range on a given channel, that channel should be recalibrated.

OUTPUT RANGE SELECTION JUMPERS				
RANGE	DAC $\emptyset$	DAC 1	DAC 2	DAC 3
$\pm 10V$ (STANDARD)	3-5 6-7	15-17 18-19	27-29 30-31	39-41 42-43
$\pm 5V$	3-5 6-8	15-17 18-20	27-29 30-32	39-41 42-44
0 to +10V	3-4 6-8	15-16 18-20	27-28 30-32	39-40 42-44
0 to +5V	1-2 3-4 6-8	13-14 15-16 18-20	25-26 27-28 30-32	37-38 39-40 42-44
4 to 20 mA CURRENT LOOP	9-10 11-12 9A-10A	21-22 23-24 21A-22A	33-34 35-36 33A-34A	45-46 47-48 45A-46A

INPUT CODE SELECTION JUMPERS				
CODE	DAC $\emptyset$	DAC 1	DAC 2	DAC 3
UNIPOLAR OR OFFSET BINARY (STANDARD)	49-50	52-53	55-56	58-59
2'S COMPLEMENT	50-51	53-54	56-57	59-60

**TRANSFER ACKNOWLEDGE (XACK/) DELAY SELECTION**

The ST-724 board generates a Transfer Acknowledge (XACK/) signal in response to Write commands from the host computer. It is sometimes desirable to delay this signal, in order to match the XACK/ signal to the host computer timing. A jumper selectable Transfer Acknowledge Delay (XACK/ delay) ranging from 50 nanoseconds to 1.5 microseconds is available in the ST-724.

The accuracy of the XACK/ delay is dependent in part on the duty cycle of the CCLK/ signal generated by the computer—shorter duty cycles result in greater accuracy. The delay time is advanced on the leading edge of CCLK/; XACK/ is generated on the trailing edge of CCLK/.

Please refer to the table below for jumper configurations yielding different delay times.

XACK/ DELAY SELECTION				
DELAY $\mu\text{sec.}$	JUMPERS			
*0.05	—	—	—	—
0.1	61-62	—	—	—
0.2	—	63-64	—	—
0.3	61-62	63-64	—	—
0.4	—	—	65-66	—
0.5	61-62	—	65-66	—
0.6	—	63-64	65-66	—
0.7	61-62	63-64	65-66	—
0.8	—	—	—	67-68
0.9	61-62	—	—	67-68
1.0	—	63-64	—	67-68
1.1	61-62	63-64	—	67-68
1.2	—	—	65-66	67-68
1.3	61-62	—	65-66	67-68
1.4	—	63-64	65-66	67-68
1.5	61-62	63-64	65-66	67-68

\*Factory supplied configuration.

**ANALOG OUTPUT CONNECTIONS**

J 1

ETCH SIDE	PIN #S		COMPONENT SIDE
NC	2	1	NC
NC	4	3	NC
NC	6	5	NC
NC	8	7	NC
NC	10	9	NC
NC	12	11	NC
NC	14	13	NC
NC	16	15	NC
NC	18	17	NC
NC	20	19	NC
NC	22	21	NC
DAC 3, V OUT	24	23	NC
DAC 3, I OUT	26	25	DAC 3, I RTN
DAC 3, LOOP V + IN	28	27	DAC 3, ANA RTN
DAC 2, V OUT	30	29	NC
DAC 2, I OUT	32	31	DAC 2, I RTN
DAC 2, LOOP V + IN	34	33	DAC 2, ANA RTN
DAC 1, V OUT	36	35	NC
DAC 1, I OUT	38	37	DAC 1, I RTN
DAC 1, LOOP V + IN	40	39	DAC 1, ANA RTN
DAC $\emptyset$ , V OUT	42	41	NC
DAC $\emptyset$ , I OUT	44	43	DAC $\emptyset$ , I RTN
DAC $\emptyset$ , LOOP V + IN	46	45	DAC $\emptyset$ , ANA RTN
POWER COMMON	48	47	POWER COMMON
-15 REF. VOLT. OUT*	50	49	+15 REF. VOLT. OUT*

\*Not intended to power external circuitry; 1 mA max.

# SineTrac™ ST-800 Series High Performance A/D & D/A Boards for SBC-80 & MULTIBUS Microcomputers

## THE FEATURES

### Simple Channel Expansion and High Channel Density

Only two cards are needed to provide 80 single-ended or 64 differential A/D channels! A/D or D/A expansion simply consists of adding cards. High density CMOS LSI multiplexers offer up to 48 Differential Expander A/D channels per card. D/A's expand in 4 or 8 channel increments.

### Highest Throughput Speed

A/D conversion and settling takes only 20 microseconds. When DMA is used, data bursts up to 36,000 samples per second may occur.

## CIRCUIT FEATURES

### Input Protection

Overvoltages up to  $\pm 35V$  won't damage the A/D section. A/D Expanders may accept input fuses or resistors and clamping diodes for higher voltages.

### 3 Scan Start Methods

1. Program scan start
2. On-board adjustable scan timer
3. External start pulse

### Current Inputs

A/D Expander boards may accept on-board resistors for 4-20mA, 1-5 mA and 10-50 mA current inputs.

### Jumper-Selected Automatic High-speed DMA

All A/D systems include jumper-selected control of a user-supplied Intel DMA (Direct Memory Access) Control Board. On-board channel address registers and logic automatically scan a program-selected channel group at the highest speed.

### Diagnostic Test Programs

Paper tapes are included plus a full listing of the Diagnostic in the supplied manual.

### Complete Manuals Included

Datel includes circuit and programming manuals with all systems. Programming manuals include sub-routine listings and programming examples.

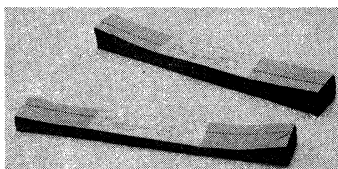
### On-board Start/Final Channel Logic for Lowest CPU Handling

Channel address registers free the CPU from channel counting and scan termination for highest speed and simplest programming.

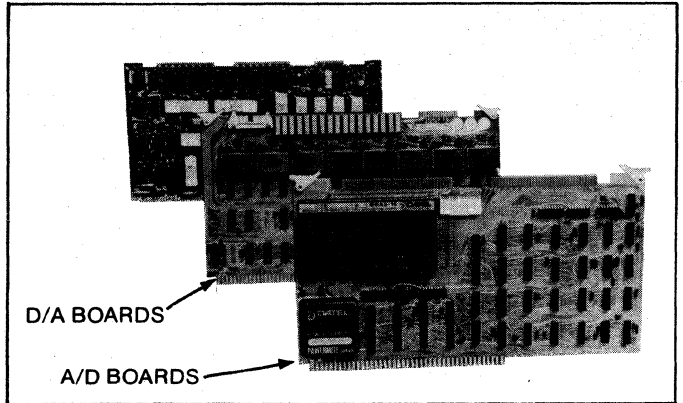
### Widest Assortment of Accessories

Datel's SineTrac 800 product line includes over a dozen optional cables/connectors, A/D-D/A expander boards and a digital output port module.

## THE PROGRAMS



Complete paper tape diagnostic programs are supplied with every system. These programs provide decimal printouts of averaged A/D scans for calibration and GO/NO-GO accuracy testing. D/A programs offer square wave and sawtooth oscilloscope outputs.

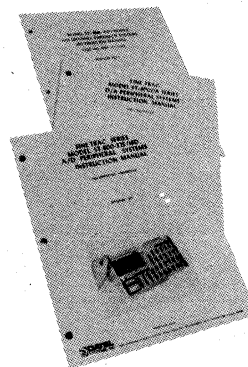


COMPATIBLE TO: **SBC-80 SERIES**  
**MDS-800**

## DATEL-INTERASIL'S FULL LINE OF A/D-D/A BOARDS FOR SBC-80/MULTIBUS MICROCOMPUTERS

Datel-Intersil has two product lines for SBC-80 and MDS-800 MULTIBUS computers. The ST-800 series presented here include separate A/D and D/A boards with additional slave channel expanders. The ST-711, 724 and 732 series includes a combination A/D-D/A board (ST-732) a D/A board with 4-20 mA current loop amplifiers (ST-724) and a low level, high isolation relay-input A/D board (ST-711RLY). Generally, the ST-800 series is treated as an I/O peripheral, features higher channel density per board, lower cost per channel, higher speeds, easy low-cost channel expansion and DMA operation when used with Intel's DMA Controller. The ST-711, 724, 732 series are memory-mapped peripherals which are exact replacements for competitive SBC-711, 724, 732 boards. This series operates directly from Intel RMX-80 software and offers more industrial and signal conditioning features such as current loop channels, programmable gain, high-gain preamplifiers and programmable Pacer start clocks.

## THE MANUALS



3 Comprehensive Systems Manuals on:

1. A/D MASTER BOARDS
2. A/D SLAVE EXPANDERS
3. D/A MASTERS AND SLAVE EXPANDER BOARDS

The manuals include full diagnostic program listings plus circuits, timing diagrams, programming, applications, and logic diagrams.

INTEL, RMX-80 AND MULTIBUS ARE INTEL CORP. TRADEMARKS

## DESCRIPTION

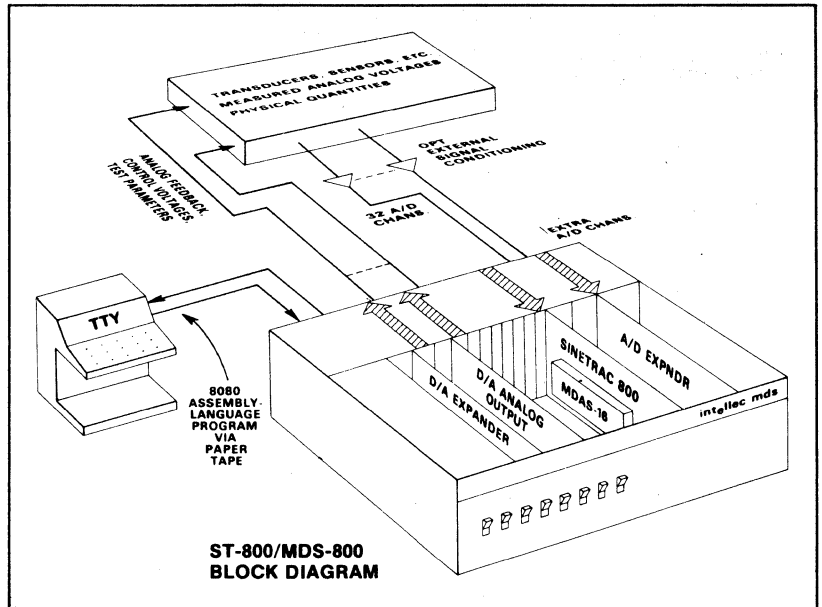
Datel offers a simple approach to measuring analog inputs via the Intel MDS-800 Microcomputer Development System or Intel's SBC-80/10 Single Board Computer. Datel's SineTrac 800 data acquisition module plugs directly into the MDS-800 or SBC-80/10, accepting 32 or more analog channels inside the same housing. The SineTrac 800 high-speed analog card communicates on the MDS or SBC CPU bus and is handled as an addressable peripheral I/O device. Analog connections are made through convenient rear-panel connections on the MDS-800 housing. Programs written in universal 8080 microprocessor assembly language instructions completely control all activities of the SineTrac 800 data acquisition card. These include random or sequential channel addressing with automatic reset on user-specified first and last channels. By using the I/O device communications capability resident in Intel's monitor program, the SineTrac 800 analog inputs can be directly printed out on a teletypewriter, punched onto paper tape or magnetic tape cassette or left in memory for further arithmetic manipulation before printout.

The SineTrac 800 card is ideal for process control, automatic test systems, laboratory measurement systems and similar applications. Additional SineTrac 800 boards allow for (1) A/D channel expansion in increments of 48 channels per board or (2) a D/A board with eight 12-bit D/A analog output converters per board (expandable to 256 channels).

The D/A option board contains storage registers for each 12-bit analog word to maintain a stabilized analog output between output cycles. The D/A option is ideal for plotter, chart recorder, oscilloscope or actuator drive.

The SineTrac 800 can accept three modes of operation including program control, direct memory access (DMA) or interrupt operation. Program mode consists of direct operation of the SineTrac 800 system by assembly language instructions at the time and sequence specified by the program. DMA operation accommodates direct memory loading in blocks using Intel's DMA board but without routing through the CPU. DMA operation can accommodate block transfers up to the SineTrac 800's full speed of 36,000 samples per second. Interrupt operation is ideal for serving other peripherals besides the SineTrac 800 whenever the device or the data is ready. Interrupt can accept virtually simultaneous data conversion, output formatting and printout.

The SineTrac 800 card is organized around Datel's MDAS-16, a high density data acquisition module employing a hybrid successive approximation A/D converter, FET multiplexer switches, integrated circuit Sample/Hold amplifier and tri-state TTL output buffer/registers.



Address decoders, bidirectional bus drivers and receivers, status registers, FET MUX switches, a  $\pm 15V$  DC/DC converter and control logic complete the rest of the SineTrac 800.

## BACKGROUND

The concept of using A/D and D/A conversion inside a computer housing is relatively new. The idea became a reality with the advent of complete miniature data acquisition modules such as Datel's MDAS-16. The MDAS-16, which is the heart of the SineTrac 800 A/D board, includes a hybrid A/D converter (Datel's model ADC-HZ) sample/hold amplifier (Datel's model SHM-LM-2), LSI CMOS analog multiplexer (Datel's MX-1606) and control logic. Earlier A/D data acquisition components consumed too much space to be conveniently packaged inside the computer housing. Another problem with an internal A/D system was the high level of logic noise from the computer's digital circuitry. This noise occurred both as electromagnetic noise and as voltage noise distributed on power supply busses. Datel has solved the noise problems by shielding the MDAS-16 module in a 6-sided steel cover and by generating filtered  $\pm 15VDC$  power from the computer's 5V bus using a modular DC to DC converter.

The advent of hybrid technology provided miniature A/D and D/A converter modules and offered very high channel

densities. A single SineTrac D/A board may contain 8 D/A channels or 32 A/D channels. The hybrid converter package includes circuit elements from different technologies which are combined by wire-bonding on a common substrate to give the highest performance.

Such dissimilar technologies as bipolar logic gates and bipolar linear circuits (with different doping characteristics) and MOS semiconductors are not easily combined in one monolithic process with cost-effective yields. But by combining dissimilar circuits on a hybrid substrate, the high speed, high accuracy, low drift performance of Datel's SineTrac systems are realized.

## USER BENEFITS

Only recently, connecting an A/D-D/A system to a computer involved three hardware problems — analog signal cabling, digital I/O cabling and the interface circuit design. The SineTrac concept of slide-in A/D-D/A cards with on-board interfaces eliminates two of the most difficult problems — digital I/O cabling and interface circuit design. Datel also offers a strong head start in one other problem area — test and development software. All SineTrac systems include a paper tape diagnostic test program written in 8080 assembly language with extensive comments. While the user still must develop his own application program, Datel's program offers quick on-the-air system check-out.

# SPECIFICATIONS (typical @ +25°C when calibrated unless noted)

## DATA ACQUISITION SECTION (A/D ANALOG INPUTS)

### SPECIFICATIONS

(Typical @ +25°C, dynamic conditions, unless otherwise specified)

#### ANALOG INPUTS

Number of Channels	32 Single-ended or 16 Differential non-isolated
Channel Expansion	Up to 256 single-ended or differential channels using ST-800-ADX slave expander cards.
Full Scale Input Voltage Ranges	0 to +5 volts 0 to +10 volts -5 to +5 volts -10 to +10 volts
Common Mode Range	±10 volts maximum
Input Overvoltage	±35 volts maximum sustained (no damage)*
Input Impedance	100 megohms differential or to ground.
Input Bias Current	3nA typical, 10nA maximum
Input Capacitance	10pF, OFF channel, 100pF, ON channel to ground.

#### PERFORMANCE

Accuracy @ +25°C	Within ±0.025% of full scale range.
Resolution	12 Binary Bits (1 part in 4096)
Nonlinearity	±½ LSB maximum
Differential nonlinearity	±½ LSB maximum
Gain error	Adjustable to zero
Offset or Zero Error	Adjustable to zero
Gain Temperature Drift	Within ±30ppm of FSR/°C
Offset or Zero Temperature Drift	Within ±7ppm of FSR/°C
Common Mode Rejection	70dB min., DC to 1kHz, with 1 Kiloohm unbalance
Power Supply Rejection	100dB to +5V Bus

#### DYNAMIC CHARACTERISTICS

Typical Data Transfer I/O Period (Total)	50 Microseconds (Program Mode) 27 Microseconds (DMA Mode)
Throughput Period	20 Microseconds max.
Acquisition Time	12 Microseconds
A/D Conversion Time	8 Microseconds
Aperture Time	50 nanoseconds
Sample/Hold Switch Feedthrough	0.01% Maximum
MUX Crosstalk from OFF Channels	0.01% @ 1KHz

#### DIGITAL OUTPUTS

Output Coding	Straight Binary (unipolar) Offset Binary (bipolar) 2's Complement (bipolar)	} Jumper Selected
Output Format	2-Byte group electrically compatible to Intel's bidirectional bus for the MDS-800 and SBC-80/10. Sign extension is jumper-installed on bits 12 thru 15 for 2's complement units. Bits 12 thru 15 are logic zero for all other units.	
Channel Addressing	Choice of Direct Memory Address or Program Mode/Program Interrupt:	
	1. Direct Memory Address (DMA) Sequential channel address under SineTrac and Intel DMA board memory address control. Program control or program interrupt mode not available.	
	2. Program Control or Program Interrupt: Random or Sequential channel addressing under program control with 2-byte data transfers to the CPU only. End of Conversion (EOC) and End of Scan (EOS) interrupts available for optional program flagging. DMA mode not available.	
Program Loaded Registers	1. Status Input-loaded from data bits D <sub>0</sub> , D <sub>1</sub> , D <sub>2</sub> D <sub>0</sub> — End of Scan (EOS, Read output on D <sub>7</sub> ) D <sub>1</sub> — Interrupt Enable (CPU grant) D <sub>2</sub> — End of Conversion (EOC, Read output on D <sub>6</sub> )	

\*Pad area available on A/D Expander boards for user to install clamping diodes and protection resistors or fuses.

2. Start Channel Address-loaded from data bits D<sub>0</sub> thru D<sub>7</sub>. A load jams the current address register.
3. Final Channel Address-loaded from data bits D<sub>0</sub> thru D<sub>7</sub>. Rewired by PC board jumpers at base address 000100XX. Bits A<sub>0</sub> and A<sub>1</sub>, decode command functions. Rewired by PC board jumpers at EOC, level 3 and EOS, level 4.

Peripheral Address\* .....

Interrupt Level\* .....

\*Test tapes supplied to users for system verification and checkout are written with the peripheral base address and interrupt levels shown. If other addresses and interrupts are required, the appropriate PC jumpers may be altered by the user after system verification with the original addresses. The verification program may then continue to be used by altering it using the Monitor.

#### POWER CONSUMPTION

1.3 Amps typical @ +5VDC supplied from CPU bus connector. On-board DC/DC converter supplies ±15VDC to linear circuits.

#### PHYSICAL

Operating Temperature Range	0° to +70°C
Storage Temperature Range	-25°C to +85°C
Card Size	12" x 6.75" x 0.5" compatible to guide spacing and I/O pinout of MDS-800 and SBC-80/10 connectors.

## DATA DISTRIBUTION SECTION (D/A ANALOG OUTPUTS)

#### ANALOG OUTPUTS

Number of Channels	8 Single-ended (Model ST-800-DA8) or 4 Single-ended (ST-800-DA4)
Channel Expansion	256 Channels addressable using ST-800-DAX8 or ST-800-DAX4 slave cards.
Full Scale Output Voltage Ranges	0 to +5 Volts 0 to +10 Volts -2.5 to +2.5 Volts -5 to +5 Volts -10 to +10 Volts
Input Coding	Straight Binary (Unipolar) Offset Binary (Bipolar) 2's Complement (Bipolar)
Output Impedance	50 milliohms
Output Current	±5mA min., short circuit proof to ground.

#### PERFORMANCE

Nonlinearity	±½ LSB, maximum.
Differential nonlinearity	±½ LSB, maximum.
Gain Error	Adjustable to zero using pot for each channel.
Offset or Zero Error	Adjustable to zero using a pot for each channel.
Scan Period Adjust	1 to 10 milliseconds.
Gain Temperature Drift	±30ppm of output/°C
Zero Temperature Drift	(Unipolar output) ±5ppm of FSR/°C
Offset Temperature Drift	(Bipolar output) ±15ppm of FSR/°C
Settling Time	4 microseconds to ±½ LSB
Power Supply Rejection	±0.02% of FSR per 1% variation.

#### POWER REQUIREMENTS

Models ST-800-DA8 and DAX8: Externally supplied ±15 VEC @ 320mA maximum and +5VDC @ 1 Amp from CPU bus connections. Models ST-800-DA4 and -DAX4: (Includes on-board DC/DC converter for ±15VDC power) Requires +5VDC @ 1.5 Amps from CPU bus connections.

#### SCAN CLOCK

Integrated circuit clock (74123) used to initiate channel scans via jumper-selectable interrupt flag (rewired at level 5). User-selected scan period by adjusting pot or rewiring RC network.

Peripheral Address\* .....

Interrupt Level\* .....

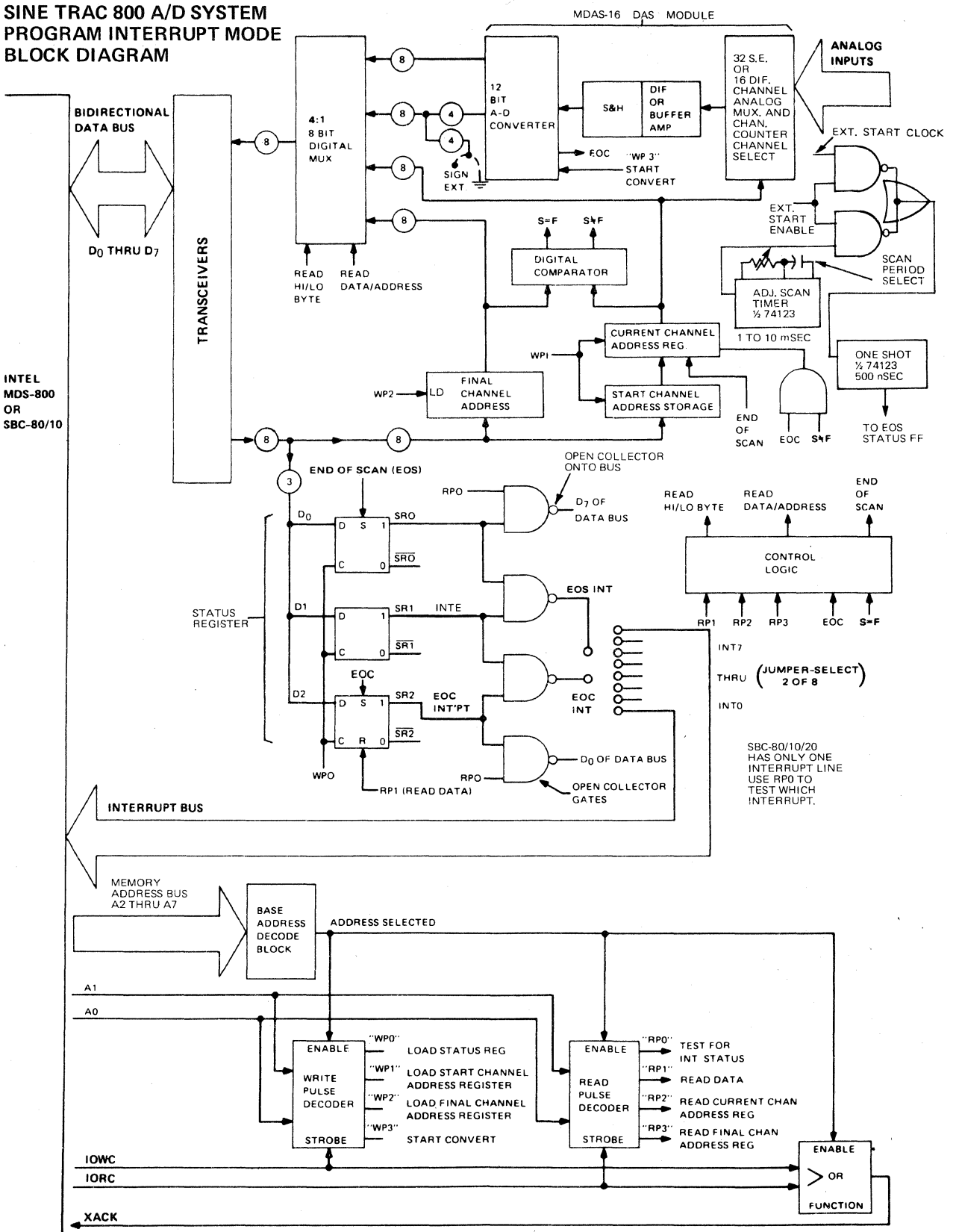
CARD SIZE (8-channel and 4-channel models) ..

- Rewired by PC board jumpers at base address 000101XX. Bits A<sub>0</sub> and A<sub>1</sub>, decode command function. (see note above about test tapes)
- Rewired by PC board jumpers at Scan Clock Time out, level 5 and End of Scan, level 6.

12" x 6.75" x 0.5" compatible to Intel guides and pinout.

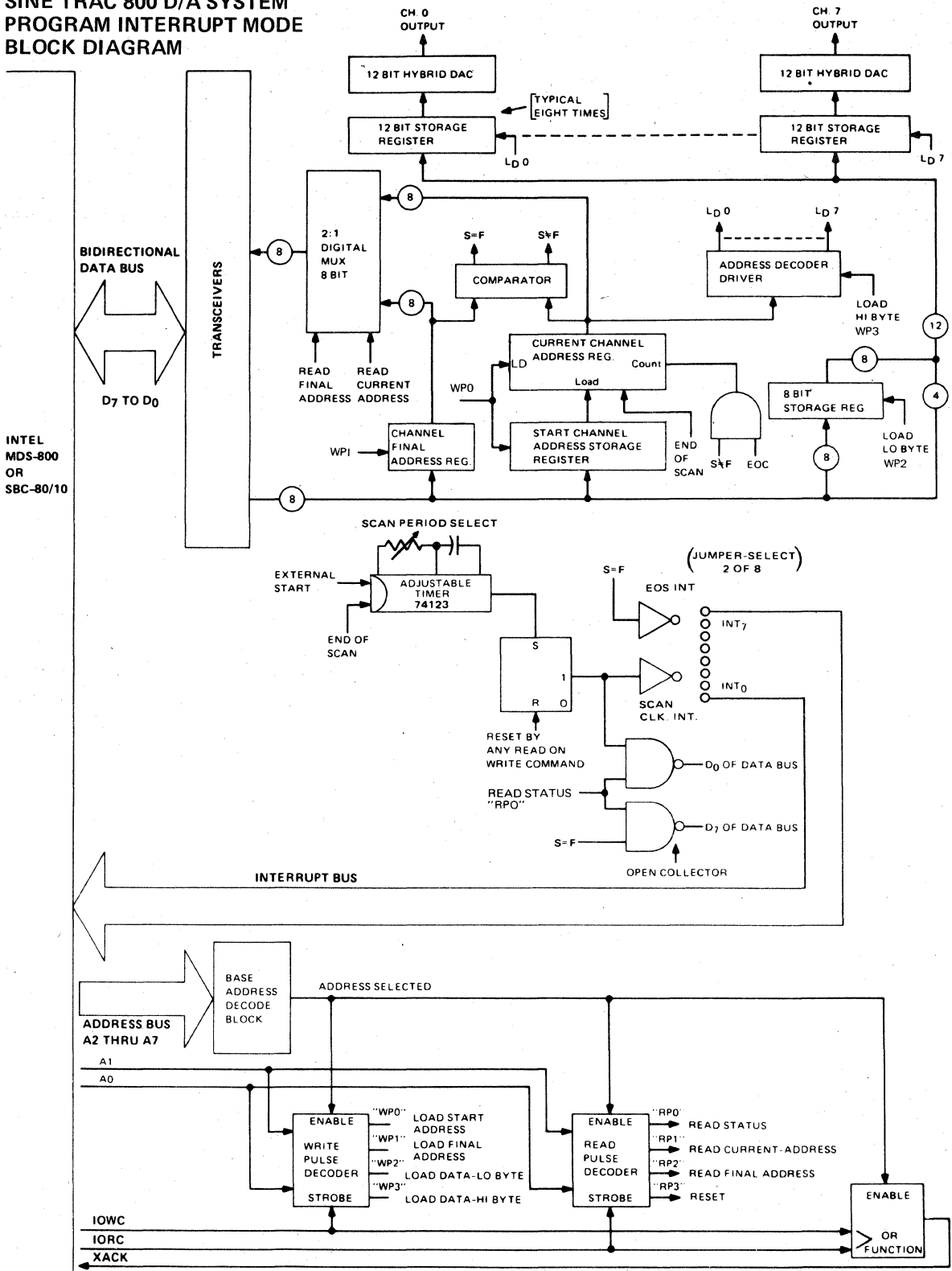
# BLOCK DIAGRAM

## SINE TRAC 800 A/D SYSTEM PROGRAM INTERRUPT MODE BLOCK DIAGRAM



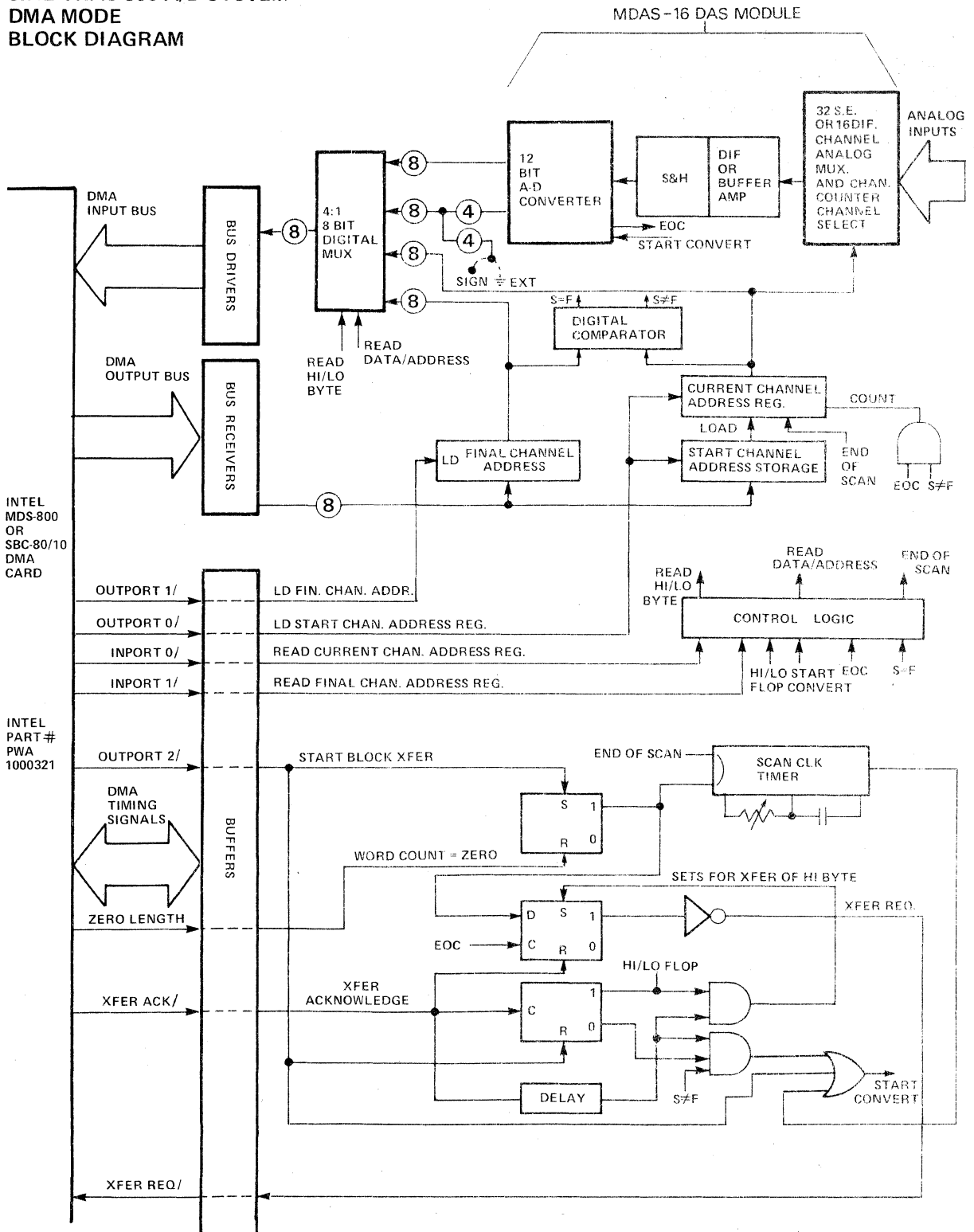
# BLOCK DIAGRAM

## SINE TRAC 800 D/A SYSTEM PROGRAM INTERRUPT MODE BLOCK DIAGRAM



**BLOCK DIAGRAM**

**SINE TRAC 800 A/D SYSTEM  
DMA MODE  
BLOCK DIAGRAM**



**A/D MASTER BOARDS**

Model	Description
<b>ST-800-32S</b>	32 Single-ended A/D Channels
<b>ST-800-16D</b>	16 Differential A/D Channels
<b>ST-800-16S</b>	16 Single-ended A/D channels
<b>ST-800-8D</b>	8 Differential A/D channels

**A/D SLAVE EXPANDER BOARDS**

<b>ST-800-ADX32S</b>	32 Chan. Single-ended
<b>ST-800-ADX32D</b>	32 Chan. Differential
<b>ST-800-ADX48S</b>	48 Chan. Single-ended
<b>ST-800-ADX48D</b>	48 Chan. Differential

**D/A MASTER BOARDS**

<b>ST-800-DA8</b>	8 D/A Channels, requires ext. ±15V @ .32A
<b>ST-800-DA4</b>	4D/A Channels, includes ±15V DC/DC Conv.

**D/A SLAVE EXPANDER BOARDS**

<b>ST-800-DAX8</b>	8 D/A Channels, requires ext. ±15V @ .32A
<b>ST-800-DAX4</b>	4 D/A Channels, includes ±15V DC/DC Conv.

4 AND 8 CHANNEL D/A CARDS CAN BE MIXED.

FOR A/D OR D/A EXPANSION AT A LATER DATE, CONTACT DATEL FOR ADDRESS JUMPER INFORMATION.

**CABLES AND ACCESSORIES**

Model	Description
<b>ST-800-11217</b>	DMA Cable and Connectors for A/D or D/A Boards. 14 in. long (35,6 cm)
<b>ST-800-11218S</b>	Prewired Voltage Divider Connector for Calibration, Single-ended A/D (Used with diagnostic program.)
<b>ST-800-11218D</b>	Prewired Voltage Divider Connector for Calibration, Differential A/D (Used with diagnostic program.)

**ST-800-11219** A/D Expander Cable and Connector for an adjacent board (64 Diff. or 80 Sing. End. Channels, total)

**ST-800-11220** Combination A/D Expander and DMA Cables and Connectors.

**ST-800-11221** A/D Input Cable and Connectors for the Intel MDS-800 only. (Contains an Amphenol connector which mounts directly inside the MDS-800 back panel.)

**ST-800-11222A** D/A Expander Cable and Ribbon Connectors, 14" (35,6 cm) long. Connects (2) D/A Boards, 16 channels total, max.

**ST-800-11222B** D/A Expander Cable and Ribbon Connectors, 14" (35,6 cm) long. Connects (4) D/A Boards, 32 channels total, max.

**ST-800-11223** D/A Output Cable and Connectors for the Intel MDS-800 only. (Contains an Amphenol connector which mounts directly inside the MDS-800 back panel.)

**56-2076060** Dual 50-pin PCB Connector (Provides input to the Intel DMA Board and ADX boards.)

**56-2076050** Dual 36-pin PCB Connector (included) (Provides A/D inputs to the ST-800-16D/32S A/D boards. Also fits the ST-800-16D/32S boards to provide DMA data output and control.)

**56-2073080** Dual 15-pin PCB Connector (included) (Provides D/A Output from all ST-800-DA and -DAX boards.)

**ST-800-11213** Digital Output Port for any D/A board. User-installed in D/A Converter locations. 12 Bits, open-collector 7406, remote pullup.

*\*When ordering, contact Datel to identify whether the scan clock will be used and what type of computer will be employed.*



## MODEL NUMBERS

### SINETRAC 800 A/D SYSTEMS

ST-800-

NUMBER OF CHANNELS AND TYPE
32S- = 32 Single-ended
16D- = 16 Differential
16S- = 16 Single-ended

FULL SCALE INPUT VOLTAGE RANGES
Unipolar Ranges
A = 0 to +5V
B = 0 to +10V
Bipolar Ranges
C = -5V to +5V
D = -10V to +10V

OUTPUT CODING
1 = Straight binary, unipolar
2 = Offset binary, bipolar
3 = 2's Complement, bipolar

MODE JUMPER	
A = DMA* (Requires Intel's DMA Board)	
B = Program Control or Program Interrupt*	
*DMA Mode is installed in all units but is selected using a PC board jumper which can be quickly changed at any time. DMA Mode and Program Control/Program Interrupt cannot be mixed simultaneously but must be changed using the jumper.	

### A/D SLAVE EXPANDER

ST-800-ADX

NUMBER OF ADDITIONAL* CHANNELS AND TYPE	
32S = 32 Single-ended	
32D = 32 Differential	
48S = 48 Single-ended	
48D = 48 Differential	
*Single-ended and differential channels cannot be mixed.	

### SINETRAC 800 D/A SYSTEMS

ST-800-

MASTER OR SLAVE EXPANDER
DA = Master
DAX = Slave (Master req'd for control)

NO. CHANNELS/CARD AND DC/DC CONVERTER
4 = 4 D/A channels DC/DC conv. included
8 = 8 D/A channels no DC/DC conv. (ext. ±15V pwr req'd)

FULL SCALE OUTPUT VOTAGE RANGE
Unipolar Ranges
A = 0 to +5V
B = 0 to +10V
Bipolar Ranges
C = -5V to +5V
D = -10V to +10V
E = -2.5V to +2.5V

INPUT CODING
1 = Straight binary, unipolar
2 = Offset binary, bipolar
3 = 2's complement, bipolar

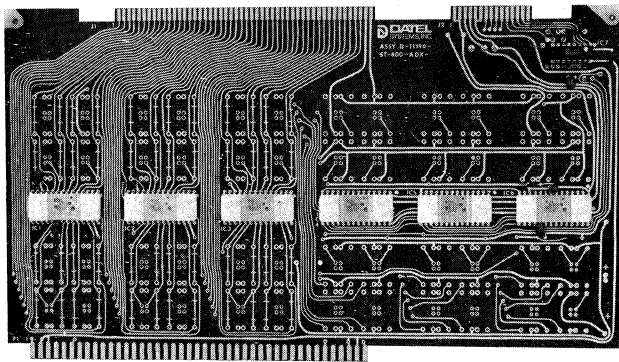
\*When ordering, contact Datal to identify whether the scan clock will be used and what type of computer will be employed.

### A/D-D/A BASE ADDRESSING and A/D STATUS REGISTER

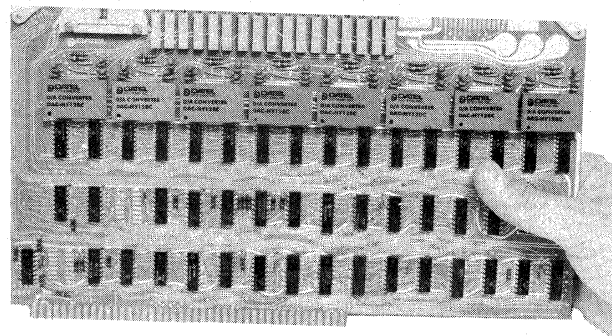
A/D-D/A systems respond to the following base addresses, distributed on the address bus. The address lists are arranged in a typical program control sequence so that if a CPU register is set aside for the base address, incrementing instructions may be used as each step is completed.

Similarly, the A/D status register listing shows that EOC and EOS interrupts may be set up several ways under program control.

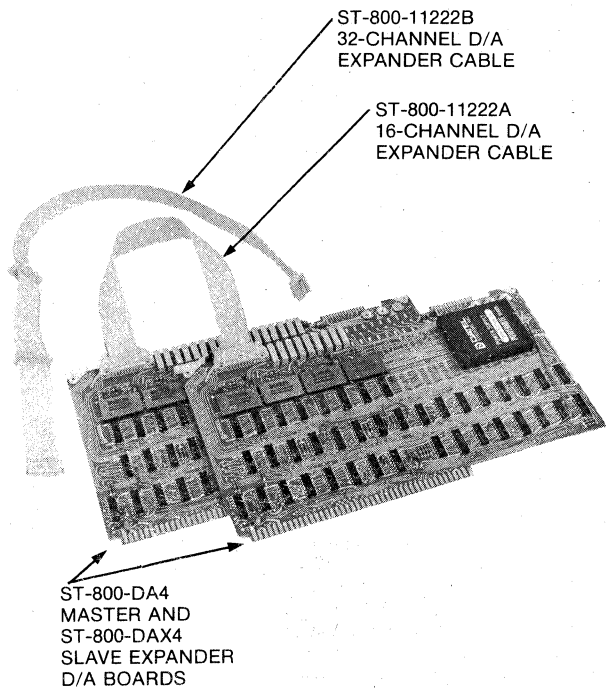
A/D BASE ADDRESSING		
Prewired Address (Hexadecimal)	I/O Command	Function
10	Write	Load D0-D2 into Status register
11	Write	Load D0-D7 into Start Channel Address Register
12	Write	Load D0-D7 into Final Channel Address Register
13	Write	Start A/D Conversion
10	Read	Read EOC Status Bit on D0. Read EOS Status Bit on D7. Enable either EOC or EOS interrupt if set.
11	Read	(1st pulse) Read A/D LSB Byte (2nd pulse) Read A/D MSB Byte
12	Read	Read Current Channel Address on D0-D7
13	Read	Read Final Channel Address on D0-D7
D/A BASE ADDRESSING		
Prewired Address (Hexadecimal)	I/O Command	Function
14	Write	Load D0-D7 into Start Channel Address Register
15	Write	Load D0-D7 into Final Channel Address Register
16	Write	Load D/A LSB Byte
17	Write	Load D/A MSB Byte
14	Read	Read D0=LO if Scan Clock has timed out. Read D7=LO if Current=Final Channel (EOS)
15	Read	Read Current Channel Address on D0-D7
16	Read	Read Final Channel Address on D0-D7
17	Read	Reset Scan Clock Interrupt FF, and all data and channel address registers.
A/D SYSTEM STATUS REGISTER		
STATUS FF	WRITE FUNCTION (Out)	READ FUNCTION (In)
End of Scan (EOS)	D <sub>0</sub> = "1" sets EOS FF	D <sub>7</sub> = "1" indicates EOS is set
Interrupt Enable (INTE)	D <sub>1</sub> = "1" sets INTE FF to enable EOS and EOC interrupts	
End of Conversion (EOC)	D <sub>2</sub> = "1" sets EOC FF	D <sub>0</sub> = "1" indicates EOC is set. Resets when A/D data is read.



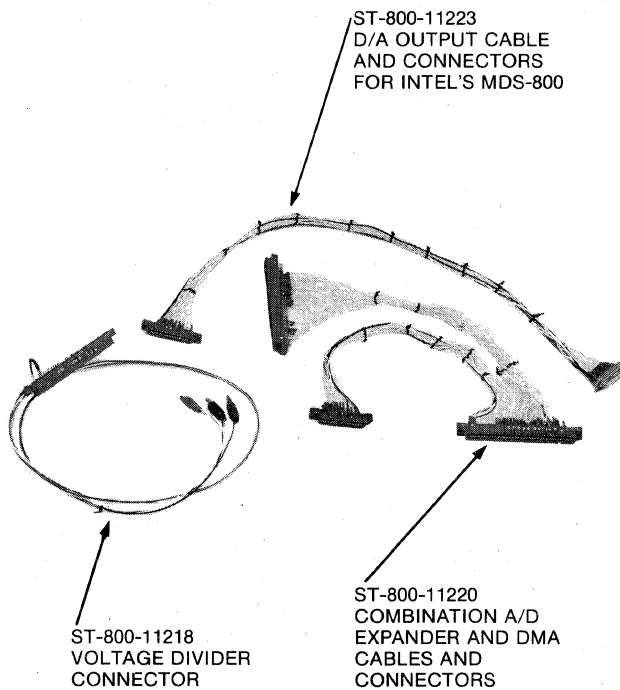
**ST-800-ADX48D**  
**48-CHANNEL A/D SLAVE EXPANDER**



**ST-800-DA8**  
**8-CHANNEL D/A MASTER BOARD**



**D/A MASTER AND**  
**SLAVE EXPANDER BOARDS**



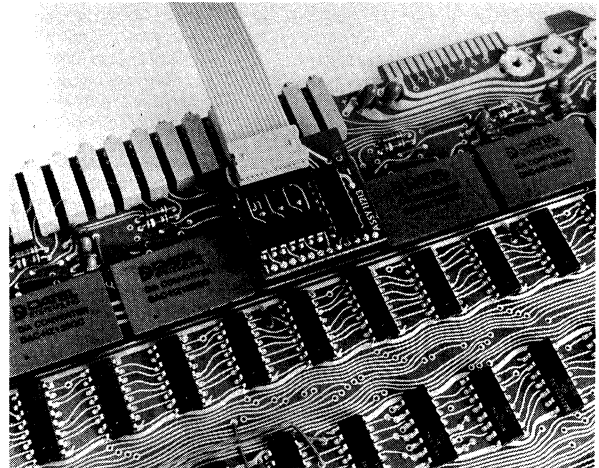
**ACCESSORY CABLES**

## DIGITAL OUTPUT PORT

A valuable accessory to the ST-800-DA and -DAX D/A Output boards is the model ST-800-11213 Digital Output Port. This consists of a 12-bit open collector TTL buffer with user-supplied remote pullup resistors to an external 5-12V power source. The Output Port is a very small PC board, slightly larger than Datel's DAC-HZ hybrid D/A Converters. Any number of Ports may be installed by the user on any D/A board by removing the appropriate DAC-HZ converter. For applications requiring only 12 output bits, an ideal location is the 5th D/A position on ST-800-DA4 and DAX4 boards adjacent to the DC/DC Converter module. This eliminates having to remove a DAC-HZ. Each ST-800-11213 consists of two 7406 open collector hex inverters capable of sinking up to 40mA pulldown current per bit from a remote 5-12V source. Remote pullup resistors to +5V are limited to 150 ohms minimum although most applications will suffice with 1000 ohms or more. Loads may be driven up to 50 feet (15m) from the DIP output socket using color-coded ribbon cable.

## APPLICATIONS

The Output Port is ideal for digital program control of output devices such as pen-up/pen-down controls to an X-Y plotter, start/stop motion to a chart recorder, write/erase commands to a memory oscilloscope, and intensify/blank or color commands to a CRT graphic display. The Output Port works in conjunction with the analog output from the D/A Converters. Other applications include Track/Hold commands to external Sample/Hold amplifiers for mixed analog/digital test systems. Communication systems may use the Digital Outputs as gating commands to gateable transmission amplifiers. The Output Port may also be used to control external logic such as start/stop/reset commands to timer/counters used with V/F inputs.



**ST-800-11213 DIGITAL OUTPUT PORT**

## SIMPLIFIED CHANNEL EXPANSION

Datel offers a very easy method of expanding A/D or D/A channels. Standard slave expansion boards are controlled by the A/D or D/A master boards and fit into identical board slots in the microcomputer housing.

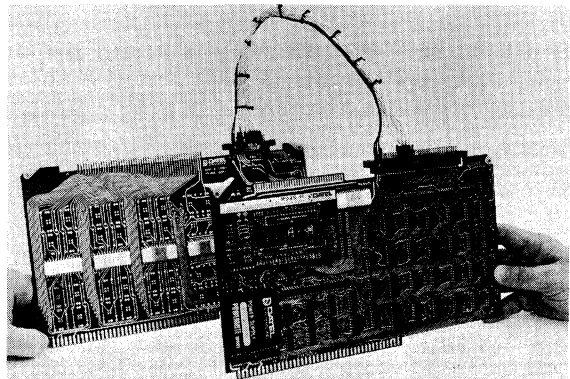
Very high channel density is featured because CMOS LSI analog multiplexers and miniature hybrid D/A converters are used. Only two boards total are needed for 80 single-ended or 64 differential A/D channels.

Expansion beyond these limits up to 256 channels may need two-level sub-multiplexing. With this configuration the master A/D board (model ST-800-32S or -16D) controls the A/D slave expanders.

The MDAS-16 A/D module on the master board sub-multiplexes the A/D expander channels. Therefore, the master board's channels are not available for direct input in the expanded configuration. For example, 96-channel, differential A/D capability requires a master board (ST-800-16D) and two 48-channel slaves (ST-800-ADX48D). The 16 differential channels on the master board are dedicated to the slaves and not usable separately.

Sub-multiplexed slave A/D channels also will have somewhat improved settling time according to the required accuracy, input impedance and number of slave channels. Contact Datel for information on your particular requirement.

D/A slave Expander boards do not have the sub-multiplex configuration. For example, 32 D/A channels can be real-



## A/D MASTER AND SLAVE EXPANDER: 80 CHANNELS TOTAL

ized with an ST-800-DA8 master board and three ST-800-DAX8 slave expanders.

Users requiring channel expansion at a later date must account for previous channel expansion by proper coding of the channel address jumpers. This information is given with each unit and users should consult Datel at the time of channel expansion.

Datel offers convenient ribbon cables for A/D and D/A expansion, with or without DMA operation. (See ordering guide). Complete pinout information is also given in the manual if users prefer to make their own cables.

## PROGRAMMING METHODS and SYSTEM ARCHITECTURE

### Busy CPU's

Datel's SineTrac 800 A/D and D/A systems are designed for high speed data acquisition and industrial data logging. Such applications typically keep the micro-computer's CPU very busy.

In a process control loop application, A/D samples must be quickly stored in memory, then arithmetically manipulated and finally returned to the external analog process through D/A converters dedicated to each A/D channel. A remote supervisory processor may oversee each satellite micro-computer controller and its A/D-D/A loops. Communicating with such a host computer requires significant CPU time to format A/D data and system status words into transceivable characters (possibly through an ASCII TTY loop or RS-232-C telephone modem).

Industrial data acquisition controllers or data loggers periodically request a sequential scan of selected A/D channels. Those channels with slowly-changing values or of less importance to a fast external process may be sampled less often to reduce the total time required to scan all possible channels. Datel's SineTrac 800 offers such flexibility by including the necessary logic to make automatic sequential scans of pre-selected high-activity channels, say from channel 180 to channel 256.

### Highest Throughput and Reduced CPU Housekeeping

The two Microcomputer CPU functions of host computer communication and A/D-D/A sample arithmetic manipulation demand the highest speed of an A/D-D/A peripheral and the shortest required program sequences for control. By including automatic sequential scan logic on Datel's SineTrac systems, CPU housekeeping is minimized. And by including fast 20 micro-second A/D Converter throughput with optional DMA (Direct Memory Access) mode, data bursts may occur at total transfer rates of 36,000 samples per second.

### Addressing Method

The SineTrac 800 systems are handled as peripheral I/O devices. The A/D and D/A sections each have hard-wired base addresses which may be rewired by the user. These peripheral addresses are distributed on 8 lines of the 16 line address bus and are enabled by the IOWC (I/OW) and IORC (I/OR) lines on the CPU control bus.

The base addresses sent to the A/D and D/A sections are variable in the 2 least significant bits. For example, the A/D system responds to base addresses 10, 11, 12 and 13 (in hexadecimal coding). Similarly, the D/A section responds to addresses 14, 15, 16 and 17 (hex.). Since each address has a read (IORC) and a write (IOWC) function, an A/D or D/A board actually responds to eight functions (see listing). Two of these functions move two 8-bit bytes comprising

an analog sample to or from memory. Four more functions load start and final channel addresses or read the current and final addresses. The remaining two functions load and read a status word which provides program control of interrupts after each analog sample (end of conversion or end of scan of preselected channels).

### Flexible On-Board Control

In order to provide this powerful flexibility, Datel's SineTrac systems include on-board start and final channel address storage registers and counters. This frees the CPU from having to increment the channel address with each conversion. Further instructions and CPU time are saved by letting Datel's SineTrac compare the current address to the final address. An interrupt and/or status bit alerts the CPU that an A/D scan is complete.

When operating in DMA, the A/D card keeps track of the start and final channel addresses to alert the DMA Controller board when the scan is complete. On-board DMA logic tells the DMA Controller to increment two bytes to store the 12-bit A/D sample.

In contrast to Datel's peripheral I/O architecture, other addressing methods, such as "memory-mapping" which assigns two memory addresses per A/D channel, use slightly simpler program sequences but take more CPU time to monitor A/D-D/A status, increment memory addresses and channels, and to terminate the scan.

## DIAGNOSTIC TEST PROGRAMS

An important advantage to Datel SineTrac 800 users is the paper tape program supplied with each system. This diagnostic test program is also supplied with a comprehensive systems manual which includes a full listing of this program, with extensive comments.

This program may be used to verify system operation when a unit is first delivered. As soon as analog inputs are connected, the program may be loaded into memory and channels will print out A/D samples on a teletypewriter or CRT terminal.

If the user purchases the optional prewired voltage divider input connector, only a single external reference voltage is needed to observe A/D conversions on the printout or display. This voltage divider is also used in the Accuracy Test (described below).

### A/D DIAGNOSTIC TEST PROGRAM

The A/D Test program performs the following tests by using a conversational (prompting) teletypewriter technique:

1. **Register Test** — Nearly all of the systems' digital IC's are tested in this mode. If an error is detected, a descriptive error message appears on the printout or display telling which bits are defective in what registers. The program will continuously loop on the error condition for oscilloscope or logic analyzer troubleshooting.
2. **Calibration Test** — An individual channel may be repeatedly sampled by pressing the teletypewriter space bar for each A/D conversion. The user may select any channel and adjust the A/D gain and offset pots for proper digital output on the printout or display. A dual trace oscilloscope may also be used to observe the A/D's serial output.
3. **Scan Test** — A selected group of channels may be printed out using the Scan Test. If the optional voltage divide input connector and a voltage reference source are used individual channels will show full scale,  $\frac{3}{4}$  scale,  $\frac{1}{2}$  scale,  $\frac{1}{4}$

scale and zero A/D conversion values in hexadecimal coding.

4. **Accuracy Test** — Both hexadecimal printout and conventional decimal voltage printout are displayed using the Accuracy Test. This test will make multiple scans (selectable up to 256) of a preselected group of channels, will average them and compare the average to stored calibration values. A tolerance or deviation from the calibration value may be specified (in LSB's of variation). Individual channels will then show as pass/fail against these tolerances and the computer prints out the number of channels within tolerance. The above series of printouts require calibrated input voltages (using the optional voltage divider connector and a reference source).

The Accuracy Test may also be used to print out decimal voltages from a channel group.

A sample of the Accuracy Test printout appears on following page:

## D/A DIAGNOSTIC TEST PROGRAM

The D/A program is similar to the A/D program and uses a conversational (prompting) teletypewriter technique.

1. **Register Test.** Like the A/D Register Test, this checks most of the logic and displays a descriptive error message for fault location.
2. **End Of Scan Test.** The status register and interrupt bus are checked with this test. Again, a TTY or CRT error message traces faulty data paths.
3. **Data Test.** This test is a comprehensive

check on all bits of each D/A converter and of the channel address registers. The Data Test automatically increments the current channel register while entering three hexadecimal digits (corresponding to 12 binary bits) into each D/A converter and its associated data registers. The hex character sequence 1, 2, 4, 8, 10, 20 — 800 inserts a bit into each D/A bit position.

4. **Square Wave Test.**
- and
5. **Sawtooth Test.** These tests insert a low

frequency waveform into a single selected D/A channel for observation on an oscilloscope.

In addition to trouble-shooting and getting a system operating quickly, the Diagnostic Test Programs give a user samples of assembly language programs required to access the A/D-D/A peripheral board. Individual tests are segregated on the program listing in the manual. Therefore, a user may extract portions needed for a particular application and write them into a supervisory program.

```

.G100
SINETRAC A/D TEST 4-11
A/D TYPE - D3B
MODE - ACCURACY TEST
START CHAN - 0
FINAL CHAN - F
WORD COUNT - 21
ACCY LIMIT - 1
    
```

CHAN NO.	EXPECTED VALUE	ACTUAL AVERAGE VALUE	DEVN	NO. WITHIN STATED ACCY.	NO. ABOVE STATED ACCY.	NO. BELOW STATED ACCY.	ACCY. LIMIT
00	+09.9951	+09.9951	+00.0000	21	00	00	+00.0048
01	+09.9951	+09.9951	+00.0000	21	00	00	+00.0048
02	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
03	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
04	+05.0000	+05.0048	+00.0048	21	00	00	+00.0048
05	+05.0000	+05.0048	+00.0048	21	00	00	+00.0048
06	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
07	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
08	+07.5000	+07.5097	+00.0097	00	21	00	+00.0048
09	+07.5000	+07.5097	+00.0097	02	1F	00	+00.0048
0A	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
0B	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
0C	+02.5000	+02.4951	-00.0048	00	00	21	+00.0048
0D	+02.5000	+02.4951	-00.0048	00	00	21	+00.0048
0E	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048
0F	+00.0000	+00.0000	+00.0000	21	00	00	+00.0048

ACCURACY TEST

## A/D ACCURACY TEST PRINTOUT

## EXTERNAL/INTERNAL START OF SCAN

Many applications require data to be taken only at preselected intervals or at specific times. In applications measuring relatively slow analog inputs (slowly-varying DC), input channels may be sampled at a slower rate. This allows time for the processor to do arithmetic on the data, format it and send it to an output device (printer, mg. tape, etc.).

Thus only a small amount of memory is required with successive scans written over previous scans. This frees up available memory to accept arithmetic and formatting programs for output.

A second class of applications require very fast data collection but only at a specific time (for example, shock tests or fast chemical reactions). At all other times, the analog

peripheral section must remain idle while the processor continues with other duties.

Datel provides both these modes of operation by using a trigger input which can accept external start pulses or from an internal IC scan clock.

Both the A/D and D/A Systems include integrated circuit scan timers with the option of internal or external or program-controlled scan intervals. The start scan clock, if used, is customer-adjusted to the desired scan interval.

In the internal mode, the scan clock is started after a scan of preselected A/D or D/A channels. When the clock times out, an A/D conversion is started and an interrupt is

generated at EOC to tell the CPU to take the A/D word.

In the external mode, an outside logic pulse initiates an immediate interrupt (not a start of conversion). The CPU, therefore, retains full control of when and whether to start a scan.

### PREWIRED SELECTABLE OPTIONS

All of the specifiers shown in the model number chart (single-ended/differential ranges, coding, etc.) are selected by wiring jumpers on the SineTrac PC board. SineTrac system manuals supplied with the boards explain how these jumpers are installed so that you can easily change the configuration if your application differs at a later date.



# SineTrac<sup>TM</sup> ST-LSI High Performance A/D & D/A Boards for DEC<sup>®</sup> LSI-11<sup>®</sup>, -11/2 Microcomputers

## THE FEATURES

- Direct expansion to 64 single-ended or 32 differential A/D channels on 2 boards.
- Automatic sequential channel addressing (Auto increment) or computer-controlled random addressing.
- 12-bit binary accuracy and resolution.
- 20 microsecond A/D throughput period.
- Compatible with LSI-11 assembly language software.

## AMPLIFIER OPTIONS

- Programmable Gain Amplifier: 2-bit control for gains of X1, X2, X4, X8 or X1, 2, 5, 10.
- Differential Instrumentation Amplifier: User-selected fixed resistor for gains of X1 to X1000.

## PACER CLOCK

- 16 programmable timebases from 30.6 microseconds to 1 second, or up to 256 seconds.
- Starts A/D scans, interrupts or DMA Block transfers.
- Optional crystal oscillator (user-installed).

## DIGITAL OUTPUT PORT

- 4 programmable bits for external device control.

**CURRENT OUTPUT AMPLIFIERS** and input shunts on the Master A/D-D/A board are directly compatible with 4-20 mA process controllers. (Optional)

## THREE SCAN START METHODS

1. Internal/External Pacer clock
2. External event interrupt
3. Program start

## OPTIONAL ON-BOARD $\pm 15V$ DC/DC POWER CONVERTER

## MODELS AVAILABLE

**ST-LSI** Full-Quad combination A/D-D/A Board, 32S/16D A/D Channels, 2 D/A Channels, Pacer Clock, Current Loop D/A Amplifiers, Digital Output, Optional PGA or Instrumentation Amplifier, Optional DC/DC Power Converter.

**ST-LSI-ADX** Half-Quad Slave A/D Channel Expanders, 32S or 16D Channels.

**ST-LSI-DA** Half-Quad 4 D/A Channels, 12 Bit Output, no Loop Amplifiers, Optional DC/DC Power Converter.

**ST-LSI2** Half-Quad A/D Board, 16S/8D Channels, Pacer Clock, PGA, DC/DC Power Converter

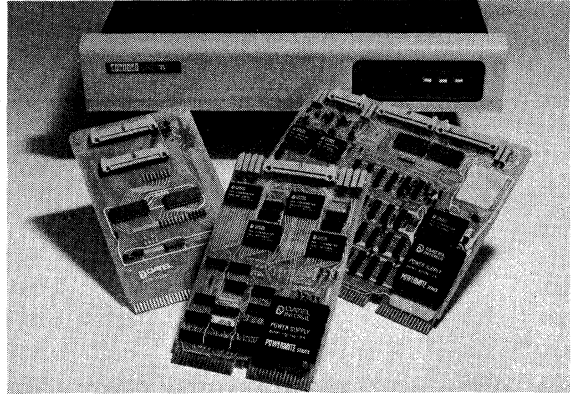
**ST-LS12-ADX** Half Quad Slave A/D Channel Expanders, 48S or 24D Channels.

**ST-LSI2-DMA** Half Quad DMA A/D Block Transfer Controller. 32,768 16-bit Words. EOC and End of Cycle Interrupts, 2 Vectors, 50 kHz Transfer Rate.

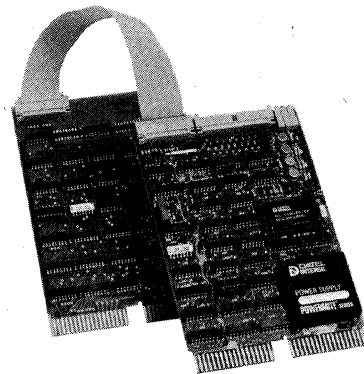
**ST-LSI-RLY** Half-quad flying capacitor relay input, 8 differential A/D Channels, 12 bits, 30 Hz, 250 VRMS isolation, 126 dB CMR, PGA and 1K gain (see ST-LSI-RLY brochure, pg. 114S)

DEC, LSI-11, and PDP are Digital Equipment Corp. trademarks

LSI-11  
COMPATIBLE TO: LSI-11/2  
PDP-11/03/23



ST-LSI Full and Half Quad Series



ST-LSI2 Half Quad Series

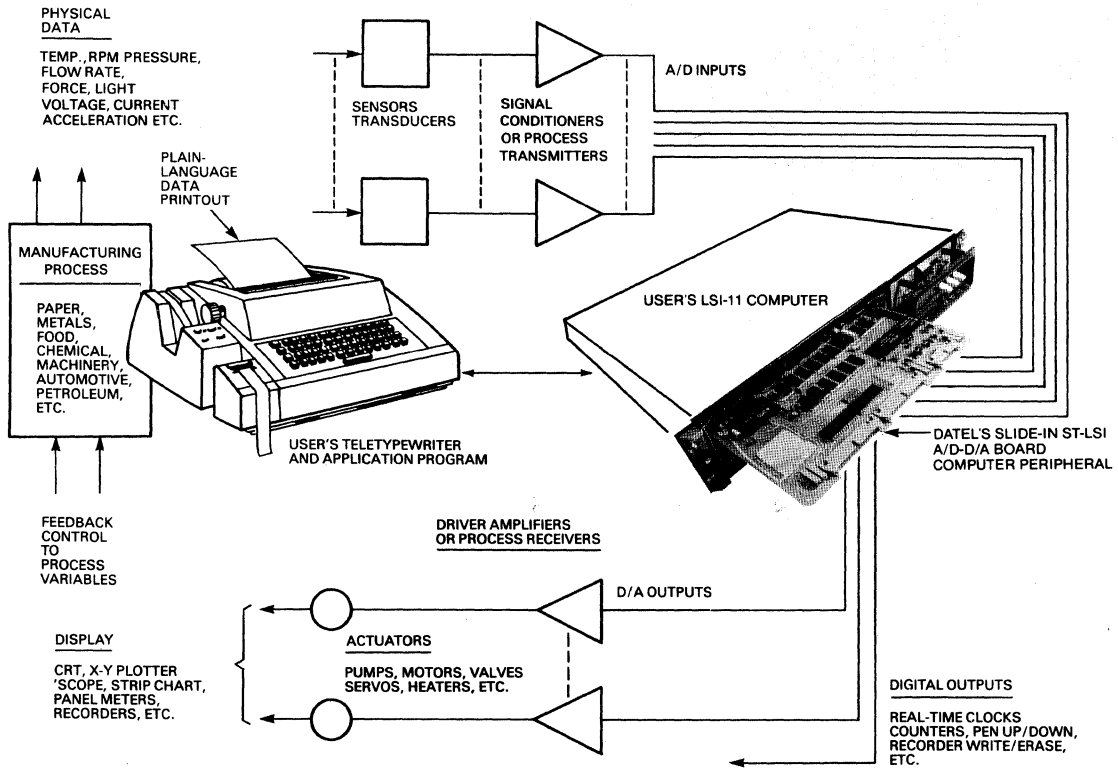
## TABLE OF CONTENTS

Introduction .....	101S
Description, Operation .....	102S
Block Diagram, Programming .....	103S
Specifications .....	104,5,6S
Programming .....	107S
Diagnostic Program .....	108S
Hardware Features .....	109S
Master Selection Guide .....	110S
Ordering Guide .....	111S
ST-LSI2 Half Quad A/D, D/A, ADX, DMA Boards .....	112,113S

SineTrac<sup>TM</sup> ST-LSI Series Q-BUS

A/D & D/A Boards

## TYPICAL SYSTEM APPLICATION



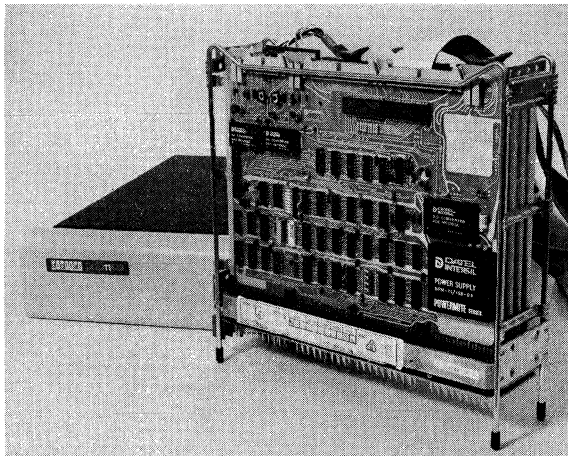
## INTRODUCTION

A natural application for DEC's popular LSI-11 and PDP-11/03 microcomputers is input/output of analog signal voltages using Datel's SineTrac LSI peripheral boards, the ST-LSI series. Addition of the appropriate ST-LSI board immediately transforms the LSI-11 into a powerful programmable data acquisition/distribution system, industrial process controller, smart data logger for analytical or instrumentation applications, or automatic test equipment controller. The system features high channel density, low cost per channel, and high speed. This suggests applications such as word recognition systems, multi-channel communication switching controllers, and speech and signal processing systems.

Datel's SineTrac concept quite simply is to place the A/D-D/A analog peripheral system *inside* the computer on slide-in circuit boards which are mechanically and electrically compatible to the back-plane bus of the LSI-11 and program-compatible to all LSI-11 and PDP-11 languages. Sets of LSI-11 assembly language instructions automatically control all activities of the ST-LSI peripheral. The ST-LSI joins other analog peripherals in Datel's Sine-Trac family for popular mini- and micro-computers including a very complete, high performance version for the PDP-11 computer.

The ST-LSI incorporates a high degree of hardware functions to relieve software requirements and achieve maximum speeds. Such features as auto-start, auto-incrementing of channels, multi-mode Pacer clock, and interrupt actuation simplify programming while offering versatility to meet many applications. This philosophy is based on the concept that high performance analog data acquisition/distribution systems for industrial and analytical laboratory applications (many channels, high speeds) require short, fast routines for maximum throughput. This especially applies if other fast peripherals are involved (CRT's, D/A's, etc.) or devices with complex protocol (for example, communication with a remote host processor through a wide bandwidth modem) or complex signal processing (Fast Fourier Transform for spectral analysis). In all these applications, programming overhead should be minimized so that other fast peripherals will not be delayed by the A/D-D/A handler routine. Datel includes a powerful diagnostic program on paper tape to get the ST-LSI operating quickly and for processor-aided troubleshooting. Octal printouts of A/D data are available immediately from the Datel Diagnostic program as soon as signal inputs are connected and the diagnostic is loaded.

\*DEC is a trademark of Digital Equipment Corporation, Maynard, Mass.



**ST-LSI INSTALLED IN A  
DEC-H9270 BACK PLANE/CARD GUIDE**

## DESCRIPTION

*(See half-quad LSI-11/2 A/D boards on page 111S)*

The ST-LSI series consists of 3 circuit boards with several variations of each board plus the diagnostic program and system documentation. The primary board is an A/D-D/A master peripheral with 32 single-ended or 16 differential A/D channels maximum and 2 optional D/A channels. A versatile Pacer clock, interrupt circuit and digital outputs are featured on this A/D-D/A master board. A 4-bit CPU code selects one of 16 Pacer time bases from 1 second to 30.6 microseconds when used with the RC oscillator. A  $\pm 15V$  DC/DC power converter is optional to this board and eliminates any external power requirements by using the computer's +5V bus supply. Current amplifiers are optional with the D/A's.

The second board is a slave A/D Multiplexer Expander which adds 32 additional single-ended or 16 differential channels to the system, offering 64 total single-ended channels maximum on 2 boards. This A/D Expander is addressed and controlled by the first A/D-D/A Master

Board and is powered by  $\pm 15V$  from the Master's DC/DC converter. Both the first and second (master and slave) boards occupy quad and dual positions inside the LSI-11 and are connected together by cable. Because of jumper-selected board addressing, additional master and slave combinations may be added for indefinite channel expansion (as long as additional card slots and power is available).

The third board is a stand-alone 4-channel D/A analog output peripheral occupying a half-quad size (8.5"  $\times$  5"). Having a unique, jumper-selected address, these D/A boards may also be indefinitely cascaded. Digital outputs are included for external Device Select lines, pen up-down controls and write-erase commands. DC/DC  $\pm 15V$  power converters are optional.

All three boards use Datel's fast, high-accuracy hybrid A/D, D/A and multiplexer microcircuits for very high channel density.

## OPERATION

The A/D-D/A Master Board uses a very fast successive approximation technique hybrid Analog to Digital (A/D) Converter microcircuit (Model ADC-HS) with a built-in sample and hold (S/H) amplifier. This microcircuit acquires and samples an analog input channeled to it through a CMOS analog multiplexer switch then converts this signal to a 12-bit binary digital word in 20 microseconds. This sequence is commanded either by program instructions, on-board or external Pacer clock or an interrupt triggered from either the Pacer or an external command. Such a command could come from a process switch closure, light beam interruption or a real-time clock. The 12-bit binary A/D representation of the analog input is routed through on-board interface logic and placed on the LSI-11 data bus under central processor control. The A/D output briefly passes through the CPU and is usually sent to memory according to the stored program. Depending on how the A/D data will be used, the data may be manipulated arithmetically and/or sent to a peripheral device such as a teletypewriter or CRT terminal, magnetic tape or floppy disc mass storage device or to a communications link (modem, etc.) for transmission to a remote super-

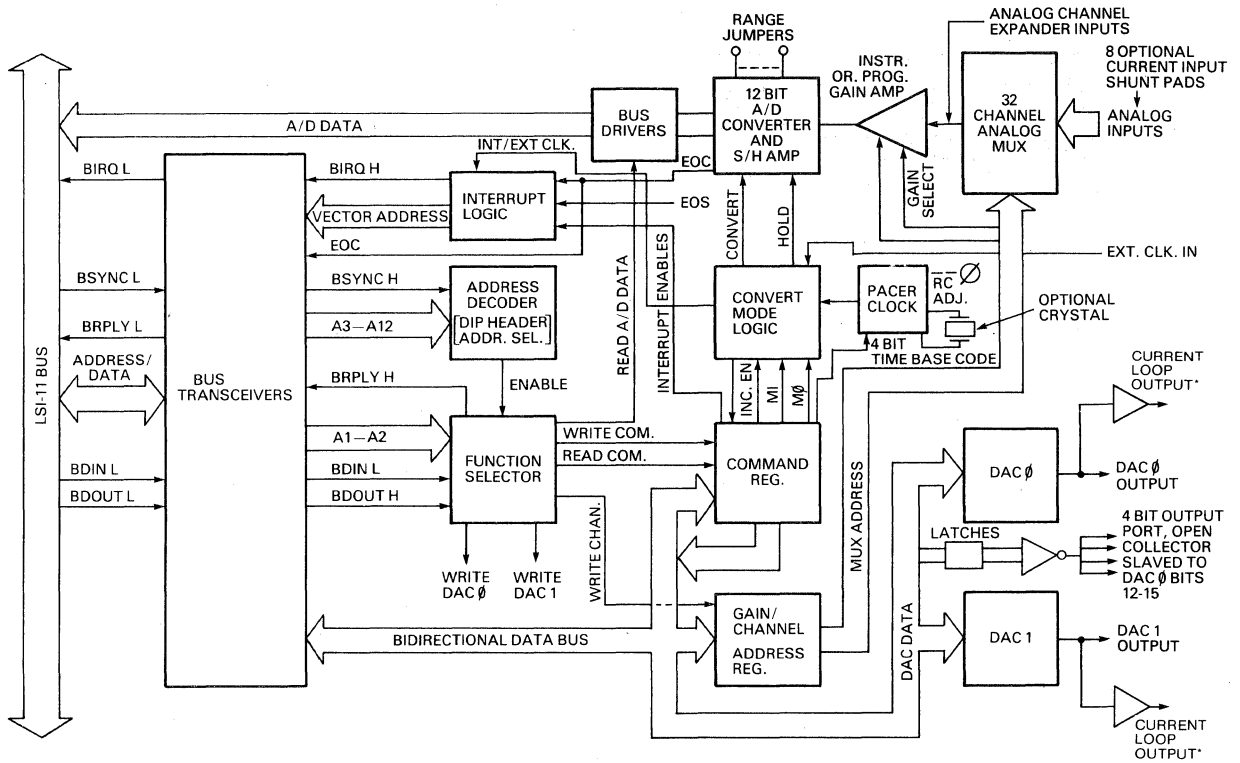
visory processor. After arithmetic, the modified A/D data may also be returned to the physical process from which it was measured to control that process. If a process actuator is used, it is controlled by an analog voltage or current signal from the ST-LSI D/A outputs inside the LSI-11 card cage. In this manner, the computer acts as a closed loop controller using a D/A dedicated to each A/D channel. Analog indicating output devices, such as oscilloscopes, X-Y plotters, chart recorders and meters may also be accessed through the D/A outputs.

The analog multiplexers (Datel's MX-1606) on the master and slave A/D boards serve to connect many inputs consecutively to the same A/D converter under program control. These multiplexers contain fast internal voltage clamps to protect against overloads up to  $\pm 35V$ . The D/A converters (Datel's DAC-HK models) each contain a latching input register to store 12-bit binary words from the LSI-11 bus to be converted to an analog output signal. Each D/A converter circuit also includes a current output amplifier to directly drive process control current receivers with the standard 4-20 mA, and 1-5 mA ranges.

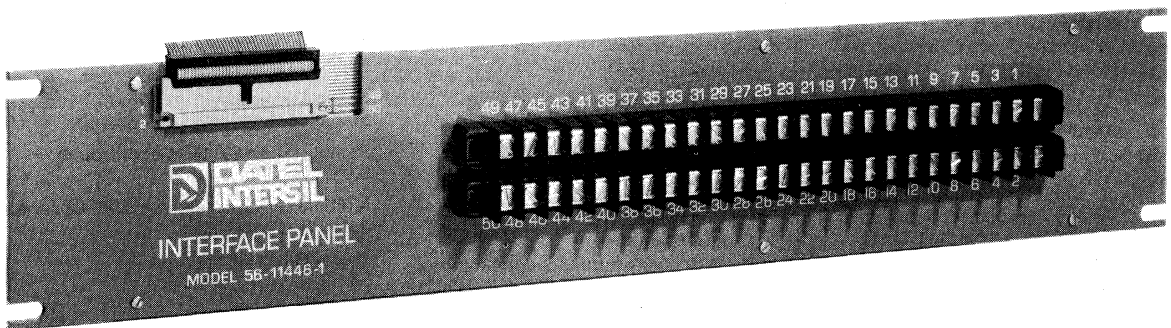


# SINETRAC LSI BLOCK DIAGRAM

## A/D-D/A COMBOMASTER BOARD



\* The current loop amplifiers require an external excitation voltage source of +18 Vdc regulated, minimum



**NEW!**

**MODEL 56-11446-1**

Rack-mounting screw-terminal interface panel for ST-LSI. Accepts 40 or 50-pin right-angle ribbon cable headers (optional).

Size: 19" x 3½" (482 x 89mm)

# ST-LSI SPECIFICATIONS

(Typical at +25°C, dynamic conditions, unless otherwise specified)

## GENERAL

### Board Configurations Available

1. ST-LSI Series Quad Master Board, 32S/16D A/D Channels, 2 D/A Channels, Current Amplifiers, DC/DC Power Converter, PGA or Diff. Inst. Ampl., Pacer Clock.
2. ST-LSI-ADX Series Half-Quad Slave A/D Channel Multiplexer Expander. Adds 32 SE or 16 Diff. A/D Channel Inputs.
3. ST-LSI-DA Series Half-Quad Independent 4-channel D/A Boards DC/DC Power Converter.
4. ST-LSI2 Half-Quad A/D Board, 16S/8D Channels, no D/A's, DC/DC Power Converter, PGA, Pacer Clock.
5. ST-LSI2-DMA Half-Quad Direct Memory Access Controller for the ST-LSI2 A/D Board, 32K Memory Words.
6. ST-LSI2-ADX Half-Quad Slave A/D Channel Multiplexer Expander. Adds 48 SE or 24 Diff. A/D Channel Inputs to the ST-LSI2.
7. ST-LSI-RLY, Half-quad, flying capacitor relay input, 8 diff. A/D channels, 12 bits, 30 Hz, 250 V<sub>RMS</sub> isolation, 126 dB CMR, PGA and 1k gain (See ST-LSI-RLY brochure, pg. 114S).

## BACKPLANE COMPATIBILITY

The full-quad ST-LSI A/D-D/A board is compatible to LSI-11 and PDP-11-03 computers which use the H-9270 backplane. The H-9270 backplane includes parallel wiring on the CD bus as well as the AB bus. The ST-LSI requires parallel wiring on both the AB and CD busses.

For computers having the H-9273-A backplane, which omits parallel wiring on the CD bus, Datel-Intersil's half-quad ST-LSI2 A/D board and any other half-quad Datel board may be used in the AB bus section without any modification.

If the full quad ST-LSI is required with the H-9273-A backplane, contact Datel-Intersil for backplane wiring modifications (Product Note LDC-523 in the ST-LSI systems manual) which the user may perform to achieve compatibility.

## A/D DATA ACQUISITION SECTION

(Applies to ST-LSI Combination A/D-D/A Master Board and ST-LSI2 A/D Board)

### ANALOG INPUTS

#### Number of Channels and Channel Expansion

(ST-LSI2 Board only):  
16 Single-ended or 8 Differential channels.  
(ST-LSI Master Board Only):  
32 Single-ended or 16 Differential channels.  
(Master Board plus one ADX Board):  
64 Single-ended or 32 Differential Channels, maximum capacity.  
Channels may be expanded indefinitely using pairs of Master and Slave A/D Boards with different base addressing. Differential Channels require the optional PGA or Diff. Inst. Ampl. Single-ended and Differential Channels cannot be mixed.

#### Input Type

High impedance voltage input, non-isolated. Differential inputs are balanced.

#### Current Inputs

Up to 8 voltage inputs may be converted to differential current inputs with shunt resistors selected and installed by the user in channels 0 to 7 only on the Master Board. A/D Slave Expanders may accept 16 additional shunts. 4-20 mA, 1-5 mA, 10-50 mA ranges and others may be accepted.

#### Input Overvoltage

±35V sustained (no damage)

#### Input Capacitance to Ground

5 pF - Off Channels, 100 pF - On Channels

### A/D DIGITAL OUTPUTS

#### Output Coding

Straight Binary } Rewired with  
2's Complement } jumpers by user or  
                          } Datel in OEM  
                          } quantities  
Offset Binary     } (Supplied standard)

#### Output Format

12-bit binary group bus-compatible to the LSI-11 or PDP-11/03. Bits 12 through 15 may be wired to mirror bit 11 (the A/D MSB) as sign extension used with 2's complement coding.

### A/D SECTION PROGRAMMING

See full systems manual for details

#### Type of Interface

Memory-mapped. The A/D peripheral appears to the CPU as four consecutive read/write memory locations.

### Data Transfer Methods

Program (Register), Interrupt or DMA (Direct Memory Access). DMA requires the user to remove D/A's and install jumpers.

### Memory Base Address

Factory selected to 170400. May be altered using on-board DIP switch-pack between 160000 and 177770.

### Output Registers

COMMAND REGISTER: Selects A/D operating modes, interrupt operation, Pacer clock modes and frequencies, and scan termination.

GAIN/CHANNEL ADDRESS REGISTER: Sets gain of optional PGA and the 6-bit A/D starting channel address.

### Input Registers

STATUS REGISTER: Indicates modes selected through Command Register.

A/D DATA REGISTER: Contains 12-bit binary results of A/D conversions.

### Pacer Clock

16-stage binary divider with 4 bit frequency selection. RC adjusted at factory for 1 second to 30.6 micro-second range. The 4-bit code is part of the A/D Command word. The RC timing circuit may be substituted with a user-supplied quartz crystal (1 MHz max.), HC/18U holder. The Pacer is used to start A/D conversions, start multi-channel scans, or flag the CPU via interrupt and/or status register bit.

An external command may also gate the Pacer and initiate an Interrupt.

### A/D Conversion Period

8 microseconds

### Sample/Hold Aperture Time

50 nanoseconds

### Sample/Hold Switch Feedthrough

0.01% maximum

### Multiplexer Crosstalk from OFF Channels

0.01%, DC to 1 KHz

### Power Supply Rejection

54 dB to +5V power bus

See power supply and mechanical information on page 106S

**PERFORMANCE**

**A/D DATA ACQUISITION SECTION (CONTINUED)**

	<b>A/D INPUT ONLY</b> (No PGA, No Diff. Inst. Ampl. Single-ended inputs only)	<b>WITH PROGRAMMABLE GAIN AMPLIFIER</b> (PGA-Datel AM-251 Module)	<b>WITH DIFFERENTIAL INSTRUMENTATION AMPLIFIER</b> (Datel AM-205 Module)
<b>Full Scale Input Ranges</b>	-10 to +10 Volts (Supplied standard) 0 to +5V 0 to +10V -5 to +5V (Rewired with jumpers by user (or by Datel in OEM quantities.)	$\pm 10V, \pm 5V, \pm 2.5V, \pm 1.25V$ "P" models or $\pm 10V, \pm 5V, \pm 2V, \pm 1V$ "R" models	$\pm 10V$ to $\pm 10$ mV  (Not available on half-quad ST-LSI2 A/D board)
<b>Amplifier Gains</b>	—	X1, X2, X4 and X8 using 2 bit input gain code which is part of the command word output to the A/D peripheral. Gains of X1, X2, X5, and X10 are available on special order using the AM-251B module. See model numbering,	X1 to X1000 with gain resistor supplied and installed by user. Input Gain Stage Equation $G1 = 1 + \frac{20,000}{Rg \text{ in } \Omega}$ G1 Range: X1 to X100 Output Stage Gain: X1 or X10 (Jumper select)
<b>Input Impedance</b>	100 Megohms min., differential or to ground.	$10^{12}$ ohms, differential or to ground.	$10^{12}$ ohms, differential or to ground.
<b>Input Bias Current</b>	3 nA typical, 10 nA maximum.	30 pA typical, 200 pA maximum.	30 pA typical, 200 pA maximum.
<b>Overall Accuracy @ +25°C</b> (including noise and quantization error, referred to input, after initial calibration.)	Within $\pm 0.025\%$ of Full Scale Range $\pm \frac{1}{2}$ LSB *X1, 2, 5, 10 gains also available,	GAIN ACC., $\pm \frac{1}{2}$ LSB X1 $\pm 0.03\%$ FSR X2 $\pm 0.03\%$ FSR X5, X4 $\pm 0.03\%$ FSR X10, X8 $\pm 0.04\%$ FSR	GAIN ACC., $\pm \frac{1}{2}$ LSB X1 $\pm 0.025\%$ FSR X10 $\pm 0.05\%$ FSR X100 $\pm 0.1\%$ FSR X1000 $\pm 0.3\%$ FSR
<b>Common Mode Voltage Range</b> (Signal plus common mode voltage)	Single-ended only, use PGA or Diff. Inst. Ampl.	Within $\pm 12V$ to analog common	Within $\pm 12V$ to analog common
<b>Common Mode Rejection</b> (1 Kilohm max. source unbalance)	None, must use PGA or Diff. Inst. Ampl.	At Gain = 1 0 Hz 100 dB 100 Hz 80 dB 1 KHz 60 dB At Gain = 8 or 10 0 Hz 120 dB 100 Hz 100 dB 1 KHz 80 dB	At Gain = 1 1 KHz 80 dB  At Gain = 1000 60 HZ 100 dB
<b>System Temperature Drift</b> (Referred to Input)	Gain: Within $\pm 20$ ppm of FSR/°C Zero: Within $\pm 5$ ppm of FSR/°C Offset: Within $\pm 10$ ppm of FSR/°C	Gain: Within $\pm 30$ ppm of FSR/°C Zero: Within $\pm 20\mu V/°C$	Gain: Within $\pm 30$ ppm of FSR/°C Zero: Within $\pm 20\mu V/°C$
<b>Amplifier Settling Time to Rated Accuracy</b> (Input = $\pm$ FSR pk-pk step)	—	8 microseconds	GAIN X1 7 $\mu S$ X10 8 $\mu S$ X100 40 $\mu S$ X1000 100 $\mu S$
<b>System Throughput Period</b> (Including A/D conversion but not CPU data I/O)	16 microseconds typ, 20 microseconds max.	16 microseconds, typ, 20 microseconds max. (An overload clamp prevents amplifier saturation when switching gains and maintains above throughput rate)	GAIN X1 15 $\mu S$ X10 16 $\mu S$ X100 48 $\mu S$ X1000 108 $\mu S$
<b>Recommended Maximum Source Impedance</b> (To maintain rated performance.)	1000 Ohms	10 Kilohms	10 Kilohms

**SPECIFICATIONS Continued (See page 112S for ST-LSI2 Half Quad Series)**

**D/A DATA DISTRIBUTION SECTION**

(Analog outputs from A/D-D/A Master Board and Stand-Alone D/A Peripherals)

**ANALOG OUTPUTS**

**Number of Channels**

2 single-ended on the A/D-D/A Master Board or up to 4 per stand-alone D/A peripheral.

**Channel Expansion**

Indefinite channel expansion using the stand-alone D/A Boards (each board is separately addressable) limited by card slots and memory capacity.

**Full Scale Voltage Output Ranges**

0 to +5 Volts } May be rewired by  
0 to +10 Volts } user or Datel in  
-5 to +5 Volts } OEM qty.  
-10 to +10 Volts } (Supplied standard)

**Digital Input Coding**

Straight Binary } May be rewired by  
2's Complement } user or Datel (OEM)  
Offset Binary } (Supplied standard)

**Output Impedance**

50 milliohms

**Output Current**

±5 mA short circuit proof to ground.

**Full Scale Current Output Ranges**

0 to 20 mA (4 to 20 mA compatible)  
0 to 5 mA (1 to 5 mA compatible)  
Single-ended. Voltage compliance:  
10 volts. 4 to 20 mA supplied standard.  
(+18V dc regulated external excitation required).

Current output amplifiers are included with each D/A channel on the Master A/D-D/A board but are not available on the stand-alone D/A peripheral.

**Digital Output Ports**

4 TTL open-collector output bits are included on the A/D-D/A master board. Internal pullup resistors to +5V are included and they may be jumpered to a higher external voltage remote pull-up or up to 30 mA per bit. The 4 bits are addressed as part of the 16 bit data word to DAC channel 1. The Stand-alone D/A Peripheral has a similar 12-bit port which is slaved to the 12-bit output to DAC channel 1.

**PERFORMANCE**

**Nonlinearity**

±1/2 LSB maximum

**Differential Nonlinearity**

±1/2 LSB maximum

**Full Scale Gain Error**

Adjustable to zero using a pot. for each channel.

**Offset or Zero Error**

Adjustable to zero using a pot. for each channel.

**Gain Temperature Drift**

Within ±30 ppm of FSR/°C

**Zero Temperature Drift**

(Unipolar output) Within ±5 ppm of FSR/°C

**Offset Temperature Drift**

(Bipolar output) Within ±15 ppm of FSR/°C

**Settling Time**

4 microseconds to within ±1/2 LSB of final value.

**Slew Rate**

20V/μsec

**Power Supply Rejection**

54 dB to dc supply buses

**D/A SECTION PROGRAMMING**

**Type of Interface**

Memory-mapped. The D/A section appears to the CPU as two consecutive, write-only memory locations. The memory addresses are the 5th and 6th in sequence after the A/D section addresses and therefore are positioned by the switch-selected base address (see A/D section programming). The 5th address, DAC channel 1 contains 4 additional bits for the output port.

The stand-alone D/A peripheral is similarly organized but has its own switch-selected base address.

**A/D CHANNEL EXPANDER**

ST-LSI-ADX SERIES AND ST-LSI2-ADX SERIES

**Function**

(Note that single-ended and differential inputs cannot be mixed.) The ST-LSI-ADX adds 32\* single-ended or 16\* differential multiplexer channels and is a slave to control by the A/D-D/A Master Board. The Master Board A/D converter is used. 16 voltage input channels may accept shunt resistors to measure current inputs.

\*ST-LSI2-ADX adds 48S or 24D channels and accepts 24 diff. current shunts.

**Multiplexer Specifications**

Same as A/D-D/A Master Board.

**Channel Expansion**

One slave expander may be used with one Master. Channels may be expanded indefinitely using Master-Slave pairs with different base addresses.

**Mounting**

Using DIP ribbon jumpers from the Master Board. The Slave Expander is inserted adjacent to the Master with 0.5" card guide spacing (LSI-11 compatible) ST-LSI2-ADX includes cable.

**Analog Input Connections**

Using 2 Ribbon-cable connectors (3M or equiv)

**GENERAL All Models**

**Power Supplies**

A/D-D/A MASTER BOARD:  
+5 Vdc at 2.5 Amps max. from LSI-11 bus ±15 Vdc at 150 mA max. supplied from optional on-board DC/DC power converter.

STAND-ALONE D/A PERIPHERAL:  
+5 Vdc at 1 Amp max. from LSI-11 bus. ±15 Vdc at 150 mA max. supplied from optional on-board DC/DC power converter for 4 D/A channels max.

A/D SLAVE CHANNEL EXPANDER:  
Power is supplied from Master Board through the connecting cable.

**Mechanical Outline Dimensions**

A/D-D/A MASTER BOARD:  
8.430 x 10.374 inches (214 x 263 mm)  
Stand-alone D/A Board and A/D Channel Expander:  
8.430 x 5.187 inches (214 x 132 mm)  
Board Spacing: 0.5 inches (12.7 mm)

**Operating Temperature Range**

0°C to +70°C

**Storage Temperature Range**

-25°C to +85°C

**Weight**

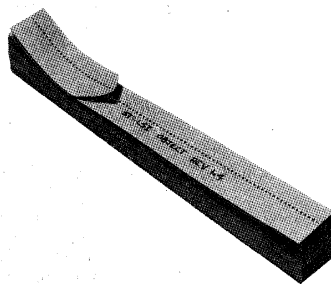
MASTER BOARD: 16 ounces (0.45 kg)  
STAND-ALONE D/A PERIPHERAL:  
12 ounces (0.34 kg)  
A/D CHANNEL EXPANDER  
8 ounces (0.23 kg)

**Relative Humidity**

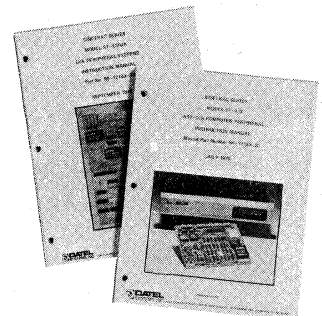
20% to 80%, non-condensing

**DIAGNOSTIC PROGRAM**

Supplied on paper tape for teletypewriter (TTY) entry for all systems. See full description elsewhere in brochure.



**PAPER TAPE DIAGNOSTIC PROGRAM**



**SUPPLIED COMPREHENSIVE SYSTEMS MANUAL WITH DIAGNOSTIC PROGRAM LISTING**

## DIAGNOSTIC TEST PROGRAM

### FEATURES

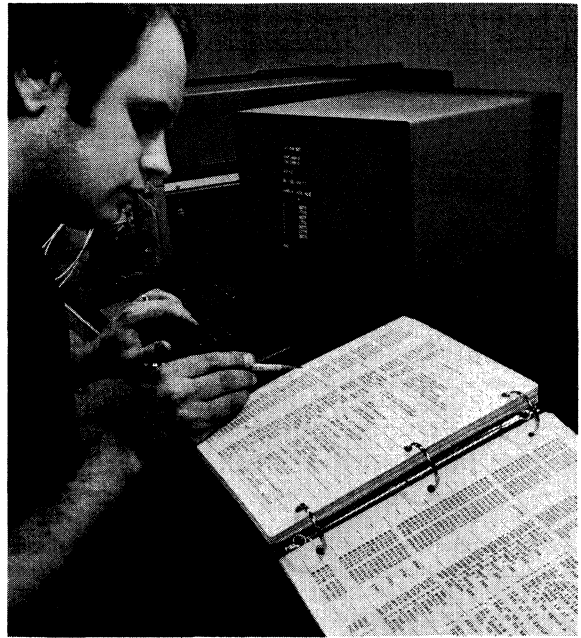
- Fully exercises all A/D and D/A conversion functions
- Tests all working registers and data paths
- Provides immediate octal A/D and D/A printouts as soon as the program is loaded and signal connections are made
- May be used to calibrate A/D channels and D/A channels
- Descriptive error messages appear on the CRT or printout if faults occur. They identify defective data paths and register contents for oscilloscope or logic analyzer diagnosis.

### DESCRIPTION

All ST-LSI systems include a diagnostic program supplied on paper tape. The tape can be loaded through a tape reader on the TTY teletypewriter and gets the ST-LSI system operating very quickly. While the Diagnostic is not a user's application program or a handler routine, the program listing of the diagnostic which appears in the supplied system manual shows examples of how the A/D-D/A function may be controlled by the computer. Selected useful portions of the Diagnostic may be extracted and written into the application program by the user.

The Diagnostic may be used as an incoming inspection aid to be sure there was no damage to the ST-LSI in shipment. This quickly verifies functions whereas systems without such an aid require the user to spend much time writing a program just to see if the system is working. Octal printouts of A/D data are available as soon as the Diagnostic is loaded and signal connections are made. For trouble-shooting, the diagnostic program tests all circuits on the ST-LSI. The program will continuously loop on error conditions for study by oscilloscope or logic analyzer. When errors are found, a descriptive error message will appear on the CRT or printout to identify the faulty data path and specific register contents.

For adjustment of the offset and gain calibration controls of the A/D and D/A microcircuits, the Diagnostic will perform conversions with each stroke of the



TTY space bar or automatic conversions of a preselected scan of channels. The digital output from the A/D section may be routed to the D/A section for comparison and an octal word may be entered for conversion into the D/A channels. Sawtooth patterns may be generated by the D/A's and any of the 16 Pacer clock frequencies may be selected.

The Diagnostic program uses an interactive (prompting) teletypewriter technique where single characters call up certain portions of the program then ask the user for more detailed selection parameters. The Diagnostic program uses just under 4K of memory.

Skilled users of the Diagnostic can quickly isolate a defective component without lengthy random testing of all devices. All the Datel proprietary microcircuits (A/D's, D/A's, MUX's, power converters, etc.) are standard catalog items for simplified repair.

TEST NAME	TTY CALL KEY	CALL NAME MNEMONIC	DESCRIPTION
A/D Command/Status Register Test	A	CMSRT	Repeatedly loads and outputs 0's and 1's into selected bits to generate a square wave output. Or, will try all codes and check for errors.
Pacer Clock Frequency Test	B	PCLFT	Generates a Pacer Clock timebase output from 4 bit clock input via 0 to 15 decimal keyboard numbers.
A/D Calibration Test	C	ADCAL	Selects a specific A/D channel and PGA Gain and gives octal outputs each time the keyboard space bar is depressed.
End of A/D Conversion Interrupt Test	D	EOCINT	Tests interrupts from multiple A/D conversions and checks the Interrupt Vector Address. Prints error message and loops on errors.
Auto Start A/D Conversion Test	E	ATSTRT	Makes repetitive A/D conversions by reading the A/D Data Register. Prints error messages and loops on errors.
Auto Increment/End of Scan Interrupt Test	F	ATINC	Requests PGA Gain, number of channels per scan and start channel. Prints out A/D results and causes interrupt. Loops on interrupt if error occurs and prints error messages.
Pacer Clock Mode Interrupt Test	G	PCMIT	1. Starts A/D Conversions from Int/Ext. Pacer Clock 2. Generates an Interrupt from the Int/Ext. Pacer Clock. Loops and prints error messages.
D/A Calibration Test	H	DACAL	Selects a D/A channel and converts an octal input code from the keyboard to an output voltage.
D/A Sawtooth Test	I	DASAW	Loads a counter input to both D/A's and increments/decrements the counter so that the D/A outputs produce a sawtooth waveform between + and - fullscale.

# DIAGNOSTIC TEST PROGRAM

The SineTrac LSI is a memory-mapped peripheral which communicates with the LSI-11 CPU through four consecutive memory locations. The base (lowest) address of these is assigned by a DIP switch pack on the ST-LSI board. The base address selected by Datel for the supplied Diagnostic Program Tape is 170400 (octal), however, the user may reset the switch pack to any base address between 160000 and 177770. To the CPU, the ST-LSI appears to be relatively slow RAM memory.

The A/D section of the ST-LSI master board contains four dedicated registers which are accessed by memory reference instructions. The D/A section contains two additional registers to hold 12-bit inputs to the D/A's and four digital output bits. Three Interrupt Vector Addresses are available for the A/D section. The A/D Section registers are:

1. **COMMAND REGISTER:** Receives an output code for:
  - a. A/D operating modes - Start convert, End of Conversion, End of Scan, Auto-Increment, Pacer Clock Start.
  - b. Interrupt operating modes - Pacer, EOC, EOS.
  - c. Pacer Divider Timebase - 16 possible timebases.

2. **STATUS REGISTER:** Command Register operating mode.
3. **GAIN/CHANNEL ADDRESS REGISTER:** PGA and starting channel address.
4. **A/D DATA REGISTER:** Stores A/D 12-bit data words. Bits 12-15 may be wired as sign extension.

The four ST-LSI registers are as follows:

MEMORY ADDRESS (OCTAL)	FUNCTION	MNEMONIC	BUS CYCLE
170400 (Base)	A/D COMMAND REGISTER	CDSTAT	DATO(B)
170400 (Base)	A/D STATUS REGISTER	CDSTAT	DATI
170402 (Base + 2)	GAIN/CHANNEL ADDRESS REGISTER	GNCHAD	DATO(B)
170402 (Base + 2)	A/D DATA REGISTER	ADDATA	DATI
170404 (Base + 4)	DEVICE SELECT/DAC 1 DATA REG.	DADAT1	DATO
170406 (Base + 6)	DAC 2 DATA REGISTER	DADAT2	DATO

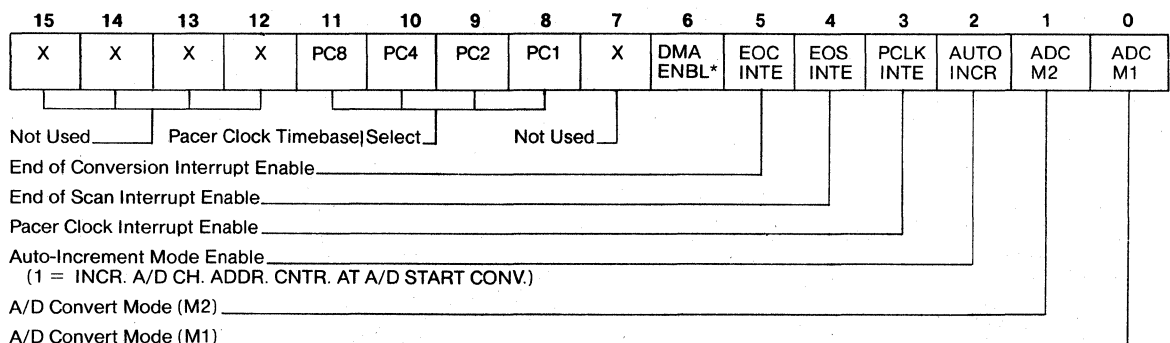
Three Interrupt Vector Addresses are included on the ST-LSI and are arranged as a Vector base address and two displacements, similar to the memory addresses. These Vector Addresses may be used to handle a specific interrupt by jumping to a subroutine which executes the function which caused the interrupt. Datel has preselected the Interrupt Base Vector address as 000360 (octal) but the user may alter this address anywhere between 000000 and 000360.

The Interrupt Vector Addresses are as follows:

INTERRUPT VECTOR ADDRESS (OCTAL)	FUNCTION
000360 (Base)	End of A/D Conversion Vector Address
000364 (Base + 4)	End of Multichannel A/D Scan Vector Address
000370 (Base + 10)	Pacer Clock Interrupt Vector Address

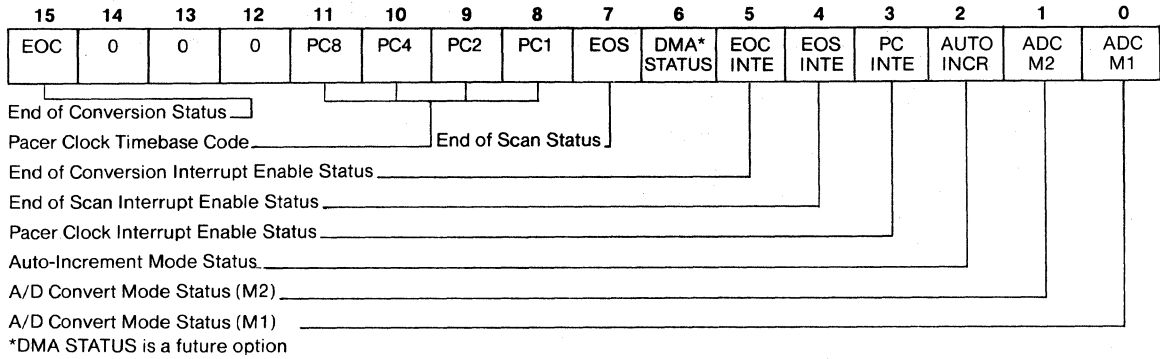
The memory register bit-function assignments are as follows:

## COMMAND REGISTER (Write Address 170400)

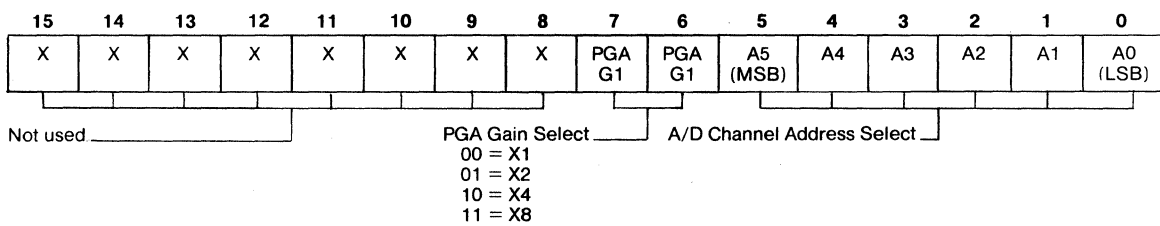


- 00 = Start Conv. by loading Gain/Ch. Addr. Reg.
  - 01 = Start Conv. by reading A/D Data Reg.; Ch. Addr. Contr. Increments if Auto-Increment is set.
  - 10 = Int. Pacer Clk. Conv. Start.
  - 11 = Ext. Pacer Clk. Conv. Start
- \*DMA ENABLE is a future option

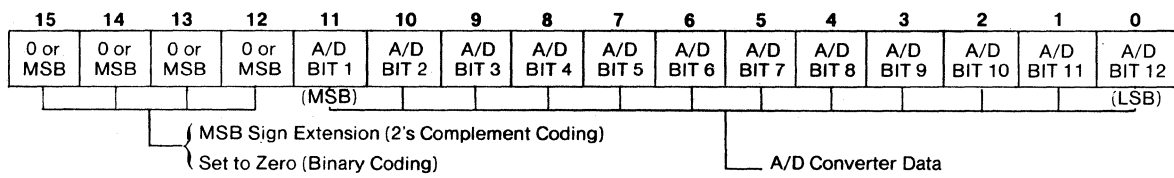
**STATUS REGISTER (Read Address 170400)**



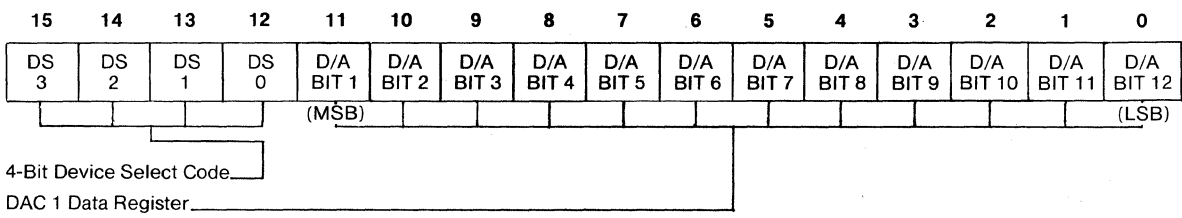
**GAIN/CHANNEL ADDRESS REGISTER (Write Address 170402)**



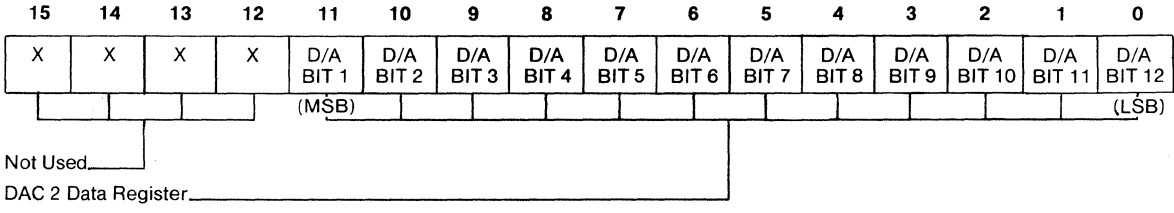
**A/D DATA REGISTER (Read Address 170402)**



**DEVICE SELECT/DAC 1 DATA REGISTER (Write Address 170404)**

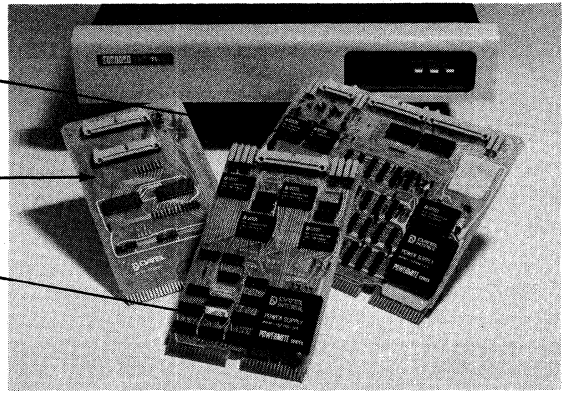


**DAC 2 DATA REGISTER (Write Address 170406)**



# MASTER SELECTION GUIDE

MASTER A/D-D/A BOARD  
 A/D SLAVE CHANNEL EXPANDER  
 INDEPENDENT D/A PERIPHERAL



Refer to the high-isolation relay  
 MUX ST-LSI-RLY on page 114S

DESCRIPTION	MASTER COMBINATION A/D-D/A BOARD			A/D SLAVE MULTIPLEXER CHANNEL EXPANDER		INDEPENDENT D/A PERIPHERALS		LSI-11/2 A/D BOARD
	ST-LSI32S	ST-LSI16D	ST-LSI16S	ST-LSI-ADX32S	ST-LSI-ADX16D	ST-LSI-DA4A (Incl. DC/DC)	ST-LSI-DA4B (No DC/DC)	
Models <sup>1</sup>	ST-LSI32S	ST-LSI16D	ST-LSI16S	ST-LSI-ADX32S	ST-LSI-ADX16D	ST-LSI-DA4A (Incl. DC/DC)	ST-LSI-DA4B (No DC/DC)	ST-LSI2
Number of A/D Channels	32 Single-ended	16 Differential	16 Single-ended	Adds 32 SE Channels	Adds 16 Diff. Channels	—		16 Single-ended or 8 Differential, Jumper-selected
A/D Current Inputs <sup>2</sup>	Accepts up to 8 user-installed current shunt resistors.			Accepts up to 16 user-installed current shunt resistors		—		Accepts up to 8 user-installed current shunt resistors (3)
A/D Channel Expansion	See ST-LSI-ADX A/D Slave Expander, Next Column			64 SE or 32 Diff. A/D Chan. max. using a Master-Slave pair. May be indefinitely expanded by cascading Master-slave pairs.		—		See ST-LSI2-ADX Series A/D Slave Expander. Total capacity, master plus slave: 64SE or 32 Diff. A/D channels.
Number of D/A Voltage Channels	2 D/A Channels Optional (includes current loop amplifiers)			—		4 D/A Channels		None, use independent D/A Boards
D/A Channel Expansion	See Independent D/A Peripheral			—		Indefinite (Limited by board slots, power and memory capacity)		—
Digital Output Bits	4 TTL bits independently addressed with D/A channel 1 output word.			—		12 TTL bits slaved to D/A Channel 1 output.		None, must use D/A board.
DC/DC Power Converter	Optional			Uses power bussed over from Master Board.		Optional		Included standard. Omitted optional in OEM quantities (Contact Datel)
Board Size	8.5" × 10" quad (21 × 26 cm)			8.5" × 5" half-quad (21 × 13 cm)		8.5" × 5" half-quad (21 × 13 cm)		8.5" × 5" half-quad (21 × 13 cm)
Options	Prog. Gain Ampl. Diff. Inst. Ampl. DC/DC Pwr. Conv. 2 D/A Chans. plus current ampl. 16 Add'l Chans. Pacer Clock Included			—		DC/DC Power Converter		Includes PGA, DC/DC Power Converter, Pacer Clock. Accepts 8 user-installed current shunts. Optional 2nd DMA board avail. (Model ST-LSI2-DMA)
Compatible Computer	LSI-11, PDP-11/03/23			LSI-11, PDP-11/03/23		LSI-11, LSI-11/2, PDP-11/03, PDP-11/23		LSI-11, LSI-11/12, PDP-11/03/23
Notes	May operate in DMA by removing D/As and adding jumpers. Ranges & coding are jumper-selected. Diagnostic program included.			Single-ended and differential chans. cannot be mixed.		May be used with LSI-11/2. Diagnostic program included.		Diagnostic program included. ST-LSI2-ADX, ST-LSI2-DMA,
	(32 SE A/D's only) plus ampl. (16 SE A/D's only) PGA or Diff. Inst. Ampl. required for Differential inputs.			(ADX 32S) (ADX 16D)		(Incl. DC/DC) (No DC/DC. Requires ext. ±15V @ 150 mA regulated)		(Incl. PGA, DC/DC Pwr. Conv., Pacer Clock and Diagnostic Program)

**Notes**

- (1) These are not complete model numbers. Please refer to the model guide to select options.
- (2) The A/D current inputs use a shunt resistor across differential voltage channels. The shunts must be supplied and installed by the user (or by Datel in OEM quantities).
- (3) The ST-LSI2-ADX accepts 24 user-supplied differential current shunts.

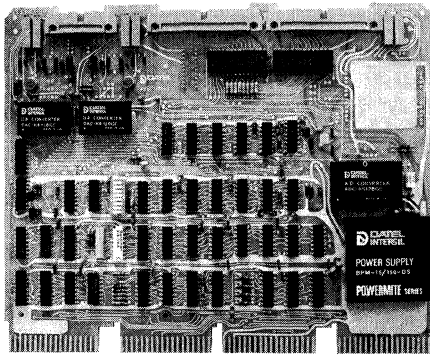


# ORDERING GUIDE

## A/D-D/A MASTER BOARD MODEL NUMBERING

See ST-LS12 information on pages 112S and 113S

ST-LSI



**NUMBER OF D/A CHANNELS**  
0 = No D/A's  
2 = 2 D/A Channels

**DC/DC POWER CONVERTER**  
1 = Included  
2 = Not Included (Ext. ±15V Power Required)

**NUMBER OF A/D CHANNELS**  
32S = 32 Single-ended  
16D = 16 Differential\*  
16S = 16 Single-ended

**PROGRAMMABLE GAIN AMPL. OR INSTRUMENTATION AMPL.**  
P = PGA (X1, 2, 4, 8) AM-251 A  
R = PGA (X1, 2, 5, 10) AM-251B  
D = Diff. Inst. Ampl., AM-205 (User-selected fixed gain)  
X = None (SE Only)

\*For differential systems the PGA or Diff. Inst. Amplifier must be used.

Standard inputs are ±10V full scale and offset binary coding. Users may rewire jumpers for other ranges and coding.

## A/D-D/A MASTER BOARD

(Single Quantity; Contact Datel for OEM Discounts)

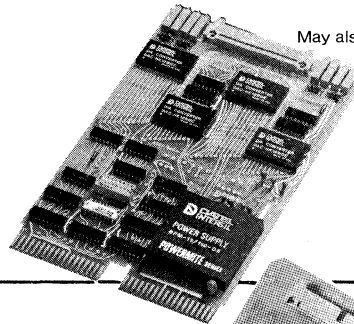
\*\*"R" models (PGA X1, 2, 5, 10) same price as "P" models

MODEL NUMBER	NO. OF A/D CHANS.	NO. OF D/A CHANS.	PGA* OR INST. AMPL.	DC/DC PWR. CONV.	MODEL NUMBER	NO. OF A/D CHANS.	NO. OF D/A CHANS.	PGA* OR INST. AMPL.	DC/DC PWR. CONV.
ST-LSI32S0P1	32S	None	PGA	Yes	ST-LSI16D2P1	16D	2 D/A's	PGA	Yes
ST-LSI32S0P2	32S	None	PGA	No	ST-LSI16D2P2	16D	2 D/A's	PGA	No
ST-LSI32S0D1	32S	None	Inst. Ampl.	Yes	ST-LSI16D2D1	16D	2 D/A's	Inst. Ampl.	Yes
ST-LSI32S0D2	32S	None	Inst. Ampl.	No	ST-LSI16D2D2	16D	2 D/A's	Inst. Ampl.	No
ST-LSI32S0X1	32S	None	None	Yes	ST-LSI16S0P1	16S	None	PGA	Yes
ST-LSI32S0X2	32S	None	None	No	ST-LSI16S0P2	16S	None	PGA	No
ST-LSI32S2P1	32S	2 D/A's	PGA	Yes	ST-LSI16S0D1	16S	None	Inst. Ampl.	Yes
ST-LSI32S2P2	32S	2 D/A's	PGA	No	ST-LSI16S0D2	16S	None	Inst. Ampl.	No
ST-LSI32S2D1	32S	2 D/A's	Inst. Ampl.	Yes	ST-LSI16S0X1	16S	None	None	Yes
ST-LSI32S2D2	32S	2 D/A's	Inst. Ampl.	No	ST-LSI16S0X2	16S	None	None	No
ST-LSI32S2X1	32S	2 D/A's	None	Yes	ST-LSI16S2P1	16S	2 D/A's	PGA	Yes
ST-LSI32S2X2	32S	2 D/A's	None	No	ST-LSI16S2P2	16S	2 D/A's	PGA	No
ST-LSI16D0P1	16D	None	PGA	Yes	ST-LSI16S2D1	16S	2 D/A's	Inst. Ampl.	Yes
ST-LSI16D0P2	16D	None	PGA	No	ST-LSI16S2D2	16S	2 D/A's	Inst. Ampl.	No
ST-LSI16D0D1	16D	None	Inst. Ampl.	Yes	ST-LSI16S2X1	16S	2 D/A's	None	Yes
ST-LSI16D0D2	16D	None	Inst. Ampl.	No	ST-LSI16S2X2	16S	2 D/A's	None	No

## INDEPENDENT 4-CHANNEL D/A BOARDS

May also be used with the LSI-11/2

MODEL NUMBER	NOTES	
ST-LSI-DA4A	DC/DC Power Converter is included.	
ST-LSI-DA4B	No DC/DC Converter (External ±15 Vdc power @ 160 mA is required.)	

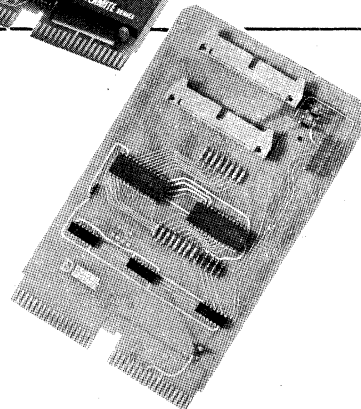


## SLAVE A/D MULTIPLEXER CHANNEL EXPANDERS

(An A/D-D/A Master Board is required for control)

MODEL NUMBER	NOTES	
ST-LSI-ADX32S	Adds 32 additional single-ended channels	
ST-LSI-ADX16D	Adds 16 additional differential channels. The PGA or Diff. Inst. Ampl. on the master board is required.	

NOTE: Single-ended and differential inputs cannot be mixed.



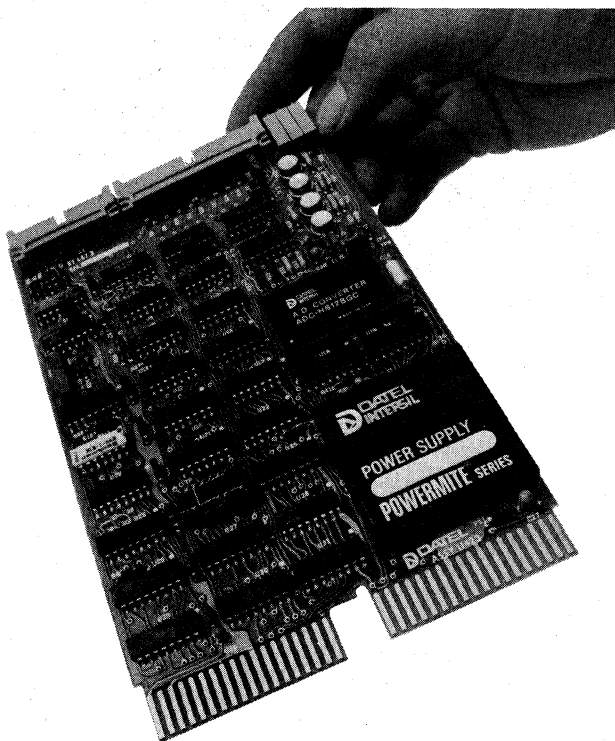
# SineTrac™ ST-LSI2 Series Half-Quad A/D and D/A Boards for DEC® LSI-11®, -11/2 Computers

Compatible to: LSI-11 } H-9270 and  
LSI-11/2 } H-9273-A  
PDP-11/03/23 } Backplanes

## ANALOG INPUT: MODEL ST-LSI2

### Features

- 16 single-ended or 8 differential A/D channels (jumper-selected) for the half-quad LSI-11/2
- Throughput speed is 20 microseconds per conversion.
- Differential Programmable Gain Amplifier (PGA) with X1, 2, 4, 8 gains included. (Low level not available.)
- On-board Pacer Clock is included to give 16 programmable timebases for A/D Start, DMA cycle or interrupt.
- DC/DC Power Converter included.
- Accepts 8 current loop shunt resistors for 4-20 mA inputs, etc.
- Powerful Diagnostic Program Tape and Manual with listing are included.
- Identical analog specifications to the full-quad ST-LSI A/D board with PGA.
- **Model ST-LSI2, Contact Datel for quantity discounts.**



## ANALOG OUTPUT: ST-LSI D/A SERIES

### Features

- Uses the identical half-quad D/A boards as the ST-LSI system.
- 4 voltage output channels per board, 12 bit binary resolution.
- 4 microsecond output settling time
- With or without optional  $\pm 15V$  DC/DC Power Converter.
- Includes 12-bit TTL output port slaved to D/A Channel 1 data.
- Includes Diagnostic Paper Tape Program and system manual with program listing.

- DIP-switch selectable board addressing (memory-mapped) for indefinite channel expansion.
- +5V, +10V,  $\pm 5V$ ,  $\pm 10V$  jumper-selected output ranges at 5 mA max.
- **Model ST-LSI-DA4A (Incl. DC/DC) ST-LSI-DA4B (No DC/DC)**

## A/D SLAVE CHANNEL EXPANDER: ST-LSI2-ADX

### Features

- Adds 48 single-ended or 24 differential A/D channels. Total capacity: 64S/32D channels on two boards.
- Addressed, powered and controlled by the ST-LSI2 Master A/D board.
- Optional DIP Ribbon jumper cable to the Master board.
- Will accept up to 24 current loop shunt resistors selected and installed by the user. Makes the A/D

- inputs compatible to industrial process transmitter ranges of 4-20 mA, 1-5 mA, 10-50 mA, etc.
- Same high performance as the ST-LSI2 Master board: 200 Megohms OFF resistance, 30 pA leakage, 5 pF input capacitance.
- Jumper-selected 48S or 24D channels.
- **Model ST-LSI2-ADX, Contact Datel for quantity discounts.**

## DIRECT MEMORY ACCESS: ST-LSI2-DMA

### Features

- Commands up to 32,768 16-bit words as A/D data transfers.
- Optional DIP Ribbon cables to master board.
- Includes on-board End of Conversion (EOC) and End of DMA Cycle Interrupt logic.

- Issues two selectable Interrupt Vector Addresses (EOC and End DMA Cycle)
- Allows A/D Multi-scan Block Transfers at 50,000 samples per second rates for dynamic real-time applications.
- **Model ST-LSI2-DMA**

DEC, PDP and LSI-11 are Digital Equipment Corp. Trademarks

## ST-LSI2 continued

### PROGRAMMING, CONTROL REGISTERS, ARCHITECTURE

The Master A/D board includes a programmable Pacer clock (16 selectable timebases) which may be used to:

1. Start an A/D conversion
2. Issue an external pulse to control real-time outside devices.

The DMA board includes interrupt logic which may be initiated by:

1. An A/D End of Conversion (EOC)
2. An End of DMA Cycle

The on-board interrupt logic for each of these functions issues a preset Interrupt Vector Address which may be altered by jumpers.

Thus there are three methods of data transfer after A/D conversion. They are:

1. Program control by polling the Status Register for End of Conversion set.

2. Generate an interrupt at EOC on the DMA/Interrupt board.
3. DMA data transfer started at EOC with the DMA Enable bit 6 set. An interrupt will occur at the end of the DMA cycle to inform the processor that the block transfer is complete and the data in memory may be further processed.

DMA block transfers may be indirectly started by the Pacer clock by starting an A/D conversion. At EOC, with the DMA Enable bit 6 set, 50 KHz sequential data transfers will occur until the DMA Word Count is reached. The Auto-Start and Auto-Increment modes are also used.

The full-quad ST-LSI A/D-D/A Master Board has somewhat more capability in that either the Pacer clock or an external event may directly cause an interrupt (using interrupt logic on the Master board). Also, the ST-LSI (full quad) includes additional gates for a user-installed quartz crystal (1 MHz max.)

### REGISTERS

The on-board registers and their corresponding memory-mapped addresses and bit assignments are identical to the full-quad ST-LSI A/D-D/A board (see pages 8 and 9) with the following exceptions:

1. The preassigned (but resettable) memory address 170404 (octal) is used for the DMA Word Count Register (see below).  
Up to 32K 16-bit words may be transferred and this register decrements with each A/D data word transfer.
2. The memory I/O Address 170406 (octal) is used for the DMA Starting Memory Address, which increments after each transfer.
3. Bit 6 in the Command/Status Registers is used for

DMA Select Enable/Status.

4. EOS and Pacer Clock Interrupt Enable/Status bits 4 and 3 are not available on the ST-LSI2. See remarks above. The EOC and DMA Interrupts are available.
5. An external Device Select is not available on the ST-LSI2 A/D board. Use the 12 Device Select bits on an independent ST-LSI-DA board instead.
6. Two Interrupt Vector Addresses are issued on the ST-LSI2-DMA board. They are:  
Base (octal) 000360 End of A/D Conversion (EOC)  
Base +4 000364 End of DMA Cycle  
Five PCB jumpers may be altered to reassign the base address between 000000 and 000360.

### DMA WORD COUNT REGISTER

Address: 170404 (octal) or base +4

Diagnostic Mnemonic: WDCNT

Instruction Cycle: DATO

Register Hardware Location:

ST-LSI2-DMA Board

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WC	WC	WC	WC	WC	WC	WC	WC	WC	WC	WC	WC	WC	WC	WC	WC
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

### DMA MEMORY ADDRESS REGISTER

Address: 170406 (octal) or base +6

Diagnostic Mnemonic: MEMADR

Instruction Cycle: DATO (set)

or DATI (test)

Register Hardware Location:

ST-LSI2-DMA Board

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	X
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	

Not Used

### PACER CLOCK TIMEBASES

Command Register Timebase Code (Octal)	Timebase Period ÷ 2 <sup>16</sup> (Standard, Factory-Adjusted)	Timebase Period ÷ 2 <sup>24</sup> (Jumper Selected: GND, Timer Pin 6)	Command Register Timebase Code (Octal)	Timebase Period ÷ 2 <sup>16</sup> (Standard, Factory-Adjusted)	Timebase Period ÷ 2 <sup>24</sup> (Jumper Selected: GND, Timer Pin 6)
0	30.6 μS	7.8 mS	10	7.8 mS	2 Sec.
1	61 μS	15.6 mS	11	15.6 mS	4 Sec.
2	122 μS	31.3 mS	12	31.3 mS	8 Sec.
3	244 μS	62.5 mS	13	62.5 mS	16 Sec.
4	489 μS	125 mS	14	125 mS	32 Sec.
5	977 μS	250 mS	15	250 mS	64 Sec.
6	1.95 mS	500 mS	16	500 mS	128 Sec.
7	3.9 mS	1 Sec.	17	1 Sec.	256 Sec.

### ST-LSI2 HALF-QUAD SERIES ORDERING GUIDE

ST-LSI2  
ST-LSI-DA4A  
ST-LSI-DA4B  
ST-LSI2-ADX  
ST-LSI2-DMA  
ST-LSI2-11452-1  
ST-LSI2-11452-2

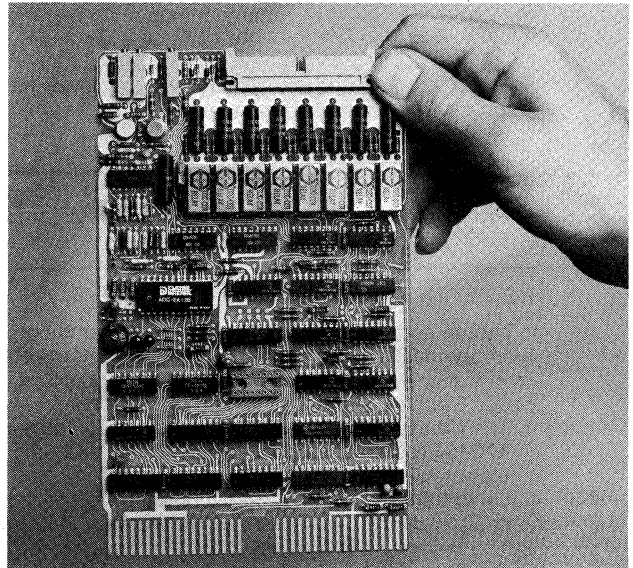
16S/8D A/D chans., Pacer clock, PGA, DC/DC  
4 D/A chans., includes DC/DC Power Conv.  
4 D/A chans. requires external ±15 Vdc reg.  
A/D Slave Expander, add 48S/24D chans.  
DMA Controller for ST-LSI2, 32K words  
Ribbon cable for A/D plus DMA or ADX (2 plugs)  
Ribbon cable for A/D plus DMA and ADX (3 plugs)

# SineTrac<sup>TM</sup> ST-LSI-RLY Relay-Input A/D Board for DEC<sup>®</sup> Q-Bus Computers

## FEATURES

- 8 Differential A/D Channels, using "Flying Capacitor" relay multiplexer.
- High Common Mode Noise Rejection (126 dB) and high isolation (250 VRMS).
- 12 bit binary resolution, with user-selected output coding.
- Software and hardware compatible with DEC's LSI-11, LSI-11/2 and PDP-11/03/23 Series of microcomputers.
- Programmable gain amplifier, selectable gain X1, X2, X5, and X10.
- Full-scale input selectable from 10 mV to 2V unipolar; from  $\pm 10$  mV to  $\pm 1$ V bipolar, using gain resistor.
- Includes paper tape Diagnostic Program for immediate TTY or CRT display of scans.
- EOC interrupt; external trigger start.
- Uses +12V and +5V from computer bus; -12V generated from on-board converter.
- Half quad size: 8.430"D x 5.187"W x .5"H.
- Channel expansion by different memory-mapped card base addresses.

COMPATIBLE TO: LSI-11      PDP-11/03      H-9270 and  
LSI-11/2      PDP-11/23      H-9273-A  
Backplanes



## INTRODUCTION

The ST-LSI-RLY board offers analog to digital conversion for up to eight relay-isolated input channels, and does so with 12 bits of binary resolution (1 part in 4096). Like its sister products, the SineTrac ST-LSI and ST-LSI2 series of A/D and D/A conversion systems, the ST-LSI-RLY is fully hardware, software, and bus compatible with Digital Equipment Corporation's LSI-11, LSI-11/2, and PDP-11/03 series of microcomputers. Because Datal has built all the necessary computer interface circuitry into the ST-LSI-RLY board, adding 8 analog input channels to the DEC LSI-11 computer is as easy as sliding in a circuit board. The customer need only supply the analog input wiring — all other interconnection is accomplished via the ST-LSI-RLY board.

The ST-LSI-RLY board was designed especially for use in industrial (and other electrically noisy) environments where long signal leads, ground loop isolation problems, and high common mode voltages are encountered. While most A/D boards use solid-state multiplexers to achieve high conversion speed and maximum channel density, such circuits constrain the common mode voltage range to about  $\pm 11$ V and have no bias current isolation. However, the ST-LSI-RLY, with its "flying capacitor" relay multiplexer, can safely handle 250 VRMS, provides 126 dB of common mode rejection at AC power frequencies (dc to 60 Hz) and has  $5 \times 10^{13} \Omega$  isolation resistance. In addition, the low pass input circuitry to each channel of the ST-LSI-RLY board serves to filter out unwanted normal mode signals.

The ST-LSI-RLY board was specifically designed for use in monitoring industrial process-control equipment. Generally, these applications involve such slowly-varying parameters as temperature, pressure, and flow rate. The transducers used for this measurement — thermocouples, strain gauges, and load cells, for example — frequently use low voltage bridge-type circuits. The ST-LSI-RLY's 30 sample-per-second throughput rate is quick enough to measure such parameters accurately; its high CMR, high gain differential inputs are ideal

for accurate bridge-type measurements of low-level signals.

The SineTrac LSI-RLY board is a memory-mapped device. It occupies two consecutive locations in the host computer's memory. For expansion, additional ST-LSI-RLY boards may be added with different base addresses. Each additional board will occupy two consecutive memory locations, which may be selected by the user. For applications requiring high speed A/D conversion, and the option of D/A conversion capability, Datal's ST-LSI and ST-LSI2 series of solid-state multiplexer boards should be considered. A chart detailing the differences among Datal's ST-LSI series of boards is included overleaf.

The ST-LSI-RLY board fits half quad spacing. It takes +5V and +12V directly from the DEC Q-bus. The -12V is generated on the board from the +5V supply. Input to the A/D board is via a Programmable Gain Amplifier — gains of X1, X2, X5, and X10 are software-selected. Other ranges (corresponding to full-scale input ranges from 10mV to 2V) may be selected by changing jumpers. Like other boards in Datal's SineTrac series, the ST-LSI-RLY is supplied with a Diagnostic Program — input formatted on paper tape, with hex A/D outputs printed on a teletypewriter or displayed on a CRT — so that the board may be running and checked for proper operation within a few minutes of installation. A complete listing of the Diagnostic is provided in the systems manual that accompanies each ST-LSI-RLY board.

## DESCRIPTION

The ST-LSI-RLY board provides A/D conversion for 8 differential inputs on a single, half quad board. Analog signals are converted to digital with 12 binary bits (1 part in 4096) of resolution. Input to the board is via a "flying capacitor" circuit. A nonpolarized storage capacitor normally tracks the input signal. When the converter reads a particular input, a computer-controlled reed relay connects the capacitor to both input leads of a differential amplifier. The relay inputs can accommodate high common mode voltages (250 VRMS

DESCRIPTION Continued

to power ground). Common mode rejection (CMR of 126 dB, from 0 to 60 Hz) is also extremely high to reduce noise errors. The storage capacitor is coupled via two resistors to the input signal, forming a one-pole low pass filter, which attenuates normal mode noise.

The input signal on the ST-LSI-RLY goes from the relay multiplexer described above to a differential programmable gain amplifier. Gains of X1, X2, X5, and X10 are software-selected via a two-bit program word. Other gains may be set by resistor change. Full scale input ranges, selectable by circuit board jumpers and PGA program word vary from 10 mV to 2.0V unipolar; or from ±10 mV to ±1.0 V bipolar. The PGA is auto-zeroed, therefore, temperature drift of zero is limited to ±¼ μV/°C. Typical amplifier gain temperature coefficient is ±10 ppm of full scale reading per degree Celsius.

Analog to digital conversion is accomplished by Datel's ADC-EK12, a 12-bit monolithic CMOS integrated circuit. The ADC-EK12 employs a charge balancing integration method of conversion, which provides high linearity, inherent monotonicity, and very high normal mode noise rejection. Converter zero temperature coefficient is ±20 microvolts/°C, while its gain tempco is ±30 ppm of FSR/°C. Nonlinearity is held to ±½ least significant bit, and system throughput period is 36 mS, sample to sample. Overall system zero tempco varies from 0.5 to 20 microvolts/°C for gains from X1 to X100, respectively, and system span tempco varies from 12 to 40 ppm of full scale reading per °C, respectively, over the same range of gains.

The output coding on the ST-LSI-RLY is jumper-selectable for straight binary (unipolar); while, for bipolar inputs, offset bi-

nary or two's complement may be used.

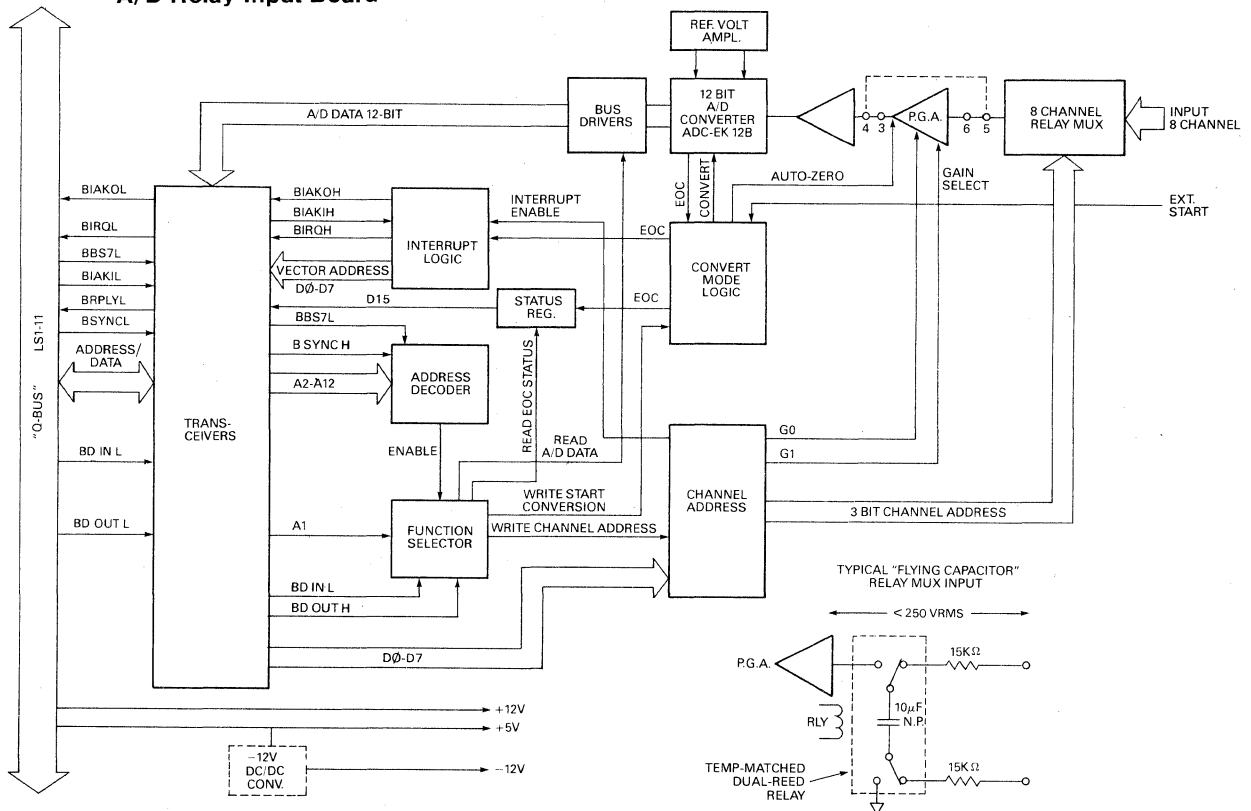
The ST-LSI-RLY board is a memory-mapped device using two consecutive memory word addresses (a base address and displacement). The base address is factory set by DIP-plug jumpers to 170400 (octal), for compatibility with the supplied Diagnostic program. The hex plug may be rewired by the user for any base address within a range of 160,000 to 177,770 (octal).

On-board registers are provided to load the PGA gain code, the starting channel address and the EOC interrupt. An on-board EOC interrupt is also provided, factory set to a vector address of 360. This vector address may be changed by the user.

An unusual and powerful feature of the ST-LSI-RLY board is the paper tape Diagnostic program shipped with each board. With the Diagnostic, all board functions are tested; the results are visible on CRT display or teletypewriter printout. Proper operation of the board, whether immediately upon installation, or at any time thereafter, may thereby be verified in a matter of minutes. In addition, the Diagnostic program has been written so that portions of it may be excerpted for inclusion in the user's own program.

The ST-LSI-RLY board fits DEC's half quad spacing, and measures 8.430"D x 5.187"W x .5"H (214 x 132 x 12,7 mm). It weighs 7.46 ounces (.212 kg). Operating temperature range is from 0 to +70°C; storage temperature range is from -25°C to +85°C. Relative humidity may vary from 10% to 90%, non-condensing.

ST-LSI-RLY  
BLOCK DIAGRAM  
A/D Relay-Input Board



**SPECIFICATIONS**

(Typical at +25°C, dynamic conditions unless noted)

**ANALOG INPUTS**

- Number of Channels** . . . . . 8 Differential
- Input Type** . . . . . Flying capacitor differential isolated relay input, multiple (DPDT) reeds per channel for temperature tracking. The input network (when a channel is de-energized) consists of 30 kilohms in series with 10 microfarads (300 mS single-pole filter)
- Input Overvoltage (Diff.)** . . . ±25V sustained, no damage
- Input Capacitance to Ground** . . . . . Approx. 2.5 picofarads per channel
- Full Scale Input Ranges** . . . Selectable from 10 millivolts to 2 volts unipolar (±10 mV to ±1V bipolar), by jumper selection and Programmable Gain Amplifier (See Chart)
- Programmable Gains** . . . . . X1, X2, X5, X10
- Input Impedance** . . . . . Dependent on input signal rate of change (Diff. cap. resistance is 20 MΩ). Insulation resistance per channel to ground is 5 x 10<sup>13</sup> ohms. See block diagram for input circuit.
- Input Bias Current** . . . . . Input must source or sink current only to charge capacitor to new value. Capacitor remains connected at all times except during A/D conversion.
- Overall Accuracy at +25°C** (Including noise, referred to input, after initial calibration) Within ±0.05% of FSR (2V Range) Within ±0.1% of FSR (10 mV Range)
- Quantization Error** . . . . . ±½ LSB
- Nonlinearity** . . . . . ±½ LSB
- Differential Nonlinearity** . . . ±½ LSB
- Resolution** . . . . . 12 Binary bits (1 part in 4096)
- Common Mode Voltage Range** . . . . . 250V RMS to power ground
- Common Mode Rejection Ratio** . . . . . 126 dB from 0 to 60 Hz
- Temperature Coefficients**
- A/D Converter Zero** . . . . . ±20 μV/°C
- A/D Converter Gain** . . . . . ±30 ppm of FSR/°C
- Input Amplifier Zero** . . . . . ±¼ μV/°C (Autozeroed)
- Input Amplifier Gain** . . . . . ±10 ppm of FSR/°C

Gain	System Zero Tempco	System Gain Tempco	FSR Input Voltage
X1	±20 μV/°C	±40 ppm of FSR/°C	±1V
X10	±2.5 μV/°C	±15 ppm of FSR/°C	±100 mV
X100	±.5 μV/°C	±12 ppm of FSR/°C	±10 mV

**System Throughput** . . . . . 30 samples per second

**A/D DIGITAL OUTPUTS**

- Output Coding** . . . . . Offset Binary is standard
- Two's Complement } Selectable
- (Bipolar) } by user-
- Straight Binary } supplied
- (Unipolar) } jumpers

**Bus Format** . . . . . Bus compatible with LSI-11, LSI-11/2 or PDP-11/03/23

**PROGRAMMING AND ARCHITECTURE**

- Type of Interface** . . . . . Memory-mapped. The ST-LSI-RLY appears to the CPU as two consecutive memory word locations.
- Memory Base Address** . . . The 2-location starting base address is factory set at 170400 (octal), but may be reassigned. The supplied Diagnostic program is preset to operate from base address 170400.
- External Trigger Start** . . . . A jumper change permits a negative TTL pulse (1.5 ±0.5 μS) to start A/D conversions.
- Interrupt** . . . . . EOC interrupt factory set at vector address 360, may be reset by user.

**PHYSICAL**

- Outline Dimensions** . . . . . 8.430"D x 5.187"W x .5"H\* (214 x 132 x 12.7 mm)
- Weight** . . . . . 7.46 oz. (.212 kg).
- Operating Temperature Range** . . . 0 to +70°C
- Storage Temperature Range** . . . . -25°C to +85°C
- Relative Humidity** . . . . . 10% to 90%, non-condensing
- Altitude** . . . . . 0 to 15,000 feet (4600 m)

**POWER CONSUMPTION**

- +5 VDC ±5% @ 1.5 Amps. max.
- +12 VDC ±5% @ 70 milliamps max.

**GENERAL**

- Compatibility** . . . . . Pin-for-pin, card guide and program compatible with DEC's LSI-11, LSI-11/2, and PDP-11/03/23 series of microcomputers.
- Operates from H-9270 and H-9273-A backplanes, AB bus.

**ORDERING GUIDE**

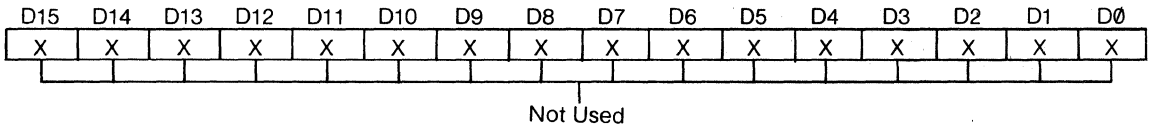
Model	Description
<b>ST-LSI-RLY</b>	8 Channels, Relay Input A/D
<b>58-2079143</b>	Connector, J1, Spare (One Included with Board)
<b>58-12140-36</b>	ST-LSI-RLY Manual, Spare (One Included with Board)

\*Due to board height, the ST-LSI-RLY should be placed in the top of the card cage or with no adjacent board.

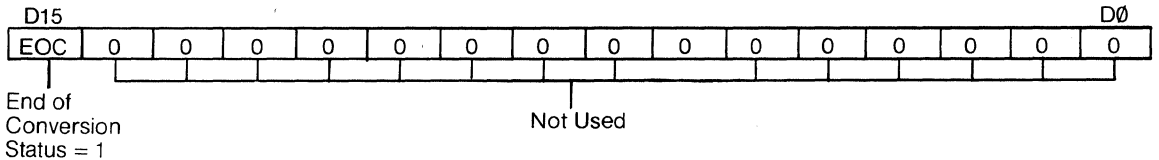
**REGISTERS**

The memory address bit-function assignments are as follows:

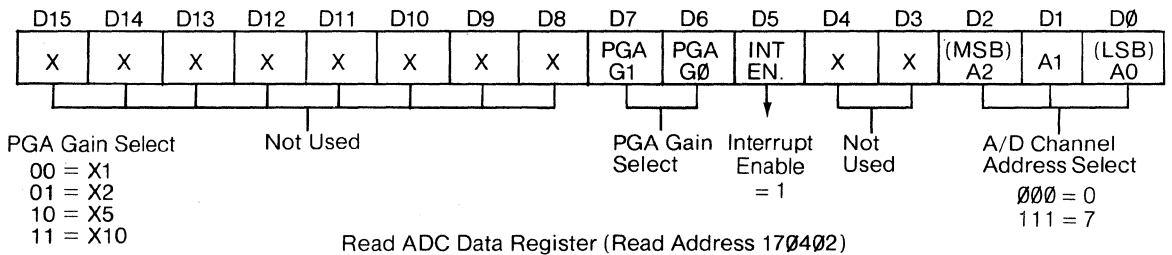
Status Register (Write Address 170400)



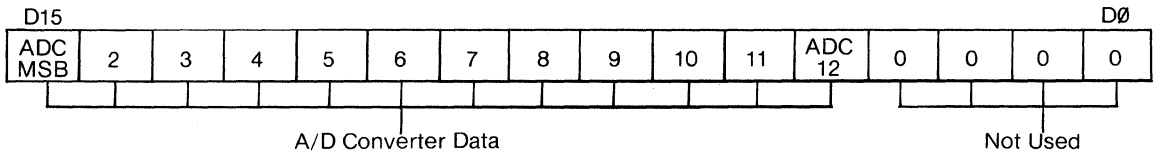
Read Status Register (Read Address 170400)



Gain and Channel Address Register (Write Address 170402)

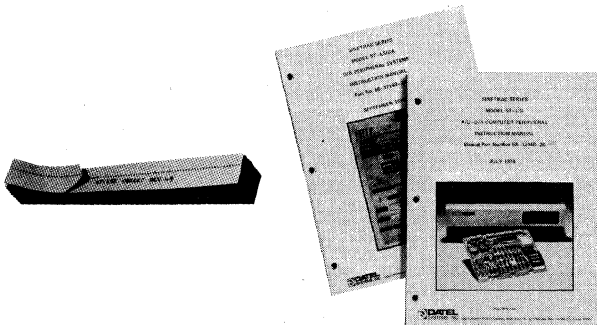


Read ADC Data Register (Read Address 170402)



**DIAGNOSTIC PROGRAM**

A Diagnostic program which tests all functions of the ST-LSI-RLY board, is supplied on paper tape format with each unit. Below is a listing of test names, call keys and descriptions of the special tests available on the Diagnostic. For more detailed information, and a complete listing of the Diagnostic, reference should be made to the systems manual supplied with each ST-LSI-RLY board.



Test Name	TTY Call Key	Description
<b>A/D Calibration Test</b>	<b>A ADCAL</b>	Selects a specific A/D channel and PGA gain and gives octal outputs each time the keyboard space bar is depressed.
<b>End of A/D Conversion Interrupt Test</b>	<b>B EOCINT</b>	Tests interrupts from multiple A/D conversions and checks the Interrupt Vector Address. Prints error message and loops on errors.
<b>Scan Test</b>	<b>C SCAN</b>	Converts all 8 channels and prints out the A/D result.

**A/D CALIBRATION PROCEDURE**

The calibration of the ST-LSI-RLY should be performed every 90 days or whenever the Full Scale Range jumpers are re-configured. The calibration of the ST-LSI-RLY is achieved by using the Diagnostic Test Program.

1. Connect the precision analog voltage source to channel 0 (J1-5 High, J1-7 Low and J1-8 Ground). A Datal DVC-8500 Voltage Calibrator or equivalent is recommended.
2. Using the Diagnostic Test Program, select the A/D Calibration Test. The data terminal will respond with:  
A-D CALIBRATION TEST  
GAIN RANGE (1) X1, (2) X2, (5) X5, (10) X10 - 1CR  
CHANNEL - 0CR  
(Underlines indicate user keyboard responses.)
3. The voltage input on channel 0 will be continuously converted and the A/D converter can be calibrated as per the next steps.
4. Adjust the voltage reference for the -F.S. +1 LSB according to the following table.

Full Scale Range	Voltage Ref. Setting	Output
0 → 100 mV	0.02 mV	000020 <sub>8</sub>
0 → 200 mV	0.01 mV	000020 <sub>8</sub>
±100 mV	-99.95 mV	000020 <sub>8</sub>

ZERO OR OFFSET ADJUST

5. Press the space bar from the terminal, and the last converted value (6 digit octal) will be printed out on the terminal.
6. Adjust R4 (Zero Adjust Pot) for Unipolar units and R1 (Offset Adjust Pot) for Bipolar units, and repeat steps 5 and 6 until the printout on the terminal is 000020 (100020 for 2's complement coding).
7. Adjust the voltage reference for +F.S. -2 LSB according to the following table.

Full Scale Range	Voltage Ref. Settings	Output
0 → +100 mV	+ 99.00 mV	177700
0 → +200 mV	+199.81 mV	177700
±100 mV	+ 99.81 mV	177700

GAIN ADJUST

8. Adjust R2 (Gain Pot), press the space bar, and repeat it until the printout on the terminal is 177700 (077700 for 2's complement coding).
9. Repeat steps 5 to 8 several times (until no further adjustment is required).
10. At the end of calibration operation, apply different voltage inputs from the voltage reference as shown in the Calibration Table and press the space bar on the terminal keyboard each time. The equivalent six digit octal value will be printed out on the terminal each time the space bar is pressed. Compare the printout to the calibration table to ensure proper operation.

**CALIBRATION TABLE**

Unipolar*			Bipolar*			6 Digit Octal	
0 → 1.0V	0 → 200mV	0 → 500mV	±1.0V	±200mV	±500mV	Straight Binary	2's Compl.
999.76mV	199.51mV	499.88mV	999.51mV	199.90mV	499.76mV	177760	077760
999.51	199.90	499.76	999.02	199.81	499.51	177740	077740
999.02	199.81	499.51	998.05	199.61	499.02	177700	077700
998.05	199.61	499.02	996.09	199.22	498.05	177600	077600
996.09	199.22	498.05	992.19	198.44	496.09	177400	077400
992.19	198.44	496.09	984.37	196.88	492.19	177000	077000
984.37	196.88	492.19	968.75	193.75	484.37	176000	076000
968.75	193.75	484.37	937.50	187.50	468.75	174000	074000
937.50	187.50	468.75	875.00	175.00	437.50	170000	070000
875.00	175.00	437.50	750.00	150.00	375.00	160000	060000
750.00	150.00	375.00	500.00	100.00	250.00	140000	040000
500.00	100.00	250.00	0.00	0.000	0.000	100000	000000
250.00	50.00	125.00	-500.00	-100.00	-250.00	040000	140000
125.00	25.00	62.50	-750.00	-150.00	-375.00	020000	120000
62.50	12.50	31.25	-875.00	-175.00	-437.50	010000	110000
31.25	6.25	15.63	-937.50	-187.50	-468.75	004000	104000
15.63	3.13	7.81	-968.75	-193.75	-484.37	002000	102000
7.81	1.56	3.91	-984.37	-196.88	-492.19	001000	101000
3.91	0.78	1.96	-992.19	-198.44	-496.09	000400	100400
1.96	0.39	0.98	-996.09	-199.22	-498.05	000200	100200
0.98	0.20	0.49	-998.05	-199.61	-499.02	000100	100100
0.49	0.10	0.24	-999.02	-199.81	-499.51	000040	100040
0.24	0.05	0.12	-999.51	-199.90	-499.76	000020	100020
0.00	0.000	0.00	-1000.00	-200.00	-500.00	000000	100000

**Note 1.** Other input range voltages may be obtained by dividing above ranges by the appropriate power of 10.

**Note 2.** Standard shipped range is ±100mV offset binary.

\*Jumpers must be reconfigured between columns to achieve above ranges.



**INPUT RANGE SELECTION**

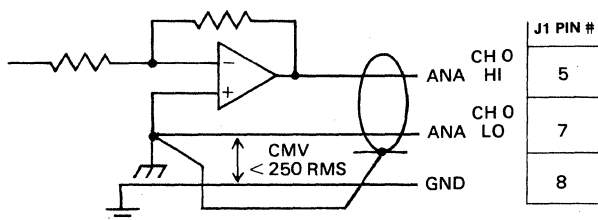
TO OBTAIN THE FOLLOWING INPUT RANGES

SOFTWARE SELECT THIS GAIN CODE				AND PLACE JUMPER PLUGS BETWEEN THESE PINS
X1 G1 G0 0 0	X2 G1 G0 0 1	X5 G1 G0 1 0	X10 G1 G0 1 1	
0 → +100mV	0 → +50mV	0 → +20mV	0 → +10mV	7-8 22-24
0 → +200mV	0 → +100mV	0 → +40mV	0 → +20mV	22-24
±100mV Off. Bin.	±50mV Off. Bin.	±20mV Off. Bin.	±10mV Off. Bin.	1-2 11-12 22-24
±100mV 2's Comp.	±50mV 2's Comp.	±20mV 2's Comp.	±10mV 2's Comp.	1-2 11-12 22-23

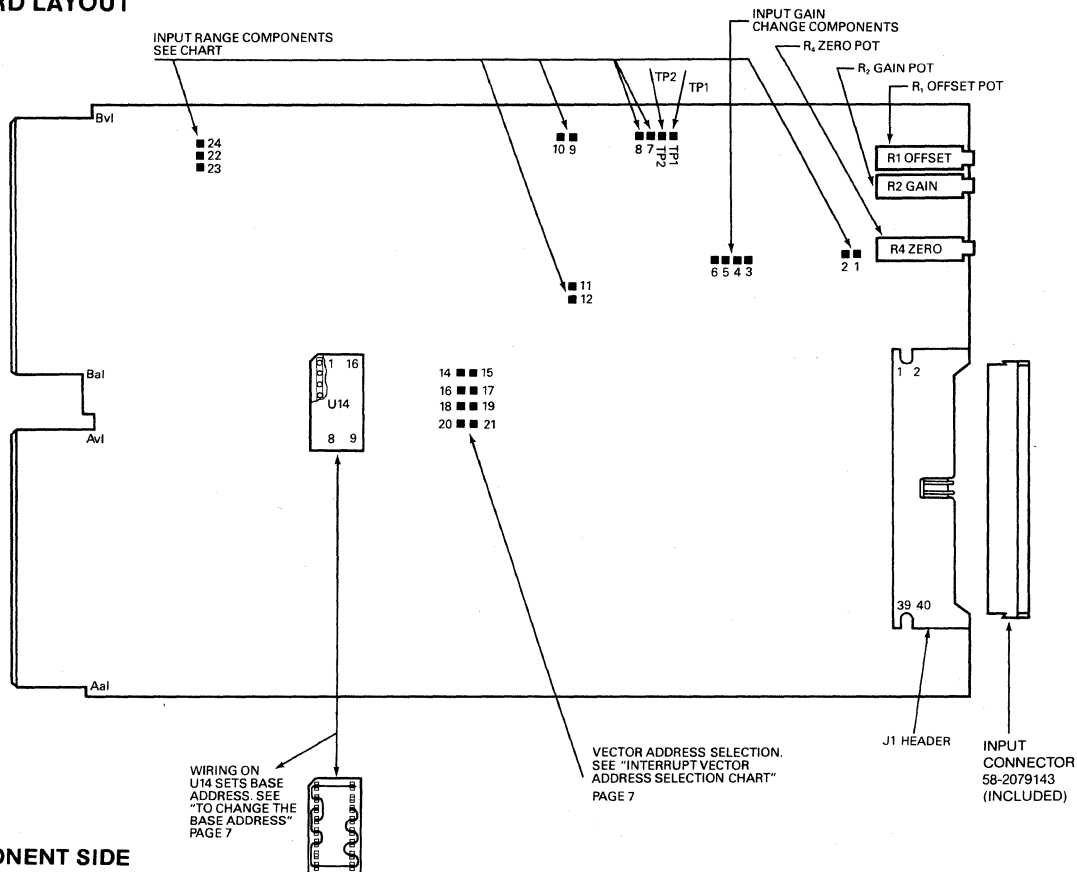
**Note:**

Installing a jumper plug from pin 9 to pin 10 will increase full-scale range by factor of 10. e.g., ±100mV range will change to ±1.000V.

**SAMPLE INPUT CONNECTIONS, CHANNEL 0**



**BOARD LAYOUT**



**COMPONENT SIDE**

**ANALOG INPUT CONNECTIONS  
J1 HEADER**

COMPONENTS		WIRING SIDE	
Upper Pins (Farthest from Board)		Lower Pins (Nearest Board)	
N.C.	1	2	-12V Power OUT 10mA max.
N.C.	3	4	+12 Power OUT
CH 0 HI	5	6	EXT TRIGGER
CH 0 LO	7	8	CH 0 GND
CH 1 HI	9	10	CH 1 GND
CH 1 LO	11	12	
CH 2 HI	13	14	CH 2 GND
CH 2 LO	15	16	
CH 3 HI	17	18	CH 3 GND
CH 3 LO	19	20	
CH 4 HI	21	22	CH 4 GND
CH 4 LO	23	24	
CH 5 HI	25	26	CH 5 GND
CH 5 LO	27	28	
CH 6 HI	29	30	CH 6 GND
CH 6 LO	31	32	
CH 7 HI	33	34	CH 7 GND
CH 7 LO	35	36	
N.C.	37	38	ANA. GND
N.C.	39	40	

**INTERRUPT VECTOR ADDRESS  
SELECTION CHART**

JUMPERS (ON BOARD)				To Give Vector Address Of
Pins 14-15	Pins 16-17	Pins 18-19	Pins 20-21	
—	—	—	—	360
—	—	—	CONNECT	340
—	—	CONNECT	—	320
—	—	CONNECT	CONNECT	300
—	CONNECT	—	—	260
—	CONNECT	—	CONNECT	240
—	CONNECT	CONNECT	—	220
—	CONNECT	CONNECT	CONNECT	200
CONNECT	—	—	—	160
CONNECT	—	—	CONNECT	140
CONNECT	—	CONNECT	—	120
CONNECT	—	CONNECT	CONNECT	100
CONNECT	CONNECT	—	—	060
CONNECT	CONNECT	—	CONNECT	040
CONNECT	CONNECT	CONNECT	—	020
CONNECT	CONNECT	CONNECT	CONNECT	000

"—" Indicates No Jumper  
"CONNECT" Indicates Jumper Plug Installed

**BASE ADDRESS SELECTION**

**DIP PLUG**

**U14 PINS**

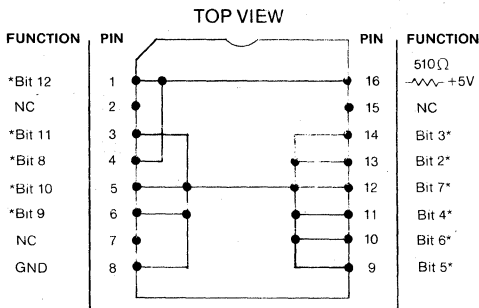
(Set for Base Address = 170400.  
Bits 8 and 12 high)

**TO CHANGE THE BASE ADDRESS**

- Select a base address. Permissible base addresses are from 160000 to 177774 (octal).
- Write it in boxes below.

1	_____	_____	_____	_____	_____
	(6 or 7)	(0 to 7)	(0 to 7)	(0 to 7)	(0 or 4)

- Determine which binary address bits must be high, and which must be low, to yield this code.
- Bits with "1" correspond to "high" voltages on U14 connector. Bits with "0" correspond to "low" voltage. Determine which pins on U14 must be high, and which must be low. The "high" pins should be wired together to +5V (pin 16). The "low" pins should be wired together to ground (pin 8).  
**Note:** Pins 2, 7, and 15 are not connected to the board etch. Any of these may either be left unconnected, or used to dress the jumper wires for either the ground or +5V lines.



\*These pins may be set "HIGH" (connected to pin 16) or "LOW" (connected to pin 8).

See "To Change The Base Address".

Internal pullup resistors are not supplied except on pin 16. Connect all pins either high or low.

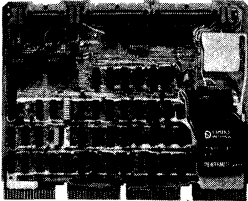
1	(6 or 7)	(0 to 7)	(0 to 7)	(0 to 7)	(0 or 4)	BASE ADDRESS (OCTAL) PERMISSIBLE VALUES		
1	4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	OCTAL BIT WEIGHTING		
15	14 13 12	11 10 9	8 7 6	5 4 3	2 1 0	BIT #		
ALWAYS HI	ALWAYS HI	Pin 1	Pin 3 Pin 5 Pin 6	Pin 4 Pin 12 Pin 10	Pin 3 Pin 11 Pin 14	Pin 13	ALWAYS LO	PIN #s ON U14

May be jumpered either LO or HI

# DATEL-INTERSIL

## SineTrac™ A/D-D/A Boards For LSI-11 Computers

Compatible to: LSI-11 / 2®, LSI-11 / 23, PDP®-11 / 03



### FULL QUAD A/D & D/A: ST-LSI SERIES

- 32 Single-ended or 16 Differential A/D Channels
- 2 12-bit D/A channels plus 4-20 mA current loops
- 20  $\mu$ S A/D throughput
- Programmable Gain Amplifier option
- Hi-gain instrumentation amplifier option
- Pacer clock with 16 programmable timebases
- 4-bit TTL output
- ST-LSI-ADX expander for 64S/32D channels
- Optional  $\pm$  15V DC/DC Converter

### HALF QUAD A/D & DMA: ST-LSI2

#### ST-LSI2

- 16 Single-ended or 8 Differential A/D channels
- 20  $\mu$ S A/D throughput
- Programmable Gain Amplifier option
- Pacer clock with 16 timebases

#### ST-LSI2-ADX

- Adds 48S/24D A/D channels
- Accepts 24 differential current inp shunts

#### ST-LSI2-DMA

- Controls 32K DMA 16-bit A/D block transfers
- End of Conversion, End of Block Interrupt Vector addresses
- 50 kHz A/D scans

### HALF QUAD D/A: ST-LSI-DA

- 4 12-bit D/A channels
- Optional DC/DC Converter
- 12-bit TTL output for external device control
  - with DC/DC Conv.
  - less DC/DC Conv.

### INDUSTRIAL HI-GAIN ISOLATED A/D: ST-LSI-RLY

- 8 Differential Channels, 12 binary bits, half quad
- 126 dB Common Mode Noise Rejection
- 250 VRMS high common mode isolation
- Programmable Gain Amplifier
- High-gain Instrumentation Amplifier: Works directly from millivolt transducers
- EOC Interrupt; external trigger start
- Includes DC/DC Converter
  - single quantity

LSI-11 and PDP are Digital Equipment Corp. trademarks

**Systems manual and Diagnostic Program included.**

**Plug your LSI-11 into the Analog world.**



11 CABOT BOULEVARD, MANSFIELD, MA 02048 / TEL. (617)339-9341 / TWX 710-346-1953 / TLX 951340  
Santa Ana, (714)835-2751 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490 • Houston, (713)781-8886 •  
Dallas, TX (214)241-0651 OVERSEAS: DATEL (UK) LTD — TEL: BASKINGSTOKE (0256)57361 • DATEL SYSTEMS SARL  
602-57-11 • DATELEK SYSTEMS GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

Printed in U.S.A. Copyright © 1980 Datel-Intersil, Inc. All rights reserved.

# SineTrac™ ST-6800 Series High Performance A/D & D/A Boards for Micromodule/ EXORciser® Computers

Compatible to: Micromodules  
M-6800 Series  
EXORciser®

## THE FEATURES

### Simple Channel Expansion and High Channel Density

Expansion up to 128 single-ended or 112 differential A/D channels may be easily accomplished by adding up to 2 ST-6800ADX Expander Cards. D/A expansion is accomplished using 4 or 8 channel stand-alone ST-6800 D/A cards.

### High Throughput Rate

A/D Settling and conversion takes only 20 microseconds resulting in data rates of up to 28,000 samples per second

## CIRCUIT FEATURES

### Input Protection

A/D inputs can withstand up to  $\pm 35$  V continuous overvoltage with no damage.

### Current Inputs

Eight of 32 analog input channels may accept on-board resistors for 4-20 mA, 1-5 mA, and 10-50 mA current inputs.

### Interrupt Capability

An external input allows for interrupt capability. Ideal for event-triggered operation.

### Memory Mapped Architecture

The ST-6800 is organized as a 512 byte block of EXORciser memory. Each A/D and D/A Channel is treated as two consecutive memory locations resulting in the simplest programming. D/A Master Boards are organized as 16-byte memory blocks.

### Digital Output Port

A 12 bit Digital Output Port is included on D/A Master Boards for use as device select or controls to external logic. The port is under full program control.

### Device Select Lines

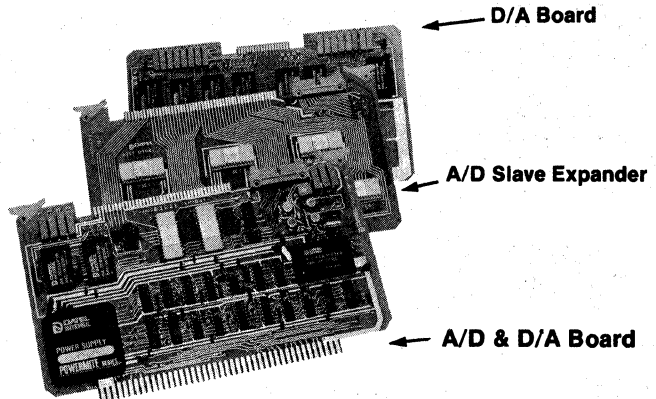
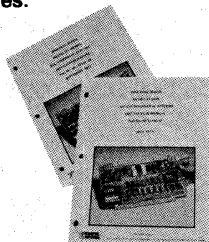
Two Device Select lines are provided for each on-board DAC on the ST-6800 A/D-D/A Master Board for use as pen-up/down controls, scope controls or external device select lines.

### On-Board DC/DC Power Converter

A/D, D/A and linear circuits are powered by an optional regulated modular  $\pm 15$ V DC/DC Power Converter which draws 1.2 Amps from the computer's +5 Vdc bus and isolates these analog circuits from the computer's noisy power supplies.

## THE MANUALS

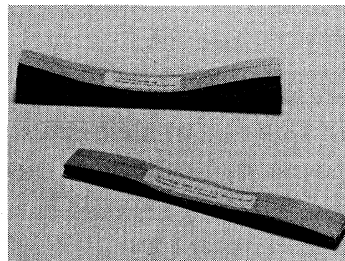
Comprehensive Systems Manuals include full listing of diagnostic test program, plus programming, applications, logic and timing diagrams, and full operating instructions.



## THE SYSTEM

High performance plug-in analog I/O cards expandable up to 128 A/D channels. D/A Systems available in increments of 4 or 8 D/A channels.

## THE PROGRAMS



Complete paper tape Diagnostic programs are supplied with each system. These programs provide for A/D and D/A calibration and offer sawtooth oscilloscope outputs. Ideal for system set-up and troubleshooting.

## TABLE OF CONTENTS

Introduction .....	Page 122S
Description .....	Page 123S
Specifications .....	Page 124S
Block Diagram, Combo A/D-D/A Board .....	Page 125S
Block Diagram, Independent D/A Board .....	Page 126S
Applications .....	Page 127S
Programming, Model Numbering .....	Page 128S
Diagnostic Program .....	Page 129S
Ordering Guide .....	Page 130S

EXORciser is a Motorola Corp. Trademark

## DESCRIPTION

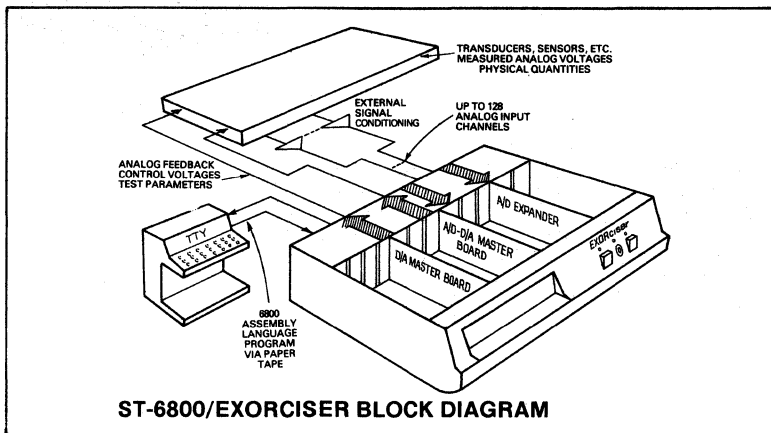
Datel's SineTrac 6800 series of data acquisition and data distribution peripherals provide a quick, efficient solution to the problem of interfacing analog inputs and outputs to Motorola's M6800 EXORciser microcomputer system. The ST-6800 A/D-D/A printed circuit cards are electrically and mechanically compatible with the EXORciser bus characteristics and slide directly into the card slots of the microcomputer housing; they are also completely compatible with all other Motorola peripherals and software support offered for the EXORciser system. The SineTrac 6800 systems offer a wide variety of available options plus the ease of future analog channel expansion, allowing the ST-6800 to be configured for virtually any application.

Applications for ST-6800 include industrial process controllers, high speed automatic test systems, intelligent analytical instruments, signal processors and analyzers, data logging, and programmable data acquisition systems. The on-board D/A converters are ideal for driving chart recorders, X-Y plotters, oscilloscopes, or actuators.

The ST-6800 A/D-D/A system is organized as a memory-mapped I/O device and appears to the M6800 MPU as a block of 512 consecutive memory locations. Programs written in 6800 assembly language completely control all activities of the SineTrac system. Analog channels may be either randomly or sequentially converted and stored in memory for further processing at rates of up to 28,000 samples per second. Users may also translate A/D-D/A control to higher level BASIC or FORTRAN programs using assembly language handler routines. As an additional feature, an external interrupt control input provides for event-triggered operation. Users would normally use this input to call up an A/D or D/A service routine whose starting address is stored in the Interrupt Vector Address location.

A Diagnostic Test Program supplied with each ST-6800 system provides immediate teletypewriter printout as soon as analog signal connections are made. This program completely exercises all interface logic for troubleshooting and fault diagnosis and provides full analog calibration for the A/D and D/A sections. The diagnostic program plus the full systems manual supplied with each unit shows the user how to control all A/D and D/A programs.

The SineTrac 6800 systems are organized around Datel's high-density hybrid A/D and D/A converters. These miniature state-of-the-art components, together with a monolithic Sample/Hold Amplifier (Datel SHM-LM-2) and LSI CMOS analog multiplexers allow 32 A/D channels and 2 D/A channels to be contained on a single PC Board along with all control logic. The A/D section features a 20 microsecond throughput period and 12-bit binary resolution with an overall system accuracy of  $\pm 0.025\%$  of the full scale input range. Signal voltages of 0 to +5 V, 0 to +10 V,  $\pm 5$  V and  $\pm 10$  V may be accepted by the A/D section. In addition, eight of the 32 analog input channels may accept on-board, user-supplied resistors for 4-20 mA, 1-5 mA, and 10-50 mA cur-



rent input operation. Input impedance for each A/D input is typically 100 Megohms resulting in CMR of 70 dB from DC to 1 kHz with 1 K ohm unbalance.

The A/D converter output coding may be user-selected for unipolar binary, offset binary, or 2's complement. Temperature drift is held to  $\pm 7$  ppm/ $^{\circ}$ C (zero) and  $\pm 30$  ppm/ $^{\circ}$ C (gain) over the 0 $^{\circ}$  to 70 $^{\circ}$ C operating range.

The D/A systems feature the same voltage ranges, input codings, and accuracy along with low output impedance (50 milliohms) capable of driving  $\pm 5$  mA. The D/A section of the Master Board includes two additional latched digital bits per D/A converter. Under program control, these bits may be used as pen up/down controls, intensify/blank Z-axis oscilloscope controls, external device select lines, or controls for external logic. These digital outputs are driven by open-collector high voltage buffers and may be pulled up to a maximum of +30 volts. The ST-6800DA Master Board includes a 12 bit Digital Output Port which may also be used for the same applications.

The ST-6800 systems draw their power from the +5 V bus of the EXORciser. An optional on-board DC to DC converter supplies  $\pm 15$  V for the linear circuits. Typical current drawn from the MPU bus is only 1.2 amps.

Future analog channel expansion is easily accomplished through the use of ST-6800ADX Expander Boards. Up to two Expander Boards may be used in conjunction with the A/D - D/A Master Board providing a maximum of 128 single-ended or 112 differential analog input channels. D/A Expansion may also be easily accomplished in increments of 4 or 8 channels by using stand-alone ST-6800 D/A cards.

## MODELS AVAILABLE

The ST-6800 family consists of three basic printed circuit board layouts. Each Board may add or delete components to make several other versions. These boards are described as follows:

1. COMBINATION A/D - D/A MASTER BOARD  
This board can accommodate up to 32 single-ended or 16 differential A/D channels plus up to two optional D/A channels. An optional  $\pm 15$  V DC/DC Converter is available to power the

linear devices on the board. This board serves as a master controller for A/D slave expander channels. The 2 D/A channels occupy 4 of the 256 memory locations in the D/A memory locations in the same address block set aside for the master A/D channels. The remaining 252 locations in the D/A memory area cannot be used. By deleting components, the A/D-D/A Master Board is available as 16 single-ended A/D channels for lowest cost.

2. A/D SLAVE EXPANDER BOARD  
The ST-6800 ADX slave expander board offers A/D channel expansion in increments of 32 or 48 channels, single-ended or differential. The ST-6800 Master is required for control and two Expanders may be linked for up to 128 single-ended or 112 differential channels.
3. D/A MASTER BOARD.  
The ST-6800 DA series boards are stand-alone D/A peripherals, not requiring control by the Combination A/D - D/A Master Board.

The ST-6800 DA boards are available with either 4 or 8 D/A channels and may be hard-wire addressed to any block of 16 memory locations in EXORciser memory. Two memory locations are required for each D/A channel.

An optional  $\pm 15$  V DC/DC Converter is available only on 4 channel D/A boards. An external  $\pm 15$  V DC supply @ 320 mA is required for 8 channel units. A 12-bit digital port is included on all models but its output bits must be slaved to the channel 1 D/A converter on 8-channel D/A boards.

## USER BENEFITS

Datel's ST-6800 system immediately solves two application problems which have hampered A/D - D/A interfacing to microcomputers. The ST-6800 relieves the user from the burden of an interface circuit (hardware) design and the bulky digital I/O cabling usually required. Only analog signal cabling is needed. Datel also gives the user a strong head start in one other problem area—a complete set of diagnostic test programs on paper tape are included with the ST-6800. These assembly language programs are given full program listings in the accompanying systems manual included with ST-6800 systems.

**DATA ACQUISITION SECTION (A/D ANALOG INPUTS)**

**ANALOG INPUTS**

<b>Number of Channels</b> .....	32 Single-ended or 16 Differential	
<b>Channel Expansion</b> .....	Up to 128 single-ended or 112 differential using ADX-Slave Expander Cards (Model ST-6800 ADX)	
<b>Full Scale Input Ranges</b> ....	0 to +5 Volts 0 to +10 Volts -5 to +5 Volts -10 to +10 Volts (Standard)	} Rewired by user or available in OEM quantity.
<b>Current Input Channel Range (8 Channels)</b> .....	4-20 mA typical, 1-5 mA, 10-50 mA using customer-installed resistors	
<b>Common Mode Range</b> .....	±10 Volts	
<b>Input Overvoltage</b> .....	±35 Volts Max. continuous	
<b>Input Impedance</b> .....	100 Megohms differential or to ground	
<b>Input Bias Current</b> .....	3 nA typ., 10 nA max.	
<b>Input Capacitance</b> .....	5 pF, OFF channel, 100 pF ON channel to ground	

**PERFORMANCE**

<b>Accuracy @ +25° C</b> .....	Within ±0.025% of full scale range
<b>Resolution</b> .....	12 Binary bits (1 part in 4096)
<b>Nonlinearity</b> .....	±½ LSB maximum
<b>Differential non-linearity</b> ....	±½ LSB maximum
<b>Gain Error</b> .....	Adjustable to zero
<b>Offset or Zero Error</b> .....	Adjustable to zero
<b>Gain Temperature Drift (Bipolar)</b> .....	Within ±10 ppm of FSR/°C
<b>Zero Temperature Drift (Unipolar)</b> .....	Within ±7 ppm of FSR/°C max.
<b>Common Mode Rejection</b> ....	70 dB min, DC to 1 kHz with 1 KΩ unbalance
<b>Power Supply Rejection</b> ....	100 dB to +5 V bus

**DYNAMIC CHARACTERISTICS**

<b>Typical Data Transfer</b>	
<b>I/O Period (Total)</b> .....	36 microseconds
<b>Throughput Period</b> .....	20 microseconds
<b>Acquisition Time</b> .....	8 microseconds
<b>A/D Conversion Time</b> .....	12 microseconds
<b>Aperture Time</b> .....	50 nanoseconds
<b>Sample/Hold Switch</b>	
<b>Feedthrough</b> .....	0.01% Max.
<b>MUX Crosstalk from OFF Channels</b> .....	
	0.007% @ 1 kHz, Rs = 1 kΩ

**DIGITAL OUTPUTS**

<b>Output Coding</b> .....	Straight Binary (Unipolar) Offset Binary (Bipolar)* 2's Complement (Bipolar)	} Jumper Selected
<b>Output Format</b> .....	2-Byte group electrically compatible to Motorola's EXORciser bidirectional bus. Sign extension is jumper selected on bits 12 thru 15 for 2's complement Units. Bits 12 thru 15 are logic zero for all other units.	
<b>Channel Addressing</b> .....	Random channel addressing may be started by external interrupt input for event operation or by internal program control.	
<b>Base Address</b> .....	Prewired by PC Board jumpers for one of 128 base addresses.	

\*Offset Binary Coding is standard. Other Coding may be rewired by the user.

**DATA DISTRIBUTION SECTION (D/A ANALOG OUTPUTS)**

(Applies to D/A's on the master board or on the independent D/A Board)

<b>Number of Channels</b> .....	1 or 2 on A/D Master Card, or up to 8 on D/A Card. Expandable to 128 channels	
<b>Resolution</b> .....	12 Bits	
<b>Full Scale Output</b> .....	0 to +5 Volts	} Rewired by user or available in OEM quantity.
<b>Voltage Ranges</b> .....	0 to +10 Volts -5 to +5 Volts -10 to +10 Volts (Standard)	
<b>Input Coding</b> .....	Straight Binary (Unipolar) Offset Binary (Bipolar) (Standard) 2's Complement (Bipolar)	
<b>Output Impedance</b> .....	0.05 ohm	
<b>Output Current</b> .....	±5 mA min. short circuit proof to ground	

**PERFORMANCE**

<b>Non-linearity</b> .....	±½ LSB, maximum
<b>Differential Nonlinearity</b> ...	±½ LSB, maximum
<b>Gain Error</b> .....	Adjustable to zero using pot for each channel
<b>Offset or Zero Error</b> .....	Adjustable to zero using pot for each channel
<b>Gain Temperature Drift</b> ....	±20 ppm of output/°C
<b>Zero Temperature Drift</b> ....	(Unipolar outputs) ±5 ppm of FSR/°C
<b>Offset Temperature Drift</b> ...	(Bipolar output) ±10 ppm of FSR/°C
<b>Settling Time (20 V change)</b> .....	
	4 microseconds to ±½ LSB
<b>Slew Rate</b> .....	20 V/μsec
<b>Power Supply Rejection</b> ...	±0.02% of FSR per 1% variation

**DIGITAL OUTPUT PORT**

A 12-bit TTL output is included on the ST-6800DA independent D/A board only. It is slaved to the input bits of DAC channel 1. Outputs are 7406 open collector buffers. Board pads are available for the user to install a pullup and pulldown resistor IC network to local or remote +5V.

Maximum sink: 40 mA pulldown per bit, 30V max, 150Ω min. pullup.

**POWER CONSUMPTION**

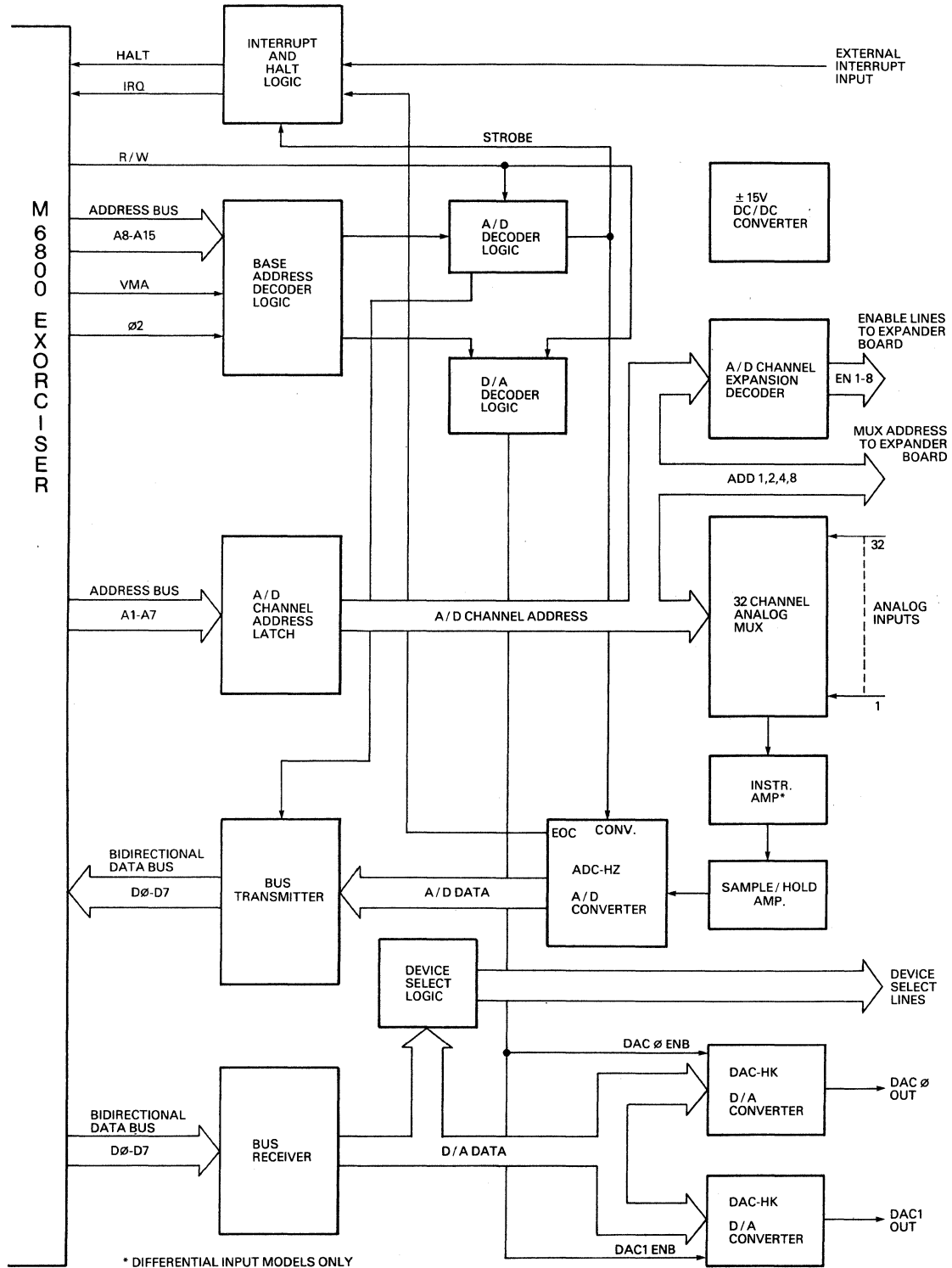
1.2 amps typical @ +5 VDC supplied from MPU bus connector. On-board DC to DC Converter supplies ±15 VDC to linear circuits. Model ST-6800 DA8: Externally supplied ±15 VDC @ 320 mA and +5 VDC @ 1 Amp from MPU bus connections.

**PHYSICAL**

<b>Operating Temperature Range</b> .....	
	0° to +70°C
<b>Storage Temperature Range</b> .....	
	-25°C to +85°C
<b>Card Size</b> .....	
	9.75"W x 5.75"H x .062"D Compatible to M6800 EXORciser housing

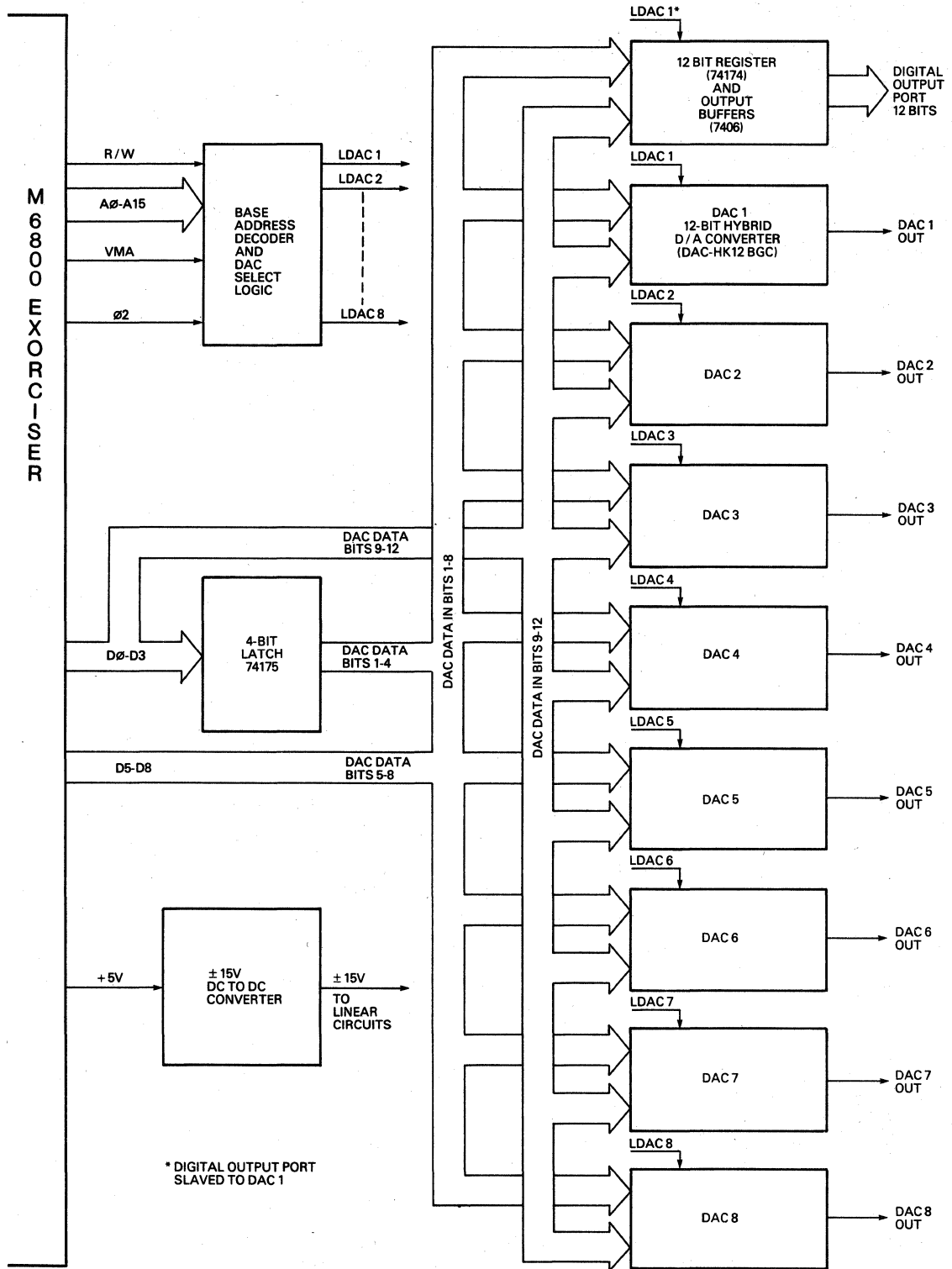
**BLOCK DIAGRAM**

**BLOCK DIAGRAM  
ST-6800 A/D-D/A  
MASTER BOARD**



BLOCK DIAGRAM

**BLOCK DIAGRAM  
ST-6800DA 8 CHANNEL  
D/A MASTER BOARD**





## DIGITAL OUTPUT PORT

A valuable feature of the ST-6800 DA Master Board is the Digital Output Port. This port consists of a storage register which may be loaded, under program control, with 12 bits of data from the microcomputer bus. The register outputs are buffered using two 7406 open collector buffers and brought out to the I/O connector of the D/A card. The output of each open-collector buffer may be pulled up to a maximum of +30 V and is capable of sinking up to 40 mA of pulldown current. Provisions are made on the PC Board for user-supplied pullup and pulldown resistors. Specifically, the user may install an IC resistor network in the space provided for that purpose. Pullup resistors to +5 V are limited to a minimum of 150 ohms although most applications will suffice with 1,000 ohms or more. Loads may be driven up to 50 feet (15 m) from the output connector using color-coded ribbon cable. The Digital Output Port is standard on both 4 and 8 Channel D/A Master Boards. However, on 8 channel boards, the Digital Output Port is slaved to DAC 1.

## APPLICATIONS

The Output Port is ideal for digital program control of output devices such as pen-up/pen-down controls to an X-Y plotter, start/stop motion to a chart recorder, write/erase commands to a memory oscilloscope, and intensify/blank or color commands to a CRT graphic display. The Output Port works in conjunction with the analog output from the D/A Converters. Other applications include Track/Hold commands to external Sample/Hold amplifiers for mixed analog/digital test

systems. Communication systems may use the Digital Outputs as gating commands to gateable transmission amplifiers. The Output Port may also be used to control external logic such as start/stop/reset commands to timers and counters used with V/F inputs.

## CURRENT INPUT CHANNELS

The ST-6800 A/D - D/A Master Board has provisions to accept 4-20 mA, 1-5 mA, or 10-50 mA current loop analog signals instead of voltage signals on eight A/D Channels. These input channels have provisions for on-board, user-supplied resistors to convert current loop signals to voltage signals. Each resistor, when installed, connects between the analog input and the analog return. For this application, precision resistors should be used. 0.1% - 10 ppm resistors are recommended. Resistor values can be calculated using the following formula:

$$R = \frac{+\text{Full Scale Range of ADC}}{+\text{Full Scale Current Input}}$$

4-20 mA current loop signals are frequently used in industrial and process control where analog signals must be transmitted over long distances. In addition, many types of transducers are primarily current output devices. A 500 ohm resistor will result in a 2 V to 10 V range. The ST-6800 should be configured as a 0 to +10 V single-ended system. The effect of a 2 volt offset can be eliminated by writing software that subtracts a digital constant from each digitized sample.

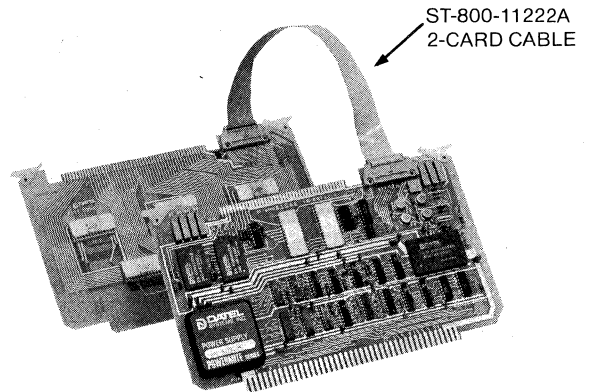
## SIMPLIFIED CHANNEL EXPANSION

Datel offers an easy method of expanding A/D or D/A Channels. Standard A/D Slave Expansion boards, which are controlled by the Master A/D - D/A board, plug directly into identical card slots in the EXORciser housing. The slave expander units are available with either 32 or 48 A/D channels and may have either single-ended or differential inputs. However, single-ended and differential inputs cannot be mixed. Up to two ST-6800 ADX Slave Expander boards can be used with each Master A/D - D/A Board, resulting in a maximum of 128 single-ended or 112 differential input channels. This difference arises because the Master Board contains 32 single-ended or 16 differential channels. The slave expander modules are designed around Datel's miniature 16-channel CMOS analog multiplexers (MX-1606) which make it possible to achieve such high channel density on a single board.

One important feature is that the input multiplexer on the master board does not sub-multiplex the A/D expander channels. This offers simplified channel addressing and cabling.

D/A channel expansion may be accomplished through the use of additional stand-alone D/A Master Boards. Each board contains 4 or 8 D/A channels plus an optional  $\pm 15$  V DC to DC converter for the 4 channel model. 8 channel D/A Master Boards require an external  $\pm 15$  V source.

Users requiring D/A channel expansion at a later date must



## A/D MASTER AND SLAVE EXPANDER 80 CHANNELS TOTAL

account for previous channel expansion by proper coding of the channel address jumpers. This information is provided with each unit and users should consult Datel at the time of channel expansion.

Datel offers convenient Master/Slave interconnection cables for A/D expansion. Complete pinout information is also given in the manual if users prefer to make their own cables.

## SYSTEM ARCHITECTURE AND PROGRAMMING METHODS

The ST-6800 A/D - D/A system is organized as a memory-mapped I/O device and appears to the M6800 MPU as a block of 512 consecutive memory locations. Since the A/D and D/A converters are 12-bit devices, two 8-bit memory locations are required for each channel. The lower 256 memory locations are reserved for up to 128 A/D channels. The upper 256 memory locations are reserved for the two D/A channels. Although only four of the 256 locations are used for the D/A converters, the remaining locations cannot be used by the programmer. The 512 byte block may be placed at any of 128 different locations in the EXORciser's 65,536 byte memory. Before any programming can be done, the user must select the base address of the memory block that the ST-6800 will occupy. All units are shipped with the base address of E000. This base address is necessary to use the Diagnostic Test Program. The base address may be easily changed by the user by rewiring jumpers on the printed circuit board. Complete information on changing the base address is given in the instruction manual.

The ST-6800 DA Master Boards differ from the Master A/D-D/A Board in that it occupies a 16 byte block in EXORciser memory. ST-6800 DA boards are shipped with a standard base address of E200. This may be changed by the user.

### PROGRAMMING THE A/D CHANNELS

The major advantage to a memory-mapped I/O device is the ease with which programming is accomplished. The A/D Conversion process will begin by the execution of an STA instruction referencing to the lower of the two memory locations of the desired A/D Channel. The contents of the accumulator are not important and do not transfer to the ST-6800. Either accumulator may be used. The STA instruction must be followed by a NOP because the MPU is halted by the ST-6800 during the conversion process. After the analog signal is converted, the A/D data is present at the data transmitters of the ST-6800 and the MPU will resume

operation and execute the next instruction. Normally, these would be Memory Read instructions referencing to the channel that was converted. The two bytes of A/D data may then be loaded into the accumulators or index register. It should be noted that the lower memory location contains the Most Significant Byte (A/D Bits 1-4), and the higher memory location contains the Least Significant Byte (A/D Bits 5-12). The following programs illustrate this process. The base address is assumed to be E000.

1. STAA E000 ; Start conversion for A/D Channel 0  
NOP  
LDAA E000 ; Load Most Significant Byte of A/D  
; Data into ACC-A  
LDB E001 ; Load Least Significant Byte of A/D  
; Data into ACC-B
2. STAB E03E ; Start A/D Conversion for A/D  
NOP ; Channel 31  
LDX E03E ; Load MSB byte from E03E into IXH  
; and LSB byte from E03F into IXL

### Programming the D/A Sections

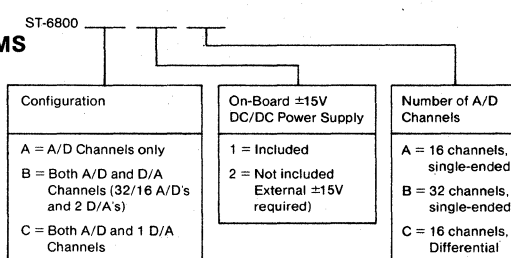
Programming the D/A Converters is even easier than the A/D section. Since 12-bit D/A Converters are used they must be loaded with two bytes of data from the EXORciser data bus. The Most Significant data byte must be loaded first. This is done by executing a Memory Write instruction that references to the lower of the two memory locations of the desired D/A channel. The Least Significant data byte is then loaded in the higher location. The analog output will appear after the Least Significant Byte is loaded. The following programs illustrate this process.

1. STAA E100 ; Store MSB into DAC 0 from ACC-A  
STAB E101 ; Store LSB into DAC 0 from ACC-B
2. STX E102 ; Store IXH (MSB) into E102 and IXL  
(LSB) in E103 (D/A Channel 1)

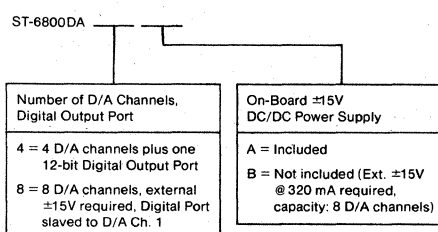
The first program loads the two bytes of data contained in the two accumulators into DAC0. The second program loads the data from the index register into DAC1.

## MODEL NUMBERS

### SINETRAC 6800 A/D-D/A SYSTEMS

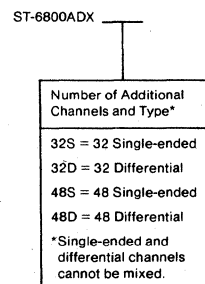


### SINETRAC 6800 D/A SYSTEMS



All models are ±10V offset binary, no sign extension. Users may rewire other ranges and coding.

### A/D SLAVE EXPANDER



All models are ±10V offset binary, no sign extension. Users may rewire other ranges and coding.

## DIAGNOSTIC TEST PROGRAMS

An important advantage to SineTrac 6800 users is the paper tape program supplied with each system. This diagnostic test program is accompanied by a comprehensive systems manual which includes a full listing of the program with extensive comments.

This program may be used to verify system operation when the unit is first delivered. As soon as analog inputs are connected, the program may be loaded into memory and A/D channels may be printed out on a teletypewriter or CRT terminal.

If the user purchases the optional prewired voltage divider input connector (Model ST-6800-11341) only a single external reference voltage is needed to observe A/D conversions on the printout or display. This test connector is also used for calibration purposes.

The Diagnostic Test Program performs the following tests by using a conversational (prompting) teletypewriter technique:

1. A/D Calibration Test - An individual A/D channel may be repeatedly converted by pressing the teletypewriter space bar for each A/D conversion. The user may select any channel and adjust the A/D gain and offset pots for the proper digital output on the printout or display. A dual trace oscilloscope may also be used to observe the A/D converter's serial output.
2. Scan Test - A selected group of channels may be printed

out by using the Scan Test. The user enters the start and final channels when requested by the program. Each channel is then converted and printed on the terminal in hexadecimal coding.

3. D/A Calibration Test - The user enters the 4 digit hex code to be converted on the D/A channels. The DAC output can then be checked using a DVM. The DAC range and offset pots may be adjusted if necessary.
4. D/A Sawtooth Test - This test causes a triangular waveform to appear on the output of the selected D/A converter so that it may be checked on an oscilloscope. All possible data combinations are converted using this test.
5. Waveform Test - In this test, the user selects one A/D and one D/A converter. The analog input of the A/D is converted to digital and the digital data is then loaded into the DAC. The DAC output should follow the A/D input for any arbitrary waveform. The input and output waveforms may be compared using a dual trace scope.

In addition to troubleshooting and getting a system operating quickly, the Diagnostic Test Programs give the user samples of assembly language programs required to control both the A/D and D/A peripheral board. Individual tests are segregated on the program listing in the manual. Therefore, a user may extract portions needed for a particular application and write them into a supervisory program.

It should be noted that the diagnostic program is not intended as a user's program but it may be used for this purpose if the user feels it appropriate for his application.

```
● X
  EXBUG 1.1 MAID
  *100;G
●
  SINETRAC ST-6800 A/D AND D/A TEST 1.1
●
  MODE-A
  A/D CALIBRATION TEST
●
  A/D CHANNEL - E000
●
  0000
●
  0800
●
  0FFF
  M
●
  MODE- S
  SCAN TEST A/D
●
  START CHANNEL -E000
  FINAL CHANNEL -E004
  0FFF
  0800
  0800
●
  MODE - D
  D/A CALIBRATION TEST
●
  HEX DATA - 0000
●
  HEX DATA - 0800
  M
●
  MODE - R
  SAWTOOTH TEST D/A
●
  D/A CHANNEL - E100
  M
●
  MODE - W
  WAVE TEST A/D AND D/A
●
  A/D CHANNEL - E000
  D/A CHANNEL - E100
  M
●
  MODE - :9
  EXBUG 1.1
```

**A/D-D/A MASTER BOARDS**

Model	Description
ST-6800A1A	16 Single-ended A/D, DC/DC incl, no D/A
ST-6800A1B	32 Single-ended A/D, DC/DC incl, no D/A
ST-6800A1C	16 Differential A/D, DC/DC incl, no D/A
ST-6800A2A	16 Single-ended A/D, no DC/DC, no D/A
ST-6800A2B	32 Single-ended A/D, no DC/DC, no D/A
ST-6800A2C	16 Differential A/D, no DC/DC, no D/A
ST-6800B1A	16 Single-ended A/D, DC/DC incl, 2 D/A
ST-6800B1B	32 Single-ended A/D, DC/DC incl, 2 D/A
ST-6800B1C	16 Differential A/D, DC/DC incl, 2 D/A
ST-6800B2A	16 Single-ended A/D, no DC/DC, 2 D/A
ST-6800B2B	32 Single-ended A/D, no DC/DC, 2 D/A
ST-6800B2C	16 Differential A/D, no DC/DC, 2 D/A
ST-6800C1A	16 Single-ended A/D, DC/DC incl, 1 D/A
ST-6800C1B	32 Single-ended A/D, DC/DC incl, 1 D/A
ST-6800C1C	16 Differential A/D, DC/DC incl, 1 D/A
ST-6800C2A	16 Single-ended A/D, no DC/DC, 1 D/A
ST-6800C2B	32 Single-ended A/D, no DC/DC, 1 D/A
ST-6800C2C	16 Differential A/D, no DC/DC, 1 D/A

All systems include a systems manual and appropriate diagnostic program on paper tape.

**D/A MASTER BOARDS**

Model	Description
ST-6800DA4A	4 D/A Channels DC/DC incl
ST-6800DA4B	4 D/A Channels no DC/DC Conv.
ST-6800DA8B	8 D/A Channels no DC/DC Conv.

**A/D EXPANDER BOARDS\***

ST-6800ADX32S	32 Single-ended
ST-6800ADX32D	32 Differential
ST-6800ADX48S	48 Single-ended
ST-6800ADX48D	48 Differential

**CABLES AND ACCESSORIES**

ST-800-11222A	First level 2 cards A/D Expansion cable
ST-800-11222B	2nd level 4 cards A/D Expansion cable
ST-6800-11341	Prewired Voltage Divider (used for calibration)
58-2079135	Dual 10 pin connector for ST-6800 and ADX Expansion connector
58-2076051	Dual 40 pin connector for ST-6800 Master Board (included)
58-2075050	Dual 18 pin connector for ST-6800 DA card (included)
56-2076060	Dual 50 pin connector for ST-6800 ADX analog input connector (included)

**\*A/D Channel Capacity**

128 Single-Ended Channels total max:

- (1) 32-Chan. SE Master Board
- (2) 48-Chan. SE Slave Expanders
- (1) ST-800-11222B Cable

112 Differential Channels total max:

- (1) 16-Chan. Diff. Master Board
- (2) 48-Chan. Diff. Slave Expanders
- (1) ST-800-11222B Cable

# Panel-Mount Thermal Printers



**APP-20**



**APP-48**



**DPP-Q7**

## IN THIS SECTION

<b>SELECTION GUIDE</b>	<b>132S</b>
<b>PARALLEL APP-20</b>	<b>133S 146S</b>
<b>APP-20D</b>	<b>147S</b>
<b>SERIAL APP-20</b>	<b>148S-157S</b>
<b>CDPP-Q7/CAPP-20</b>	<b>158S, 159S</b>
<b>APP-48</b>	<b>160S-163S</b>
<b>DPP-Q7</b>	<b>164S-174S</b>

# Panel-Mount Thermal Printers

Datel-Intersil pioneered the miniature panel-mount thermal Digital Panel Printer concept in 1975 with model DPP-7 which included all data and power supply electronics. That evolution has continued today with the whisper-quiet DPP-Q7 successor to the DPP-7. In 1978, Datel-Intersil introduced the APP-20 Alphanumeric Panel Printer which prints the full 96-character ASCII set in 20 columns using a non-moving dot-line thermal printhead. Yet the miniature APP-20 fits the DPP-Q7's small panel cutout and outline dimensions. The APP-20 continues the product concept of including all data input electronics and the AC power supply inside the miniature housing. The low-cost parallel APP-20 includes a byte-parallel, character serial TTL and control interface which is ideal for microprocessor programmable I/O port LSI circuits.

In 1979, another APP-20 version was introduced at somewhat higher cost which included a full serial 20

mA loop 2-wire data interface plus an RS-232-C interface plus the AC power supply, all inside the miniature housing! This serial APP-20 features optoisolated inputs which reject common mode and ground loop noise and can be daisy-chained with other slave APP-20's hundreds of feet from the data source. The serial APP-20 connects directly to practically all computer serial I/O ports, and CRT terminals.

Answering the need for a miniature printer powered by +12 Vdc in police and emergency vehicles, aircraft, oceanographic and rescue craft, the APP-20D is available with both the parallel and serial interfaces.

In the most ambitious thermal panel-mount printer yet, Datel-Intersil introduces the APP-48, a serial-input AC-powered unit somewhat larger than the APP-20. This 48-column printer uses 5" wide paper and weighs only 6 pounds.

## Quick Selection Guide

MODEL	NEW!			
	DPP-Q7 (pg. 164S)	APP-20 PARALLEL (pg. 133S)	APP-20 SERIAL RO TERMINAL (pg. 148S)	APP-48 RO TERMINAL (pg. 160S)
Number of Columns	7 (6 and polarity)	20 columns	20 columns	48 columns
Printing Format	7-segment thermal array	5×7 matrix, dot-line thermal	5×7 matrix, dot-line thermal	5×7 matrix, dot-line thermal
Character Size	0.155" High	0.110" High (0.165" programmable)	0.110" High (0.165" programmable)	0.110" High
Character Set	0-9 decimal or 0-F hexadecimal	Alphanumeric 96-char. ASCII	Alphanumeric 96-char. ASCII	Alphanumeric 96-char. ASCII plus 96-char. special set, selected by SO/SI software command
Speed	4 lines/second 240 lines/minute	1.2 lines/second 72 lines/minute	1.2 lines/second 72 lines/minute	1.2 lines/second 72 lines/minute
Paper Width	1.75 in. (44.5 mm)	2.31 in. (58.6 mm)	2.31 in. (58.6 mm)	5 in. (127 mm)
Data Input	TTL Full Parallel BCD, selectable Pos. or Neg. true	TTL Bit-parallel, 7-bit character—serial, selectable Pos. or Neg. true	Full serial 20mA optoisolated and RS-232-C (RO terminal)	Full serial 20mA optoisolated and RS-232-C (RO terminal)
Input Register	1-line, 7 digits	1 line, 20 characters	1 line, 20 characters	1 line, 48 characters
Data Rate	Latched, 1 μS strobe	1 character per 500 μsec. 750 mS wait while printing	75 to 9600 baud, 750 mS wait while printing	110 to 9600 baud, 750 mS wait while printing
Housing Size	4.44"W × 2.76"H × 8.00"D	4.44"W × 2.76"H × 8.00"D	4.44"W × 2.76"H × 8.00"D	8.12"W × 2.84"H × 8.32"D
Power Supply	115/230 VAC switchable, 40W max. 5 Vdc @ 10A special order	115/230 VAC, switchable, 17W, 12 Vdc @ 1A optional	115/230 VAC, switchable, 17W, 12 Vdc @ 1A optional	115, 100 or 230 VAC, 47-440 Hz, 40W peak, 12W idle
Special Feature: Tall Characters	Not available	0.165" high characters selected by TTL input	0.165" high characters selected by SO/SI data in software command	Not available
Special Feature: Inverted Text Printing	Not available	Selected by TTL input	Selected by TTL input	Selected by STX/ETX data in software command
Special Feature: Single character printing	Not available	Selected by TTL input	Selected by TTL input	Not available
Weight	4.4 lb (2.0 kg)	4.25 lb (1.9 kg)	4.25 lb (1.9 kg)	6 lb (2.7 kg)
<b>PRICE (1-4)</b>	<b>\$509.</b>	<b>\$675.</b>	<b>\$795.</b>	<b>To Be Announced Please Contact DATEL-INTERSIL</b>



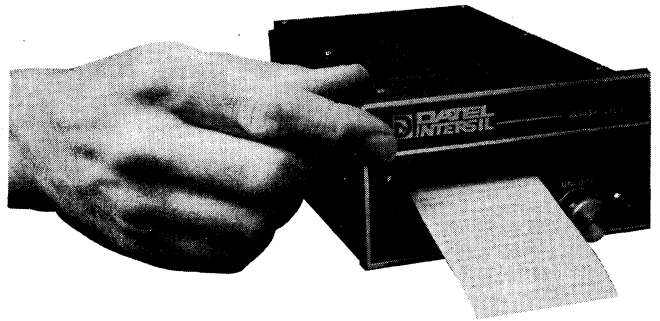
# APP-20A1, E1, J1 Series Parallel Input Alphanumeric Mini-Thermal Panel Printer

8 AND 16-BIT MICROCOMPUTERS  
COMPATIBLE TO: WITH PROGRAMMABLE  
PARALLEL TTL I/O PORTS.

## The World's Smallest Panel-Mount 20-Column Alphanumeric Thermal Printer with Full Electronics!

### PRODUCT HIGHLIGHTS

- \* **MODERN THERMAL PRINTING**  
No Ink, No Ribbons, No Hammers, No Mess, ever!
- \* **INTERNAL MICROPROCESSOR** gives you:  
Full interface electronics: 20-character, 8-bit parallel input register. No bulky cabling or extra chassis.  
Programmable Control Features  
Selectable positive or negative true data inputs to match any processor.
- \* **INTERNAL 115/230 VOLT AC POWER SUPPLY**  
No additional power supply housings.  
115 or 230 VAC is switch selectable. OEM's can stock one version.
- 4.25 POUND, 105-CUBIC INCH FEATHERWEIGHT**  
fits on any front panel.
- \* **OEM-RELIABLE SIMPLE STEPPING MOTOR DRIVE**



### CONTROL FEATURES

- \* **TALL** characters for EMPHASIS.
- \* **SINGLE CHARACTER PRINTING** (one by one) for keyboard echo.
- \* **INVERTED PRINTING** for text applications where last record is at bottom of printout.\*
- \* **AUTOMATIC HORIZONTAL TAB (HT)** advances to columns 4, 9, and 15 for data logger formats:

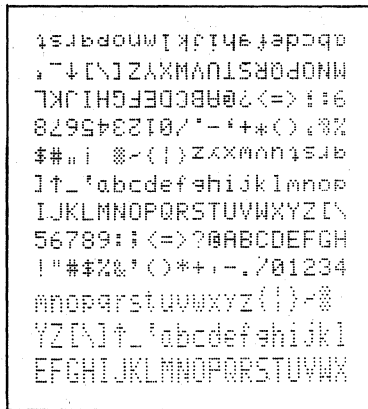
```
CH TIME DATE SAMPLE
99 2359 04/05 +12.34
```

### TABLE OF CONTENTS

	Page
Introduction and Description .....	134/S
Specifications .....	135,6,7S
Ordering Guide .....	137S
Mechanical Information .....	138S
Interfacing and Timing .....	139,140S
Input Data Coding .....	141,2S
Paper Loading .....	142S
Input/Output Connections .....	143S
Message Generator .....	144S
Servicing and Spare Parts .....	145S
Connection to an A/D Data System.....	146S

APP-20A1, E1, J1, Parallel Alpha-Thermal Printer

# This miniature alphanumeric thermal printer will revolutionize your new designs.



## PRINTOUT

- Single-character printing for keyboard echo
- Selectable positive/negative true data inputs
- Selectable inverted printing for text (TTY) applications
- Programmable features: Form feed (11 lines), horiz. tab (Cols. 4, 9, 15), Backspace, Delete (Re-index register)
- Prints intermixed TALL characters

## APP-20 FEATURES

- 20 columns per line
- Internal microprocessor for OEM features
- Panel-mounting— 4.25 lbs., 105 cubic inches
- Non-moving thermal printhead
- No ink, no ribbons, no hammers
- 1.2 lines per second/72 lines per minute
- Includes internal interface electronics and power supply

## INTRODUCTION

A miniature, panel-mounting alphanumeric printer using quiet, non-impact thermal printing makes possible all types of low cost display and instrumentation applications. This printer is Datel's Model APP-20 (Alphanumeric Panel Printer) which features 20 column-printing in a self-contained housing including interface electronics and AC power supply.

The miniature size of the APP-20 lends itself to a host of new applications. With outline dimensions of 4.44" W x 2.70" H x 8.75" D (113 x 69 x 222mm) to the rear fuseholder, the APP-20 uses just 105 cubic inches of space and weighs under 5 pounds

(2, 3 kg). The small size is made possible by using an internal dedicated microprocessor for control, timing, character generation, printhead drive and motor stepping. The APP-20 is expressly designed for smart analytical instruments, process control monitors, industrial data loggers, security systems, hotel management dispatchers, assembly line tally systems, data acquisition systems, aircraft and vehicle systems, telephone and data communications loggers and traffic, environmental and noise data loggers. In addition, the APP-20 is an ideal, low cost alphanumeric printer for most microprocessor development systems.

Datel first pioneered a panel-mounting thermal printer with complete drive electronics in 1975 with the DPP-7 numeric printer. The present APP-20 uses identical panel-mounting and outline dimensions as the DPP-7 for users who wish to upgrade to the fully alphanumeric unit. And like the earlier DPP-7, complete interface electronics and AC power supply are included **inside** the APP-20 panel-mount housing. While there are many small panel-mount alphanumeric print mechanisms available from other manufacturers, nearly all of them require separately-mounted interface electronics, power supplies and bulky cabling.

## DESCRIPTION

The APP-20 prints the full ASCII character set of upper and lower case letters, numerals, punctuation, etc. in 20 columns across 2 5/8" wide (58.6mm) thermal paper. A dot-line thermal printhead forms 5 x 7 matrix characters which are 0.11 inches (2.8mm) high. The printing rate is 1-1/2 lines per second regardless of the number of characters printed and a 150 foot roll of thermal paper prints almost 9,000 lines of data (180,000 characters max.) at 5 lines per inch (2 lines/cm) spacing.

The internal control microprocessor of the APP-20 offers special OEM programming features which would be impossible with a straight mechanical printer. Perhaps the most striking feature is the inverted text

printout mode. In this mode, printing appears upside down from the front panel. However, when the paper is torn off and inverted, the last line printed is at the bottom as normal text would be. In fact, the APP-20 may be mounted with its front panel horizontal (facing upward) for text printing applications. In these applications, the APP-20 is a text printer, like a teletypewriter. In the normal front-panel application, the APP-20 prints the last line at the top in the Lister mode. This mode is commonly used in printing data logger applications. Since the Text and Lister Modes are pin-selected, users may combine inverted text with normal listings on the same printout.

Other OEM programming features are either data-coded or pin-selected (see

specifications). These include double-height characters, single-character printing, form feed, horizontal tab, backspace, delete, and selected data polarity.

Extended-height characters are used for emphasis and may be intermixed on one line with regular height characters. Characters are normally entered as 8-bit TTL parallel asynchronous data to a 20-character line buffer. However, single characters may be printed one at a time to echo a keyboard.

A form feed (FF) character advances the paper 11 lines to separate adjacent records and a horizontal tab (HT) command indexes input data to print in columns 4, 9, and 15 for tabular data. All data inputs may be selected as positive or negative true logic coding.

## INTERFACING

The input/output connections to the APP-20 consist of TTL data and control lines configured on a single, 25-pin type "D" rear connector. Seven data inputs select upper and lower case ASCII characters and the eighth bit designates programmable formatting characters. Additional control lines form an inter-locked asynchronous handshake to enter each character into a 20-column input register. Characters are loaded sequentially as 8 bits in parallel which is compatible with most microprocessor data ports. Printing may begin after all desired characters (20 or less) are loaded into the register. A data character (CR) or a separate Print Command will start printing. Printing alone will consume about 750 milliseconds and data entry will take an additional 7 to 100 mS, depending on the

processor used and driver routine. The input register may be loaded at up to a 2.8 KHz rate. Typical complete timing for input data loading plus printing is 833 mS per line or 1.2 lines/sec.

A conventional AC power supply is used in the APP-20 but is a dual-voltage type (115/230VAC) so that OEM's need to stock only one model (either U.S.A. and European line cords are supplied, however). An internal switch, accessible when paper is replaced, selects 115 or 230 VAC ± 10%, 47 to 400 Hz. Power consumption idles at 5 watts and averages 17 watts with a 25 watt peak. About 500 mA max. of +5 VDC power may be taken to power external devices.

The APP-20 may be operated at 0° to +50°C and stored at -25°C to +85°C. (Paper will darken above +60°C.)

## INSTRUMENT BUS COMPATIBILITY

The APP-20 printer can easily interface to the General Purpose Instrument Bus (GPB-IEEE Spec 488-1975) as a Listen Only Function. The data is already in an 8-bit format. Additional terminating resistors are required as well as an 8-bit address decoder with address selector switches. Additional logic is also needed to handle control functions. A typical interface for a Listener only will take about a dozen digital IC's, passive components and a power supply. The system can easily be installed in Datel's CDP-7X Printer Housing.

Datel welcomes the opportunity to review custom OEM data logging or acquisition systems using the APP-20 and other Datel products.



# APP-20 SPECIFICATIONS

(Typical at +25° unless noted)

## GENERAL

### Function

The APP-20 prints alphanumeric information on internal roll paper from externally supplied ASCII character codes.

## PRINTOUT

### Number of Columns

20

### Characters Printed

All upper and lower case ASCII letters, numbers, punctuation and special symbols shown in the ANSI X3.4-1977 specification. (See listing elsewhere in brochure).

### Printing Format

5 columns × 7 row matrix

### Character Spacing (Horizontal)

Approx. 9 characters per inch

### Line Spacing

Approx. 0.2 inches (5.1 mm).

5 lines per inch (4 dot widths spaced between lines)

### Character Size

.110 in. H × .070 in. W

(2.8 × 1.8 mm)

### Printing Method

Dot-line, thick-film non-impact ceramic thermal printhead

### Paper Motion

Stepping Motor, Friction Roller, and gear reduction. Paper advance (4 dot widths) occurs automatically after printing. A line may be viewed immediately after printing.

### Printing Rate

1.2 lines per second regardless of number of printed characters per line.

### Data Transfer Rate

2.2 KHz max. for loading one line of 20 characters (see timing diagram).

### Printing Paper

Thermal paper 2.31 inches wide (58.6 mm) with active surface facing away from roll center. Supplied on rolls of 150 feet length (45 m). Approx. 140 feet usable (42 m). Supplied in boxes of 10 rolls, Datel model number 58-9374-1.

### Printout Color

Blue characters on white paper

### Data Capacity

Approximately 8,400 lines (168,000 characters max.) per 140 feet of paper roll.

### Printhead Life

30 million lines typ (random character distribution and usage with Datel-supplied paper and unmodified printers)

### Mechanism Life

5000 hours, typical

### Maintenance

Periodic cleaning with isopropyl alcohol of mechanism, printhead and roller is suggested for dirt accumulation depending on operating conditions. Printhead design is self-cleaning.

## FRONT PANEL

### Power On

Red Light-emitting diode illuminates when power is applied.

### Feed

2 position momentary toggle switch.

Actuating either up or down advances paper continuously at 2.9 lines/second or 0.6 inches/second (1.5 cm/sec).

### Paper Supply Indicator

Mechanical pointer which rides on paper roll showing relative amount of paper remaining.

"F" indicates full roll,

"E" indicates empty.

### Housing Latch

Rotating "UNLOCK" knob ¼ turn counter-clockwise frees mechanism from housing and electronics. Knob is pulled out to replace paper roll. This disconnects power to the mechanism and stops printing.

## POWER SUPPLY

### Supply Voltage

105 to 130 VAC (A models) (100 VAC)

210 to 260 VAC (E models) (J models)

These voltages may be switch-selected by withdrawing the front panel assembly as when the paper roll is changed.

### Frequency

47 to 440 Hz

### Power Consumption

5 Watts, idling, 17 Watts average during printing

### Line Cords

Captive 3-wire line cords approximately 6 feet (2m) long supplied with grounding plugs for U.S. (A models) or European (E models, 2 prong & gnd. shell)

### Fuses

A models: ½ Amp SLO-BLO

E models: ¼ Amp SLO-BLO

Dimensions: .25" dia × 1.25" long

3AG type accessible on rear panel

## PHYSICAL-ENVIRONMENTAL-MECHANICAL

### Operating Temperature Range

0° to +50°

### Storage Temperature Range

-25°C to +85°C (Paper darkens above +60°C)

### Altitude

0 to 10,000 feet (3000 meters)

### Relative Humidity

0% to 90% (no condensation)

### Acceleration (Non-operating)

±5G, 3 axes, 0 to 50 Hz

### Weight

4.25 pounds (with paper roll), 1.93 kg

### Housing Outline Dimensions

Identical to Datel's DPP-7 Series

4.44"W × 2.76"H × 8.75"D

(113 × 70 × 222 mm)

Allow an additional 1.5" for connector hood and cable clearance.

### Bezel Dimensions

5.25"W × 2.82"H × .78"D

(134 mm × 72 mm × 20 mm)

### Front Panel Mounting Cutout

4.50"W × 2.78"H

(115 mm × 71 mm)

### Mounting Method

Using four sets of 4-40 hardware (not supplied) in housing mounting flanges. Mounting bolts are concealed by slide-out front panel bezel.

## INPUT/OUTPUT CONNECTIONS

### Type of Interface

8-Bit parallel, character-serial interface with asynchronous interlocked handshake controls.

### Logic Levels

All connections are compatible with DTL, TTL, TTL-LS levels. CMOS 4049 buffers may also be used. Outputs can drive 2 TTL loads, min.

### Coding

Data inputs only are selectable positive or negative true (see Data Polarity Select input)

	Voltage Levels	Pos. True Coding	Neg. True Coding
INPUTS	$0 \leq \text{"LO"} \leq +0.8\text{V}$	Logic "0" or False	Logic "1" or True
	$+2.0\text{V} \leq \text{"HI"} \leq +5.0\text{V}$	Logic "1" or True	Logic "0" or False
OUTPUTS	$0 \leq \text{"LO"} \leq +0.4\text{V}$	Logic "0" or False	Logic "1" or True
	$+2.4\text{V} \leq \text{"HI"} \leq +5.0\text{V}$	Logic "1" or True	Logic "0" or False

### DC Powered Model: APP-20D1

Voltage Range: +10.5V to +15VDC

Current at 12V: 1 Amp, average during printing

## Data Inputs

Pin	Function	Pin	Function
21	Bit 0 (LSB)	24	Bit 5
20	Bit 1	25	Bit 6
18	Bit 2	23	Enable Control Characters.
19	Bit 3		(MSB) (Set False to disable control characters). See "Operating Modes"
22	Bit 4		— Does not disable alphanumerics

## Control Inputs\*

(See "Operating Modes" section and timing diagram) \*Note: All inputs have internal pullup resistors and may be floated for the + level. All inputs asynchronous, level sensitive.

Pin	Function	Description
11	Print	Falling edge prints characters stored in line buffer and advances paper one line. Pulse width 25 $\mu$ S min, 750 mS max. (LO level must be reset HI before next READY output — 750 mS after Print). The column address is then re-indexed to column 1. <i>Caution: This line is momentarily grounded through a diode drop when the front panel Paper Feed switch is activated. Use open collector TTL or 150<math>\Omega</math> max. in series if driving Print from totem-pole TTL. Holding Print LO acts as a remote Paper Feed after printing one line.</i>

*Print must be held Lo 35 $\mu$ S minimum after Data Accepted goes Lo.*

12	DATA POS/ $\overline{\text{NEG}}$ TRUE	Controls coding sense of the 7 data bits and Control Char. bit (pin 23). Tie pin 12 to +5V for Positive True. Tie pin 12 to ground for Negative True.
----	--	---

14	Print Direction Text/Lister	In the Lister Mode, characters appear non-inverted, viewed at the front panel. The last line printed is at the top of the record. Tie to ground for Lister mode.  In the Text Mode, characters appear inverted viewed at the front panel. The last line printed is at the bottom of the upright text (nearest the panel). This format is compatible with normal text such as from a teletypewriter. Print direction must be set before loading line buffer. Tie to +5V for Text mode.
----	-----------------------------	---

15	$\overline{\text{Single Character Printing}}$	With this input floated or tied to +5V, normal printing occurs after storing one character line in the buffer. With this input grounded, single character-by-character printing occurs, as in keyboard echo applications.  With the falling edge of $\overline{\text{DATA VALID}}$ , paper will retract into the printer, imprint one character in the next available column and return for viewing. The PRINT Input is not used. Each character is printed on receipt of $\overline{\text{DAV}}$ . The RFD signal ceases until the system is ready for the next entry (1.25 sec.)
----	---	---

16	$\overline{\text{Tall Characters}}$	With this line high, normal characters 0.11" (2.8 mm) high
----	-------------------------------------	--

are printed. With this line low, extended characters 0.165" (4.2 mm) are printed.

The printing rate is 1.33 lines per second if any tall characters are programmed. Normal printing is 1.2 lps. Tall and normal characters may be mixed on the same line. Tall characters may not be printed in the single character mode.

## 17 $\overline{\text{Data Valid}}$ (DAV)

*DAV must be returned high < 56 $\mu$ S after DAC goes low.*

This line is held low until the falling edge of  $\overline{\text{Data Accepted}}$  (DAC) appears (approx. >375  $\mu$ S).  $\overline{\text{DAV}}$  initiates loading of one character into the input register.

## Control Outputs

Pin	Function	Description
1	$\overline{\text{Ready for Data}}$ (RFD)*	This is a periodic negative-going 11 $\mu$ S pulse every 93 $\mu$ S while waiting for the first data character. This pulse train is interrupted by the $\overline{\text{Print}}$ command or by the $\overline{\text{Register Full}}$ state and resumes 750 mS later after the printing cycle is complete. Drive: 5 TTL loads *In the single character mode, $\overline{\text{DAV}}$ interrupts RFD until paper returns to the print position (1 sec.)

## 2 $\overline{\text{Data Accepted}}$ (DAC)

*Additional DAC pulses will appear after Register Full if DAV's are sent.*

This is a negative-going pulse occurring 375  $\mu$ S after the Data Valid signal to indicate that the input data bus may be cleared or updated. Pulse duration is 63  $\mu$ S. Drive: 5 TTL loads

## 3 $\overline{\text{Input Register Full}}$ \*

EOL	EOH	ROH
.9V @ 80mA	No Load (Pullup)	
4V @ 20mA	+5 $\pm$ .5V	4.7K $\Omega$

Periodic negative-going 25  $\mu$ S plis every 93  $\mu$ S starting about 13  $\mu$ S after the 20th  $\overline{\text{Data Accepted}}$  pulse. This  $\overline{\text{FULL}}$  pulse train is halted by the  $\overline{\text{Print}}$  command, or by  $\overline{\text{Delete}}$  or  $\overline{\text{Backspace}}$  entries. \*The  $\overline{\text{Register Full}}$  output may be externally strapped to the  $\overline{\text{Print}}$  input to automatically start printing when character number 20 is received. Note that printing won't occur with this method if less than 20 characters are received unless the sending processor supplies dummy filler spaces.

## 13 $\overline{\text{End of Paper}}$

A switch closes to ground when the paper is within 10 feet of exhaustion. An external 1 Kiloohm pullup resistor to +5V is suggested for logic compatibility. The printer is disabled when the switch closes.

## Other Connections

Pin	Function
4	Not Used
5	+5V
6	Not Used
7	Logic Ground
8,9	Not Used
10	

## Description

Regulated DC Power, approximately 500 mA may be used externally.

**Connector**

Type DB25P mounted on rear panel with two 4-40 threaded retainers. A mating DB-25S (Datel P/N 58-2079130) and strain relief hood (Datel P/N 58-2083065) are supplied.

**OPERATING MODES**

The printout format and operating control modes are programmed by an internal microprocessor. Some modes are pin-selected while others are data-coded. Some modes are mutually exclusive (see chart).

Pin-Selected Modes (see descriptions above)

1. Data Polarity (pin 12)
2. Text/Lister-inverted printing (pin 13)
3. Single Character Printing (pin 15)
4. Tall Characters Printing (pin 16)

SEE NOTE 1

Data-Coded Functions (see descriptions below)

- 1A. Delete - clears register (control functions enabled)
- 1B. Delete - prints rubout pattern (control functions disabled)
2. Horizontal Tab - arranges printout in columns
3. Line Feed - Advances one line without printing or disturbing input register.
4. Form Feed - Advances 11 lines
5. Carriage Return - Will start printing (alternate method)
6. Backspace
7. Null - Ignored by Printer

**OPERATING MODE CHART**

Modes may be either simultaneously compatible (Y = YES) or mutually exclusive (N = NO) NA = Does not apply

	SINGLE CHARACTER PRINTING	TALL CHARACTERS	HORIZ. TAB	BACKSPACE	DELETE-RE-INDEX	FORM FEED	DATA POLARITY SELECT
TALL CHARACTERS	N						
HORIZ TAB	Y	Y					
BACKSPACE	N	Y	NA				
DELETE-RE-INDEX	Y	Y	NA	NA			
FORM FEED	Y	Y	NA	NA	NA		
DATA POLARITY SELECT	Y	Y	Y	Y	Y	Y	
TEXT (INVERTED) PRINTING	Y	Y	Y	N	Y	Y	Y

**Data-Coded Function Codes**

The following functions are enabled only if Data Bit 7, Pin 23 is set "true" (logic 1) except \*(Delete)

NAME	ASCII MNEMONIC	INPUT DATA CODES		RESPONSE
		HEXADECIMAL	OCTAL	
Delete	DEL	FF	377	Clears contents of input register, and re-indexes character column address to column 1
*(Delete)	(DEL)	(7F)	(177)	If bit 7 is set "false" (logic 0), the rubout pattern ☒ will be printed.
Backspace	BS	88	210	Decrements the input register column address and deletes entry as it goes. Backspacing is not allowed with single character printing.
Horizontal Tab	HT	89	211	Advance column address to columns 4,9,15 in turn. This may be used to arrange tables or vertical printout columns such as CH TIME DATE DATA 99 0900 04/05 123456
Line Feed	LF	8A	212	Advances one line of paper. Data entry is disabled until finished.
Form Feed	FF	8C	214	Advances 11 lines of paper (2.2" - 56 mm) to separate adjacent records.
Carriage Return	CR	8D	215	This is an alternate method of issuing a print command and is compatible with many processors unable to activate the PRINT input (pin 11).  The Carriage Return input responds with a REGISTER FULL output in addition to Data Accepted. NUL is ignored without incrementing the column column address. A Data Accepted pulse is issued.
Null	NUL	00 or 80	000 or 200	

**ORDERING GUIDE**

Models	Description
APP-20A1	115/230 VAC Power, U.S.A. plug
APP-20E1	115/230 VAC Power, European plug
APP-20J1	100 VAC Power, U.S.A. plug
APP-20D1	+12VDC-power @ 1 Amp
58-9374-1	Box of 10 rolls of printing paper
CAPP-20X	Printer Housing for table-top mounting of user-supplied interfaces and circuits
9568A	Message Generator, 115 VAC, U.S.A. plug
9568E	Message Generator, 230 VAC, European plug

**OEM OPTIONS:**

Add Suffix	Description	Price
-9554	No front panel label	No charge Same price
-9555	No connector included	Same price
-9556	No label, No connector	Same price
Example: APP-20E1-9556		

**NOTE 1:** The Clear Register Delete function is selected using the 8th data input (data bit 7, pin 23). Since conventional ASCII code is 7 data bits (128 states), typical integrated circuit LSI ASCII code generators are not able to select between the two Delete functions by data coding. The rubout function however, is selectable by 7 bits only and so appears as part of the printable ASCII character set. In order to enable the control characters, data bit 7 must be true and therefore the clear register Delete function takes the place of the rubout Delete function. This situation is of no concern if data bit 7 is controlled by the user's external logic. However, if the user must strap data bit 7 true or false (i.e., not logically controlled), modes of operation are predetermined as follows:

**DATA BIT 7**

TRUE  
  
FALSE

IF DATA BIT 7 IS HARDWIRED:

**DELETE FUNCTION**

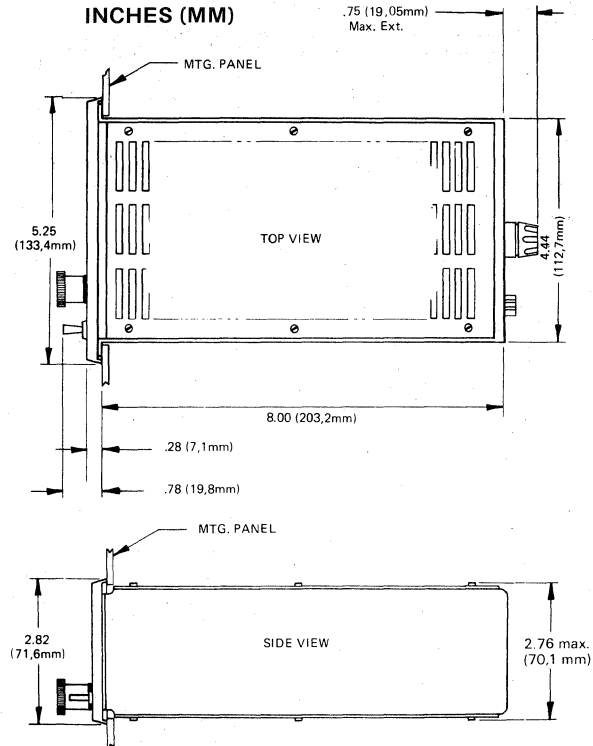
CLEAR REGISTER (WON'T PRINT RUBOUT)  
RUBOUT (CAN'T CLEAR REGISTER)

**PRINT COMMAND**

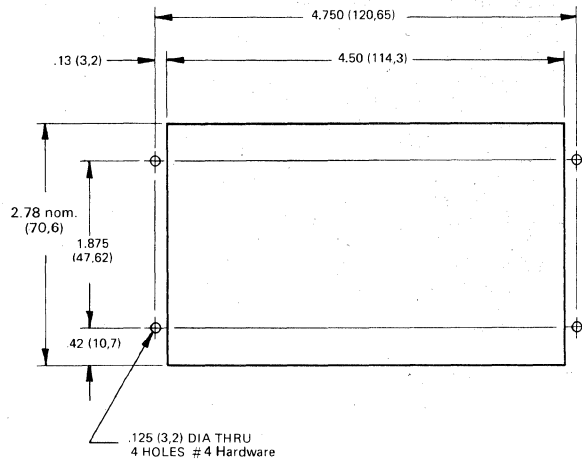
EITHER ASCII "CR" OR TTL PRINT INPUT (PIN 11)  
TTL PRINT INPUT (PIN 11). WILL NOT PRINT ON ASCII "CR"

# APP-20 MECHANICAL INFORMATION

## OUTLINE DIMENSIONS INCHES (MM)

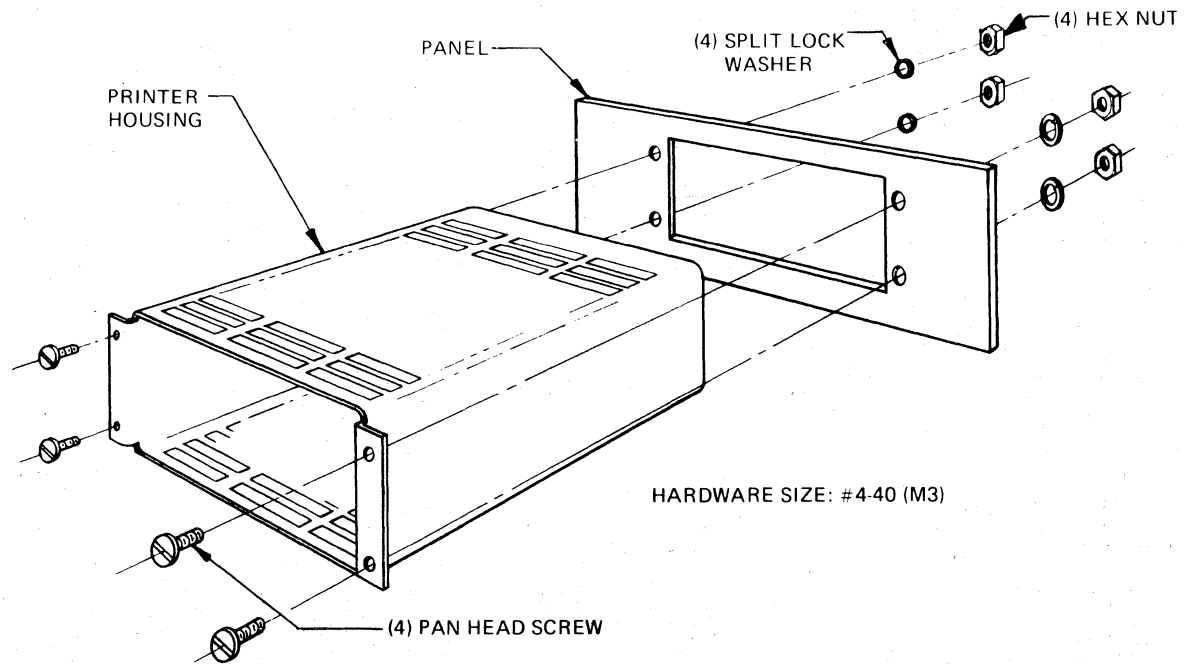


## PANEL CUTOUT



NOTE:  
TOLERANCE: .XX ± .01 (0,25)  
.XXX ± .005 (0,10)

## MOUNTING DETAILS



# APP-20 INTERFACING

## INTERFACE TIMING DESCRIPTION

As previously described, the APP-20 uses an 8-bit parallel data input with asynchronous interlocked handshakes to load data into a 20-character input register. With the APP-20 idling while waiting for data, the Ready For Data (Ready) output sends a steady pulse train while the internal microprocessor loops in a ready state. The external data source should sense that the Register Full output is high (i.e. there is room for data). Ordinarily, power-on reset in the APP-20 will insure that the character counter is at position one (left margin) when first loading data or after printing a line. The data source should use the Ready output to gate valid ASCII data for the 1st character onto the bus. The data source should inform the APP-20 that data is ready to be loaded by using a Data Valid falling edge input, which will load the data. The APP-20 will respond within 375 microseconds with a Data Accepted output, telling the external data source to update the bus with data for the second column character. These cycles are repeated at any rate up to about 350 microseconds minimum per character. If all 20 characters are loaded, the APP-20 will start a Register Full output pulse train from an internal looping routine. If a short line (less than 20 characters) is transmitted, the unsent characters will appear as blanks (unprinted).

If the user prefers to use a "Carriage Return" (CR) data character to start printing rather than the Print input, the CR may be entered as the 21st (or any other) character, so that up to 20 full characters may be printed. In this case, the user's interface must ignore the Register Full output or use the Register Full to place the CR on the bus.

The other control characters (Backspace, Delete, Form Feed) may also be sent as a 21st character and the APP-20 will respond. Although the APP-20 does not issue a Busy output during printing, the Ready For Data pulses stop with start of the printing cycle and may be used for this purpose.

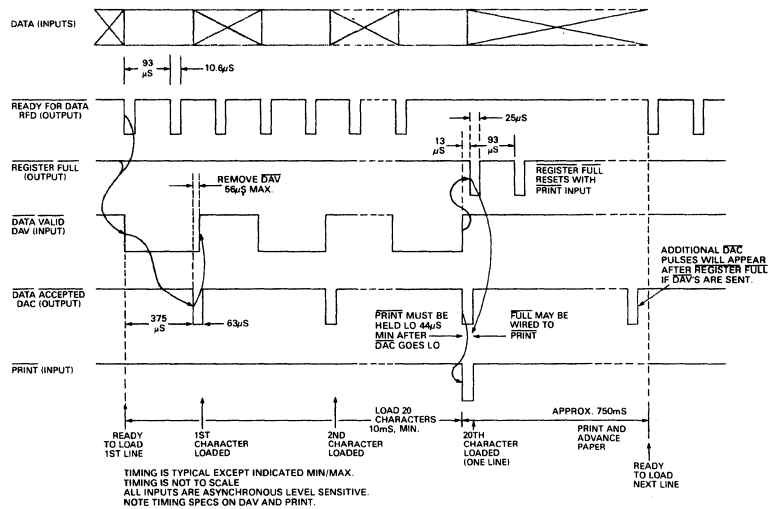
The user may also externally connect the Register Full output to the Print input. However, 20 characters must then always be sent and the external data source must supply filler space characters to make short lines 20 characters long. If preferred, the Register Full output may also be wire-OR'ed with an external Print input as another variation insuring that 20 characters will always cause a printout.

There are some important things to remember when interfacing the APP-20.

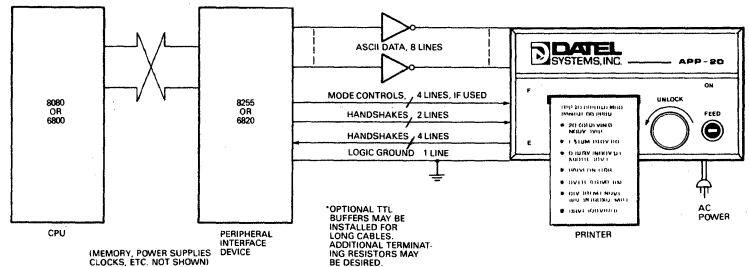
### 1. Data Bit 7 does not lock out alphanumerics

The Control Character Data Bit, pin 23, bit 7, does not lock out alphanumeric characters, but does lock out programmable

## APP-20 PRINTER TIMING-PRINTING ONE LINE



## TYPICAL MICROPROCESSOR INTERFACING



## I/O LINE LISTING

Data	{ ASCII characters	7 lines
	{ Control Bit	1 line
Mode Inputs	{ Data Pos/Neg. True	1 line
(If used, internal pull-ups supplied)	{ Text/Lister	1 line
	{ Single Char. Print	1 line
	{ Tall Characters	1 line
Handshake Inputs	{ Data Valid	1 line
	{ Print	1 line
Handshake Outputs	{ Ready for Data	1 line
	{ Register Full	1 line
	{ Data Accepted	1 line
	{ End of Paper	1 line
	(Sw. to gnd.)	
Logic Ground		1 line

## INTERFACING (Continued)

control characters, including Carriage Return (CR) which is the software print command. One function of this bit is to ignore CR's at the wrong places in incoming text, such as text programmed for another printer with differing characters-per-line length, compared to the APP-20.

However, if the CR is ignored, the Print Command *must* be used to print the register contents when it is full. The number of characters per line must be counted externally (with Print commands every 20 characters) or the Print input can be externally connected to the Register Full Output for automatic printing when the register is full.

Normally, users will have full control of the printout formatting so that misplaced CR's will not be a problem.

### 2. APP-20 is level sensitive; min/max. pulsewidths required

The control microprocessor in the APP-20 senses input line states by polling those lines. The polling program performs many other tasks at the same time and this activity is not tightly synchronized to external line changes. Therefore, there is some uncertainty as to exactly when a particular line is sensed. However, in each case, there is a maximum time required for each line sensing and this simply requires that line states must have minimum pulsewidths to adequately insure sensing.

This means that the APP-20 is *not edge sensitive but is level sensitive* instead. In addition, the handshakes are interlocked, meaning that they are not synchronous to a master system clock but that levels must proceed in the sequence shown on the timing diagram.

### Bring data valid high within 56 μS after Data Accepted

For programming reasons, the APP-20 does not stop periodically polling the Data Valid input after Data Accepted goes low. If Data Valid is not brought high within 56 microseconds after Data Accepted goes

low, Data Valid will be polled again and the APP-20 will load whatever is on the data bus as the next character, whether the bus is ready or not.

For users running from only a micro-computer parallel I/O port, the user's program must be optimized to sense the Data Accepted low state and respond by bringing Data Valid high within 56 μS.

If Data Accepted is connected to a microcomputer interrupt line, some time must still be allowed for the interrupt polling program to decide priorities. Even if the APP-20 is highest priority, (not always possible in real-time and data acquisition applications), the polling routine (and the Data Valid high response) will still take time. Users must carefully calculate the number of clock phases, machine cycles and period of the clock.

A hardwired-priority interrupt (electrical distance from CPU) simplifies matters as does the higher speed of a full minicomputer.

### 3. Hardware Interfacing Options

Users will generally have 3 classes of hardware circuit methods to implement the interface or some combination of them. They are:

A. Dedicated, user-designed, user-fabricated *discrete logic hardware interface*. This concept will help to minimize programming while taking the lowest processor time. Since each processor is unique, the design is left to the user.

One simple part of the circuit will easily take care of resetting the Data Valid. That is shown in Figure A which is a flip flop to reset the Data Valid from Data Accepted. The circuit also generates an output to place the next character on the bus. A power-on reset circuit is included.

B. *Computer parallel I/O port without interrupt*. This will require the host processor to continually poll the handshakes looking for state changes. During data loading only, a typical 8-bit microcomputer

will be highly dedicated to the APP-20 with little or no time for formatting or data manipulation, which should be done while printing or while idling. This approach takes little or no hardware fabrication at all, except cables and connectors. The user must write an efficient, optimized program to sense and respond to the handshakes within the timing diagram limits.

C. *Computer parallel I/O port with interrupt*. This variation of the previous interface will tie up the processor less with polling routines, and uses the processor efficiently. The raw Data Accepted output may or may not be used directly as an interrupt since some processors require that an Interrupt Acknowledge output would be responded to by removing the requesting interrupt. This would require a flip-flop, power-on resets and associated logic. Such logic would have to be designed, fabricated, and mounted by the user (See Figure B). The interrupt would quickly jump to a subroutine to remove the Data Valid from the parallel outputs within 56 microseconds.

Again, the user must write programs for both the parallel port and the interrupt arbitration.

Some combinations of all these approaches may be desired. The simple Data Valid flip flop makes the parallel I/O port less critical for timing. Other outputs, such as Register Full and Ready for Data, may be monitored if there are spare interrupt lines of lower priority.

Since these are both pulse trains, rather than single onetime synchronous pulses or resettable levels, the program should be written so that successive pulses do not retrigger the interrupt. Instead, the interrupts should interlock so that, for example, the Ready for Data Interrupt cannot be reenabled until the Register Full interrupt occurs and the Register Full interrupt would not be reenabled until Ready for Data reappeared.

## TWO WIRE DATA TRANSFER

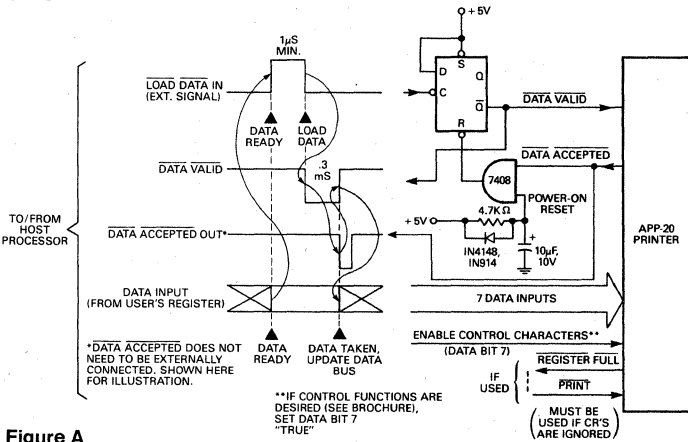


Figure A

## TYPICAL CIRCUIT TO RESET DATA VALID FROM DATA ACCEPTED INTERRUPT (SEE FULL TIMING DIAGRAM)

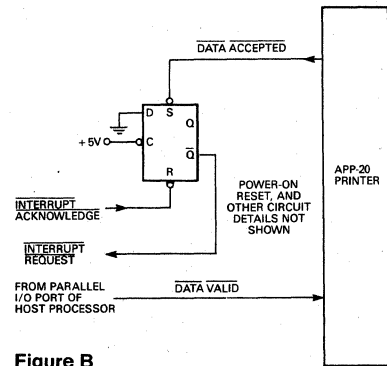


Figure B

# APP-20 INPUT DATA CODING

## BINARY DATA CODING

DATA BITS	DATA BITS 654											
	3	2	1	0	000	001	010	011	100	101	110	111
0 0 0 0					NUL		Space	0	@	P	'	P
0 0 0 1				!			1	A	B	R	a	q
0 0 1 0				"			2	B	C	R	b	r
0 0 1 1				#			3	C	D	S	c	s
0 1 0 0				\$			4	D	E	T	d	t
0 1 0 1				%			5	E	F	U	e	u
0 1 1 0				&			6	F	G	V	f	v
0 1 1 1				'			7	G	H	W	g	w
1 0 0 0	BS			(			8	H	I	X	h	x
1 0 0 1	HT			)			9	I	J	Y	i	y
1 0 1 0	LF			*			A	J	K	Z	j	z
1 0 1 1				+			B	K	L	[	k	[
1 1 0 0	FF			,			C	L	M	\	l	l
1 1 0 1	CR			.			D	M	N	]	m	n
1 1 1 0				/			E	N	O	^	n	o
1 1 1 1				~			F	O		_	o	DEL

## AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE (ASCII) CODING PER ANSI X3.4-1977 SPECIFICATIONS

MNEMONIC	MEANING
NUL	Null is ignored and the column address does not increment. Unused data codes are considered a NUL and are ignored.
BS	Backspace: Decrement column address and delete entry.
HT	Horizontal Tab: Jumps column address to 4, 9, 15 in sequence.
LF	Line Feed: Advance one line, no print, no change of input register.
FF	Form Feed: Advance 11 lines.
CR	Carriage Return: Software print command
DEL	Delete clears the input register if Data Bit 7 is "true" (logic 1). If Data Bit 7 is "false" (logic 0), the rubout (obliteration) pattern is printed.

## ASCII HEXADECIMAL AND OCTAL CODING

CHARACTER	NOTES	HEXADECIMAL (4 BITS)	OCTAL (3 BITS)	PARITY
Space	Blank	20	040	Odd
!		21	041	Even
"		22	042	Even
#		23	043	Odd
\$		24	044	Even
%		25	045	Odd
&	Ampersand	26	046	Odd
'	Apostrophe	27	047	Even
(		28	050	Even
)		29	051	Odd
*		2A	052	Odd
+		2B	053	Even
,	Comma	2C	054	Odd
.	Minus	2D	055	Even
/		2E	056	Even
0	Number zero	30	060	Even
1	Number one	31	061	Odd
2		32	062	Odd
3		33	063	Even
4		34	064	Odd
5		35	065	Even
6		36	066	Even
7		37	067	Odd
8		38	070	Odd
9		39	071	Even
A		3A	072	Even
B		3B	073	Odd
C	Less Than	3C	074	Even
D		3D	075	Odd
E	Greater Than	3E	076	Odd
F		3F	077	Even
0		40	100	Odd
1		41	101	Even
2		42	102	Even
3		43	103	Odd
4		44	104	Even
5		45	105	Odd
6		46	106	Odd
7		47	107	Even
8		48	110	Even
9	Letter I	49	111	Odd
A		4A	112	Odd
B		4B	113	Even
C		4C	114	Odd
D		4D	115	Even
E		4E	116	Even
F	Letter O	4F	117	Odd

CHARACTER	NOTES	HEXADECIMAL (4 BITS)	OCTAL (3 BITS)	PARITY
P		50	120	Even
Q		51	121	Odd
R		52	122	Odd
S		53	123	Even
T		54	124	Odd
U		55	125	Even
V		56	126	Even
W		57	127	Odd
X		58	130	Odd
Y		59	131	Even
Z		5A	132	Even
[		5B	133	Odd
\		5C	134	Even
]		5D	135	Odd
^		5E	136	Odd
_	Underline	5F	137	Even
`	Accent Grave	60	140	Even
a		61	141	Odd
b		62	142	Odd
c		63	143	Even
d		64	144	Odd
e		65	145	Even
f		66	146	Even
g		67	147	Odd
h		68	150	Odd
i		69	151	Even
j		6A	152	Even
k		6B	153	Odd
l	Letter l	6C	154	Even
m		6D	155	Odd
n		6E	156	Odd
o	Letter o	6F	157	Even
p		70	160	Odd
q		71	161	Even
r		72	162	Even
s		73	163	Odd
t		74	164	Even
u		75	165	Odd
v		76	166	Odd
w		77	167	Even
x		78	170	Even
y		79	171	Odd
z		7A	172	Odd
[		7B	173	Even
\		7C	174	Odd
]		7D	175	Even
^		7E	176	Even
_		7F	177	Odd
⌘	Rubout Pattern			

## CONTROL CODES

CHARACTER	NOTES	HEXADECIMAL (4 BITS)	OCTAL (3 BITS)	PARITY
NUL	Null, Ignored	00	000	Even
BS	Backspace	08	010	Odd
HT	Horizontal Tab, Cols. 4, 9, 15	09	011	Even
LF	Line Feed, No Print	0A	012	Even
FF	Form Feed, 11 Lines	0C	014	Even
CR	Carriage Return, Software Print Command	0D	015	Odd
DEL	Delete, Clear Input Register	FF	377	Even
☒	Rubout (Obliteration) Pattern	7F	177	Odd

} See Note 1, pg 1375

## APP-20 PAPER LOADING

### HOW TO LOAD PAPER

1. Shut off all power to the printer.
2. Slide out the printer mechanism by first loosening the front panel thumbscrew counterclockwise until it stops. Pull the thumbscrew firmly straight out and the front panel/printer assembly will slide out all the way. Some force may be needed to release the internal PC connection.
3. Raise the paper loading door by pulling forward until it stops. This automatically lifts the thermal printhead from the paper drive roller (see photo). Remove any paper from a previous roll.
4. Pull the remaining paper backward out from under the printhead. Grasp both ends of the paper roll axle with fingertips and pull straight up out of the printer assembly. The axle will slide past the circular axle retaining spring as shown in the photo.

### INSERTING NEW ROLL

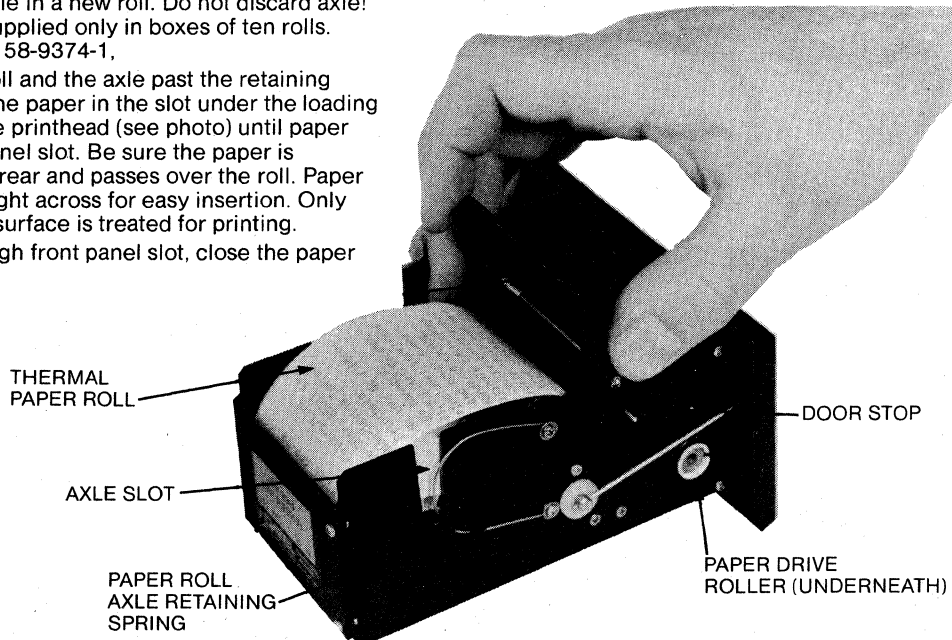
5. Slide the paper roll axle out of the used paper roll and reinsert the axle in a new roll. Do not discard axle! The paper roll is supplied only in boxes of ten rolls. Order box number 58-9374-1.
6. Slide the new roll and the axle past the retaining spring and insert the paper in the slot under the loading door and under the printhead (see photo) until paper appears at front panel slot. Be sure the paper is threaded from the rear and passes over the roll. Paper should be cut straight across for easy insertion. Only the outside paper surface is treated for printing.
7. Pull paper through front panel slot, close the paper

loading door by depressing the door stop downwards, and slide the printer mechanism back into the housing. Press the front panel printer assembly firmly into the housing as far as it will go. This will seat the internal PC board connection.

8. Rotate the thumbscrew clockwise until it stops and turn on power. Advance the paper by pressing the front panel switch. Paper may be manually advanced simply by pulling out of the front slot.

### RELOADING SUMMARY

1. Loosen thumbscrew, pull out mechanism.
2. Lift paper loading door.
3. Lift out used roll and reinsert axle in new roll.
4. Press new roll and axle into axle slot past circular spring.
5. Thread paper over top of roll and under printhead out through front panel slot. Depress stop, close door.
6. Push mechanism back into housing and retighten thumbscrew.





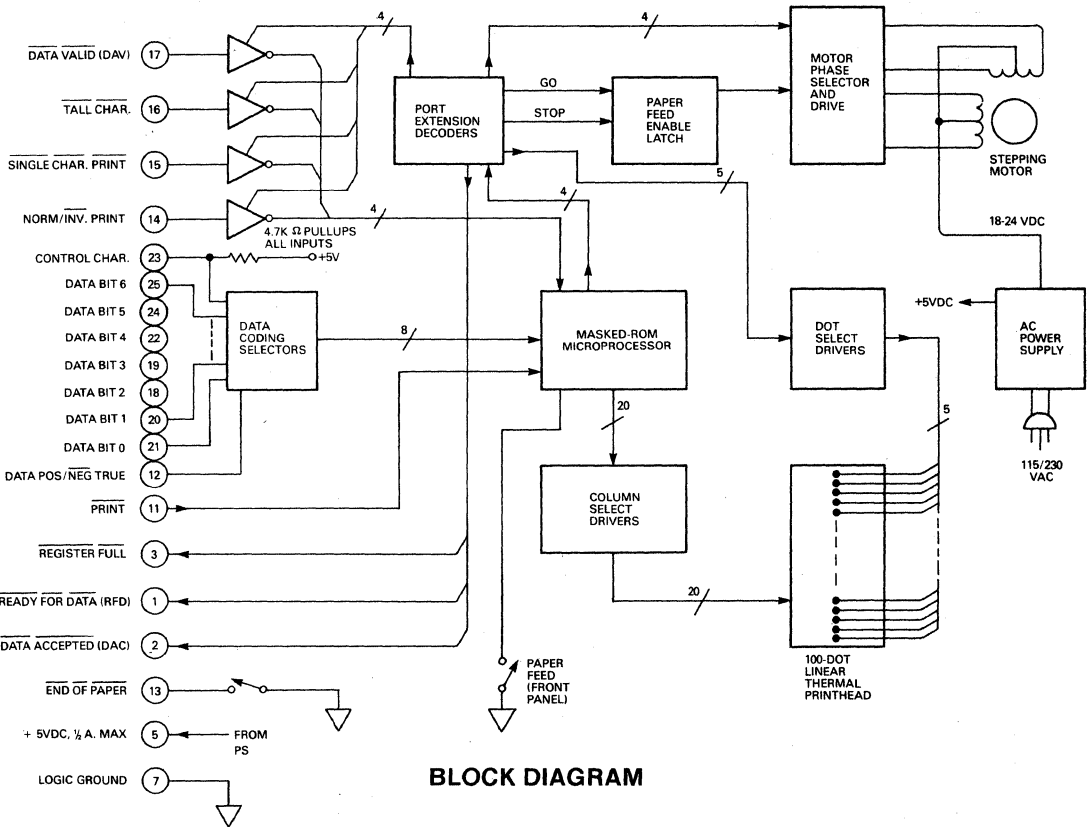
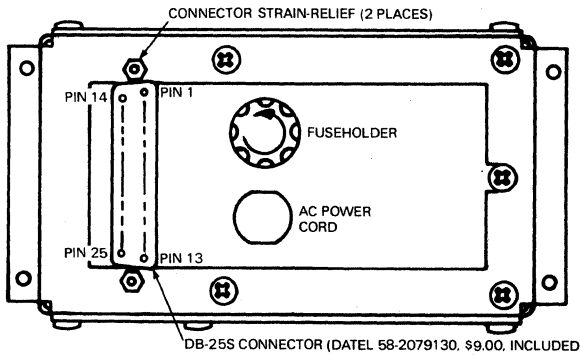
# APP-20 INPUT/OUTPUT CONNECTIONS

## LINE FUNCTIONS

PIN	FUNCTION	PIN	FUNCTION
14	Text/Lister (Norm/InV-Input)	1	Ready for Data (Output)
15	Single Char. Print (Input)	2	Data Accepted (Output)
16	Tall Characters (Input)	3	Input Register Full (Output)
17	Data Valid (Input)	4	Not Used
18	Data Bit 2 (Input)	5	+5 Vdc Power Out, .5A max.
19	Data Bit 3 (Input)	6	Not Used
20	Data Bit 1 (Input)	7	Logic Ground
21	Data Bit 0 - LSB (Input)	8	Not Used
22	Data Bit 4 (Input)	9	Not Used
23	Control Characters - MSB (Input)	10	Not Used
24	Data Bit 5 (Input)	11	Print (Input)
25	Data Bit 6 (Input)	12	Data POS/NEG True (Input)
		13	End of Paper (Output)

Data Bit 7 →

## PRINTER REAR VIEW PIN LOCATIONS



**BLOCK DIAGRAM**

# MODEL 9568 MESSAGE GENERATOR



ALPHANUMERIC  
PANEL-MOUNTING  
THERMAL PRINTER  
MODEL APP-20

- \*20 Columns/Line
- \*96 Char. ASCII Set
- \*Non-Moving Thermal Printhead-  
No ink. No ribbons.  
No hammers.
- \*1.5 Lines/Second.
- \*Includes interface and power supply.
- \*Under 5 pounds.
- \*Single char. print for keyboard echo.
- \*Selectable pos/neg true inputs.

- \*Selectable INVERTED printing for Text (TTY) applications where last record is at bottom of printout.
- \*Intermixed TALL characters for EMPHASIS.

```
!#$%&'()*+,-./0123
456789:;<=>?@ABCDEFGHI
HIJKLMNOPQRSTUVWXYZ
\]_`{abcde}~!@#ijklmno
pqrstuvwxyz{|}~*#
```

DATAL  
11 Cabot Boulevard  
Mansfield, MA U.S.A.

Datal's Model 9568 Message Generator may be used to fully exercise Datal's APP-20 Alphanumeric Thermal Printer. The 9568 is ideal for quantity users of the APP-20 Printer who need to test printers or check their function in an operating system. While the 9568 is intended for the APP-20, its design may be adapted to other message applications such as displays for advertising, hotels, trade shows, ticket agencies, sporting events, demonstrations, announcing systems, etc.

The 9568 consists of two type 2708 semiconductor Read-Only Memories (ROM's) which contain the message shown below. One of the 2708's contains 1024 x 8 bits (1K) of characters, while the other 1K ROM contains 2-bit control codes (TEXT/LISTER

and TALL CHAR.). 6 spare bits are unassigned. Both 2708's are addressed simultaneously as the message is transferred in byte parallel to the APP-20 printer.

The 2708 ROM's may also be reprogrammed by the user to accept any 1024-character message. After the ROM's are removed from their PC board sockets, the supplied message may be erased by exposing the windows on top of the ROM's to a specified dosage of ultraviolet light. The user's new message may then be entered using a ROM Programmer supplied by the user. Datal does not offer programmers or UV lights. These are available from many computer manufacturers and independent Programmer makers.

## OPERATION

The 9568 Message Generator includes a cable which connects to the APP-20 printer. The front panel switches operate as follows:

1. "Power On" applies AC power (choice of 115 or 230 VAC, 50-60 Hz) to the message generator and an LED pilot light confirms that power is on. The APP-20 Printer must be turned on separately. Note: +5V @ 50 mA is supplied by the APP-20 to the 9568.
2. "MAN AUTO" - If this switch is in "AUTOMATIC", the printer will immediately start operation when power is applied to both units. Automatic disables the "ENTER" and "PRINT" pushbuttons. Both pushbuttons are enabled in "MANUAL".
3. "1X1 NORM" selects the one-by-one mode (single character printing) or complete lines printed simultaneously ("NORMAL"). In "AUTO", the printer will continuously print single characters in the "1X1" mode, with the paper cycling in and out of the

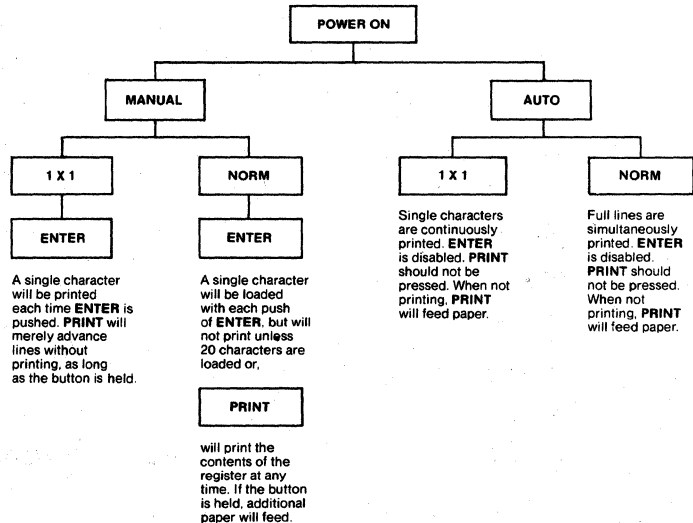
printer as characters are printed at a 1 character per second rate.

- Similarly, in the "1X1" Mode in "MANUAL", single characters may be printed at 1 char./sec. with each push of the "ENTER" button. The "PRINT" pushbutton merely advances lines without printing in "MANUAL".
4. The "ENTER" pushbutton may be used to load characters singly in "MANUAL" and "NORMAL". A partially filled line may be commanded to "PRINT" at any time, thereby clearing the input register. Or, the "ENTER" pushbutton may be cycled until the line is filled and the printer prints automatically because of Carriage Return codes in the data stream.
  5. The "READY" and "REGISTER FULL" LED lamps indicate the status of the corresponding output lines from the APP-20. The READY lamp will be lit while characters are being accepted. REGISTER FULL will light briefly as all 20 characters are filled and printing starts.

## MODELS

**9568A** 115 VAC, 60 Hz Power,  
USA Cord

**9568E** 230 VAC, 50 Hz Power,  
European Cord



## APP-20 SERVICING

### CLEANING

The APP-20 requires periodic cleaning of the thermal printhead. Improved head efficiency will result if the head is cleaned occasionally (every 5 to 25 printing hours) with clinical-grade isopropyl alcohol to remove dirt and residue. Do not use industrial-grade isopropyl alcohol which may contain dissolved distillates that would leave a film. The rubber drive roller may also be cleaned at this time. Do not get any alcohol near the stepping motor to prevent diluting the oil sealed in the motor since this would cause motor failure due to poor lubrication.

### SERVICING

Datel maintains full service and calibration facilities at its Mansfield, Mass. U.S.A. home plant, and limited capabilities at its direct sales offices.

Datel's Service Department will either perform the repair, invoice and return the printer after receipt of a purchase order, or will wait for a user's instructions after issuing a repair quotation (a not-to-exceed amount) or estimate. In all cases, a purchase order is required before starting repair.

Datel recommends that users with critical applications should consider stocking whole spare printers to reduce downtime. Users who wish to do their own servicing may stock selected spare parts from the list below, consisting of mechanical and electronic parts. Datel does not offer parts other than those shown. Other electronic parts are generally available from component distributors.

Servicing the printer will require a known source of input data such as Datel's Model 9568 series Message Generator for the APP-20. The 9568 contains two UV-programmable type 2708 Read-Only-Memories (ROM's) containing the message shown (see 9568 information elsewhere in this brochure). One of the 1024 x 8 bit ROM's contains the message and the other contains 2-bit control codes to format the message. Users may write their own test message by reprogramming the 2708's with a ROM Programmer (available through most computer manufacturers).

Repairs should be attempted only by qualified service personnel familiar with digital electronics. Components and boards are easily damaged by improper desoldering and repair techniques. Service personnel must be completely knowledgeable in digital test equipment.

### PROCEDURE

Use a cotton swab moistened (not soaking) in isopropyl alcohol. Flatten the swab to fit between the printhead and the roller. Lift the printhead away from the paper drive roller by pressing down on the loading door stop. This will allow access to the printhead. The roller may be advanced manually for cleaning. Other areas such as the door and guides may also be cleaned with the swab or dry, oil free compressed air.

**Do not lubricate.** The stepping motor and print roller bearings are permanently lubricated and will last the life of the printer. Additional oil or grease will only congeal and collect dirt, limiting the printer's service life.

The masked-ROM microprocessor inside the printer is socket-replaceable but is not repairable. The stored program is company-proprietary and is not available. Datel welcomes the opportunity to review custom reprogramming for OEM quantity users.

A set of schematic and assembly drawings only are available (Document No. 58-12140-37) on request to customers.

### APP-20 PRINTER SPARE PARTS

DESCRIPTION	REF. NO.	ORDERING MODEL NO.
Masked-ROM 3870 Micro-processor, Tested	0341390	33-9334-1
Stepping Motor	2206320	33-6539-1
Printhead Assembly, Mounted	7530100	33-9365-1
Controller Printed Circuit Board, Including All Components but Less Microprocessor	7550532	33-9349-1
Front Panel Printed Circuit Board, with Components	7322900	33-9366-1
Front Panel Switch	2194050	33-6826-7
Transformer, 115/230V, 47-440 Hz	7483219	33-9029-5
Assembled 115V Power Supply (Includes Xfmr, Regulator, Fuse, USA Cord, Rear Mounting Plate, etc.		33-9296-3
Assemb. 230V Power Supply (As above, European Cord)		33-9296-2
Print Drive Roller	7615025	33-9300-1
Print Drive Roller Bearing		33-2216500
Removable Print Module Assembly	7550910	33-9616-1

## NEW!! FULL SERIAL APP-20A2, E2 See full information starting page 148S

### FEATURES

- Needs only 2 wires to interface, simplifies input connections to any computer serial port.
- Includes all internal serial data and drive electronics and AC power supply. No extra electronics required. No bulky additional chassis or cables.
- Serial 20 mA TTY current loop input is optoisolated 300 VRMS, 100 Megohms. Eliminates ground loop noise problems. Can position APP-20 hundreds of feet from computer.
- Standard RS-232-C connection also included.
- 4.25-pound featherweight, 1.2 lines per second (72 lines/min.) at high baud rates.
- Jumper or logic selected baud rate (50 to 9600) 9-11 bit character length.

- Character-selected (SO/SI) tall characters.
- Jumper or logic-selected inverted (text) printing or normal (lister) printing.

### APPLICATIONS - Use the Serial APP-20 for:

- Remote Slave Printer Terminal hundreds of feet from data source.
- Multiple-station, daisy-chained message repeater using 2-wire interconnects.
- Serial interface factory data logger or industrial data acquisition system with terminal at operator's station remote from hazardous process.

## CONNECTING THE APP-20 TO AN ANALOG DATA SYSTEM

The APP-20 will print out coded, digitized real-world analog signals which are supplied from transducers and sensors detecting physical variables such as temperature, pressure, flow rate, etc. Since the APP-20 accepts only data-coded digital signals, the continuous analog signals must be converted to digital form and then data-coded and formatted to make readable printout. The two common devices for making the digital conversion are Digital Panel Meters (DPM's) and Analog to Digital Converters (ADC's). While these devices make the digital conversion, they do not perform the ASCII data-coding, printout formatting (arranging in columns, adding spaces) and variable units labelling (gallons per hours, pounds per square inch, temp. degrees Celsius, etc.).

DPM outputs are generally in full parallel non-gated Binary Coded Decimal (BCD). The typical A/D converter has binary outputs. While both BCD and binary data are digital, they must be converted to ASCII coding and formatted before the APP-20 can use them. The two methods to make the coding and formatting conversions are to design a discrete logic controller or to use a mini or microcomputer.

Some sort of digital processor (either discrete or LSI-microprocessor based) will be required to perform other system functions in addition to code conversion and formatting. These functions would include printing out a real time clock, starting channel scans at preselected intervals, supplying gain codes to signal conditioners, sequencing channel addresses, performing scaling, offsetting and curve-fitting arithmetic on the data and terminating the scan.

The discrete logic approach requires a detailed logic circuit design and may require several dozen TTL integrated circuits. The cost will be modest but the design cannot easily be changed once the circuit is fabricated. No programming will be required. The microcomputer approach may cost more initially and will trade circuit design time for programming and debug time. An optional development system will be very useful to write the program but will be unused once the program is running the ADC or DPM and the APP-20. The method of operation, printout formatting, scan time control, channel addressing and many other system parameters may be radically changed merely by rewriting the program with practically no hardware changes. Therefore, system

operation is very flexible and the user need not be overly concerned about having to change something after the system is running.

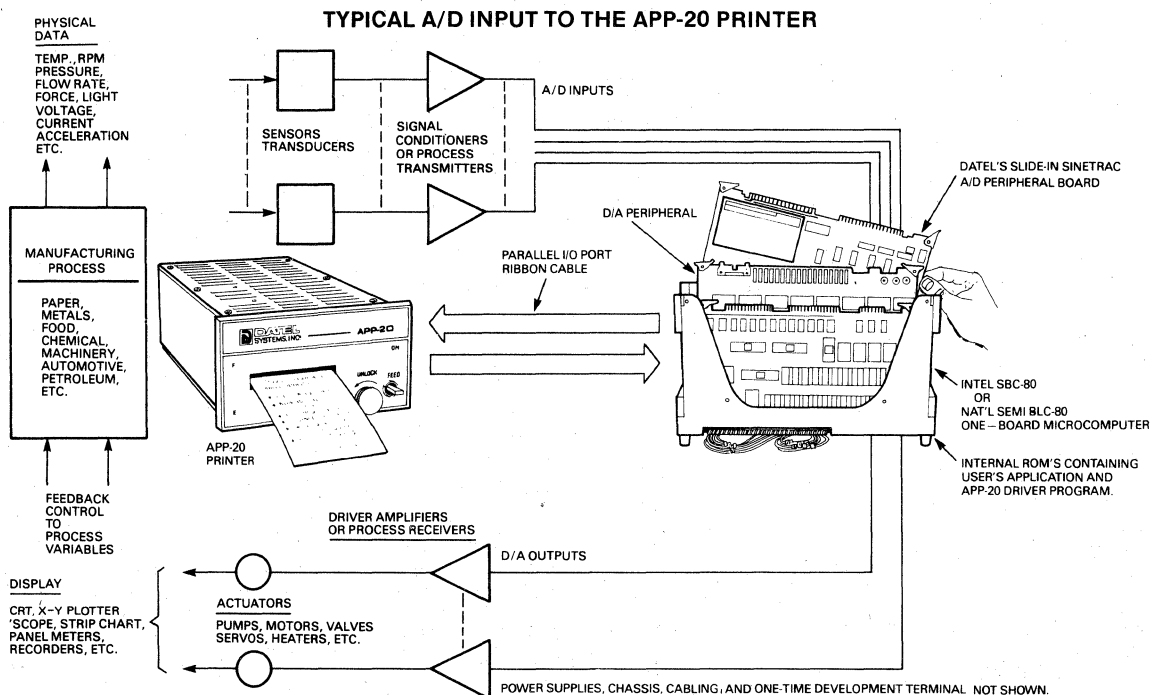
A cost compromise between the discrete logic design and a preassembled microcomputer, is to custom design a microprocessor-based system. Development system components (a terminal, editor, assembler and debug software, etc.) will not be needed if a software consultant or contractor writes the program. This may not be desirable since it leaves the user unfamiliar with the operating program in case future program changes are desired.

**A simple multichannel A/D Data System** using the APP-20 may be easily realized using two standard circuit boards, a card cage, power supply, cabling and sensors and a user-written operating program. An Intel SBC-80 Series Single Board Computer will be used as an example although one-board computers from several other manufacturers (DEC, Motorola, National Semiconductor, etc.) will perform just as well.

A/D conversion is performed by Datel-Intersil's SineTrac-series standard single-board data acquisition system, model ST-732. The ST-732 accepts 32 single-ended or 16 differential A/D channels, digitizes them to 12-bit resolution and places them on the computer's bus under command of the SBC-80 computer.

The SBC-80 computer contains memory circuits to store the operating program which the user has written for this application. This program completely controls all activities of both the Datel-Intersil APP-20 printer and the Datel-Intersil ST-732 A/D data acquisition board. The SBC-80 also includes a programmable parallel I/O port which is used to connect to the parallel APP-20. In case a serial APP-20 Printer is preferred, the SBC-80 also includes standard serial current loop and RS-232-C connections to be used instead of the parallel I/O port.

The two boards (the SBC-80 and the ST-732) may be mounted in a small card cage and with the addition of a power supply, cabling and analog sensors, the APP-20 based system is ready to go to work as a laboratory data acquisition system, factory data logger, scientific data monitor or other application.





# APP-20D1, APP-20D2 12-Volt DC-Powered Panel-Mount, Alpha-Serial, Mini-Thermal Printers

## FEATURES

- Powered from +12 Vdc — built-in DC-to-DC Power Converter
- Low current draw (1A printing, 200 mA standby), light weight (4.25 lbs.) and compact size (4.44" W × 2.76" H × 8.75" D) make printer ideal for vehicle installations.
- Prints 20 columns per line, 1,2 lines per second, using full ASCII character set
- Internal microprocessor provides full interface electronics, programmable control features, and selectable positive/negative true data inputs
- Quiet, inkless thermal printing
- APP-20D1 — Parallel Data Input; Has 20-character, 8-bit input buffer
- APP-20D2 — Serial input for simple, two-wire data interface; Standard RS-232-C connection also included; Jumper or logic selected baud rate (50 to 9600)

## APPLICATIONS

- Portable test and measurement instrumentation for field use
- Hard copy printer for medical systems, analytical instruments and diagnostic testers
- Remote data logging

## POWER SUPPLY SPECIFICATIONS

(for full printer specifications, see appropriate literature)

### POWER SUPPLY

**Supply Voltage** ..... +12 Vdc nominal; printer performs accurately with supply voltages from +10.5 to +15 Vdc

**Power Consumption** ... 1A typical in printing cycle; 200 mA standby

**Power Connector** .... Molex® 03-09-1094 receptacle with Molex® 02-09-1118 crimp-on female terminals.

**Fuse** ..... 2A SLO-BLO; .25" × 1.25" long, 3 AG Type, Datal Model 33-2187030

**NOTE:** This data sheet is an addendum to the complete literature on the APP-20 (parallel), and the Serial APP-20. For additional information on the APP-20D1, see the (parallel) APP-20A1, -E1 literature. For information on the APP-20D2, see the literature for the (serial) APP-20A2, -E2

## DESCRIPTION

Datal-Intersil's miniature, panel mount 20-column thermal printer, the APP-20, is now available in a 12-volt dc-powered version specially designed for use in vehicles. The APP-20 "D" series (the APP-20D1 with parallel data input; and the APP-20D2, with an interface to accept serial data) use a built-in DC-to-DC converter to power the printer's circuitry. In mechanical and electrical performance, they correspond exactly to the AC-powered APP-20 models.

Both provide inkless thermal printing of the full ASCII character set of letters, symbols, numerals, and punctuation. Both print at a rate of 1.2 20-column lines per second. The APP-20D1 and APP-20D2 are controlled by an internal microprocessor which provides all the instruction decoding and generation necessary to interface directly with a microcomputer. Built-in microprocessor control also makes possible inverted character printing (Text mode); extra-height TALL characters; single-character printing for keyboard echo; and backspace, delete, and Form Feed (paper advance) functions.

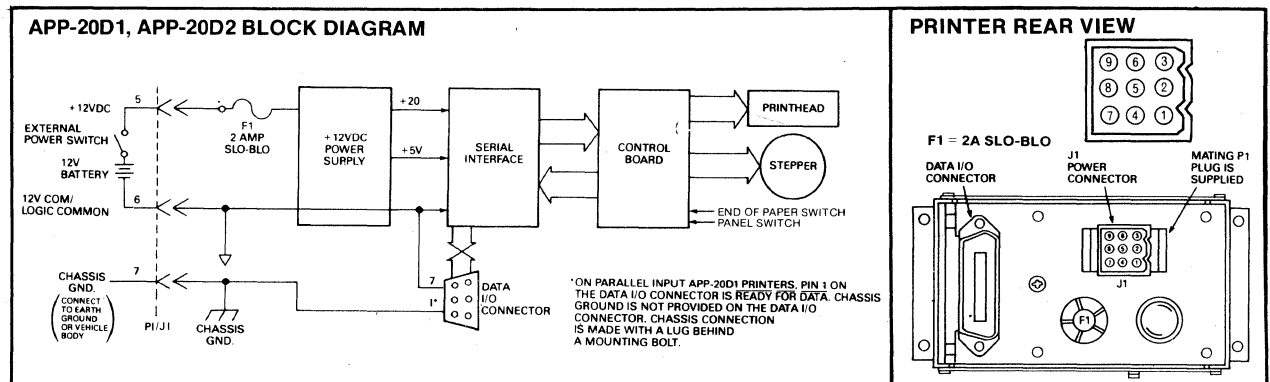
These new dc-powered models should be of particular interest wherever mobile data logging is required. Ambulances, communication vehicles, meteorological and oceanographic vessels can all benefit from the APP-20D's easy microprocessor interface, compact size, and quick quiet printing operation. In addition, since the APP-20's thermal printing mechanism requires virtually no maintenance, no replacement printheads and ribbons need to be carried with the unit.

The APP-20D1 and APP-20D2 require +10-1/2 to +15 Vdc at 1A (200 mA in standby mode). No special power line filtering is required; however, when the printer is installed in a vehicle, it is recommended that printing begin after the engine is running.

## APP-20D1 AND APP-20D2 ORDERING GUIDE

MODEL	DESCRIPTION
APP-20D1	Thermal Printer, Parallel Input, DC-Powered
APP-20D2	Thermal Printer, Serial Input, DC-Powered
33-9371-17	Replacement Plug, P-1 (One Supplied with Printer) <sup>1</sup>
33-2187030	Replacement Fuse, F1, 3AG, 2A SLO-BLO (One Supplied with Printer)
33-9655-1	Replacement 12 Vdc Power Supply with Transformers (a Spare Part; One Supplied with Printer)

1. Consists of one Molex® 03-09-1094 receptacle, and several Molex® 02-09-1118 crimp terminals. Refer to Molex® literature, or qualified personnel, for wire installation and plug assembly.



Molex® is a registered trademark of Molex Incorporated

12-Volt DC-Powered Panel-Mount, Alpha-Serial, Mini-Thermal

Printers



# APP-20A2, E2, J2 Panel-Mount Alphanumeric Serial-Input Thermal Mini-Printer

## FEATURES

- Needs only 2 wires to interface, simplifies input connections to any computer serial port.
- Includes all internal serial data and drive electronics and AC power supply. No extra electronics required. No bulky additional chassis or cables.
- Miniature 20-column alphanumeric panel-mount thermal printer.
- Internal microprocessor and BAUD UART includes 1-line, 20 character buffer.
- Serial 20 mA TTY current loop input is optoisolated 300 VRMS, 100 Megohms. Eliminates ground loop noise problems. Can position APP-20 hundreds of feet from computer.
- Standard RS-232-C connection also included.
- 4.25-pound featherweight, 1.2 lines per seconds (72 lines/min.) at high baud rates.
- Jumper or logic selected baud rate (50 to 9600) 10/11 bit character length.
- Character-selected (SO/SI) TALL CHARACTERS.
- Jumper or logic-selected inverted (text) printing or normal (lister) printing.
- Includes switchable dual 115/230 VAC power supply; OEM's stock one version, choice of line cords.
- Optional 12 Vdc power for vehicle mobile use.



## APPLICATIONS - Use the Serial APP-20 for:

- Miniature hard copy printer for medical systems, analytical instruments and diagnostic testers.
- Remote Slave Printer Terminal hundreds of feet from data source.
- Multiple-station, daisy-chained message repeater using 2-wire interconnects.
- Portable test and measurement instrumentation for laboratory or field use.
- Serial interface factory data logger or industrial data acquisition system with terminal at operator's station remote from hazardous process.

## INTRODUCTION

A miniature, panel-mounting alphanumeric printer using quiet, non-impact thermal printing makes possible all types of low cost display and instrumentation applications. The printer is Datel-Intersil's Model APP-20 (Alphanumeric Panel Printer) which features 20-column printing in a self-contained housing including interface electronics and AC power supply.

The miniature size of the APP-20 lends itself to a host of new applications. With outline dimensions of 4.44"W x 2.70"H x 8.75"D (113 x 69 x 222 mm) to the rear fuseholder, the APP-20 uses just 105 cubic inches of space and weighs under 5 pounds (2.3 kg). The small size is made possible by using an internal dedicated microprocessor for control, timing, character generation, printhead drive and motor stepping. The APP-20 is expressly designed for smart analytical instruments, process control monitors, industrial data loggers, security systems, hotel management dispatchers, assembly line tally systems, data acquisition systems, aircraft and vehicle

systems, telephone and data communications loggers and traffic, environmental and noise data loggers. In addition, the APP-20 is an ideal, low cost alphanumeric printer for most microprocessor development systems.

Datel first pioneered a panel-mounting thermal printer with complete drive electronics in 1975 with the DPP-7 numeric printer. The present APP-20 uses identical panel-mounting and outline dimensions as the DPP-7 for users who wish to upgrade to the fully alphanumeric unit. And like the earlier DPP-7, complete interface electronics and AC power supply are included inside the APP-20 panel-mount housing. While there are many small panel-mount alphanumeric print mechanisms available from other manufacturers, nearly all of them require separately-mounted interface electronics, power supplies and bulky cabling.

### In This Brochure

Introduction, Features, Description .....	Page 148S
Description Continued, Sample Printout, Specifications .....	Page 149S
Specifications, Continued .....	Page 150, 151S
Input/Output Connections, Pin Programming .....	Page 152S
Applications (Data Formats, Paper Loading, etc.) .....	Page 153S
Selection Guidelines, Typical Connections ...	Page 154S
ASCII Data Coding .....	Page 155S
Interfacing, Timing, Data Source Considerations .....	Page 156S
Mechanical Dimensions, Panel Mounting .....	Page 157S

APP-20A2, E2, J2 Serial Alpha-Thermal Printer

**SERIAL APP-20**

**DESCRIPTION**

The APP-20 prints the full ASCII character set of upper and lower case letters, numerals, punctuation, etc. in 20 columns across 2-5/16" wide (58,6 mm) thermal paper. A dot-line thermal printhead forms 5 x 7 dot-matrix characters which are 0.11 inches (2,8 mm) high. The printing rate is 1.2 lines per second regardless of the number of characters printed per line and a 150 foot roll of thermal paper prints almost 9,000 lines of data (180,000 characters max.) at 5 lines per inch (2 lines/cm) spacing.

The internal control microprocessor of the APP-20 offers special OEM programming features which would be impossible with a straight mechanical printer. Perhaps the most striking feature is the inverted text printout mode. In this mode, printing appears upside down from the front panel. However, when the paper is torn off and inverted, the last line printed is at the bottom as normal text would be. In fact, the APP-20 may be mounted with its front panel horizontal (facing upward) for text printing applications. In these applications, the APP-20 is a text printer, like a teletypewriter. In the normal front-panel application, the APP-20 prints the last line at the top in the Lister mode. This mode is commonly used in printing data logging applications. Since the Text and Lister Modes are pin-selected, users may combine inverted text with normal listings on the same printout.

Other OEM programming features are either data-coded or pin-selected (see specifications). These include extended-height characters, single-character printing, form feed, horizontal tab, and backspace.

Extended-height characters are used for emphasis and may be intermixed on one line with regular height characters. Single characters may be printed one at a time to echo a keyboard.

A form feed (FF) character advances the paper 11 lines to separate adjacent records and a horizontal tab (HT) command indexes input data to print in columns 4, 9 and 15 for tabular data.

A conventional AC power supply is used in the APP-20 but is a dual-voltage type (115/230 VAC) so that OEM's need to stock only one model (either U.S.A. and European line cords are supplied, however). An internal switch, accessible when paper is replaced, selects 115 or 230 VAC ± 10%, 47 to 400 Hz.

Power consumption idles at 5 watts and averages 17 watts with a 25 watt peak.

The APP-20 may be operated at 0° to +50° C and stored at -25° C to +85° C. (Paper will darken above +60° C).

**SAMPLE PRINTOUT, ACTUAL SIZE**

```

qbcdefghijklmnopqrst
12345678901234567890
NOPQRSTUVWXYZ[\]^_`
9:;:;<=>?@AB CDEFGHIJKL
829789:;:;<=>?@AB CDEFGH
#%&'()*+,-./0123456789
:;:;<=>?@AB CDEFGHIJKL
mnopqrstuvwxyz()~*
YZ[\]^_`abcdefghijklmnop
efghijklmnopqrstuvwxyz
    
```

**INTERFACING**

The serial APP-20 simplifies external wiring to the minimum by requiring only 2 wires for the 20 mA current loop interface. Most any type of wire may be used for short distances and for longer distances with higher quality wire, the optoisolation feature protects against common mode noise and ground loop problems.

The APP-20 accepts full serial input data which has been ASCII formatted. Both 20 mA loop and RS-232-C electrical levels may be accepted on separate logic-gatable input pins. One printable line (up to 20 columns) of input data is stored in an internal input register. Data input is then halted briefly (750 mS) while the APP-20 drives the thermal printhead and advances one line after printing. Data may be accepted at pin-selectable data rates from 50 to 9600 baud, commonly used with teletypewriters, computer serial I/O ports and data terminals.

The RS-232-C input includes a Data Terminal Ready standard control output to synchronize start-stop data loading from a remote source.

**SERIAL APP-20 SPECIFICATIONS**

(Typical at +25° C unless noted)

**GENERAL**

**Function**..... The APP-20 prints alphanumeric information on internal roll paper from externally supplied ASCII character codes.

**PRINTOUT**

**Number of Columns**..... 20

**Characters Printed**..... All upper and lower case ASCII letters, numbers, punctuation and special symbols shown in the ANSI X3.4-1977 specification. (See listing elsewhere in brochure)

**Printing Format**... 5 columns x 7 row dot matrix

**Character Spacing**

**(Horizontal)**..... Approx. 9 characters per inch  
**Line Spacing**..... Approx. 0.2 inches (5,1 mm), 5 lines per inch (4 dot widths spaced between lines)

**Character Size**..... .110 in.H X .070 in. W (2,8 x 1,8 mm)

**Printing Method**... Dot-line, thick-film non-impact ceramic thermal printhead

**Paper Motion**..... Stepping Motor, Friction Roller, and gear reduction. Paper advance (4 dot widths) occurs automatically after printing. A line may be viewed immediately after printing.

**Printing Rate**..... Up to 1.2 lines per second max. (72 lines per minute) depending on baud rate. The time required to print each line is:

$$\left[ \frac{\text{char./line} \times \# \text{ bits/char.}}{\text{Baud Rate}} + 0.75 \right] \text{ Seconds}$$

The 0.75 second is the time required after loading data when data transmission must stop while printing and line advance occur.

**Printing Paper**..... Thermal paper 2.31 inches wide (58,6 mm) with active surface facing away from roll center. Supplied on rolls of 150 feet length (45 m). Approx. 140 feet usable (42 m). Supplied in boxes of 10 rolls. Datel model number 58-9374-1.

**Printout Color**..... Blue characters on white paper  
**Data Capacity**..... Approximately 8,400 lines (168,000 characters max.) per 140 feet of paper roll.

**Printhead Life**..... 30 million lines typ. (random character distribution and usage with Datel-supplied paper and unmodified printers)

**Mechanism Life**... 5000 hours, typical

**Maintenance**..... Periodic cleaning with isopropyl alcohol of mechanism, printhead and roller is recommended for dirt accumulation depending on operating conditions.

**FRONT PANEL**

**Power On**..... Red light-emitting diode illuminates when power is applied.

**Feed**..... 2 position momentary toggle switch. Actuating either up or down advances paper continuously at 2.9 lines/second or 0.6 inches/second (1,5 cm/sec).

**Paper Supply Indicator**..... Mechanical pointer which rides on paper roll showing relative amount of paper remaining.  
 "F" indicates full roll.  
 "E" indicates empty

**Specifications, Continued**

**Housing Latch** ... Rotating "UNLOCK" knob 1/4 counter clockwise frees mechanism from housing and electronics. Knob is pulled out to replace paper roll. This disconnects power to the mechanism and stops printing.

**POWER SUPPLY**

**Supply Voltage** ... 105 to 130 VAC (A models)  
210 to 260 VAC (E models)  
100 VAC (J models)  
These voltages may be switch-selected by withdrawing the front panel assembly as when the paper roll is changed.

**Frequency** ... 47 to 440 Hz

**Power Consumption** ... 5 Watts, idling, 17 Watts average during printing, 25 Watts peak

**Line Cords** ... Captive 3-wire line cord approximately 6 feet (2m) long supplied with grounding plug for U.S. (A models) or European (E models — 2 prongs and ground shell)

**Fuses** ... A models: 1/2 Amp SLO-BLO  
E models: 1/4 Amp SLO-BLO  
Dimensions: .25" dia. x 1.25" long  
3AG type accessible on rear panel

**PHYSICAL-ENVIRONMENTAL**

**Operating Temperature Range** ... 0 to +50°C

**Storage Temperature Range** ... -25°C to +85°C (Warning: Paper darkens at +60°C)

**Altitude** ... 0 to 10,000 feet (3048 meters)

**Relative Humidity** ... 0% to 90% (no condensation)

**Acceleration (Non-Operating)** ... .5G, 3 axes, 0 to 50 Hz

**Weight** ... 5 pounds (with paper roll), 2.3 kg

**Housing Outline Dimensions** ... Identical to Datel's DPP-Q7 Series  
4.44"W x 2.76"H x 8.75"D (113 x 70 x 222 mm)  
Allow an additional 1.5" for connector hood and cable clearance

**Bezel Dimensions** ... 5.25"W x 2.82"H x .78"D (134 mm x 72 mm x 20 mm)

**Front Panel Mounting Cutout** ... 4.50"W x 2.78"H (115 mm x 71 mm)

**Mounting Method** ... Using four sets of 4-40 hardware (not supplied) in housing mounting flanges. Mounting bolts are concealed by slide-out front panel bezel.

**INTERFACE & INPUT/OUTPUT CONNECTIONS**  
(Refer to I/O Listing, pg. 151S)

**Interface Type** ... Full serial asynchronous, either with or without data loading handshake controls

**Input Data Rate** ... Rear-connector pin-selected (jumpers or TTL logic levels) to one of the following baud rates, 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600 (see chart for pins 21 thru 24).

**Number of Bits Per Character** ... 9 to 11 bits, selected by pins 11, 12 and 13

**Data Electrical Inputs** ... Two inputs, selected by pin 5 to either a 20 mA current loop or an RS-232-C input (mutually exclusive, can therefore accept two logic-gatable data sources).

**Data Coding Levels** ... (Applies only to data; on the I/O connection chart, controls that are low true, electrically more negative, are barred).

	Current Loop	RS-232-C
"1" (MARK)	20mA nominal (15 to 25mA)	-3 to -15V
"0" (SPACE)	0mA nominal (0 to 1mA) 2.6 to 2.8V drop on "1" further isolation: 300 Vrms, 100 Megohms, min.	+3 to +15V Refer to EIA spec. for further information

**TTL INPUT/OUTPUT CONNECTIONS**

**Logic Levels** ... All connections are compatible with DTL/TTL and TTL-LS levels. CMOS 4049 buffers may also be used. Outputs can drive 2 TTL loads, min.

	VOLTAGE LEVELS	POS. TRUE CODING
INPUTS	0 ≤ "LO" ≤ +0.8V	Logic "0" or False
	+2.0V ≤ "HI" ≤ +5.0V	Logic "1" or True
OUTPUTS	0 ≤ "LO" ≤ +0.4V	Logic "0" or False
	+2.4V ≤ "HI" ≤ +5.0V	Logic "1" or True

All logic inputs include internal pullup resistors and may be floated for the positive level. All inputs are level sensitive; risetime is not critical.

**CONTROL INPUTS**

**Auxiliary Print Input (Pin 25)** ... Falling edge prints characters stored in line buffer and advances paper one line. Pulse

width 20 μS min, 600 mS max. The column address is then re-indexed to column 1. Caution: This line is momentarily grounded through a diode drop when the front panel Paper Feed switch is activated. Use open collector TTL or 150Ω max. in series if driving Print from totem-pole TTL. Holding Print LO acts as a remote Paper Feed after printing one line.

**Print Direction Text/Lister In (Pin 14)**

In the Lister Mode, characters appear non-inverted, viewed at the front panel. The last line printed is at the top of the record. Tie to ground for Lister mode.

In the Text Mode, characters appear inverted viewed at the front panel. The last line printed is at the bottom of the upright text (nearest the panel). This format is compatible with normal text such as from a teletypewriter. Print direction must be set before loading line buffer. Float pin for Text mode.

**Single Character Printing In (Pin 15)**

With this input floated, normal printing occurs after storing one character line in the buffer. With this input grounded, single character-by-character printing occurs, as in keyboard echo applications. Paper will retract into the printer, imprint one character in the next available column and return for viewing. The PRINT Input is not used. This mode does not set Busy, therefore the user must not overrun the input register.

**Current Loop/RS-232-C Select Input (Pin 5)**

This input logically enables either the 20 mA loop data input (pin 5 floated) or the RS-232-C data input (pin 5 grounded). Both data inputs may remain simultaneously connected so that selectable 2-channel operation is possible.

**Tall Characters Select Input (Pins 8, 9)**

	PIN 8	PIN 9
TALL CHARACTERS ONLY	FLOAT	FLOAT
NORMAL CHARACTERS ONLY	GROUND	FLOAT
TALL ASCII SO	GROUND	GROUND
NORMAL ASCII SI		

(Note: This is *not* upper/lower case selection, which is always available by appropriate character code in either TALL or normal modes) Tall and normal characters may be mixed on the same line. Tall characters may not be printed in the Single Character mode. Printing rate with TALL characters is 1 line/second. TALL characters are 0.165" (4.2mm) high.

**Baud Rate Select Inputs** ... See table on page 151S  
Pin 21 22 23 24  
(MSB) (LSB)



Specifications, Continued

CONTROL OUTPUTS

Baud Rate Select

BAUD	OCTAL	BAUD	OCTAL	BAUD	OCTAL
50	02	150	16	1200	13
75	03	200	05	1800	12
110	17	300	15	2400	07
134.5	04	600	00	4800	11
				9600	10

Character Format Select	START	DATA	STOP	TOTAL	OCTAL IN
Inputs	1	7	1	9 Bits	2
(Pins 13, (MSB), 12, 11 (LSB))	1	7	2	10 Bits	3
	1	8	1	10 Bits	6
	1	8	2	11 Bits	7

**Input Register Full Output (Pin 2)**

Periodic negative-going 25 microsecond pulse every 93 microseconds, starting after 20 printable characters are loaded into the data register. This FULL pulse train is halted by a PRINT command or by Backspace entries.

**Data Terminal Ready Output (Pin 20)**

This Ready/Busy output is RS-232-C compatible and goes low (-3V to -15V) after a Carriage Return (CR) is transmitted and returns high (+3V to +15V) approximately 750 milliseconds later after the printing and line advance cycle. Since data cannot be accepted during this 750 millisecond period, the data source must completely stop data transmission after the CR or pad NUL characters until the

Ready level reappears. Since most data transmitter UART's require a finite time to respond to the Busy and stop transmission, 2 NUL characters should always automatically be sent after the CR.

**End of Paper (pin 16)**

A switch closes to ground when the paper is within 10 feet of exhaustion. An external 1 Kilohm pullup resistor to +5V is suggested for logic compatibility. The printer is disabled when the switch closes.

**Connector**

Type DB25P mounted on rear panel with two 4-40 threaded retainers. A mating DB-25S (Datel P/N 58-2079130) and strain relief hood (Datel P/N 58-2083065) are supplied.

**OPERATING MODE CHART**

Modes may be either simultaneously compatible (Y = YES) or mutually exclusive (N = NO) NA = Does Not Apply

	SINGLE CHARACTER PRINTING	TALL CHARACTERS	HORIZ TAB	BACKSPACE	FORM FEED
Tall Characters	N				
Horiz Tab	Y	Y			
Backspace	N	Y	NA		
Form Feed	Y	Y	NA	NA	
Text (Inverted) Printing	Y	Y	Y	N	Y

Data-Coded Functions

NAME**	ASCII MNEMONIC	INPUT DATA CODES		RESPONSE
		HEXADECIMAL	OCTAL	
Backspace	BS	88	210	Decrements the input register column address and deletes entry as it goes. Backspacing is not allowed with single character printing.
Horizontal Tab	HT	89	211	Advance column address to columns 4,9,15 in turn. This may be used to arrange tables or vertical printout columns such as CH      TIME      DATE      DATA 99      0900      04/05      123456
Line Feed*	LF	8A	212	Advances one line of paper. Data entry is disabled until finished.
Form Feed*	FF	8C	214	Advances 11 lines of paper (2.2"-56 mm) to separate adjacent records
Carriage Return*	CR	8D	215	Carriage Return is the normal ASCII software print command. CR will cause printing of one line stored in the input data register, automatically advances one line, clears the register and indexes the column address counter to column 1. CR must always be followed automatically with 2 NUL's to allow time for the data source to respond to Busy by completely halting data transmission during the 750 mS printing and advance cycle.
Null	NUL	00 or 80	000 or 200	NUL is ignored without incrementing the column address counter.
Shift Out	SO	0E	016	Print TALL characters
Shift In	SI	0F	017	Print Normal Characters

\*2 NUL's must automatically follow any LF, FF or CR character to allow time for the data source to completely halt transmission during the printing and advance cycle.

\*\*All data-coded functions briefly set the Busy Output. 2 NUL's should be automatically sent after the function code to avoid loss of data synchronization.

APP-20A2, E2, J2, D2 INPUT/OUTPUT CONNECTIONS

(SHOWN AS VIEWED FROM REAR OF PRINTER)

PIN	FUNCTION
14	Print Direction, Text/Lister, (Normal/Inverted) (Input)
15	Single Character Printing (Input)
16	End of Paper (Output)
17	20 mA Current Loop IN +
18	20 mA Current Loop IN -
19	No Connection
20	Data Terminal Ready (RS-232-C Output) (Note 1)
21	Bit 3
22	Bit 2
23	Bit 1
24	Bit 0
25	Auxiliary Print (Input)

PIN	FUNCTION
1	Chassis Ground
2	Input Register Full (Output)
3	Received Data (RS-232-C Input)
4	No Connection
5	Current Loop/RS-232-C Select (Input)
6	No Connection
7	Signal Ground
8	Tall Characters Select Input
9	Tall Characters Select Input
10	No Connection
11	Bit 0
12	Bit 1
13	Bit 2

Internal pullup resistors are supplied on all programmable inputs to achieve logic "HI"

**Note:** Many RS-232-C pins are assigned to programmable features. Check sender connector wiring carefully before use!! Barred inputs indicate functions achieved with a logic "LO" (grounded) input.

Tall/Normal Character Selection

Fig. 1

	PIN 8	PIN 9
TALL CHARACTERS ONLY	+5V OR TO PIN 9	+5V OR TO PIN 8
NORMAL CHARACTERS ONLY	N.C. OR GND	N.C. OR +5V
TALL/NORMAL SELECTED BY SHIFT UP/SHIFT DOWN (016/017 OCTAL) (SO/SI)	N.C. OR GND	GND

POWER-ON RESETS TO NORMAL CHARACTERS

Note 1

"Data Terminal Ready" Levels comply with RS-232-C. If desired, the negative excursion can be eliminated by wiring a 1N4148 diode or equivalent from pin 20 (cathode) to ground, pin 7 (anode).

Levels

"1" (MARK)  
"0" (SPACE)

TTY Current Loop

20 mA  
0 mA  
Isolation: 300 Vrms,  
100 Megohms min.

RS-232-C

-3 to -15V  
+3 to +15V  
(Refer to EIA spec.  
for further information)

H = FLOAT OR +5V  
L = GND

Note 2

When using the current loop input, the "Data Terminal Ready" output is normally not sensed. Therefore, the user must insure that the APP-20's input data register is not overflowed. This requires that:

1. No more than 20 printable characters are loaded into the data register per line.
2. Printing is initiated using the CR ASCII character.
3. That data transmission is completely halted during the 750 millisecond printout and line advance cycle. Alternatively, the user may pad 750 milliseconds worth of NUL characters before transmitting any more printable data characters.

Note 3

Typical data sequence (one character):

Start Bit = "0"  
Data Bit 0 (LSB)

...

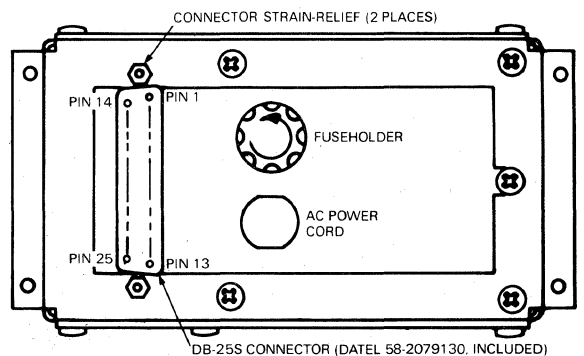
Data Bit 6 (MSB)  
Parity Bit (Ignored)  
Stop Bit = "1"  
Stop Bit = "1"

11 Bits Per Character

Baud Rate Select Table Fig. 3

BAUD	PIN 21 BIT 3	PIN 22 BIT 2	PIN 23 BIT 1	PIN 24 BIT 0	EQUIV. OCTAL
9600	H	L	L	L	10
4800	H	L	L	H	11
2400	L	H	H	H	07
1800	H	L	H	L	12
1200	H	L	H	H	13
600	L	H	H	L	06
300	H	H	L	H	15
200	L	H	L	H	05
150	H	H	H	L	16
134.5	L	H	L	L	04
110	H	H	H	H	17
75	L	L	H	H	03
50	L	L	H	L	02

Rear Panel Connector Pin Locations



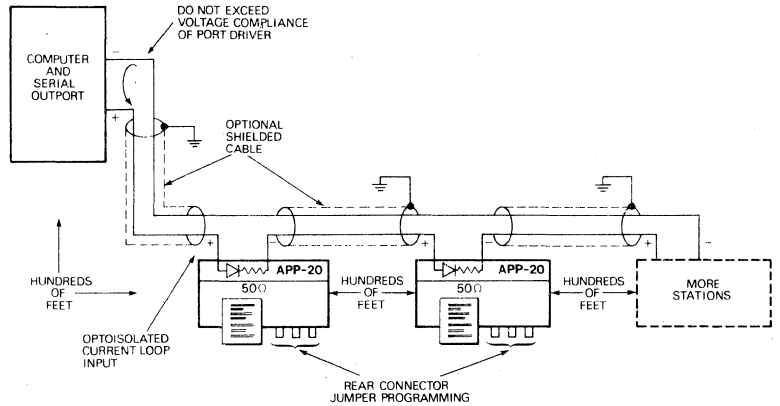
APPLICATIONS

Multiple-Station Applications

Several serial APP-20's can be daisy-chained together using the 20 mA loop to form a multiple-station remote slave terminal network all driven from the same computer port. Examples of this include plant security systems where several stations are linked by APP-20's to give periodic hard-copy printout of plant security status and time of day.

Wiring is non-critical unless very long distances, high electrical noise or high baud rates are involved. These conditions would suggest coax or biaxial cable, line transceivers or repeaters.

Input polarity should be observed (see diagram) as well as the maximum voltage compliance of the computer's loop driver. Each APP-20's optoisolator input drops about 2.6 to 2.8 volts. Be sure the sum of APP-20 isolator drops does not exceed the loop driver compliance.



Paper Loading

The paper roll is reloaded by removing the front panel print mechanism assembly from the housing and electronics section which remains captive to the user's panel. Proceed as follows:

1. Shut off power to the printer.
2. Slide out the printer mechanism by first loosening the front panel thumbscrew 1/4 turn counter clockwise until it stops. Slide the whole front panel assembly straight out by pulling firmly on the thumbscrew, to release the internal PCB connection.
3. Remove the previous paper roll by depressing the thermal printhead on top to release any remaining paper. Grasp both ends of the paper roll axle with the fingertips and pull straight up out of the printer assembly past the circular axle retaining spring. **DO NOT DISCARD THE AXLE!!!**
4. Insert the axle into the new roll of paper and reverse the above procedure, sliding the new roll and axle into the axle slot past the retaining spring. Be sure that the edge of the paper feeds forward, passing over the top of the roll. Only the outside paper surface is coated for printing.

Note: Paper is supplied only in boxes of ten rolls. Reorder box number 58-9374-1.

5. Again lift the printhead away from the rubber drive roller by depressing the head assembly at the rear near the paper roll. Thread the paper under the head until it appears out through the front panel slot.
6. Reassemble the front panel print mechanism into the electronics housing by pushing firmly into the housing to seat the internal PCB connection. Rotate the thumbscrew 1/4 clockwise and test the printer advance switch for proper operation. Paper may also be advanced manually by simply pulling out of the front slot.

Data Format and Character Length Select

Description	Character Format	Pin Connections**			Octal								
		(Bit 2) (Pin 13)	(Bit 1) (Pin 12)	(Bit 0) (Pin 11)									
7 DATA, 1 STOP (9 BITS/CHAR.)	<table border="1" style="display: inline-table;"> <tr> <td>0</td> <td>7 DATA BITS</td> <td>1</td> </tr> <tr> <td>1 START BIT LSB</td> <td></td> <td>MSB 1 STOP BIT</td> </tr> </table>	0	7 DATA BITS	1	1 START BIT LSB		MSB 1 STOP BIT	GND	FLOAT	GND	2		
0	7 DATA BITS	1											
1 START BIT LSB		MSB 1 STOP BIT											
7 DATA, 2 STOPS (10 BITS/CHAR.)	<table border="1" style="display: inline-table;"> <tr> <td>0</td> <td>7 DATA BITS</td> <td>11</td> </tr> <tr> <td>1 START BIT LSB</td> <td></td> <td>MSB 2 STOP BITS</td> </tr> </table>	0	7 DATA BITS	11	1 START BIT LSB		MSB 2 STOP BITS	GND	FLOAT	FLOAT	3		
0	7 DATA BITS	11											
1 START BIT LSB		MSB 2 STOP BITS											
8 DATA, 1 STOP (10 BITS/CHAR.)	<table border="1" style="display: inline-table;"> <tr> <td>0</td> <td>7 DATA BITS</td> <td>X</td> <td>1</td> </tr> <tr> <td>1 START BIT LSB</td> <td></td> <td>MSB PARITY OR USER-ASSIGNED*</td> <td>1 STOP BIT</td> </tr> </table>	0	7 DATA BITS	X	1	1 START BIT LSB		MSB PARITY OR USER-ASSIGNED*	1 STOP BIT	FLOAT	FLOAT	GND	6
0	7 DATA BITS	X	1										
1 START BIT LSB		MSB PARITY OR USER-ASSIGNED*	1 STOP BIT										
8 DATA, 2 STOPS (11 BITS/CHAR.)	<table border="1" style="display: inline-table;"> <tr> <td>0</td> <td>7 DATA BITS</td> <td>X</td> <td>11</td> </tr> <tr> <td>1 START BIT LSB</td> <td></td> <td>MSB PARITY OR USER-ASSIGNED*</td> <td>2 STOP BITS</td> </tr> </table>	0	7 DATA BITS	X	11	1 START BIT LSB		MSB PARITY OR USER-ASSIGNED*	2 STOP BITS	FLOAT	FLOAT	FLOAT	7
0	7 DATA BITS	X	11										
1 START BIT LSB		MSB PARITY OR USER-ASSIGNED*	2 STOP BITS										

\*The parity or 8th data bit is ignored by the APP-20.

\*\*Internal pullup resistors are included to establish a logic "1" with no external connection ("Float").

NOTICE

This applications information shows typical suggested circuits to illustrate design examples. Since Datel-Intersil has no control over the selection, mounting, interconnection, fabrication and environmental factors of external apparatus and components to this product, specific performance cannot be warranted. This information is believed to be accurate and reliable. No respon-

sibility is assumed for any errors or omissions. Nor does Datel-Intersil, Inc. assume responsibility for the use of such information or for any infringement of present or future patents or other third party rights resulting from such use. No license is granted by implication or otherwise under any patent, patent rights, or otherwise of Datel-Intersil, Inc. Prices and specifications are subject to change without notice.

APPLICATIONS, CONTINUED

Selection Guidelines

Serial vs. Parallel APP-20 Printers

Both the serial and parallel APP-20 printers are identical in overall performance (characters per line, characters printed, speed, special programmable features, etc.). The parallel APP-20A1, E1 is somewhat cheaper but requires more wiring to connect to a computer and requires a simple parallel port handler program written by the user to work the handshake controls and data inputs. On the other hand, 2-wire connections to the serial APP-20 are simple and work with most any serial computer port and off-the-shelf associated driver software. Most single-board microcomputers include a serial port on the board. A few microcomputers and minicomputers may require an additional board for the serial port. This would increase the total system cost substantially.

Parallel APP-20 For Custom Designs

For users making a custom-designed microprocessor or discrete logic system, the parallel APP-20 will be cheaper since the companion transmitting UART, oscillator and baud rate generator clock circuits, prototyping and board area will not be required. Slightly more custom-written but simple driver software may be needed in ROM for the parallel APP-20.

The serial APP-20 includes an additional serial port UART/ baud generator board inside. OEM's would consider stocking this additional board as a spare part and this would add slightly to maintenance inventory expense.

Conceptually, users find the 2-wire serial APP-20 sheer simplicity to connect to. Most of the additional programmable controls can be ignored (except for the baud rate selection and enabling either the TTY or RS-232-C data inputs) if the user doesn't care to learn to use them. The serial APP-20 user is cautioned that many programmable features are included on the RS-232-C connector so that direct connection to some terminals may not be possible without internally disconnecting lines. There are some software reasons why terminal connections may need modification. See "Interfacing".

Finally, the 20 mA loop serial input can be positioned many hundreds of feet remote from the computer. The parallel APP-20 uses TTL logic levels and if cabling is used much beyond 10 to 25 feet, the user may need special wire, and/or line drivers and receivers.

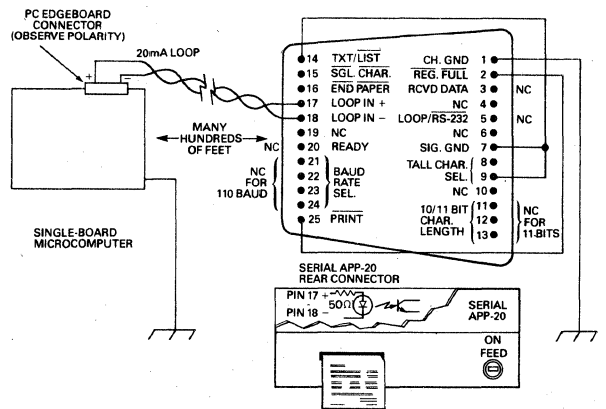
Guidelines on Current Loop or RS-232-C Usage

The serial APP-20 has two separate data inputs (current loop and RS-232-C) which are logic or jumper selectable (using pin 5). Therefore two separate data sources could be connected if desired.

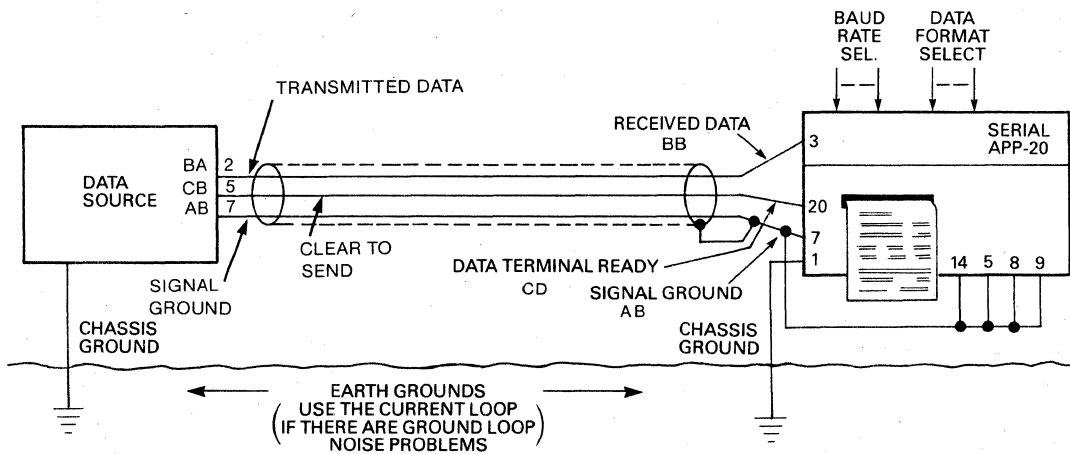
The current loop should be used if there are ground loop problems, if the connecting wire quality is low, for longer distances or for higher common mode noise situations such as an industrial factory. The current loop's optoisolated input should be used where up to several hundred volts separate the printer and data source grounds.

The RS-232-C inputs should be used if the sender data source cannot be made to automatically wait 750 mS between lines of input data. The APP-20's Data Terminal Ready output would halt the sender after each line to allow time for printing.

Typical Current Loop Wiring



Typical RS-232-C Connections



# SERIAL APP-20 INPUT DATA CODING

## BINARY DATA CODING

DATA BITS	DATA BITS 654											
	3	2	1	0	000	001	010	011	100	101	110	111
0 0 0 0					NUL		Space	0	@	P	'	P
0 0 0 1							!	1	A	Q	q	a
0 0 1 0							"	2	B	R	r	b
0 0 1 1							#	3	C	S	s	c
0 1 0 0							\$	4	D	T	t	d
0 1 0 1							%	5	E	U	u	e
0 1 1 0						SO	&	6	F	V	v	f
0 1 1 1					SI		'	7	G	W	w	g
1 0 0 0	BS						(	8	H	X	x	h
1 0 0 1	HT						)	9	I	Y	y	i
1 0 1 0	LF						*	A	J	Z	z	j
1 0 1 1							+	B	K	[	{	k
1 1 0 0	FF						,	C	L	\		l
1 1 0 1	CR						·	D	M	^	~	m
1 1 1 0							/	E	N	_		n
1 1 1 1							/	O			o	DEL

## AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE (ASCII) CODING PER ANSI X3.4-1977 SPECIFICATIONS

MNEMONIC	MEANING
NUL	Null is ignored and the column address does not increment. Unused data codes are considered a NUL and are ignored.
BS	Backspace: Decrement column address and delete entry.
HT	Horizontal Tab: Jumps column address to 4, 9, 15 in sequence.
LF	Line Feed: Advance one line, no print, no change of input register.
FF	Form Feed: Advance 11 lines.
CR	Carriage Return: Software print command
SO	Print TALL characters
SI	Print normal characters

## ASCII HEXADECIMAL AND OCTAL CODING

CHARACTER	NOTES	HEXADECIMAL (4 BITS)	OCTAL (3 BITS)	PARITY
Space	Blank	20	040	Odd
!		21	041	Even
"		22	042	Even
#		23	043	Odd
\$		24	044	Even
%		25	045	Odd
&	Ampersand	26	046	Odd
'	Apostrophe	27	047	Even
(		28	050	Even
)		29	051	Odd
*		2A	052	Odd
+		2B	053	Even
,	Comma	2C	054	Odd
·	Minus	2D	055	Even
/		2E	056	Even
0	Number zero	2F	057	Odd
1	Number one	30	060	Even
2		31	061	Odd
3		32	062	Odd
4		33	063	Even
5		34	064	Odd
6		35	065	Even
7		36	066	Even
8		37	067	Odd
9		38	070	Odd
:		39	071	Even
;		3A	072	Even
<	Less Than	3B	073	Odd
=		3C	074	Even
>	Greater Than	3D	075	Odd
?		3E	076	Odd
@		3F	077	Even
A		40	100	Odd
B		41	101	Even
C		42	102	Even
D		43	103	Odd
E		44	104	Even
F		45	105	Odd
G		46	106	Odd
H		47	107	Even
I	Letter I	48	110	Even
J		49	111	Odd
K		4A	112	Odd
L		4B	113	Even
M		4C	114	Odd
N		4D	115	Even
O	Letter O	4E	116	Even
		4F	117	Odd

CHARACTER	NOTES	HEXADECIMAL (4 BITS)	OCTAL (3 BITS)	PARITY
P		50	120	Even
Q		51	121	Odd
R		52	122	Odd
S		53	123	Even
T		54	124	Odd
U		55	125	Even
V		56	126	Even
W		57	127	Odd
X		58	130	Odd
Y		59	131	Even
Z		5A	132	Even
[		5B	133	Odd
\		5C	134	Even
]		5D	135	Odd
^		5E	136	Odd
_	Underline	5F	137	Even
`	Accent Grave	60	140	Even
a		61	141	Odd
b		62	142	Odd
c		63	143	Even
d		64	144	Odd
e		65	145	Even
f		66	146	Even
g		67	147	Odd
h		68	150	Odd
i		69	151	Even
j		6A	152	Even
k		6B	153	Odd
l	Letter l	6C	154	Even
m		6D	155	Odd
n		6E	156	Odd
o	Letter o	6F	157	Even
p		70	160	Odd
q		71	161	Even
r		72	162	Even
s		73	163	Odd
t		74	164	Even
u		75	165	Odd
v		76	166	Odd
w		77	167	Even
x		78	170	Even
y		79	171	Odd
z		7A	172	Odd
{		7B	173	Even
		7C	174	Odd
}		7D	175	Even
		7E	176	Even
		7F	177	Odd
	Rubout Pattern			

INTERFACING

Interfacing

Most users will normally connect the serial APP-20 to the serial output port of a mini- or microcomputer. (Be sure to check polarity!) Using a microcomputer or microprocessor-based input immediately satisfies several APP-20 requirements including data timing, character generation and sequencing, since these items can be controlled by programming without having to build additional electronics. For the current loop input at least, this provides literally a 2-wire connection and the printer can be positioned many hundreds of feet away from the sender computer as a remote slave printer using practically any wiring including voice-grade telephone wire, twisted pair, coax, etc. On older minicomputers, sometimes an additional PC board is required for a serial output. On newer microprocessor-based single-board computers, the serial port is included on the board and wiring is made up to the edgeboard connections.

Using the APP-20 in Place of a TTY

Although the APP-20 has a current input and responds to most ASCII characters, it can only be used directly in place of a teletypewriter if the user has direct control over the data source to observe the APP-20's timing requirements and print control, namely allowing sufficient idle time for the APP-20 to print and advance each line. While the APP-20's net printing rate is about 1.2 lines per second or 24 characters per second, the APP-20 still cannot be directly connected to a continuous TTY 10-character per second (110 baud) input. This is because the data input must pause a minimum of 750 milliseconds with each line to allow for printing and line advance. Typical 110 baud common carrier message sources operate almost continuously, line after line and of course, can be up to 80 characters per line.

For most laboratory, analytical instrument, test and measurement systems APP-20 applications, the system designer will have complete control over the printout format and data timing into the APP-20.

When connecting directly to an RS-232-C terminal, the user is cautioned that many programmable features (both inputs and outputs) are included on the APP-20's RS-232-C connector. However, some terminals may use some of these same pins for RS-232-C functions which are not available or not required for the APP-20. It may be necessary to internally disconnect some wires before direct connection to such terminals. Also, CR characters must be sent at least every 20 characters to print the input buffer register contents of the APP-20.

Finally, note that internal pullup resistors are provided on all of the APP-20's programmable inputs. This will automatically cause a "HI", "logic 1" or non-barred function to occur if no external connections are made. Such inputs may be externally controlled by the user's TTL logic if desired

or merely jumpered to ground or left open for LO and HI (barred and unbarred) functions, respectively. Be sure to check the function of each line and whether it is grounded to avoid faulty operation.

APP-20 Timing Considerations

There are three phases to the serial APP-20 operation; idle, data load, and print/advance. During idling, the printer is powered up and is ready to accept serial data. Data may be loaded at any time while idling into the one-line, 20 character line buffer register. Data must be loaded at the pin-selected baud rate. Normally, data is loaded completely in sequence with no interruptions between characters.

DATA SOURCE CONSIDERATIONS

The APP-20 has only a one-line 20 character data buffer. After a C.R. character (print command) is received, the data source must stop sending data during the print cycle (750 mS to print one line).

There are two methods to input data successfully to the Serial APP-20 printer. Both of them allow the APP-20 printer sufficient time to print and advance a line while external data transmission is halted.

Method A

For conventional RS-232-C practice, connect the Data Terminal Ready/Busy output (pin 20) to the "Clear to Send" input at the data source. This control line must be monitored to prevent data transmission when the printer is busy. Also, terminate each line of 20 or less printable characters with a C.R. character (print command) followed by 2 NUL characters. The 2 NUL's act as padding characters to allow time for the data source to stop transmission. "Clear to Send" is RS-232-C circuit CB, pin 5.

Method B

Continuous, unstoppable data (such as that from common carrier teletypewriter information) cannot be accepted at any baud rate.

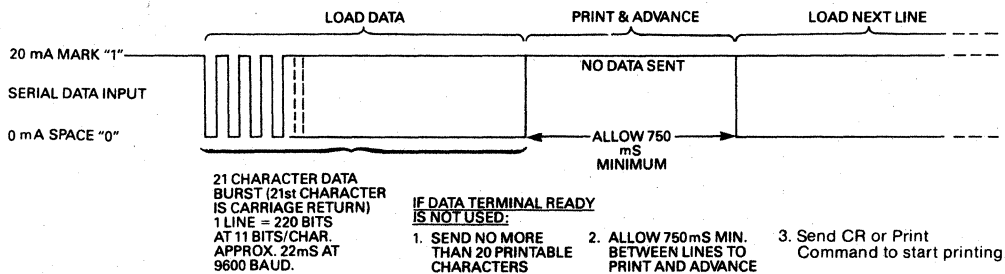
Normally the Data Terminal Ready output stops the data with each CR but if Ready is not used, external 0.8-second wait periods (no data transmitted) may be added after every CR print command to allow printing time. Typical methods using a computer data source include an external 0.8-second hardware timer, or an 0.8-second software timing loop. The hardware timing would normally initiate an interrupt so that the computer would not be tied up polling an input bit.

The 0.8-second wait method is not conventional RS-232-C practice but is very easy to implement, if the user has control over the data source. It is also a true 2-wire interface since Data Terminal Ready is not used.

If the user cannot control the data source, an external user-designed FIFO data buffer should be considered.

2-Wire Current Loop Timing

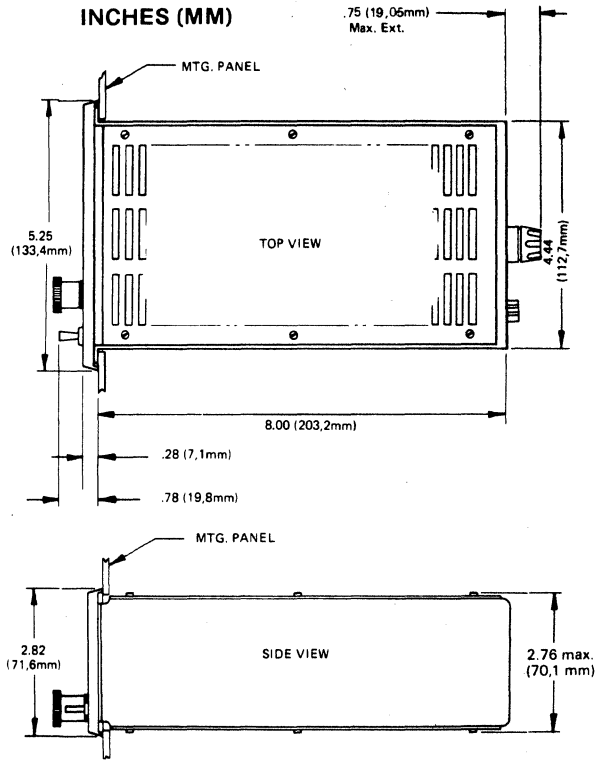
(Data Terminal Ready Output is not used)



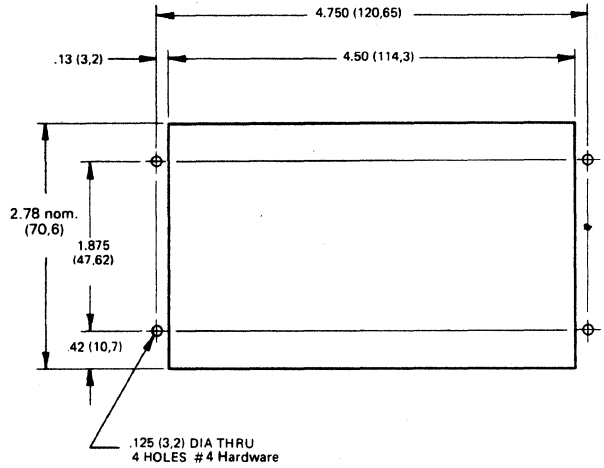
TIMING NOT TO SCALE

**SERIAL APP-20 MECHANICAL INFORMATION**

**OUTLINE DIMENSIONS  
INCHES (MM)**

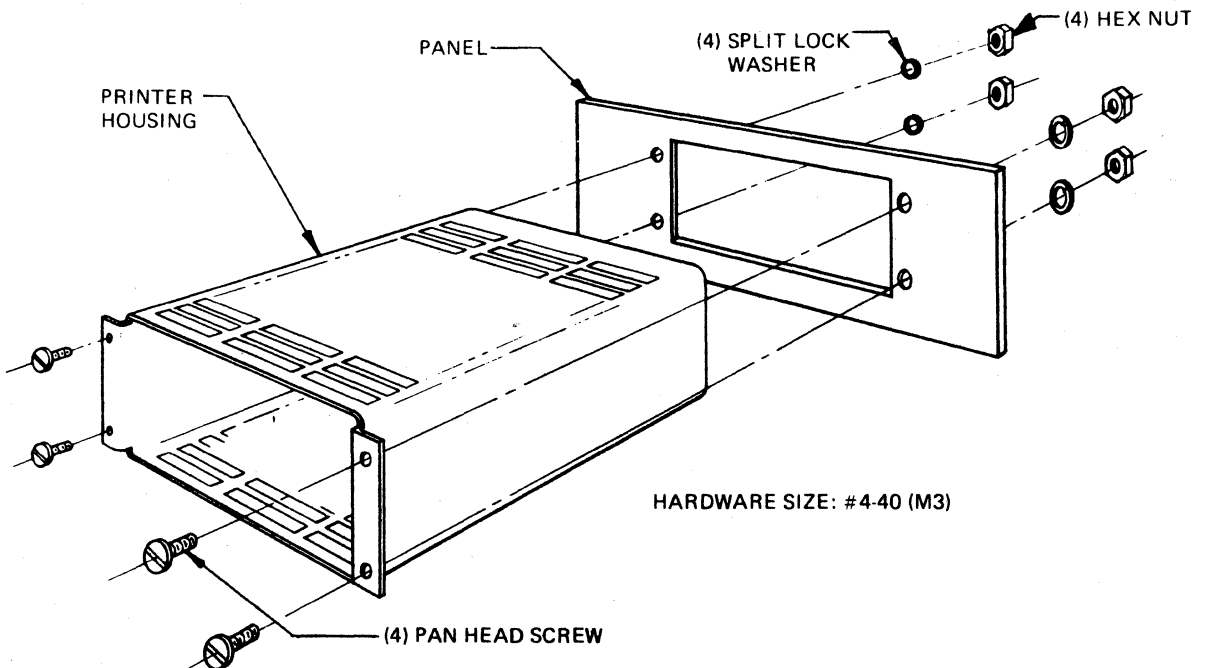


**PANEL CUTOUT**



NOTE:  
TOLERANCE: .XX ± .01 (0,25)  
.XXX ± .005 (0,10)

**MOUNTING DETAILS**



# CDPP-Q7, CAPP-20 Series Thermal Printer Instrument Housings

## FEATURES

- ▶ Uses Datel's miniature 7-column and 20 column thermal printers.
- ▶ Benchtop case with tilt-up stand includes line cord and switch.
- ▶ Additional internal space and front panel area for user's circuit cards, displays, or controls.
- ▶ Easily adapted to ½ rack width mountings.

## DESCRIPTION

Datel-Intersil's DPP-Q7 and APP-20 miniature thermal printers are now available mounted in a benchtop instrument housing, models CDPP-Q7 and CAPP-20. This instrument housing is intended for stand-alone use and may be ordered with the appropriate printer installed or as a housing only for users who already have the printer. This housing includes a power switch, fuse, tilt stand, U.S.A. or European detachable line cord and data cable strain relief clamps. Additional internal room and front panel area is left for user-fabricated circuit boards, power supplies, displays or controls.

Since the decimal 7-column DPP-Q7 has the same cutout and outline dimensions as the alphanumeric 20-column APP-20, either printer fits this housing. Both AC and DC-powered printers may be used.

CDPP-Q7 housings include 2 internal PC edgeboard connectors mounted on standoffs to mate to the PC board edge fingers protruding from the rear of the DPP-Q7 series printers. These connectors are mounted to a rear cover plate and cable clamp assembly which is removable by 4 corner screws.

CAPP-20D DC-powered versions include the internal Molex +12 Vdc power connector with spade lug connections for power and chassis ground in place of the AC power cord.

Partial disassembly of the top and rear covers will be required by the user to wire to the supplied data connectors on all models.



## SPECIFICATIONS

- Stand:** ..... Collapsible tilt-stand folds under the housing for level mounting or angled mounting.
- Support:** ..... Four plastic feet provide quiet operation with mar-proof protection.
- Power Switch:** Front panel power switch disconnects all AC or DC power to the printer.
- Rear Panel:** ... 3-prong U.S. or European grounded line cord supplied. Fuse: AGC type, externally serviceable. Cable Clamp Strain Relief: To hold data, control and flag wiring.
- Construction:** Extruded aluminum throughout, case wired to chassis ground.
- Dimensions:** ... 10"L x 4.09"H x 7.37"W (254 x 103,8 x 187,2 mm)
- Weight:** ..... 10 Pounds (4,5 Kg) Printer plus housing  
5 Pounds (2,3 Kg) Housing only, no printer

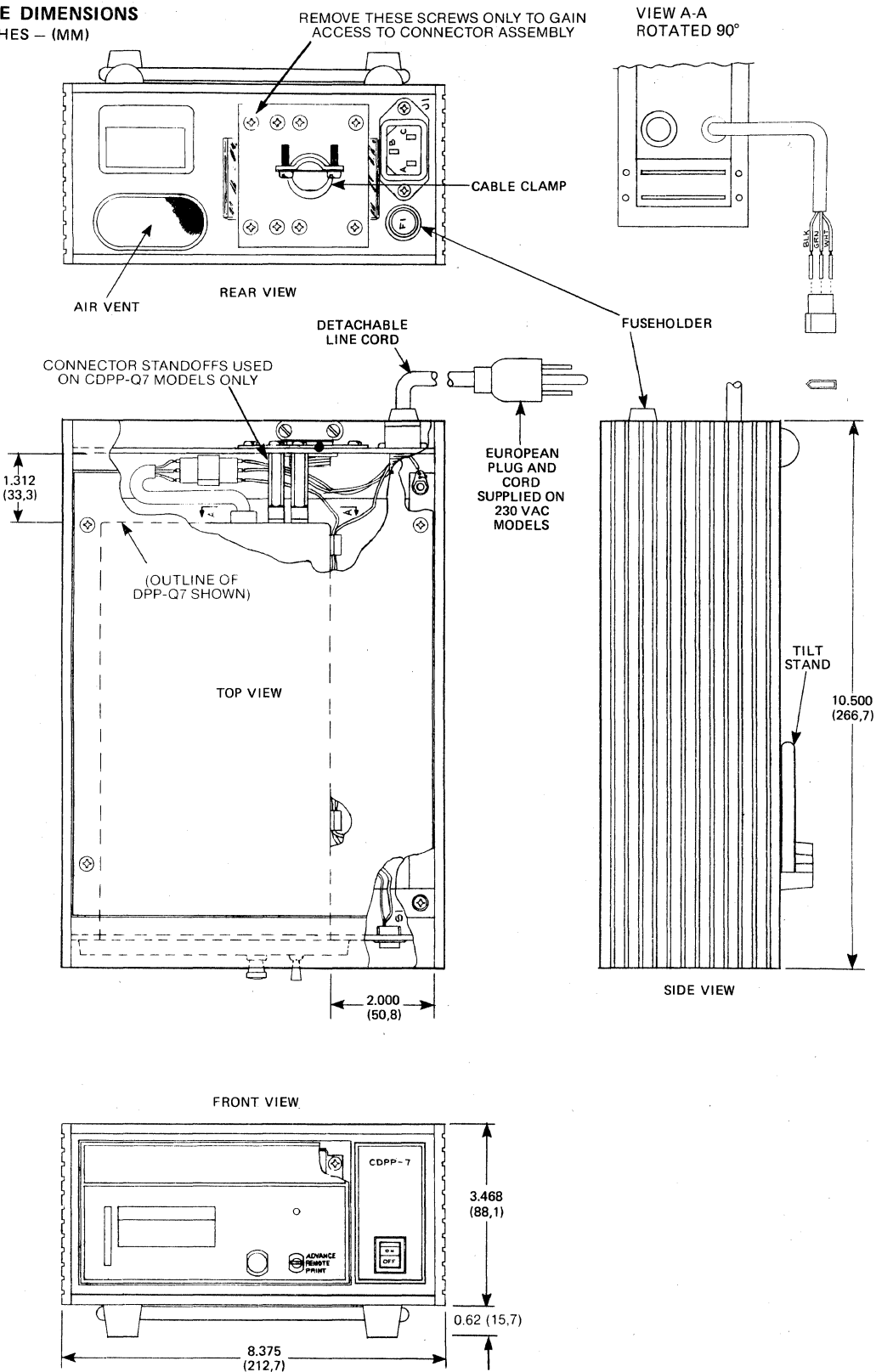
## ORDERING GUIDE

CDPP-Q7X	Housing only for 7-column decimal printer
CDPP-Q7	Housing with 7-column decimal printer installed (specify model type)
CAPP-20X	Housing only for 20-column alphanumeric printer
CAPP-20	Housing with 20-column alphanumeric printer installed (specify model type)

*Refer to the appropriate product literature for full printer specifications*



**OUTLINE DIMENSIONS**  
INCHES - (MM)



Printed in U.S.A. Copyright © 1980 Datel-Intersil, Inc. All rights reserved.



11 CABOT BOULEVARD, MANSFIELD, MA 02048 / TEL. (617)339-9341 / TWX 710-346-1953 / TLX 951340  
 Santa Ana, (714)835-2751, (L.A.) (213)933-7256 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490  
 • Houston, (713)781-8886 • Dallas, TX (214)241-0651 OVERSEAS: DATEL (UK) LTD—TEL: ANDOVER (0264)51055  
 • DATEL SYSTEMS SARL 602-57-11 • DATELEK SYSTEMS GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

**NEW PRODUCT  
PRELIMINARY INFORMATION**  
At presstime, (May 1980) this information  
is believed to be accurate and reliable.  
Please contact Datal-Intersil for the latest  
information and a full product brochure

## APP-48 Panel-Mount 48-Column Alphanumeric Full Serial Thermal Printer

**COMPATIBLE TO:** 20mA TTY and Computer Ports  
RS-232-C CRT Terminals

### FEATURES

- **Complete 48-column panel-mount printer with full serial data electronics and AC power supply built in.**
- **Prints full 96-character, upper and lower case ASCII alphanumerics.**
- **Dot-line thermal printhead, few moving parts for OEM reliability. No ink, no ribbons, no hammers, no mess!**
- **Includes a full second 96-character set of special figures, currency symbols, European punctuation, mathematical operators, Greek letters, etc. Accessed by software (SO/SI) control.**
- **Prints inverted text (like a TTY) under software control (ETX/STX). Last printed line is at bottom of text.**
- **Serial 20 mA TTY optoisolated current loop data input needs only 2 wires to interface. Operates hundreds of feet from data source. Optoisolation rejects common mode noise.**
- **Internal microprocessor includes 1-line, 48-column data buffer.**
- **Includes standard RS-232-C input and D-connector to operate from computer port or CRT terminal, 110 to 9600 baud, switch-selected.**
- **Prints up to 72 lines per minute.**
- **6-pound (2,7 kg) mini-lightweight.**



### DESCRIPTION

Datal-Intersil's APP-48 panel-mount alphanumeric thermal printer highlights half a decade of thermal printer experience and leadership. Beginning in 1975, Datal-Intersil pioneered the concept of including *all* data and power supply electronics *inside* the miniature housing.

The non-moving thermal printhead technology employed today in the APP-48 obsoletes ink printers with their twirling printwheels, banging hammers, and internal mess due to ink ribbons or platens.

THE APP-48 accepts full serial input data which has been formatted into 10 or 11-bit packed ASCII characters, and is driven to either 20 mA loop or RS-232-C data levels. One printable line (up to 48 columns) of input data is stored in an internal input register. Data input is then halted briefly (750 mS) while the APP-48 drives the thermal printhead elements and advances to the next line after printing. The character is formed in a 5 column by 7 row dot matrix on specially-coated, thermally sensitive paper measuring 5 inches (127 mm) wide. Input data may be accepted at switch-selected data rates from 110 to 9600 baud, commonly used with teletypewriters, computer serial I/O ports and data terminals.

The 20 mA current loop data input is optoisolated so that common mode noise is rejected. Also, the APP-48 may be operated at lower baud rates many hundreds of feet from the data source using only voice grade telephone wire.

The RS-232-C inputs include Request To Send and Data Terminal Ready standard control signals to synchronize start-stop data transfer from a remote source. A rear-panel DIP switch set selects the data baud rate, input format and other parameters.

Two software-controlled modes are made possible only by the microprocessor circuit design. A second 96-character

alphanumeric data set is stored in internal memory. This set may be accessed by transmitting the shift out control code (SO) before loading the next character. Shift in (SI) restores the normal 96-character ASCII set. The second set includes special figures, currency symbols, mathematical operators, European punctuation, Greek letters, etc.

The STX/ETX control codes change the mode to inverted printing where the last record is at the bottom of the text when viewed normally. In this mode, the APP-48 may be mounted with its panel horizontal with printout feeding upwards like a teletypewriter. Under software control, lines may be alternated between lister (normal) and text (inverted) print modes.

The print mechanism of the APP-48 consists of a stationary dot-line thermal printhead, software-controlled stepping motor and cogged belt/print roller drive. The lightweight 6 pound (2,7 kg) APP-48 mounts through a 8.40"W x 2.92"H (213,4 x 74,2 mm) front panel cutout with four screws. A 3-prong line plug is captive to the internal AC power supply which is available as 115, 230 or 100 VAC, 47 to 440 Hz. Power consumption is 40 watts, maximum during printing and 12 watts while idling or accepting data. The overall dimensions of the APP-48 are 8.12"W x 2.84"H x 8.32"D (206,3 x 72,2 x 211,3 mm). The operating temperature range is 0 to +50°C and the front bezel measures 9.25"W x 3.25"H x 0.75" thick (235,0 x 82,6 x 19,1 mm).

#### IN THIS DATA SHEET

Introduction, Description	Page 160S
Specifications	Pages 161, 162S
Mechanical Outline Dimensions	
Front panel cutout, rear panel, panel mounting	Page 163S

## CONDENSED PRELIMINARY SPECIFICATIONS, (Typical at +25° C unless noted)

These specifications are subject to change and modification

### PRINTOUT

- Number of Columns** ..... 48
- Characters Printed** ..... 96-character set, upper and lower case ASCII letters, numbers, punctuation per ANSI X3.4-1977 Specification. A second 96-character set is accessible by transmitting the ASCII Shift Out (SO) character. This second set consists of European characters, mathematical symbols, Greek letters, some graphics symbols, monetary symbols and others. The original ANSI X3.4 set is restored using the Shift In (SI) control character.
- Printout Inversion** ..... Character-lines may be printed out inverted with the STX and ETX control characters.  
**(Note: Normal and Inverted Text may not be Intermixed on the Same Line)**
- Printout Format** ..... 5 dot columns by 7 dot row matrix per character
- Printout Color** ..... Blue characters on white paper
- Line Spacing** ..... 0.164 inch (4.2 mm) line to line. Approximately 6 lines per inch
- Vertical Spacing Between Characters** ..... 0.1 inch (2.5 mm)
- Printout Width (48 Columns)** ..... 4.77 inches (121.2 mm)
- Character Size** ..... 0.070"W × 0.110"H (1.8 × 2.8 mm)
- Printing Method** ..... Dot-line, non-impact, inkless ceramic thermal printhead
- Printing Rate** ..... Up to 72 lines per minute (1.2 lines per second) at highest 9600 baud rate, regardless of the number of characters printed per line. The time required to print each line is:  

$$\left[ \frac{\text{char./line} \times \text{bits/char.} + 0.75}{\text{Baud Rate}} \right] \text{ Seconds}$$
- Printing Paper** ..... Thermal paper 5 inches (127 mm) wide × 150 foot (45m) rolls. Supplied only in boxes of 10 rolls. Reorder part no. 32-9469-1. A red warning stripe is displayed on the paper when approximately 10 feet of paper remain.
- Data Capacity** ..... Approx. 11,000 lines in 150 feet usable per roll.
- Printhead Life** ..... 30 million characters typical with random characters and Datel 32-9469-1 paper rolls.
- Mechanism Life** ..... 5000 hours, typical in non-hostile environments.

### INTERFACE

- Interface Type** ..... Full serial asynchronous, either with or without data loading handshake controls.
- Input Data Rate** ..... A rear panel DIP switch set selects one of the following data baud rates:
- |     |      |
|-----|------|
| 110 | 1200 |
| 150 | 2400 |
| 300 | 4800 |
| 600 | 9600 |
- Note:* The external data source must either halt or pad nulls during the 750 mS print and advance cycle. Continuous data cannot be accepted at any baud rate.
- Data Format** ..... Selectable 10 or 11 bits per character, 7 or 8 data bits, odd, even or no parity, 1 or 2 stop bits
- Electrical Data Inputs** ..... Two inputs, EIA RS-232-C or 20 mA teletypewriter current loop on separate pin sets on the rear panel DB-25P data connector. A Request to Send output (RS-232-C circuit CA, pin 4) and Data Terminal Ready output (RS-232-C circuit CD, pin 20) are provided.
- Self Test** ..... An internal rotating 96-character ASCII set may be printed using two external jumpers from pin 25 to pin 7 (ground) and from pin 2 to 3.
- Data Coding Levels** ..... Current Loop\* RS-232-C
- |     |                   |            |
|-----|-------------------|------------|
| "1" | (Mark) 20 mA nom. | -3 to -15V |
| "0" | (Space) 0 mA nom. | +3 to +15V |
- \*10<sup>5</sup> Megohms resistance, 1500 Vdc isolation.

### DATA-CODED FUNCTIONS

Character	Meaning	Hex.	Octal
NUL	Null, ignored	00	000
BS	Backspace, delete previous character <sup>2</sup>	08	010
SO	Shift Out, Maps input data into the 2nd 96-character (non-standard set)	OE	016
SI	Shift In, Reset into standard ASCII data set	OE	016

**Note:** SO and SI may be transmitted before each character. If SO or SI are not sent, printer will remain in last character set status. Power-on reset selects the ASCII character set.

**Note 2:** Backspace decrements the column address counter, loads a space character and leaves column counter decremented. The recommended procedure to clear a line of any length before printing is to load 48 backspaces.

Character	Meaning	Hex.	Octal
STX	Changes to inverted printing (text) mode	02	002
ETX	Changes to normal, non-inverted (lister) printing mode	03	003
<b>Note:</b> STX and ETX must be transmitted before each line and cannot be accepted within a line. If STX and ETX are not sent, the printer will remain in the last mode status. Power-on reset may be DIP-switch selected to automatically start with either the text or lister mode.			
Character	Meaning	Hex.	Octal
HT	Horizontal tab, successively indexes to columns 9, 17, 25 and 33 for data logging or tabular applications	09	011
LF	Line Feed, advances one line, no print, no change of input register	0A	012
FF	Form Feed, advances 11 lines, no register change		
CR	Carriage Return is used to print register contents, clear the register and advance one line. CR requires 750 mS, during which input data cannot be accepted. LF is not required to advance the line. If the sequence CR, LF is sent, LF is ignored.*	0D	015
DEL	Delete, Clear previous character column, load rubout obliteration pattern, and advance column counter to original address. It is not possible to backspace and obliterate previously-printed characters. *A full input register will also automatically start the printing cycle.	7F	177

**FRONT PANEL**

**Power On** ..... Yellow Light Emitting Diode (LED) illuminates when power is applied. Note: Since most users will connect the APP-48 through a master system power on-off switch, there is no separate power on-off switch on the APP-48.

**Feed** ..... Momentary pushbutton switch (Note 1) advances paper as long as it is depressed. (Note 2)

**End of Paper** ..... Red LED illuminates when approx. one inch of paper is remaining and disables further printing until paper is renewed. A red warning stripe appears on paper before the LED illuminates. (Note 2)

Note 1: A line will finish printing if Feed is depressed while executing the print and advance cycle.

Note 2: Feed and End of Paper functions cause Ready to Send to go false to inhibit the data transmitter.

**POWER SUPPLY**

**Model A** ..... 105 to 130 VAC, 47 to 440 Hz.

**Model E** ..... 200 to 250 VAC, 47 to 440 Hz

**Model J** ..... 90 to 110 VAC, 47 to 440 Hz

**Power Consumption** ..... 12 Watts, max., idling  
40 Watts, max., while printing

**Fuses** ..... 115 VAC - 1 Amp  
230 VAC ½ Amp

**PHYSICAL**

**Operating Temperature Range** ..... 0 to +50° C

**Storage Temperature Range** ..... -30° C to +85° C without paper  
Warning: The paper begins to darken after long exposure to +60° C and above.

**Weight** ..... 6 pounds (no paper) (2,7 kg.)

**Paper roll** ..... 0.7 lbs (0,3 kg)

**Outline Dimensions** ..... 8.12"W x 2.84"H x 8.32"D  
(206,25 x 72,14 x 211,33 mm)

**Bezel Dimensions** ..... 9.25"W x 3.25"H x 0.75"Thk  
(235,0 x 82,6 x 19,1 mm)

**Mounting Method** ..... Through a front panel cutout measuring 8.40"W x 2.92"H (213,4 x 74,2 mm). 4 #8 mounting bolts and hardware are required.

**Mounting Position** ..... Horizontal (Panel Mount) or Vertical (with panel facing upwards)

**Acceleration (Non-operating)** ..... Within ±5G, 0 to 50 Hz, 3 Axes

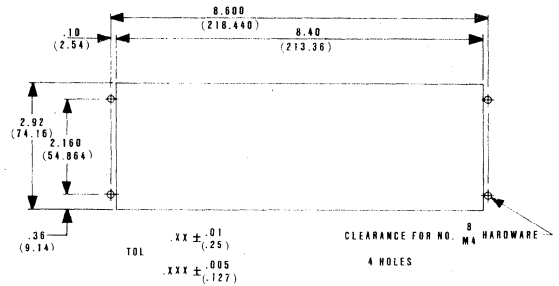
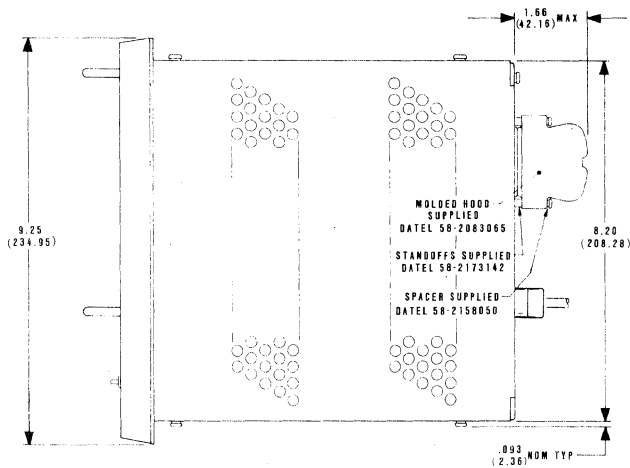
**Relative Humidity** ..... 0 to 90%, non-condensing

**Altitude** ..... 0 to 10,000 feet (3048m)

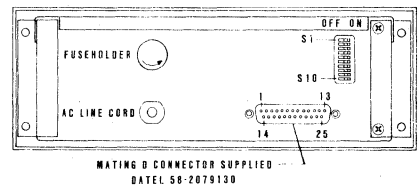
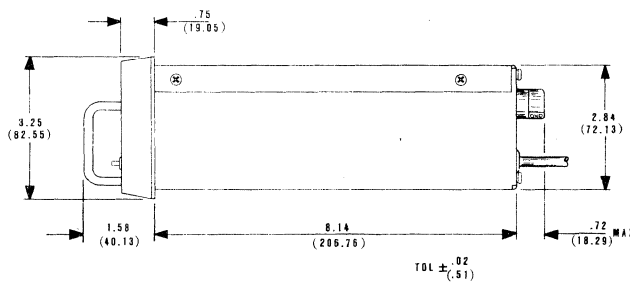
**ORDERING INFORMATION**

MODEL	DESCRIPTION
<b>APP-48A</b>	Printer, 115 VAC, 47-440 Hz
<b>APP-48E</b>	Printer, 230 VAC, 47-440 Hz
<b>APP-48J</b>	Printer, 100 VAC, 47-440 Hz
<b>32-9469-1</b>	Box of 10 thermal paper rolls (150 feet per roll)

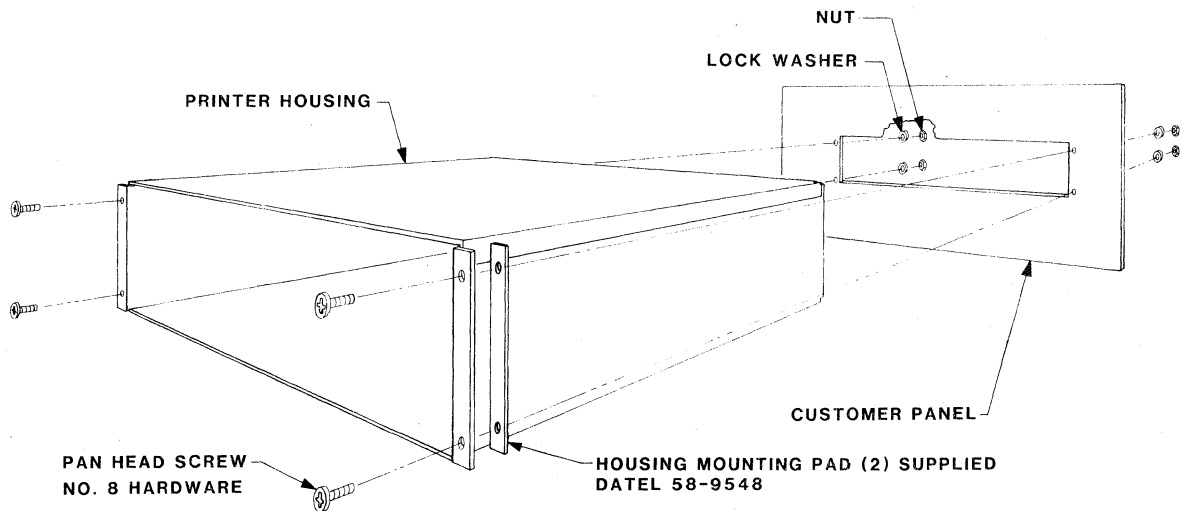
**MECHANICAL DIMENSIONS—INCHES (MM)**



**SUGGESTED MOUNTING DIMENSIONS**



**MOUNTING DETAILS**



Printed in U.S.A. Copyright © 1980 Datel-Intersil, Inc. All rights reserved.



11 CABOT BOULEVARD, MANSFIELD, MA 02048 / TEL. (617)339-9341 / TWX 710-346-1953 / TLX 951340  
 Santa Ana, (714)835-2751, (L.A.) (213)933-7256 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490  
 • Houston, (713)781-8886 • Dallas, TX (214)241-0651 OVERSEAS: DATEL (UK) LTD—TEL: ANDOVER (0264)51055  
 • DATEL SYSTEMS SARL 602-57-11 • DATELEK SYSTEMS GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

# DPP-Q7 Digital Thermal-Numeric Panel Mount Mini-Printer

## FEATURES

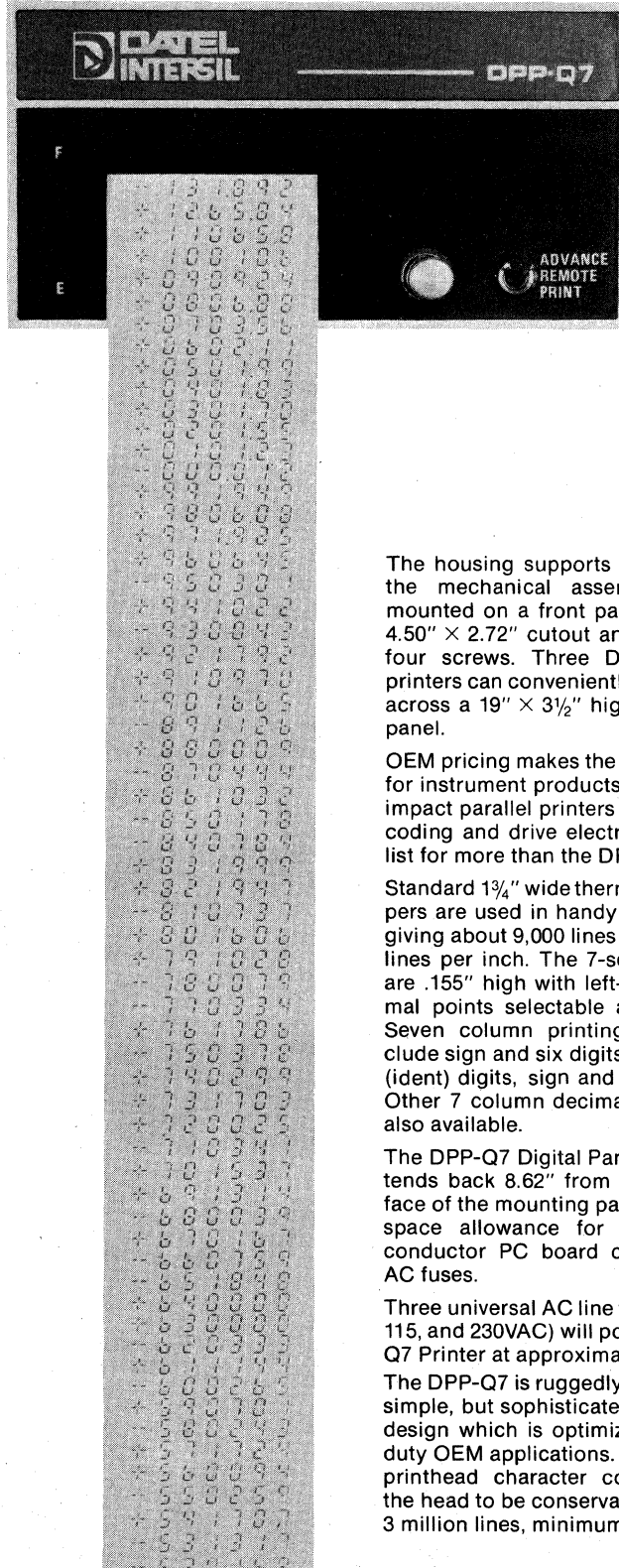
- Thermal Printhead uses no ink, no ribbons and no hammers - Whisper Quiet
- Panel-Mounting Miniature, Featherweight - 4.4 pounds (2 Kilograms)
- Includes all BCD Electronics plus Input Storage Register
- 6 Digits and Sign up to 4 lines per second, Numeric or Hexadecimal
- OEM reliable - only 2 moving parts
- Selectable Positive or Negative True Parallel TTL Inputs
- Selectable dual-voltage 115/230 VAC AC Power
- Generous OEM-quantity discounts

## GENERAL DESCRIPTION

Imagine a low cost 7-column panel-mounting printer just slightly larger than most digital panel meters. Imagine this lightweight, high-reliability digital panel printer installed in your instrument or system front panel. And imagine an inkless, non-impact thermal printing method with only two moving parts which will last for years.

This is Datal's miniature 4 line per second DPP-Q7 thermal panel printer. A no-nonsense, simple to apply, OEM-designed digital output device that weighs in at only 4.4 pounds (2.0 Kg). OEM features are designed in to the DPP-Q7 such as selectable leading zero blanking, selectable positive or negative true coding inputs and choice of 100 to 230 VAC line power. Full parallel TTL input BCD electronics are included as standard.

Other OEM design features include a selection of printout formats, manual print and advance front panel switch, and a low-paper switch output. A unique mounting technique uses an aluminum housing which attaches directly through a front panel cutout. This housing permanently holds the electronics, although the mechanical assembly can be completely removed for paper replacement using a single front panel thumbscrew. As the mechanical assembly is removed, it disconnects from the internal electronics PC board connectors, so that no lethal power voltages are exposed during paper reloading. However, the external PC board connectors at the rear of the case remain connected to the internal electronics.



The housing supports the weight of the mechanical assembly and is mounted on a front panel through a 4.50" x 2.72" cutout and secured by four screws. Three DPP-Q7 panel printers can conveniently be mounted across a 19" x 3 1/2" high rack mount panel.

OEM pricing makes the DPP-Q7 ideal for instrument products. Comparable impact parallel printers with BCD decoding and drive electronics usually list for more than the DPP-Q7.

Standard 1 3/4" wide thermographic papers are used in handy 150 foot rolls giving about 9,000 lines per roll with 5 lines per inch. The 7-segment digits are .155" high with left-of-digit decimal points selectable at each digit. Seven column printing formats include sign and six digits or 2-channel (ident) digits, sign and 4 data digits. Other 7 column decimal formats are also available.

The DPP-Q7 Digital Panel Printer extends back 8.62" from the front surface of the mounting panel, including space allowance for the two 30-conductor PC board connectors of AC fuses.

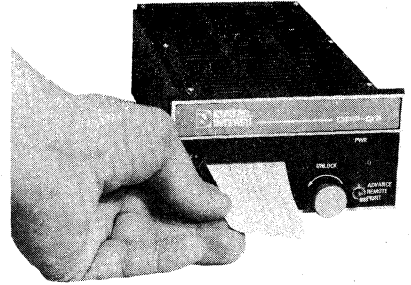
Three universal AC line voltages (100, 115, and 230VAC) will power the DPP-Q7 Printer at approximately 20 watts. The DPP-Q7 is ruggedly built, using a simple, but sophisticated mechanical design which is optimized for heavy duty OEM applications. A proprietary printhead character coating allows the head to be conservatively rated at 3 million lines, minimum.

DPP-Q7 Thermal-Numeric Panel Printer

# HIGHLIGHTS

## 4.4 Pound Panel-Mounting Featherweight

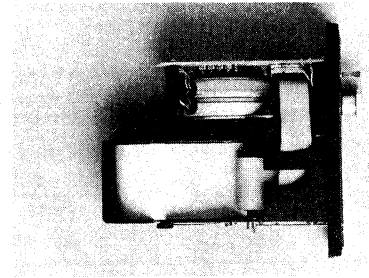
At 4.4 pounds (2.0 kg) the DPP-Q7 is one of the lightest panel-mounted printer available. It is directly compatible with the size, shape and interfacing of Digital Panel Meters.



## OEM Reliable — Only Two Moving Parts

Instead of the usual assembly of noisy ratchets and gears, the DPP-Q7 Digital Panel Printer needs only two long-life moving parts—a brushless digitally-controlled stepping motor and the paper advance roller. There are no banging hammers or twirling printwheels to collect dirt and fail. All electronics use low power Schottky logic, assuring minimal heat rise and long service life.

Components have been generously derated and were selected particularly for their cost-effective OEM reliability. A full one-year warranty provides further assurance of product excellence. An absolute minimum of maintenance is needed. Suggested occasional print-head cleaning can be safely ignored for extended periods because of the wiping action of the paper over the large-area, fully-formed bar segments.

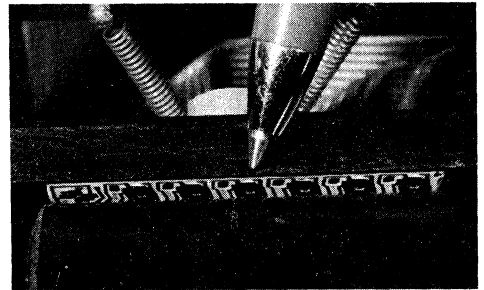


## Complete with Binary Coded Decimal Inputs and Storage Register.

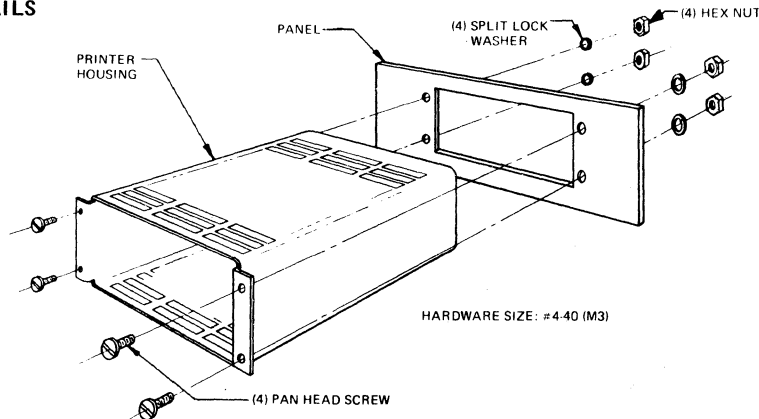
Datel's Miniature DPP-Q7 Printer is complete with BCD electronics. Many competitive printers don't include full parallel BCD or if they do, it is an expensive additional chasses with bulky cabling and unique power requirements. Datel's little DPP-Q7 printer is ready to use and all BCD I/O logic (with selectable positive or negative true TTL coding) is built in. A strobed input storage register allows multiplexing with other I/O devices sharing the same data bus lines.

## Thermal Printhead with Easy-to-Read 7 Segment Digits.

Printing couldn't be simpler. Heat-sensitive thermographic paper is positioned under six decimal digits in 7-segment format. Each digit consists of conductive thickfilm resistor matrix segments deposited on a ceramic substrate. Segment-parallel, digit-serial power pulses are applied to each digit for 25 milliseconds.  $I^2R$  heating then darkens the paper in contact with the heated segments, leaving crisp, black printed digits. A proprietary, thermally conductive surface on the thickfilm elements has high wear resistance allowing a conservative 3 million line print-head life. Characters are formed along the bottom edge of the print-head so they may be viewed immediately after printing.



## MOUNTING DETAILS



# SPECIFICATIONS (TYPICAL @ +25°C UNLESS NOTED)

## General

Number of columns: 7

7-column formats available:

- Leading  $\pm$  sign and 6 decimal digits
- 2 leading ident or channel digits,  $\pm$  sign and 4 data digits

Decimal digit format:

7-segment 0 to 9 digits .155" (4 mm) high with 10° slant and selectable left decimal point.

Printing method:

Thick film thermal print head, black characters on white paper (using 3M Type 161 paper)

Printer paper:

1.75" wide x 150 feet long, (44,5 mm x 45 m), 3M-type 161 thermal paper roll with the thermal surface facing away from the center of the roll.

Paper advance:

Via DC servomotor wormgear and optocoded paper advance roller.

## Performance

Max. printing rate: 4 lines per second

Print and paper advance cycle: 250 milliseconds

Line spacing: 0.2 inch (5 mm)

Line density: 5 lines per inch

Line capacity per paper roll: approx. 9,000 lines

Minimum print head life: 3 million lines

Average print pulse on-time: 25 mSec. (height varied by temperature feedback)

## Inputs

DTL/TTL compatible, selectable positive or negative true, level sensitive. TTLs low power Schottky logic used on all inputs.

Logic Levels:

Positive true:	$+2.0V \leq "1" \leq +5.0V$ $0V \leq "0" \leq +0.5V$	} Note TTLs logic levels
Negative true	$0V \leq "1" \leq +0.5V$ $+2.0V \leq "0" \leq +5.0V$	

Note: Pullup resistors to +5V may be optionally removed on all inputs and outputs.

Data: (24 lines)

Full parallel BCD (1-2-4-8), selectable positive or negative true, 1 TTLs load plus 10 K ohm pullup to +5V. May be used with Form A (normally open) or Form B (normally closed) switch closure inputs. Level sensitive (rise-time non-critical). Data is stored (see timing, pg. 8)

Change Data Polarity: (Pin C1-B11)

Selects input polarity of data, decimal points and  $\pm$  sign simultaneously.

LOW = positive true coding

HIGH = negative true coding

6 TTLs loads, plus 1 K ohm pullup to +5V, level sensitive

Print and Advance Command: (Pin C1-B14)

Level sensitive for Form A or Form B contact closure,

selectable positive or negative true.

1 TTLs load plus 10K ohm pullup to +5V.

Pulse Width: 1 microsecond to 200 mSec (data must be valid 1  $\mu$ sec. after leading edge and 500 nSec. before the print command).

Maximum print command rate: 3 per second.

Paper advance automatically occurs after digit printing. Holding print command TRUE longer than the busy output is true (200 to 250 mSec, typ) causes continuous 4 lines/sec. printing.

Change Print Polarity: (Pin C1-B7)

HIGH = negative true coding

LOW = positive true coding

1 TTLs load, plus 10K ohm pullup to +5V, level sensitive.

Leading Zero Suppress: (Pin C1-B4) blanks all leading zero's to the left of decimal point except a zero just left of the decimal point

HIGH = Leading 0's blanked

LOW = full print (no suppression)

2 Low Power TTL loads, plus 10K ohm pullup to +5V, level sensitive.

Minus Sign: (Pin C1-B1)

Selectable positive or negative true using data level select input.

1 TTLs load, plus 10K ohm pullup to +5V, level sensitive.

Plus Sign: (Pin C1-A5)

(Selectable positive or negative true using change data polarity input). (Minus sign must also be printed since it is used as the horizontal portion of the plus sign).

1 TTLs load, plus 10K ohm pullup to +5V, level sensitive.

Note: Printing "plus" sign only results in vertical portion of plus sign. See above. Usable as 100% overrange digit

Blanked Character:

Created by loading 1-1-1-1 in a given column. Can be hard-wired.

Decimal Points: (6 lines)

1 TTLs load, plus 10K ohm pullup to +5V, level sensitive.

(Selectable positive or negative true using change data polarity inputs).

No-Print Paper Advance: (Pin C1-A3)

Ground this line 5 mSec min to advance one line. Hold to ground for continuous advance at 6.7 lines per second.

1 TTLs load plus 10K ohm pullup to +5V.

No Print Paper Advance:

May also be created by loading the illegal BCD character 1-1-1-1 in all decimal locations, and disabling all decimal points and  $\pm$  signs, then initiating a print/advance command.

Test: (Pin C2-B6)

LOW =  $\pm .8 .8 .8 .8 .8$  printout when print/advance command is given.

1 TTLs load, plus 10K ohm pullup to +5V, level sensitive (2 minutes max. this test, DPP-7)

Change Busy Polarity: (Pin C1-A2)

HIGH = positive true busy out

LOW = negative true busy out

1 TTLs load, plus 10K ohm pullup to +5V, level sensitive.

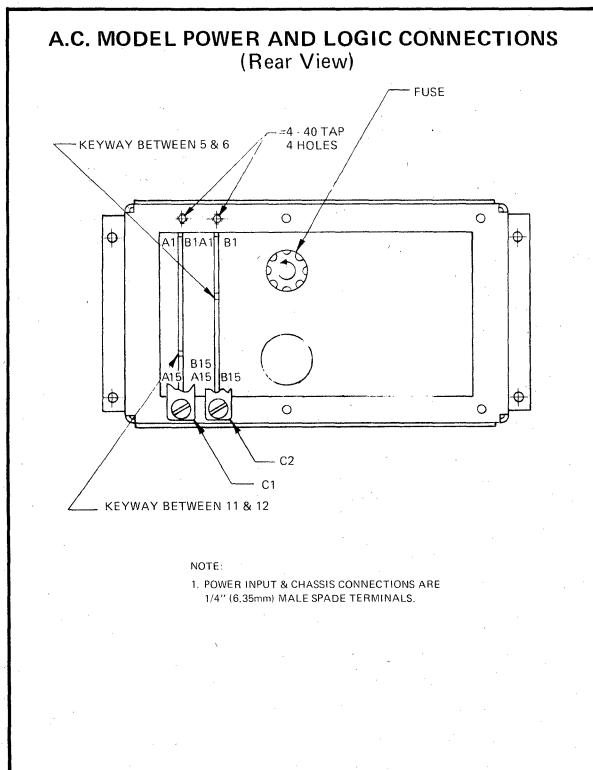
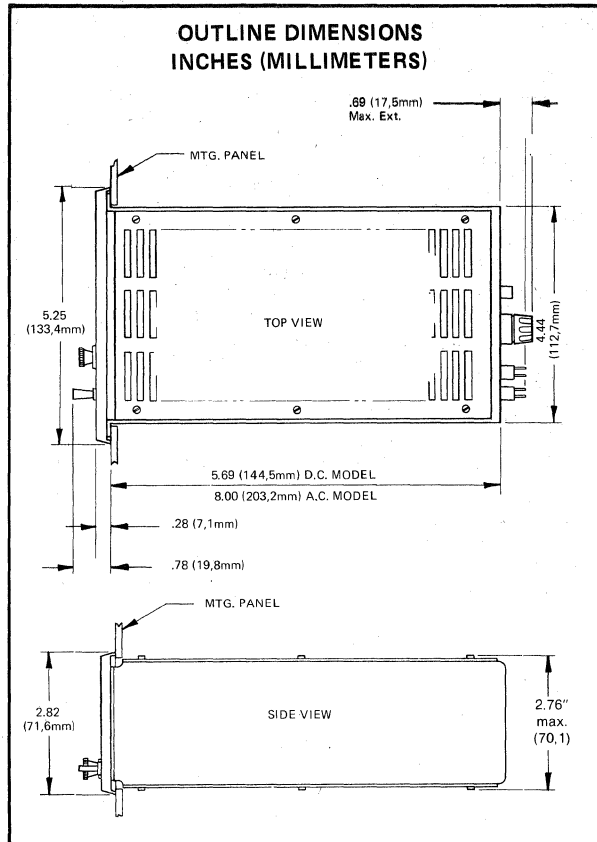
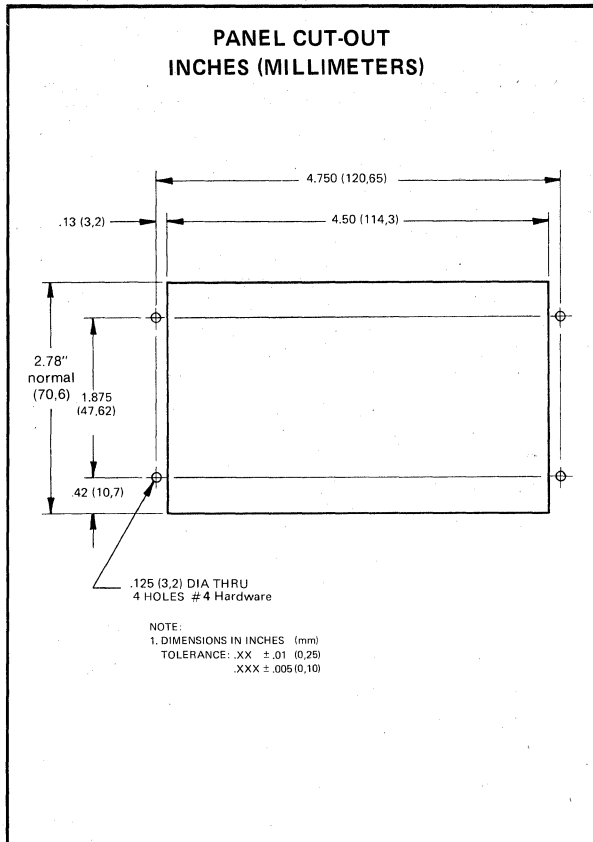
GROUND C1-B11 AND C1-B7 FOR POSITIVE TRUE INPUTS.



# SPECIFICATIONS (continued)

<p><b>Outputs</b></p> <p><b>DTL/TTL compatible</b></p> <p>Positive true: <math>0V \leq "0" \leq +0.4V</math>  <math>+2.4V \leq "1" \leq +5.0V</math></p> <p>Negative true: <math>+2.4V \leq "0" \leq +5.0V</math>  <math>0V \leq "1" \leq +0.4V</math></p> <p><b>Busy: (Pin C2-B12)</b> (Open collector TTL 7438 with 1K ohm pullup to +5V)</p> <p>Remains TRUE during print and advance cycle (approximately 200 to 250 milliseconds). Data inputs may be changed 500 nSec. after transition to TRUE. Next print command can be enabled when busy goes FALSE. Selectable positive or negative true. 10 TTL loads.</p> <p><b>Out of Paper: (Pin C2-B4)</b> see dwg. pg. 10</p> <p>Switch opening via mechanical pawl when approx. 6' (2m) of paper are left on roll. Paper roll visually indicates "low paper" within 10 to 15 feet (3 to 4.5m) of end of roll using red stripe on roll. Switch is in series with PC board contacts which disconnect if printer mechanism is not completely seated in case. Open switch contacts or print mechanism removed will disable both local and remote print command. Pin C2-B4 has an internal 1K ohm pullup to +5V normally grounded by switch before paper is low.</p>	<p><b>Hexadecimal Printout</b></p> <p>Users requiring full alphanumeric printout (upper and lower case letters, numerals, punctuation and special characters) should select Datel's Model APP-20 thermal printer using a 5 x 7 dot matrix character format. Ask for an APP-20 brochure from your nearest Datel office.</p> <p>The DPP-Q7 is also available as an extended numeric printout called hexadecimal which includes 6 extra letters (A through F) beyond the 10 numerals. Hexadecimal code is ideal for machine language instruction and data code printout from microprocessor systems. Because of the 7-segment format, the b and d must be lower case. Also, the 1-1-1-1 code will no longer blank a column, although leading zero suppression may be selected. The type 4 printout (.9.9.9 .9.9.9 decimal or .F.F.F .F.F.F hexadecimal) with a blanked center column is available for two data points printed on the same line.</p> <p><b>Hexadecimal Coding</b></p> <table border="1"> <thead> <tr> <th>Input</th> <th>Printout</th> <th>Input</th> <th>Printout</th> </tr> </thead> <tbody> <tr> <td>0000</td> <td>0</td> <td>1000</td> <td>8</td> </tr> <tr> <td>0001</td> <td>1</td> <td>1001</td> <td>9</td> </tr> <tr> <td>0010</td> <td>2</td> <td>1010</td> <td>A</td> </tr> <tr> <td>0011</td> <td>3</td> <td>1011</td> <td>B</td> </tr> <tr> <td>0100</td> <td>4</td> <td>1100</td> <td>C</td> </tr> <tr> <td>0101</td> <td>5</td> <td>1101</td> <td>D</td> </tr> <tr> <td>0110</td> <td>6</td> <td>1110</td> <td>E</td> </tr> <tr> <td>0111</td> <td>7</td> <td>1111</td> <td>F</td> </tr> </tbody> </table>	Input	Printout	Input	Printout	0000	0	1000	8	0001	1	1001	9	0010	2	1010	A	0011	3	1011	B	0100	4	1100	C	0101	5	1101	D	0110	6	1110	E	0111	7	1111	F
Input	Printout	Input	Printout																																		
0000	0	1000	8																																		
0001	1	1001	9																																		
0010	2	1010	A																																		
0011	3	1011	B																																		
0100	4	1100	C																																		
0101	5	1101	D																																		
0110	6	1110	E																																		
0111	7	1111	F																																		
<p><b>Front Panel</b></p> <p><b>LED red power-on lamp</b></p> <p><b>Paper Quantity Indicator:</b>  Mechanical pointer which rides on paper roll, indicating relative amount of paper left.</p> <p><b>Paper Roll Replacement:</b>  By sliding out front panel printer assembly. PC board interlock automatically disconnects all power to printer assembly and power supply with electronics remain with housing case. Removal by a single Dzus-type front panel thumbscrew.</p> <p><b>Print/Remote/Advance</b>  Front panel 3 position toggle switch, stable in center position (REMOTE), must be held in top (ADVANCE) or bottom (PRINT) positions.</p> <p><b>ADVANCE:</b>  When switch is held up, the printer continuously advances paper without printing at a 6.7 line per second rate.</p> <p><b>REMOTE:</b>  Center position enables all external inputs.</p> <p><b>PRINT:</b>  When switch is pushed down, printer prints one line and stops. After print and advance, external input is accepted even if the switch is held down.</p>	<p><b>Power Supply</b></p> <p><b>AC Version:</b>  105-125 VAC, 47-440Hz @ 40 watts max (10 watts, typ standby)</p> <p><b>May be switch-selected to:</b>  205-240 VAC, 47-440Hz @ 40-watts max (10 watts, typ standby)</p> <p><b>Optional: (J models)</b>  90-110 VAC, 47-440Hz @ 40 watts max (10 watts, typ standby)</p> <p><b>AC Fuse:</b> 1/4" x 1-1/4" Buss MDL or equivalent 1/2 A, SLO-BLO, 115VAC, 1/4A, SLO-BLO, 230 VAC.</p> <p>Note: Case is grounded to AC power ground +5V, 200mA max. logic power out available with AC version.</p> <p><b>Connectors</b></p> <p><b>Data and Controls:</b>  (2)30-conductor (15 per side).  Double-sided PC board connectors.  0.1" centers, Datel# 58-2073083  2 included with printer).</p> <p><b>AC Power</b>  Supplied captive line cord with European or U.S.A. plug.</p>																																				
<p><b>Temperature Ranges</b></p> <p><b>Operating:</b> 0 to +40°C (to +50°C at derated speed)</p> <p><b>Storage:</b> -25°C to +85°C (Paper darkens above +60°C)</p> <p>Active printhead temperature sensor is employed to maintain proper print head temperature at all ambient temperatures and during warmup.</p>	<p><b>Weight (with housing and full paper roll)</b>  4.4 lbs. (2.0 kg)</p> <p><b>Dimensions</b></p> <p>Front panel mounting cutout:  4.50" WIDE x 2.72" HIGH (115 mm x 69 mm)</p> <p>Front panel Bezel dimensions:  5.25" WIDE x 2.82" HIGH (134 mm x 72 mm)</p> <p>Depth behind front surface of mounting panel including clearance for rear PC connectors and fuses:  8.7" (221 mm)</p>																																				

# MECHANICAL DIMENSIONS



### NEW IMPROVED MODEL DPP-Q7

The DPP-Q7 Printer is a pin-for-pin form, fit and function successor to Datal's original DPP-7 Printer introduced in 1975. The DPP-7 was the world's first miniature, panel-mount thermal printer which included all interface electronics and power supplies. While the DPP-Q7 is a direct replacement for the DPP-7, the internal electronics are totally new. Other changes include:

1. The servomotor-wormgear paper advance of the -Q7 is whisper-quiet compared to the solenoid-clutch advance of the -7.
2. Printing speed has improved on the -Q7 to 4 lines per second.
3. The Q7-s wormgear locks the roller so that paper must be advanced using the front panel switch or pin C1-A3.
4. A DC-powered version of the Q7 is not available at this date. however, users may continue to order the 5V-powered DPP-7D with minimum piece orders and scheduled (longer) deliveries. Contact Datal's sales offices for information.  
Users have found that the DC-powered DPP-7D required a separate, large, expensive 5V power supply to handle the 10 Amp current pulses required by the DPP-7D.  
Users with mobile (vehicle) applications will find it more cost-effective to operate the DPP-Q7 from a 12 or 24 Vdc to 115 VAC inverter.
5. The older DPP-7's are available with scheduled (longer) deliveries in minimum quantities for users who must have them.

# INPUT/OUTPUT CONNECTIONS

## DPP-Q7 PRINTER PINOUT

Connector Pinouts Are Shown As Viewed From Rear Of Printer

Connector C1		Connector C2		
A	B	A	B	
1. Dec Pt .0000	Sign "___"	1. BCD 8,000	BCD 800,000	1.
2. Chg. Busy Polarity	Dec Pt .00000	2.	BCD 80,000	2.
3. No Print Advance	Dec Pt .000000	3.		3.
4. Logic & Pwr. Gnd.	Leading Zero Suppress	4.	End of Paper	4.
5. Sign "I"		5.	Logic & Pwr. Gnd.	5.
6. Dec Pt .0	Dec Pt .000	6.	Enable Print Test	6.
7. Dec Pt .00	Chg. Print Polarity	7.	BCD 800	7.
8. BCD 400,000	BCD 80	8. BCD 200,000	BCD 20,000	8.
9. BCD 20	BCD 8	9.		9.
10. BCD 2	BCD 40,000	10.	BCD 2,000	10.
11. BCD 100,000	Chg. Data Polarity	11.	BCD 200	11.
12. BCD 10,000		12.	Busy	12.
13. BCD 40	+5V Logic Power	13. BCD 1,000	+5V Logic Power	13.
14. BCD 400	Print Command	14.	BCD 10	14.
15. BCD 4,000	BCD 4	15. BCD 100	BCD 1	15.

### NOTES

- +5V contacts (C1-B13 & C2-B13) are internally connected
- Ground contacts (C1-A4 & C2-B5) are internally connected
- On AC Models, +5V contacts (C1-B13 & C2-B13) will provide +5V power out at 200mA max.

GROUND C1-B11 AND C1-B7 FOR POSITIVE TRUE INPUTS.

**BCD INPUTS** Binary Coded Decimal inputs are shown cross-referenced to their corresponding connectors and pins.

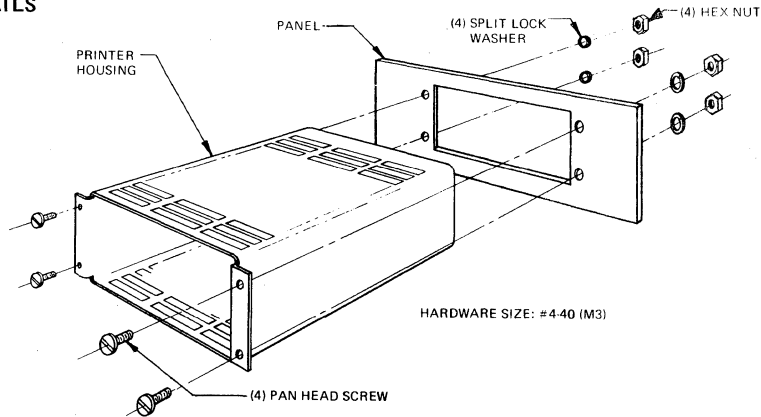
For other print formats (see ordering guide, pg. 12) blanked columns will appear between digits shown.

CONNECTOR	100,000's			10,000's			1,000's			100's			10's			1's			CONNECTOR												
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	8	4		2	1										
C1	A	8	A	11	B	10	B	12	A	15			A	14			B	8	A	13	A	9	B	9	B	15	A	10	C1		
C2	B	1	A	8	B	2	B	8	A	1	B	10	A	13	B	7	B	11	A	15			B	14					B	15	C2

± sign located here on type 2 print format

NOTE: PULLUPS PROVIDED ON ALL LOGIC CONNECTIONS. CHECK RESULTANT CODING ON UNCONNECTED TERMINALS.

### MOUNTING DETAILS



# PAPER LOADING

## HOW TO LOAD PAPER

1. Shut off all power to the printer if the printer uses a separate power switch.
2. Slide out the printer mechanism by first loosening the front panel thumbscrew counterclockwise until it stops. Pull the thumbscrew firmly straight out and the front panel/printer assembly will slide out all the way. Some force may be needed to release the internal PC connection.
3. Raise the paper loading door by pulling forward until it stops. This automatically lifts the thermal printhead from the paper drive roller (see photo). Remove any paper from a previous roll.
4. Pull the remaining paper backward out from under the printhead. Grasp both ends of the paper roll axle with fingertips and pull straight up out of the printer assembly. The axle will slide past the circular axle retaining spring as shown in the photo.

### Inserting new roll

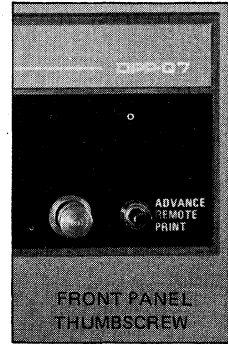
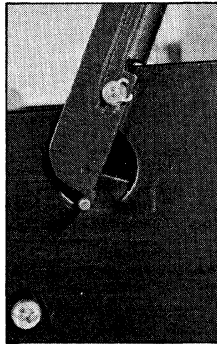
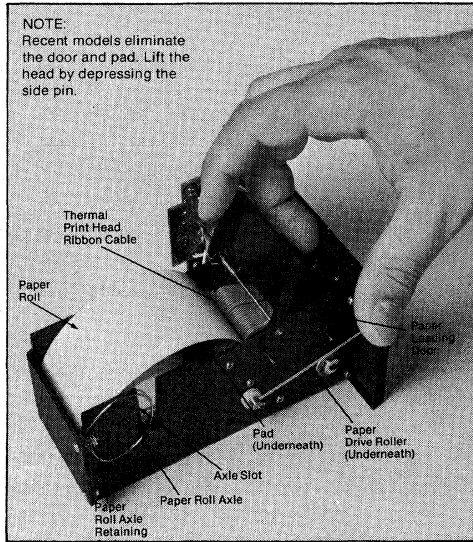
5. Slide the paper roll axle out of the used paper roll and reinsert the axle in a new roll. Do not discard axle!!! The paper roll is Datel part number 9101 supplied only in boxes of ten rolls. Order box number 9114. Spare axles are Datel part number 9062.
6. Slide the new roll and the axle past the retaining spring and insert the paper

over the pad and under the printhead ribbon cable (see photo) until paper appears at front panel slot. Be sure the paper is threaded from the rear and passes over the roll. Paper should be cut straight across for easy insertion. Only the outside paper surface is treated for printing.

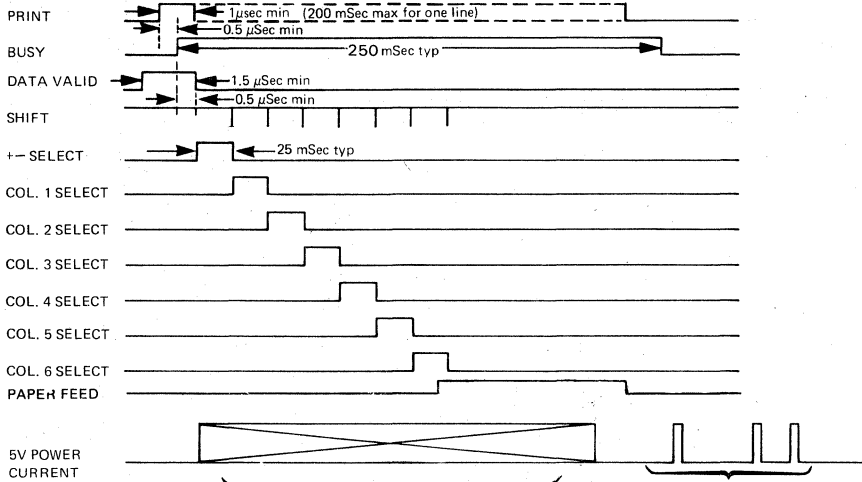
7. Pull paper through front panel slot, close the paper loading door and slide the printer mechanism back into the housing. Press the front panel printer assembly firmly into the housing as far as it will go. This will seat the internal PC board connection.
8. Rotate the thumbscrew clockwise until it stops and turn on power. Paper may be manually advanced simply by pulling out of the front slot.

### Reloading summary:

1. Loosen thumbscrew, pull out mechanism.
2. Lift paper loading door.
3. Lift out used roll and reinsert axle in new roll.
4. Press new roll and axle into axle slot past circular spring.
5. Thread paper over top of roll and under printhead out through front panel slot. Close door.
6. Push mechanism back into housing and retighten thumbscrew.



## TIMING DIAGRAM



Note: Valid data required 500n Sec min before print command

(DPP-7D only)

Random 8 Amps max. current pulses during printing have 10% to 90% duty cycle depending on leading zeroes, decimal points, sign, digits printed, and ambient operating temperature.

Random 8 Amp 5 to 20mSec wide current pulses occur several times per second in standby

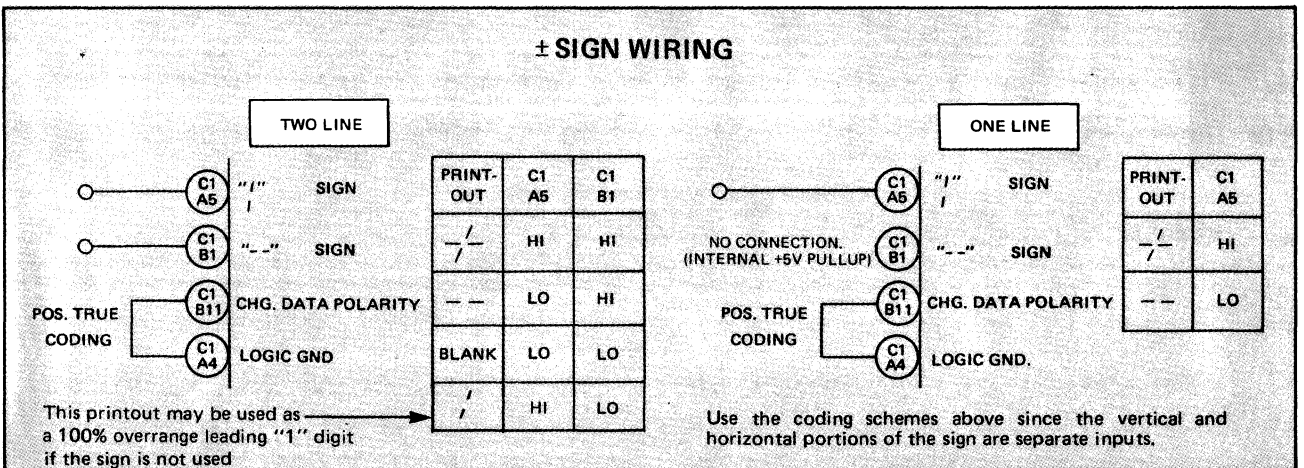
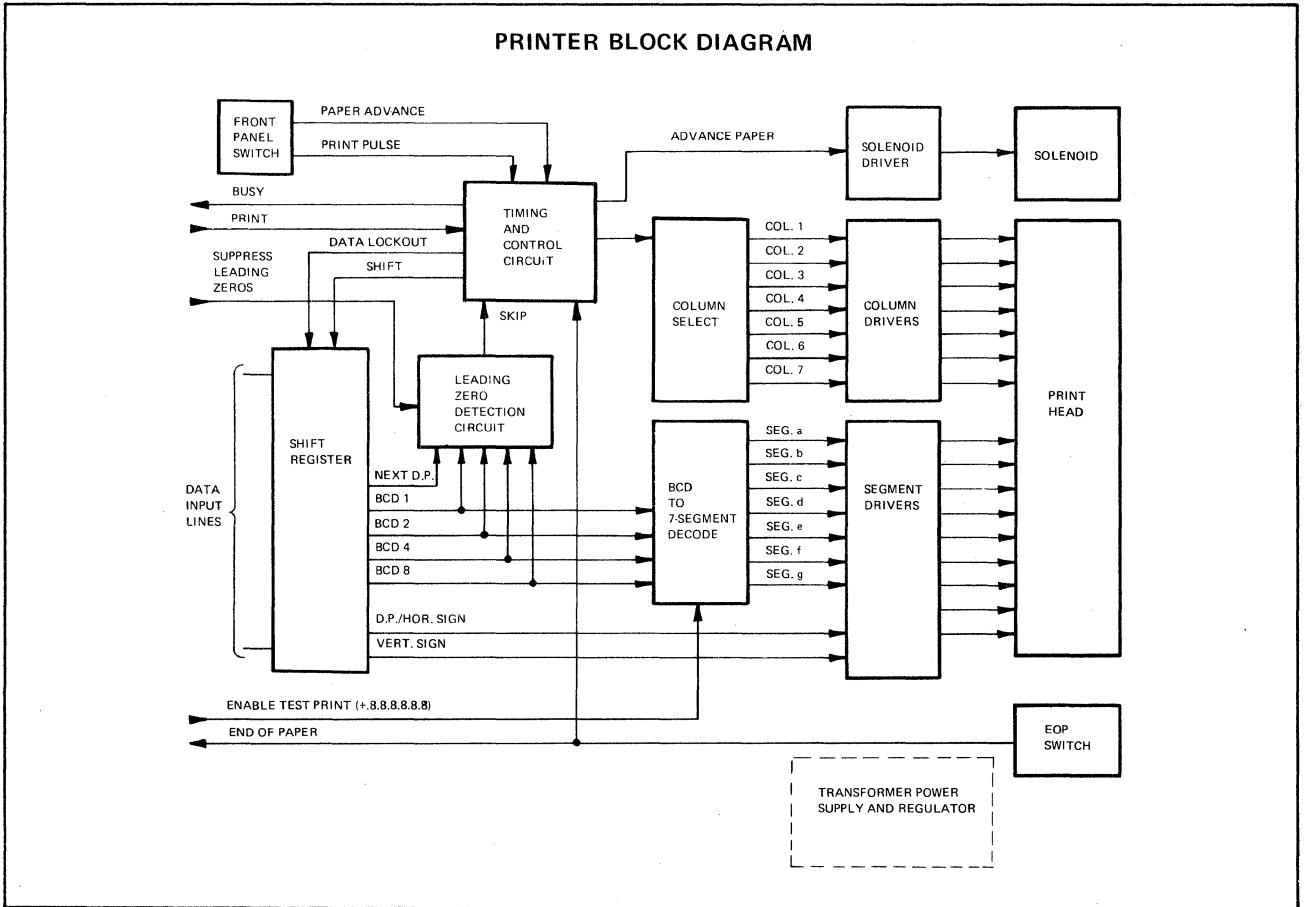
# APPLICATIONS

An ideal use for the DPP-Q7 is to record analog values from a BCD output A/D converter or Digital Panel Meter. A simple external clock circuit or an A/D converter with an adjustable conversion rate can be used to form a printing data logger. With the addition of Datel's digital time-of-day clock and data acquisition module, a complete multi-channel logging system can be made.

Most scientific and analytical instruments with digital interfacing capability will have full parallel BCD outputs which can be directly connected to the DPP-Q7.

Use the DPP-Q7 with Datel's autoranging DM-2000AR Digital Panel Meter to create an analog sampling system with 3-1/2 digit resolution over 3 decades from 200mV to 20V full scale.

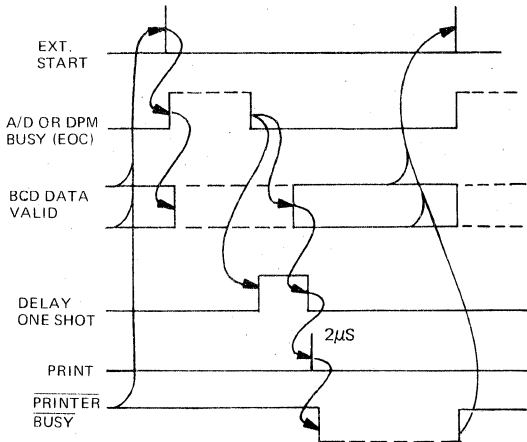
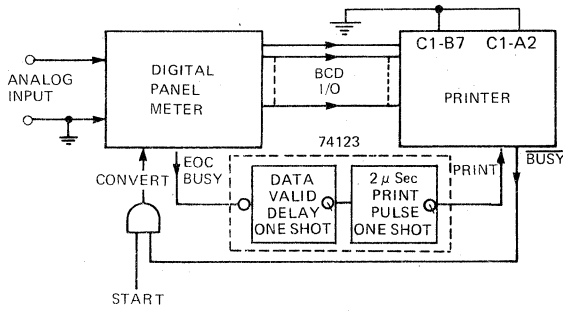
Using the DPP-Q7 printer with a DPM will allow faster sampling than taking readings by hand or by visual sampling of the DPM readout. Longer-term variations and drifts are more easily viewed when the printer and DPM work hand-in-hand.



## BCD Source to Printer Block Diagram

When used with a Digital Panel Meter or A/D converter with BCD output, the interconnections with the Printer are made as shown here. The converter or DPM's output connects to the printer input. The EOC (Busy) output generates a print pulse using a monostable and a system gate inhibits further conversions until the print and advance are completed.

A basic interface of this type is detailed in the circuit on page 11. More logic may be required if any coding is inverted although this may be accommodated by the selectable coding feature of the DPP-Q7. Some types of conversion systems might require time-synchronous levels and would need more circuitry than shown here. Important circuit details have been omitted for clarity.

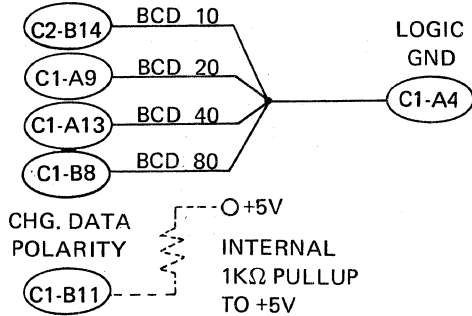


## BLANKED COLUMNS

Many applications require one or more columns to be blanked. For example, if a printout is needed which displays a 4-digit data value with sign and then a 0 to 9 channel identification digit, the printout would be:

±9999 9

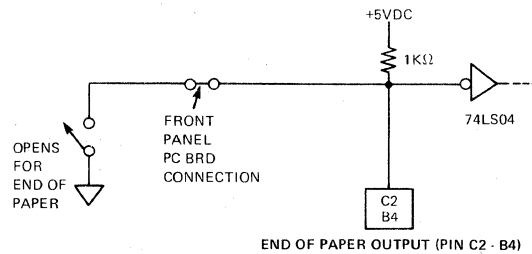
In order to continually blank the second column, the illegal BCD digit 1-1-1-1 is hard-wired as follows. The typical example shown here assumes negative true coding:



The data is negative true because pin C1-B11 is floated and the internal pullup resistor to +5V automatically causes negative true data coding. Other columns can be blanked in a similar manner. With positive true coding (C1-B11 and C1-B7 grounded), internal pullup resistors on all BCD data inputs will automatically blank all unused columns.

## End of Paper Switch

The end of paper switch is connected in series with a PC board connector as shown. Opening the switch inhibits further print pulses.



## FUSES

**AC Fuses** — are replaced using the fuseholder on the rear panel.

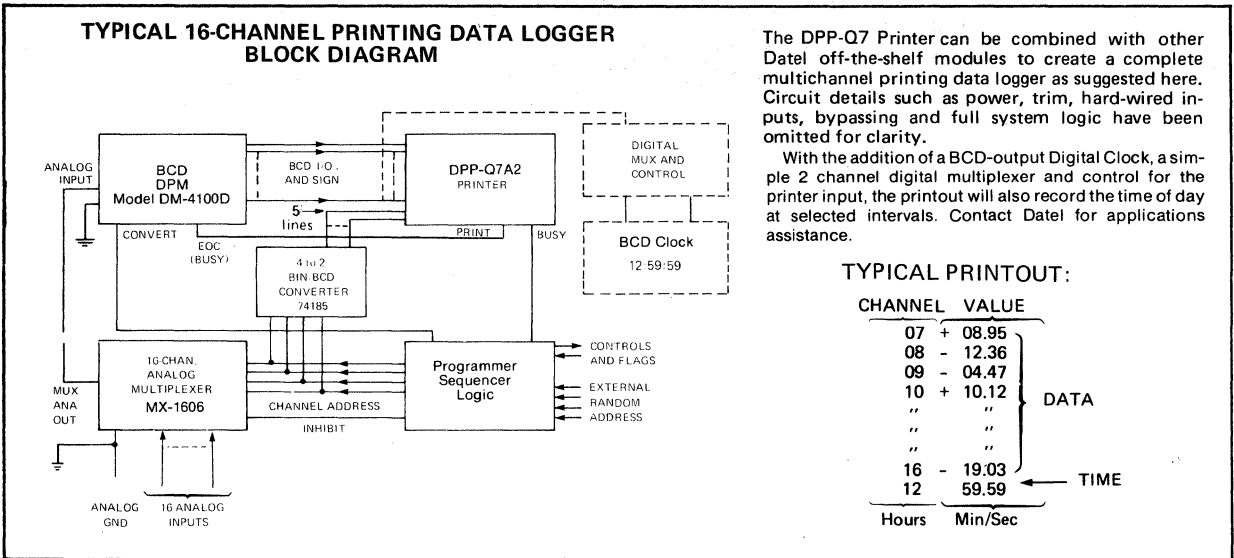
The fuses are:

100 or 115 VAC: 1/2 Amp Buss MDL SLO-BLO  
1/4" x 1-1/4" or equivalent

230 VAC: 1/4 Amp Buss MDL SLO-BLO  
1/4" x 1-1/4" or equivalent

# APPLICATIONS

## TYPICAL 16-CHANNEL PRINTING DATA LOGGER BLOCK DIAGRAM



The DPP-Q7 Printer can be combined with other Datel off-the-shelf modules to create a complete multichannel printing data logger as suggested here. Circuit details such as power, trim, hard-wired inputs, bypassing and full system logic have been omitted for clarity.

With the addition of a BCD-output Digital Clock, a simple 2 channel digital multiplexer and control for the printer input, the printout will also record the time of day at selected intervals. Contact Datel for applications assistance.

### TYPICAL PRINTOUT:

CHANNEL	VALUE	
07	+ 08.95	} DATA
08	- 12.36	
09	- 04.47	
10	+ 10.12	
"	"	
"	"	
16	- 19.03	} TIME
12	59.59	
	Hours	Min/Sec

### APPLICATION EXAMPLE:

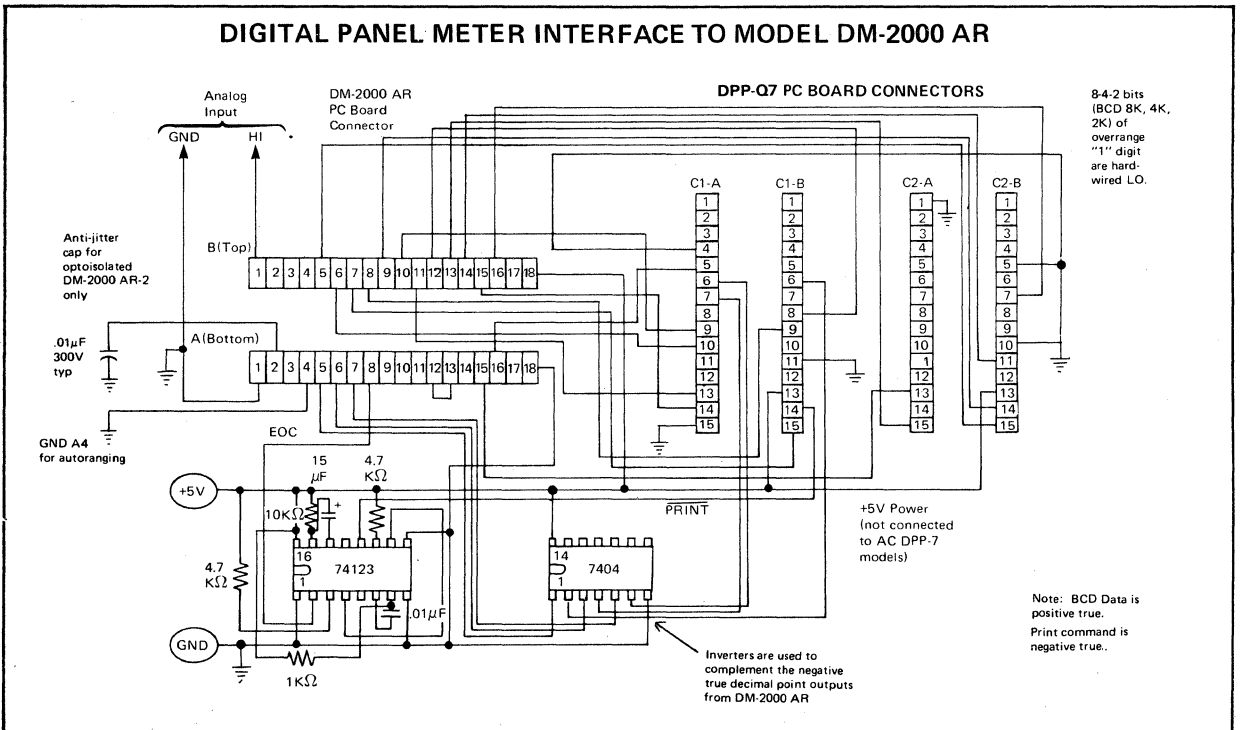
#### DIGITAL PANEL METER TO PRINTER INTERFACE

The typical interface circuit shown will connect a DPP-Q7 Printer and a Datel DM-2000AR Autoranging Digital Panel Meter. The DPM will shift decimal points over three full scale ranges ( $\pm 1.999V$ ,  $\pm 1.999V$ , and  $\pm 19.99V$ ) and the DPP-Q7 Printer will automatically print out data with the sign and correctly positioned decimal points. The DM-2000AR Digital Panel Meter is internally set to make two samples per second of analog input voltages. The leading edge of the EOC (Busy) line from the DPM is used to trigger one of the monostables in the 74123 integrated cir-

*Refer to a Typical Interface to Datel-Intersil's Low-Cost DM-4100D DPM on Page 174S*

cuit. Thirty-three milliseconds later, the EOC line is low and valid BCD data is available from the DPM. The first 50mS monostable times out and triggers the second monostable in the 74123. This second monostable produces a 2 microsecond print pulse. The next start pulse from the DPM's internal start clock commands another sampling interval and a printout 50 milliseconds after sampling. The entire operation is controlled by the DPM start clock at about 2 samples and printouts per second. This clock can be slowed down or controlled externally (see DM-2000AR data sheet).

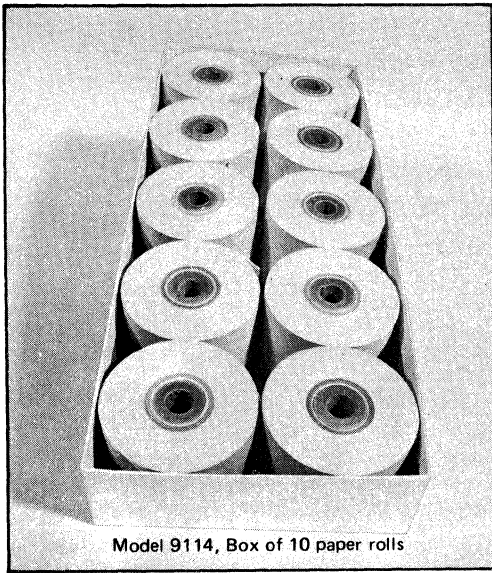
#### DIGITAL PANEL METER INTERFACE TO MODEL DM-2000 AR



Note: BCD Data is positive true. Print command is negative true.

Datel's products are available both direct and through GSA. If you are connected with a military or federal agency or receive federal funds, you may be entitled to purchase Datel's Digital Panel Printers and other products through

the General Services Administration to expedite requisitioning and order processing.



Model 9114, Box of 10 paper rolls

**MODEL NUMBER**

**DPP-Q7**

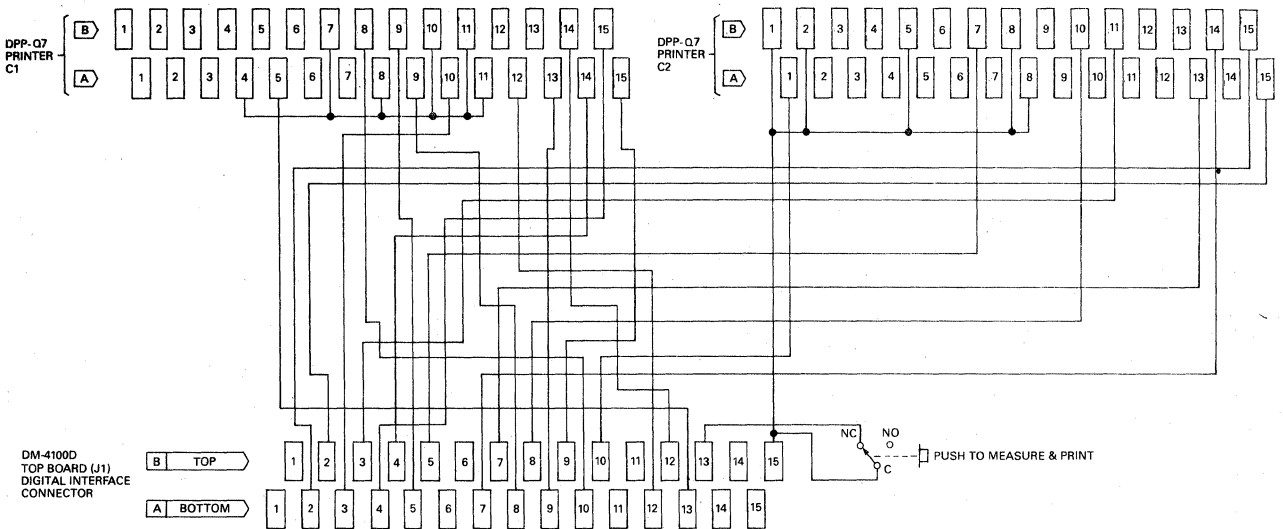
Power Supply	Printout Format	Characters
J = 100 VAC B = Both 115/ 230 VAC Dual-winding transformer, shipped as 230 VAC. Rewired by user to 115 VAC	1 = ±.9.9.9.9.9 2 = .9.9:9.9.9.9 3 = 9±.9.9.9.9 4 = 9.9.9.9.9.9 5 = .9.9.9.9.9.9 6 = .9.9.9.9.9.9	Leave] = Decimal Blank] = Digits  H = Hexadecimal Digits  Add for Hexadecimal printout.

OEM Versions available (same prices)  
DPP-Q7 -9554 ..... no panel label  
DPP-Q7 -9555 ..... no connectors  
DPP-Q7 -9556 ..... no label,  
no connectors

\*All A and E models now include dual voltage 115/230V transformers.

**DM-4100D INTERFACE WITH DPP-Q7 THERMAL PRINTER**

The DM-4100D may be connected directly to Datel-Intersil's DPP-Q7 Miniature Printer to form a functional data logger. The required connections are shown below.

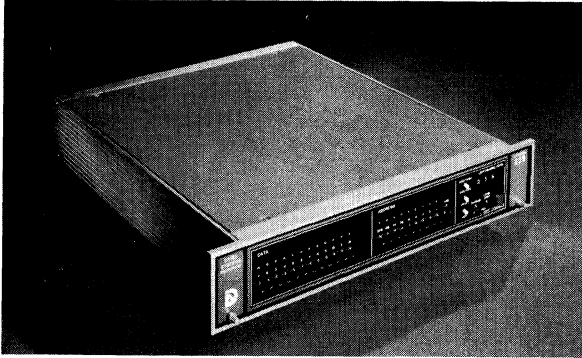


**Notes:**

1. Leading zero suppression on the printer may be activated by grounding printer pin B4 on connector C1 (join B4 to A4 on C1).
2. To select the desired decimal point on the printer, ground all unused decimal points to C1 pin A4. Only the unconnected decimal point is enabled.
3. The Run/Hold input on the D.P.M. can be used to trigger a Measure/Print cycle. A logic input or contact opening can be used (no debounce is necessary). Leaving the Run/Hold open or high will cause the system to free run at about 3 measurements per second.



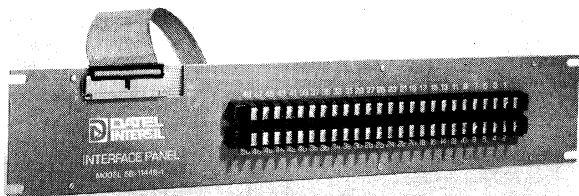
# A/D-D/A Computer Data Systems



**DAS-256**



**PDAS-250**



**INTERFACE PANEL**

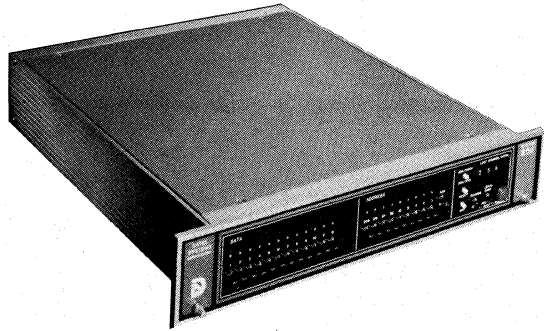
## IN THIS SECTION

<b>DAS-256</b>	<b>176S-189S</b>
<b>PDAS-250</b>	<b>190S-196S</b>
<b>INTERFACE PANEL</b>	<b>197S, 198S</b>

# System 256 (Model DAS-256) High Performance A/D-D/A Computer Peripheral System

## FEATURES

- Up to 256S/128D A/D Channels per housing
- A/D's expandable to 512S/256D channels (2 housings) and beyond
- Up to 32 D/A channels per housing
- D/A's expandable to 64 channels (2 housings) and beyond
- 12 bit Binary Resolution
- Optional 64 Simultaneous Sample/Holds for dynamic, realtime FFT's, spectrum analyzers and signal processors
- 50 or 100,000 A/D samples per second throughput
- Minicomputer-style, binary LED/toggle switch, front panel for control, display or calibration of A/D-D/A data and addresses
- Operates off-line (front panel) or on-line (remote computer control)
- Modular channel expansion and configuration for optimized capacity versus cost.
- Internal CMOS circuits for low power, low drift. External multiplexed-bus TTL I/O with stored commands.



## DESCRIPTION

The System 256 is a separate housing for A/D and/or D/A converters including a power supply and a minicomputer-style, binary LED/Toggle-switch front panel for complete calibration and troubleshooting access to the addressing and data bits of the analog channels. System 256 can accommodate up to 256 single-ended or 128 differential analog channels. (It can easily be expanded to 512S/256D channels in two housings and beyond). Special performance features include A/D through-put periods down to 10 microseconds (for 12 bits) and up to 64 simultaneous A/D sample/hold amplifiers for fast dynamic events. A related product, Model PDAS-250, may be used with DMA components for 12-bit A/D sequential channel block data bursts at rates up to 250,000 channels per second (4 microseconds total data sample transfer period).

System 256 is configured in a 3½-rack-high housing with supplied slides for standard 19 inch RETMA rack mounting.

The system is organized as a parallel-interface A/D-D/A peripheral with automatic internal control of channel addressing modes (random/sequential) sequencing and converter controls.

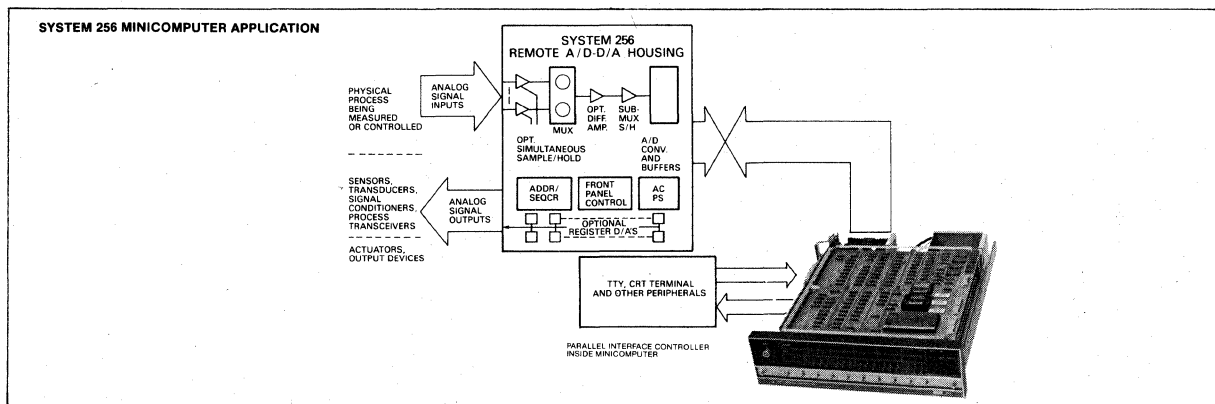
Besides offering very high channel density in one housing, System 256 may be located up to 25 feet (10m) from the computer to

position the analog channels near sensors, experimental apparatus and process equipment.

A very unusual option with System 256 is Simultaneous Sample/ Hold where up to 64 analog A/D channels may be sampled at precisely the same time ( $\pm 1$  nanosecond) and then rapidly digitized and transmitted to computer memory.

Simultaneous Sample/ Hold is ideal for fast dynamic events such as shock, vibration or impulse studies, fast chemical reactions, aircraft flutter testing, and dynamic load studies. This concept of taking a fast "digital snapshot" of rapidly-changing analog events allows known, real-time data analysis. Users are currently applying sophisticated mathematical techniques such as FFT (Fast Fourier Transform) to determine spectral (phase, amplitude, frequency) contours of dynamic data. By appropriate programming, a plot or map of the event can be reconstructed from the computer's memory.

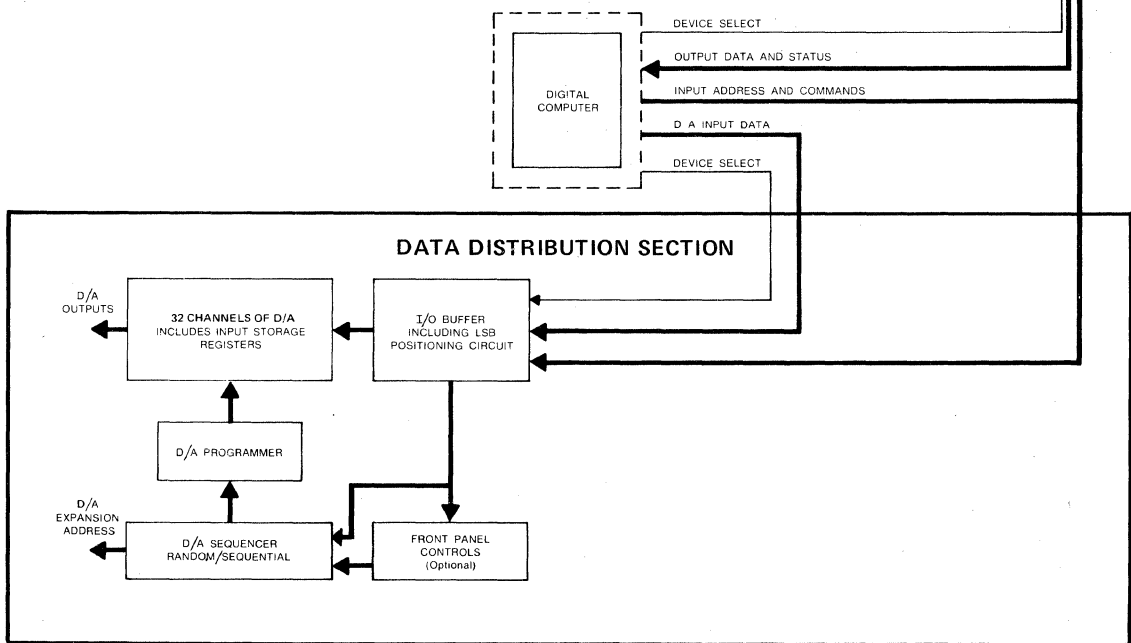
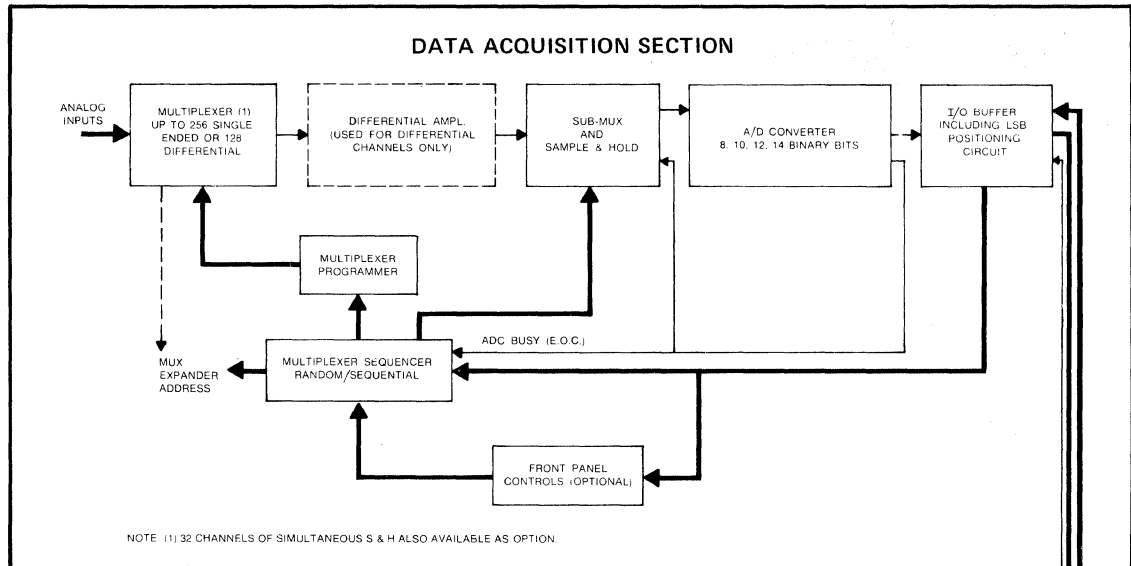
The optional 12-bit D/A section fits co-resident in the same 3½ inch-high rack-mount housing. Internal logic is CMOS for low power and low analog drift due to minimal heat rise and for enhanced reliability. External interfacing is TTL levels for computer bus compatibility.



DAS-256 A/D-D/A Computer Peripheral

System

# SYSTEM 256 BLOCK DIAGRAM



# SYSTEM 256 CONFIGURATIONS

System 256 is housed in a 3½"Hx19"Wx19"D enclosure with slides for mounting to a 19" standard RETMA rack. The minimum ordering configuration is 32 single-ended or 16 differential analog input channel capacity, Sample and Hold, A/D Converter full capacity power supplies, full programming capacity for 256 channels, Computer Input/Output interface, connectors and hardware included.

System 256 D/A section consists of one or two motherboards. One for up to 16 channels and two for up to 32 channels.

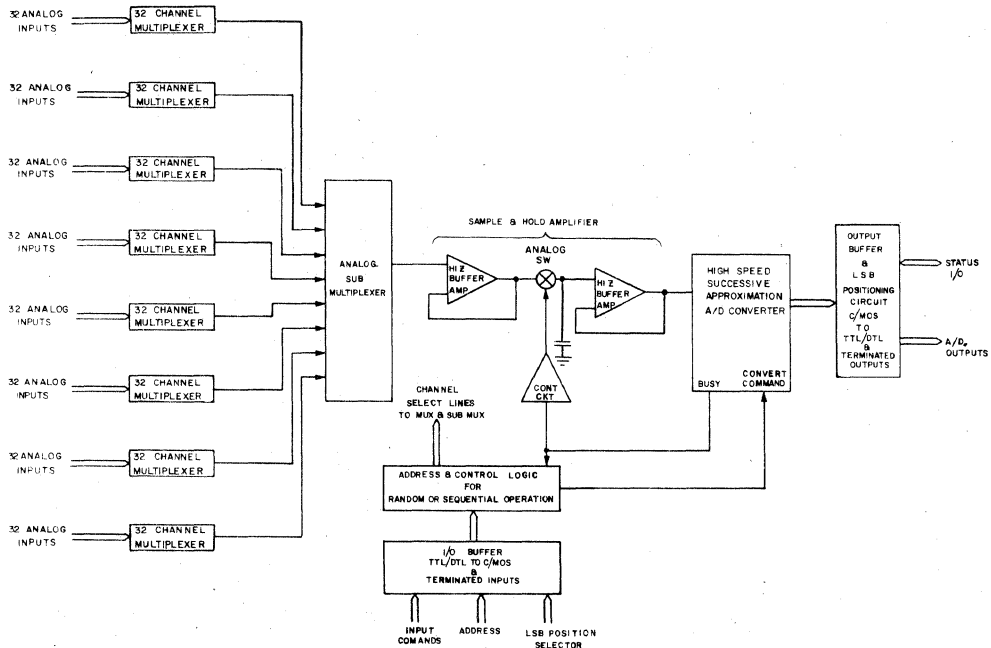
When both the A/D & D/A sections are used all of the control and address lines are common, except the device select line. The user has the option of having a separate device

select line for both the A/D and D/A sections or having the A/D section device select line OV true and the D/A section device select line positive true by use of a single line.

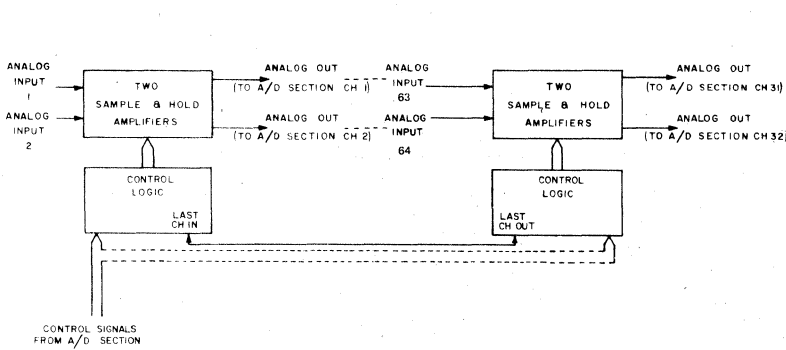
The addressing and commands are identical to that of the A/D section except that there are only 8 address lines for the D/A section (2 lines for expansion). Like the A/D section the D/A inputs may be multiplexed by using the D/A device select line.

System 256 Simultaneous Sample/Hold section consists of one mother board capable of housing up to 32 channels. They may be ordered in increments of two channels.

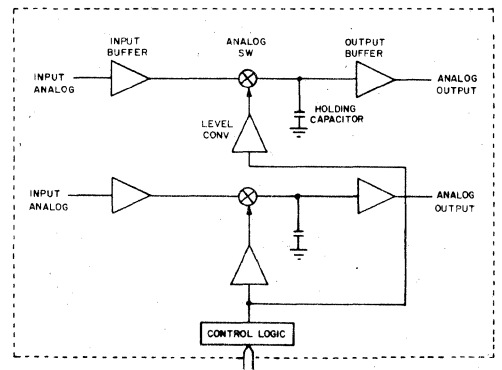
## SINGLE ENDED INPUT-256 CHANNELS-A/D SECTION



## SIMULTANEOUS S/H-64 CHANNELS-A/D SECTION



## TWO CHANNELS OF SIMULTANEOUS S/H



Channel expansion of System 256 is simple and straight forward. Expansion may be accomplished by adding an additional enclosure. All control signals necessary for expansion are carried from the basic system which then becomes the *master* and the second enclosure the *slave*.

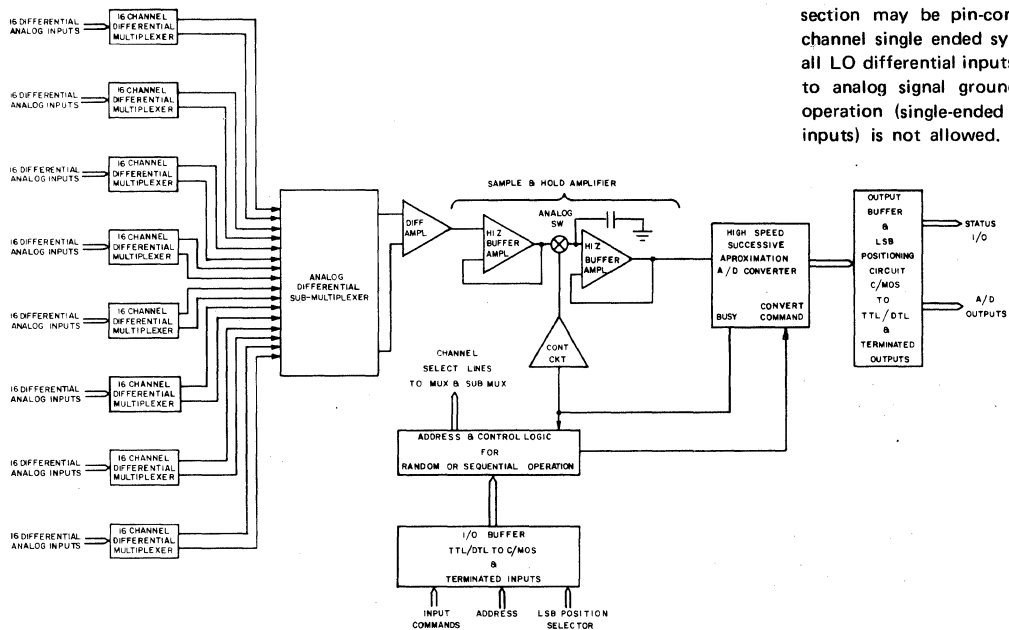
All that is needed to address the second 256 channels is one control line called *address 256*.

When used with the front panel, the address switch marked 256 is used to address the *slave*.

In addition, System 256 may be purchased now or later on with any of the extended configurations given below:

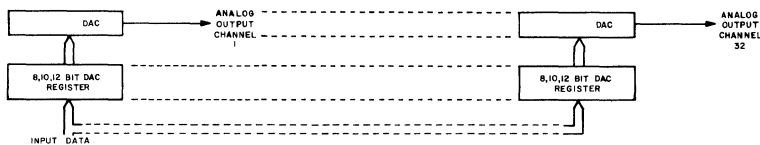
1. Up to 256 single-ended multiplexed A/D channels.
2. A/D channel expansion can be made in 16 channel min. increments, up to 256 single-ended inputs.
3. Up to 128 differential multiplexed A/D channels.
4. A/D channel expansion can be made in 8 channel min. increments, up to 128 differential inputs.
5. Up to 256 single-ended or 128 differential multiplexed A/D channels, and up to 32 D/A channels.
6. Up to 256 single-ended or 128 differential multiplexed A/D channels, and up to 64 simultaneous sample and hold channels.
7. Up to 256 single-ended or 128 differential multiplexed A/D channels and up to 32 simultaneous sample and hold channels, and up to 16 D/A channels.
8. Up to 32 D/A channels.
9. Installation of DAC channels consists of a basic 16 channel D/A section, expandable to 32 channels. D/A channels may be purchased in increments of single channels.

### DIFFERENTIAL INPUT-128 CHANNELS-A/D SECTION

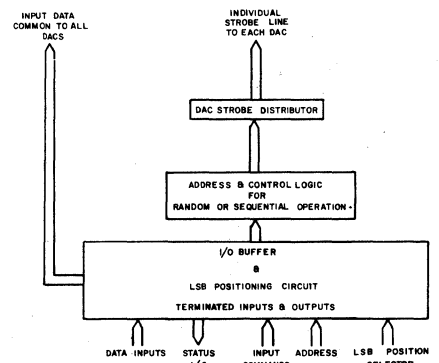


A sixteen channel differential input A/D section may be pin-converted to a 16 channel single ended system by ganging all LO differential inputs and tying them to analog signal ground. Mixed mode operation (single-ended and differential inputs) is not allowed.

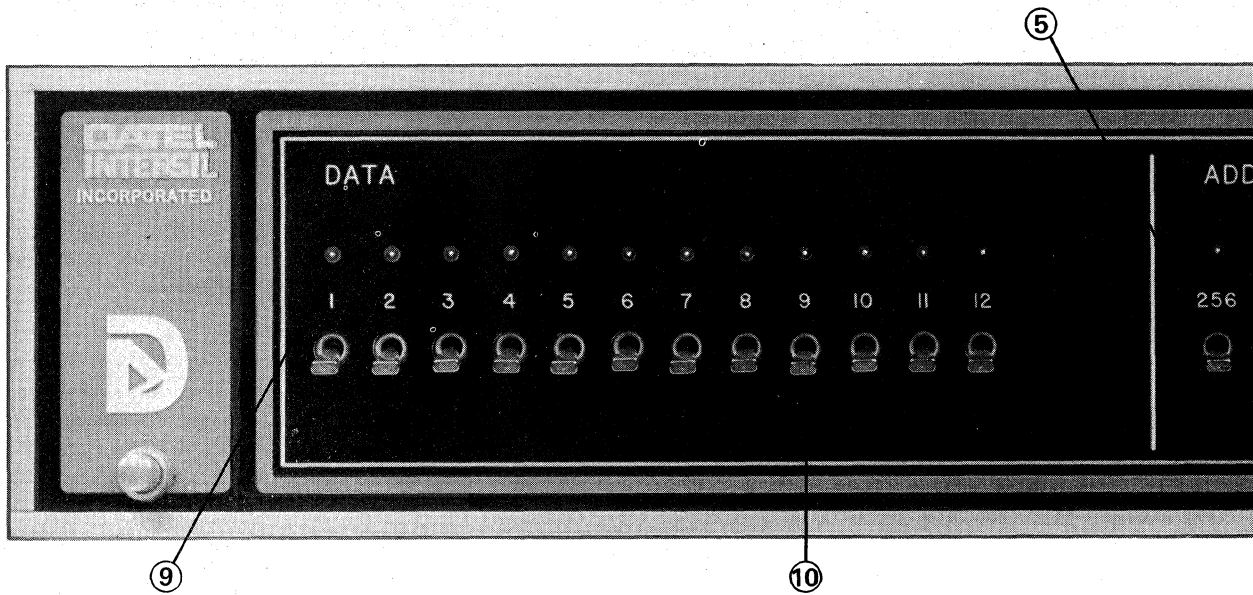
### 32 ANALOG OUTPUT CHANNELS-D/A SECTION



### D/A CONTROL SECTION



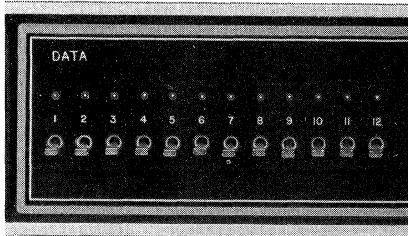
# FRONT PANEL CONTROLS AND DISPLAY ADD "OFF LINE" CAPABILITY (1)



## GENERAL

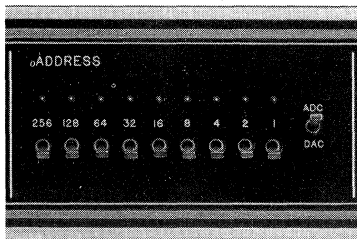
The front panel controls and display add tremendous system flexibility. It is useful for the initial system installation, test calibration, or OFF LINE data logging. Once the LOCAL CONTROL switch is activated the ON LINE computer is locked out allowing the user complete freedom via the front panel controls and display. The front panel is broken up into three sections – DATA, ADDRESS, and CONTROL.

The DATA SECTION consists of up to fourteen solid state lamps displaying the A/D output data plus input data switches allowing the user to manually load data into each D/A converter.



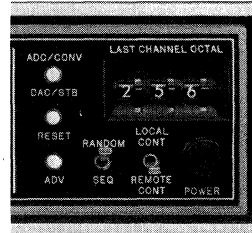
DATA SECTION  
12 BITS SHOWN

The ADDRESS SECTION contains up to nine channel address toggle switches, address output display lamps, and A/D or D/A operation switch.



ADDRESS SECTION

The CONTROL SECTION is made up of the Random or Sequential toggle switch, internal or remote toggle switch, advance A/D or D/A momentary switch, reset momentary switch, last channel octal thumbwheel switch, and power on/off lighted power switch.



CONTROL SECTION

### ① Function Selector Switch

Selects either A/D or D/A operation.

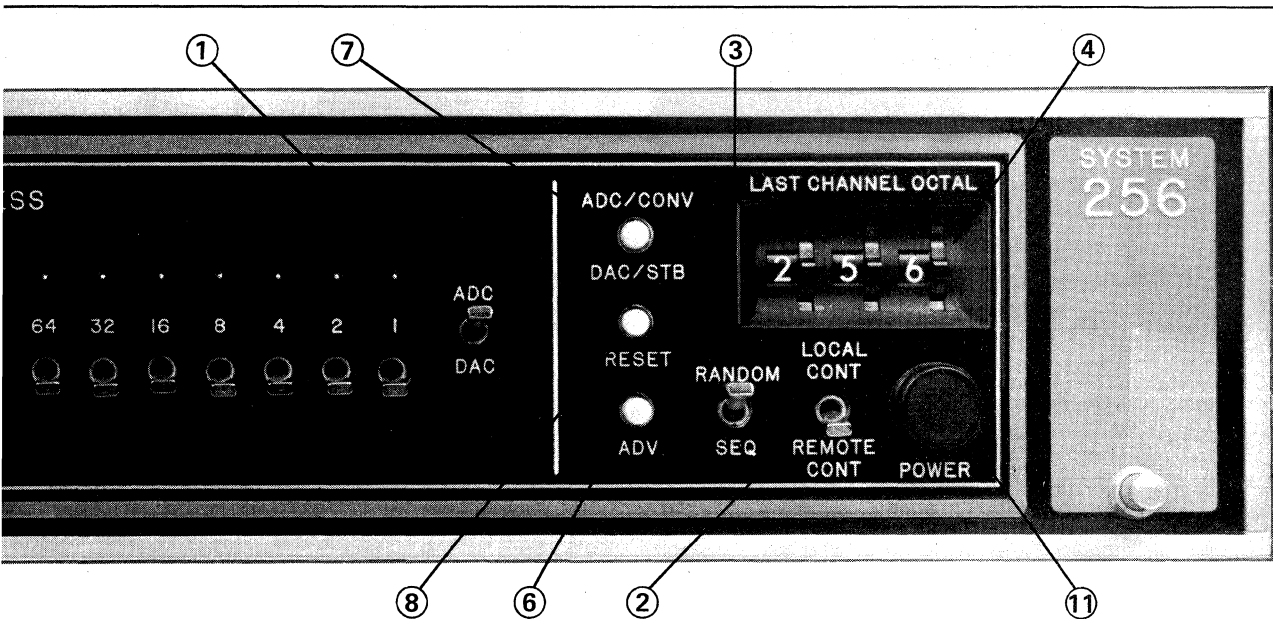
### ② Local/Remote

This switch selects the source of control for System 256. When it is in the *Remote* position, System 256 is under control of your computer. When in *Local*, System 256 is controlled by the front panel and all signals from the *Remote* source are disconnected (logically locked out).

### ③ Random/Sequential

The *Random/Sequential* switch selects the mode of operation.

When in the *Random* position, the channels may be selected individually at random by using the address switches and the advance momentary switch Ⓞ. To select a channel



in the random mode, simply set the address switches to the appropriate binary number for that channel and press the advance button. The channel addressed is now selected. A conversion of that channel is not made, however, until the Convert/Strobe momentary switch ⑦ is depressed.

When in the *Sequential* position, sequential addressing of either the analog multiplexer or the D/A channels is possible. To advance to the next higher order channel simply press the advance button ⑥ and the analog multiplexer or D/A will advance one channel. This channel will not be converted (A/D or D/A) until the *Convert/Strobe* switch is depressed ⑦.

#### ④ Last Channel Thumbwheel Selector

The function of the last channel octal switch is to be able to short cycle either the analog multiplexer or D/A converter channel in the sequential mode of operation. For example, if only 8 channels are to be scanned, the last channel octal switch would be set to 010 (actual channel count is N-1), each channel could then be scanned one through eight.

#### ⑤ Channel Address

The Channel Address section consists of address toggle switches and solid state display lamps projecting the analog multiplexer position or D/A channel in either the random/sequential modes.

#### ⑥ Channel Advance

The Channel Advance push button has a two-fold effect.

1. In the Random mode, when depressed it will select the channel represented by the address switches.

2. In the Sequential mode, it will advance to the next higher channel for either the analog multiplexer or D/A converter.

#### ⑦ A/D Convert or D/A Strobe

The A/D Convert or D/A Strobe momentary switch will cause a conversion to be initiated when in either the random/sequential modes. It will convert the channel that the analog multiplexer or D/A sequencer is on at that time and remain on that channel until a new channel is selected or advanced to, or if desired several conversions may be made on the same channel.

#### ⑧ Reset

The Reset momentary switch will cause a reset to channel one for either the analog multiplexer or D/A converter whether in the Random or Sequential mode.

#### ⑨ Output Data Display

Up to 12 bits of parallel binary A/D data is displayed depending on the number of bits supplied.

#### ⑩ D/A Data Inputs

The D/A Data Input switches determine the value of the output voltage to be converted by the D/A which has been addressed either randomly or sequentially.

#### ⑪ Power Switch

System 256 is supplied with a combined power *on-off* switch and indicator. Pushing on the indicator applies AC power to the system and lights the power indicator.

(1) FRONT PANEL CONTROLS ARE STANDARD. BLANK PANEL IS OPTIONAL — CONTACT FACTORY.

# COMPUTER INTERFACE

## COMPUTER INTERFACE DESCRIPTION

System 256 is designed as a high speed, full parallel I/O device which is fully remote controlled in realtime by your computer. While the internal logic is power-saving CMOS, all external interfacing is fully TTL/DTL compatible.

To interface to System 256, the user must do two things. He must provide a full-parallel hardware interface circuit and he must develop a computer program which will control and access System 256 through this interface. The first requirement (the parallel interface), is straightforward using standard parallel I/O boards offered by the various computer manufacturers. Also, many minicomputer makers offer both development and executive software to help the user generate the final operating program.

System 256 is unique in that it has stored input command modes with virtually a single-line enable to start an A/D conversion scan once all the modes have been preloaded. This allows System 256 to be used in true high-speed realtime modes with very little delay once the user commands the start of a scan. Also, the command storage features lets other parallel devices (such as other System 256 units) share the same parallel bus using only separate single-line enables to address each device.

Input/Output Control Command and status flag lines are fully described in the DAS-256 Systems manual (available on letterhead request) and a brief listing of these lines is included below:

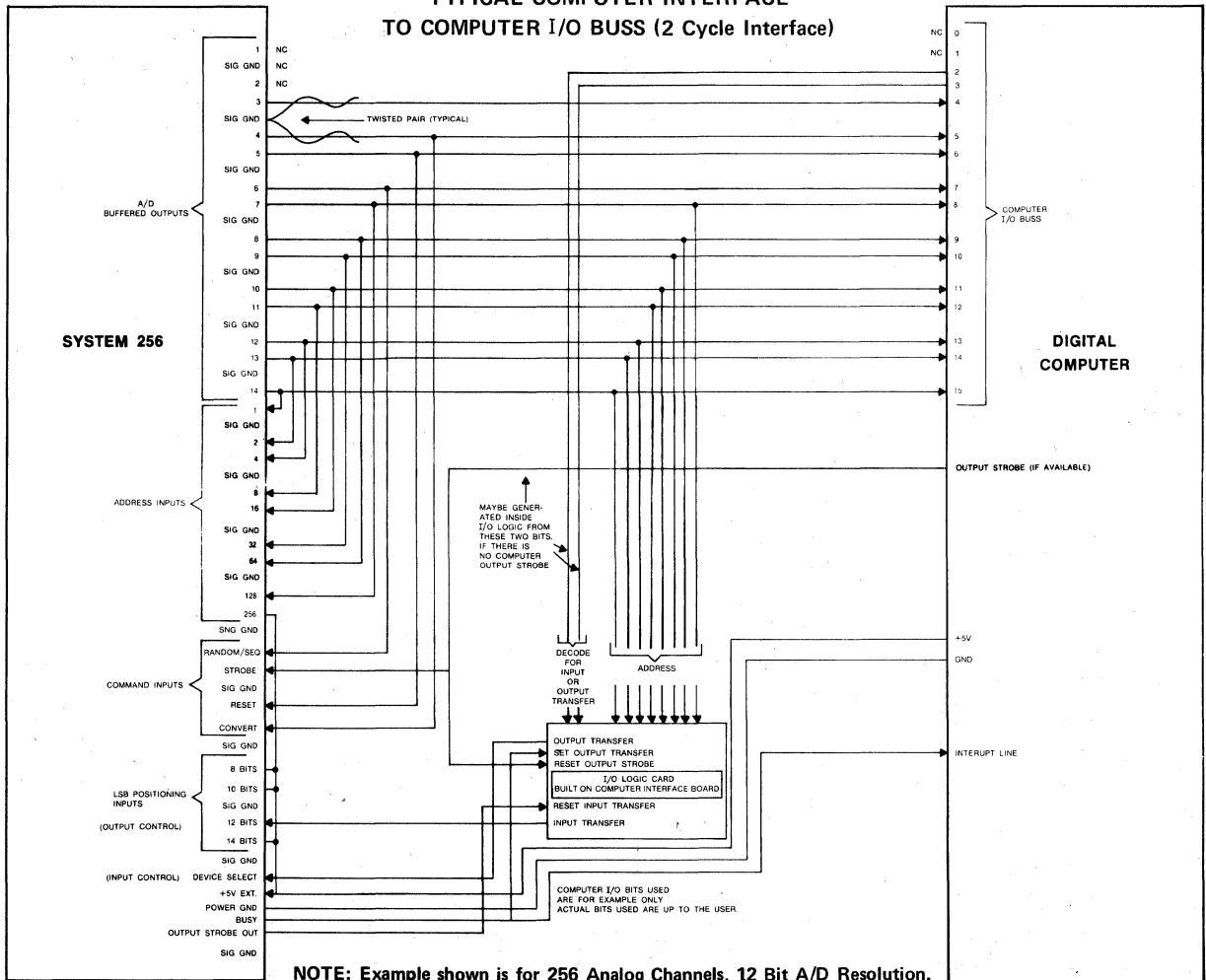
### Input Control Lines

- Device Select Command
- Strobe Command
- Random/Sequential Command
- Random Address Inputs
- A/D Convert Command
- Reset Command (A/D Address to channel one)
- LSB Positioning Inputs
- Input Buffer Full Input
- Initialize Input
- +5V External (for I/O line terminators)

### Output Status Lines

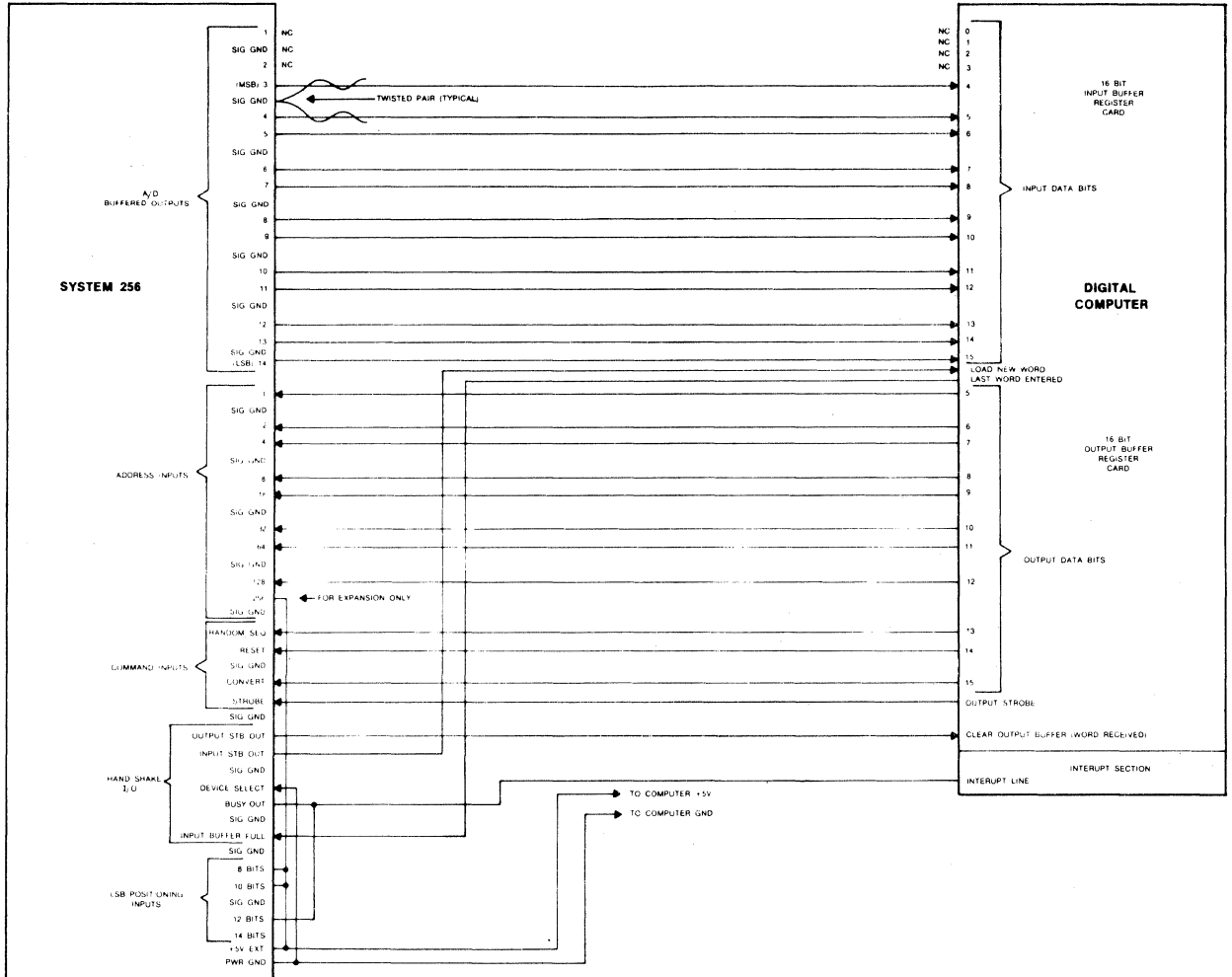
- A/D Converter Busy
- Frame Sync (= channel one)
- Data Outputs
- Output Strobe

TYPICAL COMPUTER INTERFACE  
TO COMPUTER I/O BUSS (2 Cycle Interface)





# COMPUTER INTERFACE (continued)



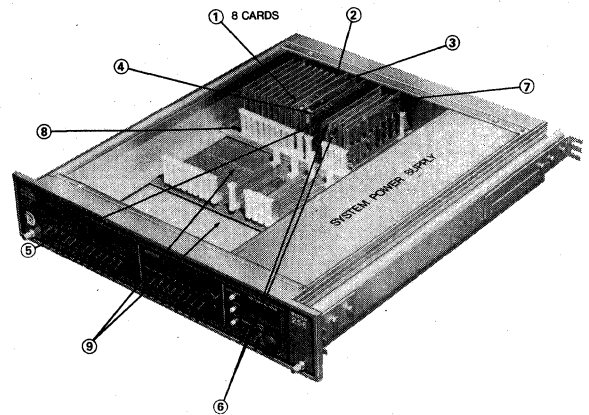
**TYPICAL COMPUTER INTERFACE  
USING PERIPHERAL I/O BUFFER CARD  
OFFERED BY MINICOMPUTER MANUFACTURERS.**

**NOTE: Example shown is for  
256 Analog Channels — 12 Bit Resolution**

## GENERAL

The packaging technique used in the System 256 is modular. Each section, i.e., A/D, D/A, or Simultaneous Sample and Hold, has its own printed circuit mother board. Printed circuit cards plug into the mother boards via edge connectors and the mother boards are interconnected via ribbon cable connectors. Any mother board or any PC card may be removed individually for service. The chassis is top loaded and is provided with slides for easy access.

Another feature of System 256 packaging is that all of the analog inputs to the multiplexer come directly from the I/O connector to the printed circuit card. This technique effectively shortens the route from the I/O to the multiplexer switch, helping to eliminate *pick up* while at the same time allowing a tighter packing density/channel by not being pin limited on the PC card, due to the large number of analog inputs.



### ① Analog Multiplexer Cards

System 256 contains up to eight 32 channel analog multiplexer cards. Each card consists of 32 MOS multiplexer switches and decoding logic to select each channel input individually to a common output. Each multiplexer card may be configured for either 16 channel differential or 32 single ended channels by means of jumpers (located on the P.C. card) and the way they are addressed by the programmer card.

### ② Submultiplexer and Sample/Hold Card

This card consists of either 8 or 16 MOS multiplexer channels (8 for single ended input or 16 for differential operation) along with the necessary decoding logic to select any one channel input to a common output. The purpose of these multiplexer channels is to submultiplex each of the 32 input channels through one channel of *Sub-Mux* to a Sample & Hold or Buffer Amplifier. This feature minimizes the input capacitance presented to the high speed Sample & Hold or Buffer Amplifier allowing for fast input settling time.

In addition, to the Sub-Mux channels, a choice exists between a Sample & Hold Amplifier or Buffer Amplifier. If simultaneous Sample & Hold input channels are used on the input or the data rate is slow enough, a Sample & Hold Amplifier is not needed, however, one or the other is required to present a high impedance to the multiplexer switch. The Sample & Hold Amplifier basically consists of a high input impedance *Follower* amplifier coupled by a FET switch into a Holding capacitor at the input of a high impedance low drift *Follower* output amplifier which in turn presents a low impedance output to the input of the Analog-to-Digital Converter. Its primary function is to decrease the system *Aperture Time* from the A/D conversion

time to less than 50 nanoseconds. If this aperture time is not needed due to low frequency or DC input signals (such as with simultaneous Sample/Hold inputs) a high slew, fast settling, high input impedance (greater than 100 megohms) *follower* amplifier is provided in place of the Sample/Hold amplifier.

### ③ Differential Amplifier/Inverting Amplifier Card

The purpose of this card is two-fold.

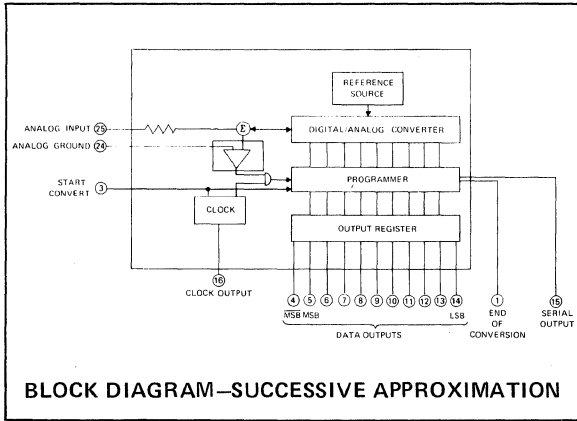
1. To provide a differential input from the differential multiplexer to a single ended output to the Sample/Hold amplifier. In this case two high speed *Follower* amplifiers (to provide a high impedance to the outputs of the multiplexer switches) are fed to the inputs of an ultra high speed differential amplifier.
2. To provide voltage inversion when needed at the input to the A/D Converter which assures that all output data coding from the A/D Converter is uniform.

### ④ Analog-to-Digital Converter Card

This card consists of a family of A/D Converters to choose from, plus adjustments for full scale and zero. These converters, which belong to the successive approximation family are identical in operation. The only difference being in their conversion time. The key advantages of successive approximation are conversion speed, resolution and accuracy.

The converter continuously approximates the analog input voltage by a factor of two. The complete conversion requires "n" steps, when "n" is the number of bits of the converter. The *programmer* section of the converter shifts a "1" from the most significant to the least

significant position of the *output register* in incremental steps. At each step, a comparison is made that decides whether to retain a "1" in that same position of the *output register* or to remove it. If the output of the D/A section of the converter is less than the analog input signal, then the "1" is removed. When the process reaches the *n*th step, a conversion has been completed to within the resolution of 1/2 the least significant bit.



### 5 System Programmer Card

This card provides the necessary address lines for groups of 16 channels (single ended) or 8 channels (differential) to be scanned. Its input is from the System Sequencer Card and its outputs are fed to the individual multiplexer cards.

### 6 System 256 I/O Cards

System 256 I/O cards provide three functions:

1. They level convert between the internal C/MOS logic and the external world of TTL/DTL logic.
2. They provide single (1 TTL load) inputs with provision for termination resistors of all inputs and open collector outputs with provision for pull-up resistors on all outputs.
3. The A/D converter output is provided with an LSB position circuit. Four lines are available — 14, 12, 10 and 8 bits. Grounding the appropriate line for the resolution of the converter in System 256 assures that the LSB is always positioned in the extreme right hand position. The same line may be used to multiplex the open collector outputs onto the output lines, if required.

### 7 System Sequencer Card

This card has two modes of operation: Random and Sequential. In the random mode, any channel may be selected by presenting an 8 bit address to the address inputs. In the sequential mode, each channel may be selected in sequence. Appropriate control inputs are presented to the user for maximum flexibility of application, the inputs have the ability to be multiplexed as in a computer *Single Buss, Two Cycle* interface situation.

Typically, many peripherals are connected to the input buss of a computer and each peripheral has its own address.

System 256 has the ability to interface to most mini computers with a standard interface board supplied by the computer manufacturer. In cases where such a board is not available, a minimum amount of logic circuitry is required to provide such an interface, actually only a decoding gate is necessary to decode the address assigned to System 256 as a peripheral.

### 8 Mother Board

The mother board houses the entire A/D section of System 256. At the rear of the mother board an edge connector protrudes through the rear panel of System 256. The edge connector has the necessary logic *carry* signals to drive a *slave* A/D section consisting of an additional 256 single ended or 128 differential multiplexer channels. The analog output of these channels is fed down to the output of the *master* channels via a BNC connector and cable.

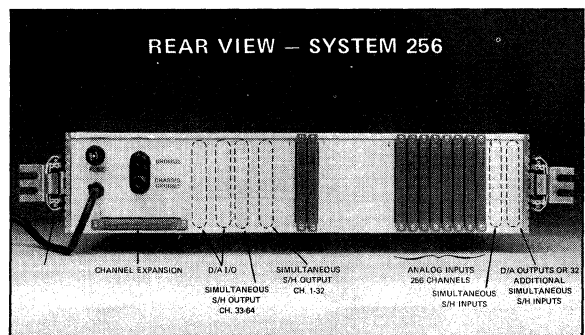
### 9 D/A Converter and Simultaneous Sample/Hold Mother Boards

System 256 can also be supplied (in addition to 256 analog channels) with up to 32 D/A channels, 64 simultaneous sample/hold channels, or any combination of up to 16 D/A channels and 32 simultaneous sample/hold channels.

One or two additional mother boards are available for this purpose.

When both the A/D & D/A sections are used all of the control and address lines are common, except the device select line for both the A/D & D/A sections or having the A/D section device select line "0" true and the D/A section device select line positive true by use of a single line.

The addressing and commands are identical to that of the A/D section except that there are only 8 address lines for the D/A section (2 lines for expansion). Like the A/D section the D/A inputs may be multiplexed by using the D/A device select line. A conversion will not take place unless a convert command is acted upon and this is under control of the D/A device select line.



# SYSTEM 256 SPECIFICATIONS

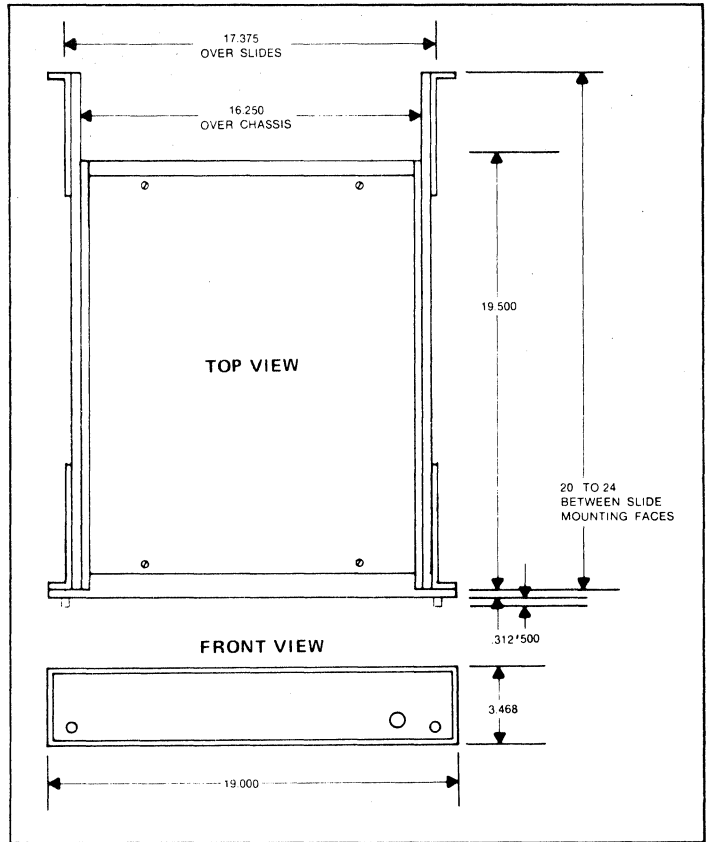
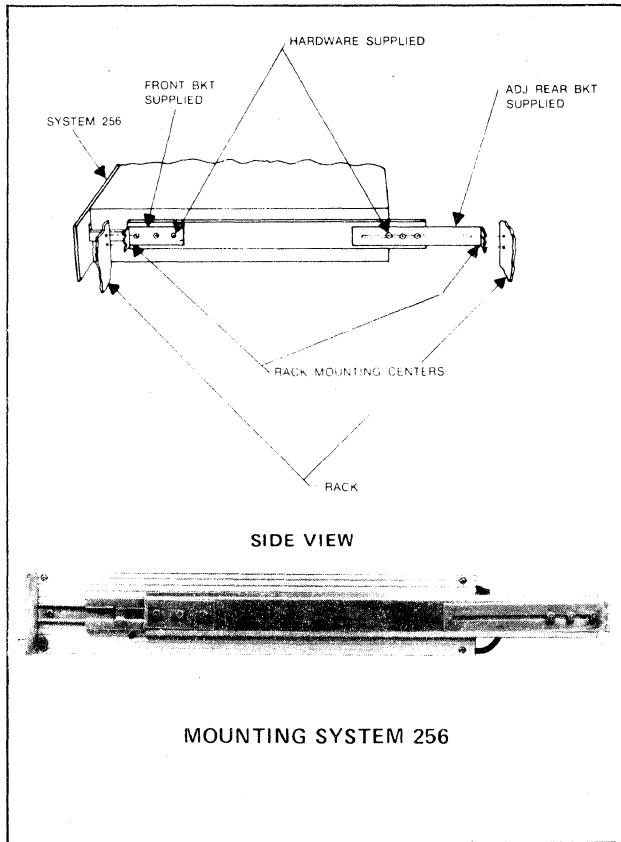
PARAMETER	A/D SECTION
<b>ANALOG INPUTS</b>	
Number of Multiplexer Channels Single Ended Input	Expandable to 256 channels in 32 channel increments
Number of Multiplexer Channels Diff. Input (Optional)	Expandable to 128 channels in 16 channel increments
Number of Simultaneous Sample/Hold Channels	Expandable to 64 channels in 2 channel increments
Input Voltage Ranges	+5V FS, +10V FS, ± 5V FS, ± 10V FS
Channel Input Acquisition Time	5usec to ± 0.025% of FS
Channel Input Impedance	100 Megohms—"on" or "off"
Input Configuration	Single ended or Differential
Maximum Input Overload	± 15V
Input Channel Time Skew Simultaneous S/H Section	50nsec
Maximum Common Mode Voltage — (3)	Any Combination of 20V P to P — Es + ECM
Common Mode Input Impedance — (3)	>100 Megohms
Common Mode Source Impedance — (3)	1 Kohms unbalanced
Common Mode Rejection Ratio — (3)	60db @ 1 KHz 80db @ 60 Hz
Crosstalk (Between inputs)	80db @ 100 Hz 45db @ 10MHz
<b>SYSTEM PERFORMANCE</b>	
Output Resolution	12, binary bits
Output Data Coding (4)	Straight Binary — unipolar input Offset Binary — bipolar input 2's Complement — bipolar input
Throughput Rate	12 Binary Bits—50 KHz or 100 KHz
Aperture Time	50nsec
Accuracy	± 0.02% of FS ± ½ LSB
Temperature Coefficient	40ppm/°C
Linearity	± ½ LSB
<b>DIGITAL CONTROL INPUTS</b>	
Device Select	1 line, 1 TTL Load—Negative True
Random/Sequential	1 line, 1 TTL Load—Negative True (seq.)
Reset	1 line, 1 TTL Load—Negative True
Strobe	1 line, 1 TTL Load—Negative True
Convert Command Input	1 line, 1 TTL Load—Negative True
Random Address Inputs	9 lines, 1 TTL Load—Negative True
<b>DIGITAL OUTPUTS</b>	
A/D Converter Data	Up to 14 parallel lines—TTL Compatible (1)
Serial Output Train	1 line—TTL Compatible (1)
Busy (E.O.C.)	1 line—TTL Compatible (1)
Frame Sync	1 line—TTL Compatible (1)
A/D Clock	1 line—TTL Compatible (1)
Input Strobe Output	1 line—TTL Compatible (1)
Output Strobe Output	1 line—TTL Compatible (1)
Buffer Full Output	1 line—TTL Compatible (1)
<b>FRONT PANEL CONTROLS</b>	
Output Data Display	Up to 14 Bits of A/D Data Read Out
Channel Address Switches	Address Multiplexer in Random Mode
Channel Address Lamps	Display Multiplexer Position
A/D Mode Switch	Selects A/D Operation
A/D Convert Switch	Will Initiate an A/D Conversion
Reset Switch	Resets Multiplexer to Channel One
Random/Sequential Switch	Selects Multiplexer Mode of Operation
Advance Switch	Random Mode—Will Select Addressed Channel Sequential Mode—Will Advance to Next Higher Channel
Local/Remote Switch	Selects Source of System Control, Front Panel Controls or Computer
Last Channel Selector	Short Cycle Multiplexer in Sequential Mode
Power ON/OFF Switch	Applies AC power to System
<b>MECHANICAL—ENVIRONMENTAL</b>	
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	-55°C to 85°C
Relative Humidity	10% to 90% Non-condensing
Physical Size	3½" H x 19"W x 19"D
Weight	12 LBS (Typ.)
I/O Mating Connectors	Up to Eleven Viking #3VH25/IJN5 (Datel 31-2076040)
Input Power	115 VAC ±10 VAC @ 47 to 440 Hz 225 VAC ±15 VAC @ 47 to 440 Hz
(1) Open Collector. Will Sink 30 ma (2) Optional (3) Pertains only to Differential Input	

PARAMETER	D/A SECTION
<b>DIGITAL INPUTS</b>	
Number of Channels	Expandable to 32 channels in 1 channel increments
Resolution	12 Binary Bits
Digital Coding (3)	Straight Binary Offset Binary Two's Complement
Data Inputs	DTL or TTL compatible Negative True Logic Loading: one TTL Load
Data Strobe	Information must be present at the register inputs of the DAC prior to strobing. Loading: one TTL Load
Update Rate	500 KHz
<b>ANALOG OUTPUT</b>	
Number of Analog Outputs	up to 32 channels
Accuracy	±0.01% of FS ± ½ LSB
Output Voltage Range (2)	OV to + 10V FS OV to + 5V FS ±10V FS ± 5V FS
Output Current	±5 mA (typ.)
Output Loading	1 Kohms for + 10V Output 500 ohms for + 5V Output
Output Settling Time	2 usec to ±0.025% of FS
Resolution	±1 LSB of 12 bits
Linearity	±½ LSB of 12 bits
Temperature Coefficient	±20ppm/°C of FS
Long Term Stability	±0.01%/6 month period
Reference Source	Internal
<b>DIGITAL CONTROL INPUTS</b>	
Device Select	1 line, 1 TTL Load—Negative True
Random/Sequential	1 line, 1 TTL Load—Negative True (seq.)
Reset	1 line, 1 TTL Load—Negative True
Strobe	1 line, 1 TTL Load—Negative True
Convert Command Input	1 line, 1 TTL Load—Negative True
Random Address Inputs	9 lines, 1 TTL Load—Negative True
<b>DIGITAL OUTPUTS</b>	
Input Strobe Output	1 line, TTL Comp. (1)
<b>FRONT PANEL CONTROLS</b>	
Input Data Switches	Allows Manual Loading of Data Into Each D/A
Channel Address Switches	Address D/A's in Random Mode
Channel Address Lamps	Display D/A Channel Position
D/A Mode Switch	Selects D/A Operation
D/A Strobe Switch	Will Initiate a D/A Conversion
Reset Switch	Resets D/A's to Channel One
Random/Sequential Switch	Selects Mode of Operation
Advance Switch	Random Mode—Will Select Addressed Channel Sequential Mode—Will Advance to Next Higher Channel.
Local/Remote Switch	Selects Source of System Control, Front Panel Controls or Computer.
Last Channel Selector	Short Cycle D/A Channels in Sequential Mode
Power On/Off Switch	Applies AC Power to System
<b>MECHANICAL—ENVIRONMENTAL</b>	
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	-55°C to + 85°C
Relative Humidity	10% to 90% Non-condensing
Physical Size	3½"Hx19"Wx19"D
Weight	12 LBS (Typ.)
I/O Mating Connectors	Viking #3VH25/IJN5 (Datel 31-2076040)
Input Power	115 VAC ±10 VAC @ 47 to 440 Hz 225 VAC ±15 VAC @ 47 to 440 Hz
(1) Open Collector. Will Sink 30ma	
<p><b>FOR IMMEDIATE APPLICATION ASSISTANCE —</b></p> <p><b>CALL OR WRITE</b></p> <p><b>DATEL-INTERSIL</b></p> <p><b>11 CABOT BLVD.</b></p> <p><b>MANSFIELD, MASS. 02048</b></p> <p><b>(617) 339-9341</b></p>	

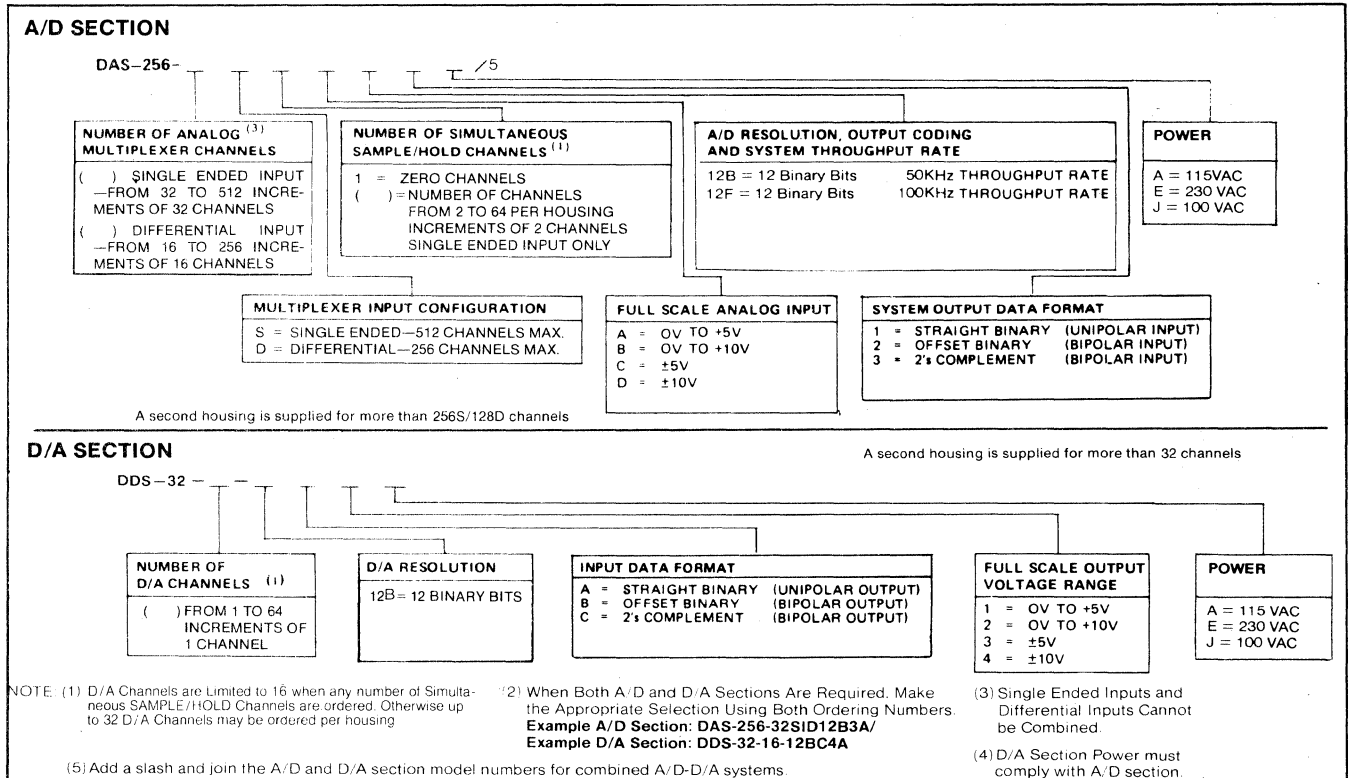
ALL DIGITAL TERMINATIONS ARE 1KΩ UNLESS OTHERWISE SPECIFIED

# MECHANICAL DIMENSIONS

SYSTEM 256 IS AVAILABLE UNDER GSA CONTRACT



# SPECIFYING SYSTEM 256 TO MEET YOUR PARTICULAR NEEDS



CONTACT DATEL FOR 250 KHz SYSTEMS (PDAS-250)

NUMBER OF ANALOG INPUT CHANNELS (BASE PRICES)	
Single Ended	Differential
32S \$2660	16D \$2970
64S 3120	32D 3425
96S 3565	48D 3870
128S 3995	64D 4305
160S 4431	80D 4730
192S 4855	96D 5150
224S 5270	112D 5565
256S 5670	128D 5960

NUMBER OF SIMULTANEOUS SAMPLE & HOLD (SSH)	
1 = Main S/H Only \$0000	
Add	Add
2 \$ 650	34 \$4580
4 870	36 4800
6 1090	38 5020
8 1315	40 5240
10 1535	42 5460
12 1755	44 5680
14 1975	46 5900
16 2195	48 6120
18 2415	50 6340
20 2635	52 6565
22 2855	54 6785
24 3075	56 7005
26 3295	58 7225
28 3520	60 7445
30 3740	62 7665
32 3960	64 7950

INPUT VOLTAGE RANGE
<input type="checkbox"/> A = 0V to +5V
<input type="checkbox"/> B = 0V to +10V
* C = ±5V
* D = ±10V

NUMBER OF BITS & THROUGHPUT
12B = (50 kHz) 12 bits Add \$000
12F = (100 kHz) 12 bits Add \$300
For PDAS-250 Models Add \$825 Use the 12F Designator

OUTPUT FORMAT
<input type="checkbox"/> 1 = Straight Binary
* 2 = Offset Binary
* 3 = Two's Compl.

POWER SUPPLY
A = 115 VAC
E = 230 VAC
J = 100 VAC

SECOND HOUSING: TOTAL SYSTEM PRICES	
Single Ended	Differential
288S \$ 6670	144D \$6950
320S 7290	160D 7580
352S 7745	176D 8045
384S 8325	192D 8505
416S 8680	208D 8965
448S 9140	224D 9440
480S 9600	240D 9895
512S 10,065	256D 10,360

NOTES

- D/A channels are limited to 16 when any number of Simultaneous Sample/Hold (SSH) channels are ordered. Otherwise up to 32 D/A channels may be ordered.
  - When both A/D and D/A sections are desired in the same housing, use both ordering numbers (see D/A section model numbering) and join both model numbers with a slash.
  - Single-ended and differential input cannot be combined.
  - The D/A section power is shared with the A/D section and must be the same voltage.
  - These prices include complete housing (19"W x 19"D x 3.5"H) with rails for standard RETMA mounting, front panel display and controls, power supply, full programming for 256 channels, sample and hold, computer I/O cards, connectors and hardware.
  - Beyond 256 single-ended or 128 differential channels, a second housing (slave unit) of the same dimensions is included. For slave units only (remote control only, no front panel controls), deduct \$210 for blank front panels (special order). Add the letters "SL" to the model number.
- Differential SSH requires twice as many inputs as single-ended systems. Example: DAS-256-32D64 is valid; -32D32 will apply SSH to only 16D channels.

SYMBOLS MUST MATCH

DDS-32 AND PDS-32 (D/A SECTION) WITHOUT A/D SECTION

DDS-32-

NUMBER OF ANALOG OUTPUTS	
No. of Channels	12 Bits
1	\$1565
2	1700
3	1845
4	1980
5	2120
6	2260
7	2400
8	2535
9	2680
10	2815
11	2950
12	3090
13	3230
14	3370
15	3510
16	3650
17	3880
18	4015
19	4160
20	4295
21	4435
22	4575
23	4715
24	4850
25	4995
26	5130
27	5265
28	5410
29	5545
30	5685
31	5820
32	5965

NUMBER OF BITS
12B = 12 Binary Bits

INPUT DATA FORMAT
<input type="checkbox"/> A = Straight Binary
* B = Offset Binary
* C = 2's Compl.

FULL SCALE OUTPUT VOLTAGE RANGE
<input type="checkbox"/> 1 = 0V to +5V
<input type="checkbox"/> 2 = 0V to +10V
* 3 = ±5V
* 4 = ±10V

POWER SUPPLY
A = 115 VAC
E = 230 VAC
J = 100 VAC

SYMBOLS MUST MATCH

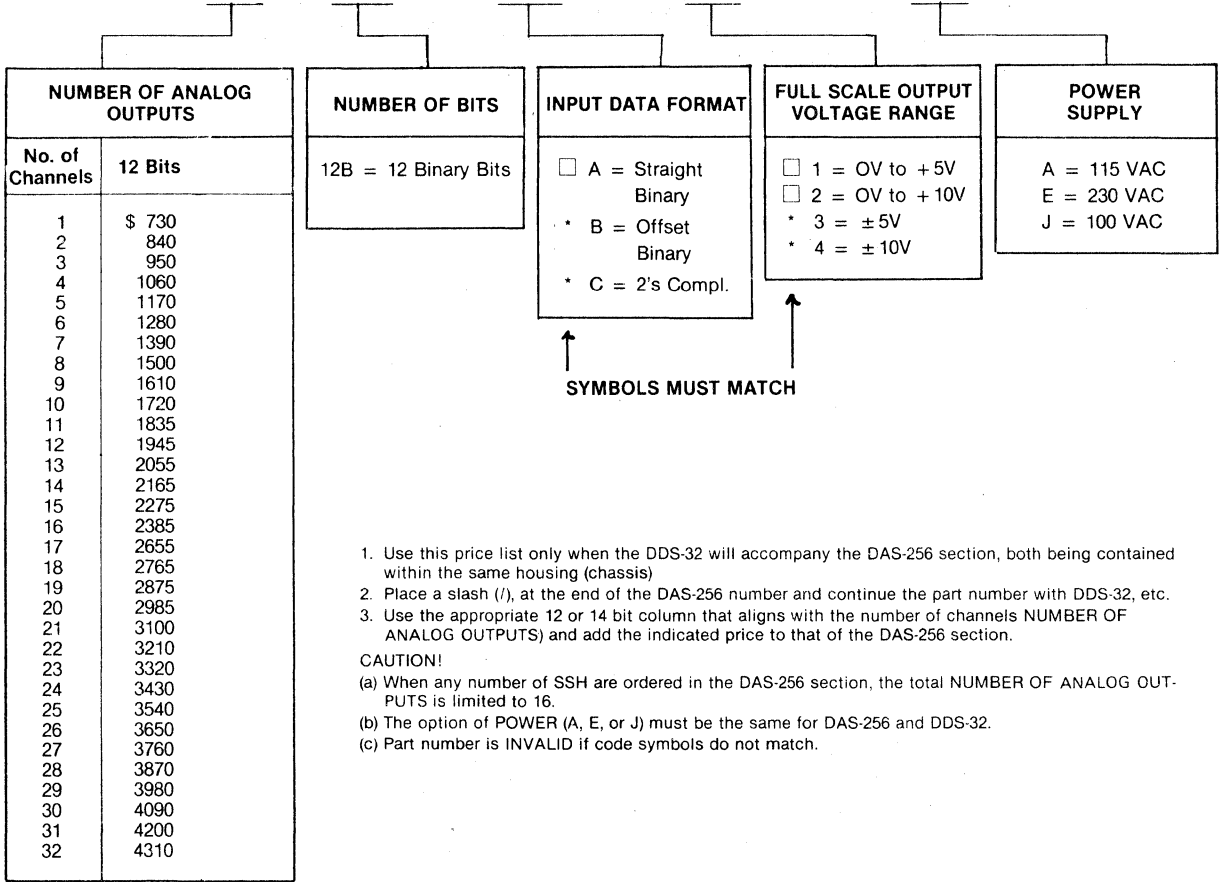
- Use this price list only when the DDS-32 will STAND ALONE without a DAS-256 within the same enclosure.
- Use the appropriate 12 or 14 bit column that aligns with the number of channels (NUMBER OF ANALOG OUTPUTS) to determine the total price.
- Two or more housings are required beyond 32 D/A channels.
- For 14 bit D/A systems, output ranges are 0 to +10VFS, 0 to -10VFS, or ±5 VFS. Straight or offset binary coding is available.

CAUTION!

- The option for POWER (A, E, or J) must be the same for DAS-256 and DDS-32.
- Part number is INVALID if code symbols do not match.

DDS-32 AND PDS-32 (D/A SECTION) ADD-ON

DDS-32-



NUMBER OF ANALOG OUTPUTS	
No. of Channels	12 Bits
1	\$ 730
2	840
3	950
4	1060
5	1170
6	1280
7	1390
8	1500
9	1610
10	1720
11	1835
12	1945
13	2055
14	2165
15	2275
16	2385
17	2655
18	2765
19	2875
20	2985
21	3100
22	3210
23	3320
24	3430
25	3540
26	3650
27	3760
28	3870
29	3980
30	4090
31	4200
32	4310

NUMBER OF BITS
12B = 12 Binary Bits

INPUT DATA FORMAT
<input type="checkbox"/> A = Straight Binary
* B = Offset Binary
* C = 2's Compl.

FULL SCALE OUTPUT VOLTAGE RANGE
<input type="checkbox"/> 1 = 0V to +5V
<input type="checkbox"/> 2 = 0V to +10V
* 3 = ±5V
* 4 = ±10V

POWER SUPPLY
A = 115 VAC
E = 230 VAC
J = 100 VAC

↑ ↑  
SYMBOLS MUST MATCH

1. Use this price list only when the DDS-32 will accompany the DAS-256 section, both being contained within the same housing (chassis)
2. Place a slash (/), at the end of the DAS-256 number and continue the part number with DDS-32, etc.
3. Use the appropriate 12 or 14 bit column that aligns with the number of channels NUMBER OF ANALOG OUTPUTS) and add the indicated price to that of the DAS-256 section.

CAUTION!

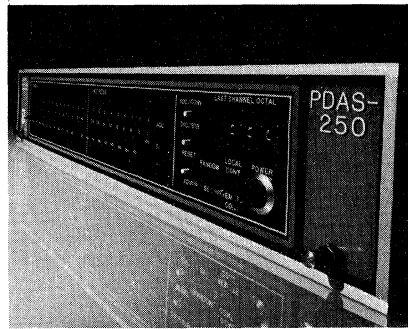
- (a) When any number of SSH are ordered in the DAS-256 section, the total NUMBER OF ANALOG OUTPUTS is limited to 16.
- (b) The option of POWER (A, E, or J) must be the same for DAS-256 and DDS-32.
- (c) Part number is INVALID if code symbols do not match.

- ▶ **Quarter Megahertz Throughput**
- ▶ **256 A/D Channels**
- ▶ **12 Bit Binary Resolution**

No other system available today simultaneously offers the speed, channel capacity and high resolution of Datel's PDAS-250. A unique overlapped conversion method offers total sample-to-sample throughput of 250,000 samples per second. Use the PDAS-250 as the nucleus of a fast array processor, signal processor/analyzer, programmable Fast Fourier spectrum analyzer or high speed data acquisition system.

PDAS-250 offers additional features such as simultaneous sample and hold, optional D/A section and easy channel expansion to 512S/256D total channels in a second housing.

The PDAS-250 includes a high speed, buffered TTL general purpose parallel I/O interface which is ideal for any dedicated mini- or microcomputer.



- ▶ **Simultaneous Sample/Hold Amplifier Option ( $\Delta \pm 1 \text{ nS}$ ) for fast realtime, signal analyzer and FFT applications.**

Introduction	Page 191S
Block Diagrams	Page 192S
Specifications, Timing	Page 193S
Timing Diagrams	Page 194S
Ordering Information	Page 195S
Timing Discussion	Page 196S



## FEATURES

- High Speed, High Density, High Resolution A/D Analog Data System for Mini and Microcomputers
- Quarter - Megahertz throughput rate (4 microseconds per conversion; 250,000 samples per second)
- High Channel Density - 256S/128D A/D channels per housing - select the number of channels required.
- 12-bit binary A/D resolution

- Parallel port interface for mini- or microcomputer.
- Up to 64 simultaneous Sample/Hold (SSH) inputs for real time signal processing (FFT, Spectrum Analyzers, etc.) of dynamic events.
- Will accept up to 32 12-bit D/A channels (Model PDS-32) in the same housing
- System expansion up to 1024 channels and beyond
- Binary LED/Toggle Switch front panel for complete access to all data and addresses.

## DESCRIPTION

Datel's PDAS-250 A/D data acquisition system offers quarter-megahertz throughput rates and high channel density in a complete A/D-D/A system compatible with most minicomputers and high-speed 16-bit microcomputers. The PDAS-250 is the first system to combine 12-bit binary A/D-D/A resolution; 250 KHz throughput and channel density of 256 A/D channels per housing. A complete front panel binary controller with data and channel LED indicators and toggle switches is included with the PDAS-250 for local manual access to the system. The front panel may also be disabled from the local mode, so the PDAS-250 is controlled by the host computer in the high speed remote mode. Up to 256 single-ended or 128 differential A/D channels are available co-resident with up to 32 D/A channels or 64 Simultaneous Sample and Hold (SSH) A/D channels. The SSH optional feature is ideal for real-time dynamic events where all channels are acquired simultaneously and then converted sequentially in 4 microseconds per channel.

The PDAS-250 consists of an A/D section with a fast solid state multiplexer, sample and hold section, successive approximation 12-bit Analog to Digital Converter, data output register and gatable buffer.

Random and sequential channel address logic, mode controllers, status registers, front panel and the AC line power supply complete the system. The PDAS-250 employs a unique overlapped conversion technique whereby a previous A/D conversion is stored in a data register while the multiplexer switches and acquires the next channel. The optional 12-bit D/A section fits co-resident in the same 3½ inch-high rack-mount housing but is ordered under the PDS-32 series model number. Internal logic is CMOS for low power, low analog drift due to minimal heat rise and enhanced reliability. External interfacing is TTL levels for computer bus compatibility.

Channel addresses may be supplied externally from the host computer ("random" addressing) or internally from a channel address counter ("sequential" addressing). Both the A/D and D/A sections interface to parallel Input/Output ports on digital computers. Because digital input mode commands are latched (stored) and the data and digital status outputs are gatable onto open-collector computer buses, the PDAS-250 system Device Select inputs for both sections may be used to share the system with other devices on a multiplexed computer data bus. Two separate 16-bit I/O words would normally be used for data input, address outputs, mode commands and status inputs.

## INTERFACING

The PDAS-250 by itself requires a minimum of a parallel I/O digital port module on the user's host computer.

The recommended interface technique using a parallel I/O port module from the computer manufacturer, will require a handler program written by the user to control and respond to the command and status bits of the PDAS-250 and to supply addresses and take data. One 16-bit input word would accommodate A/D data and status bits and one 16-bit output word will supply channel addresses and mode commands.

The PDAS-250 is an outgrowth of Datel's 50 and 100 KHz DAS-256 Data Acquisition Systems, all featuring internal CMOS logic, low power requirements, external TTL I/O interfacing and 3½ inch-high rack-mount housings.

Users may select PDAS-250 A/D systems in 32S/16D channel increments up to a maximum of 256S/128D A/D channels per housing. Two housings may be directly stacked for 512S/256D capacity and simple external expansion logic offers capacity to 768 channels and beyond.

Outstanding analog specifications have not been compromised by the speed and channel density of the PDAS-250. Over-all system accuracy at +25°C is within ±0.04% of the Full Scale Range (FSR), ±2 mV (single-

ended) and ±0.05% FSR, ±2 mV (differential). Nonlinearity and differential nonlinearity are ±½ LSB and gain temperature drift is typically within ±40 ppm of FSR/°C over the operating temperature range of 0 to +70°C.

Full scale input ranges are 0 to +5V, 0 to +10V, -5V to +5V or -10V to +10V. Input overvoltage is ±35V maximum continuous (no damage) with input impedance of 100 Megohms minimum and typical input bias current of 3 nA. Differential inputs have a common mode range of ±10V and common mode rejection of 80 dB from dc to 60 Hz (1Kilohm unbalance).

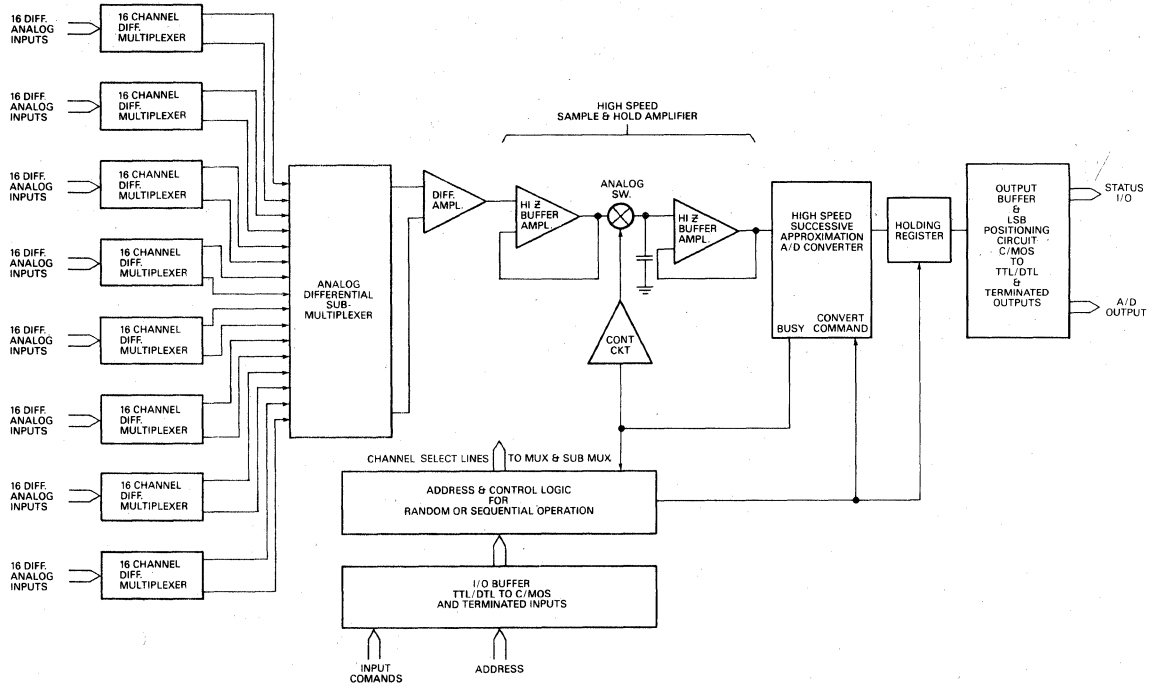
The A/D converter 12 bit output coding is available as straight binary (unipolar), offset binary (bipolar) or 2's complement (bipolar).

Co-resident PDS-32 D/A systems may be expanded in 2-channel increments and co-resident SSH systems may be obtained in 2-channel increments.

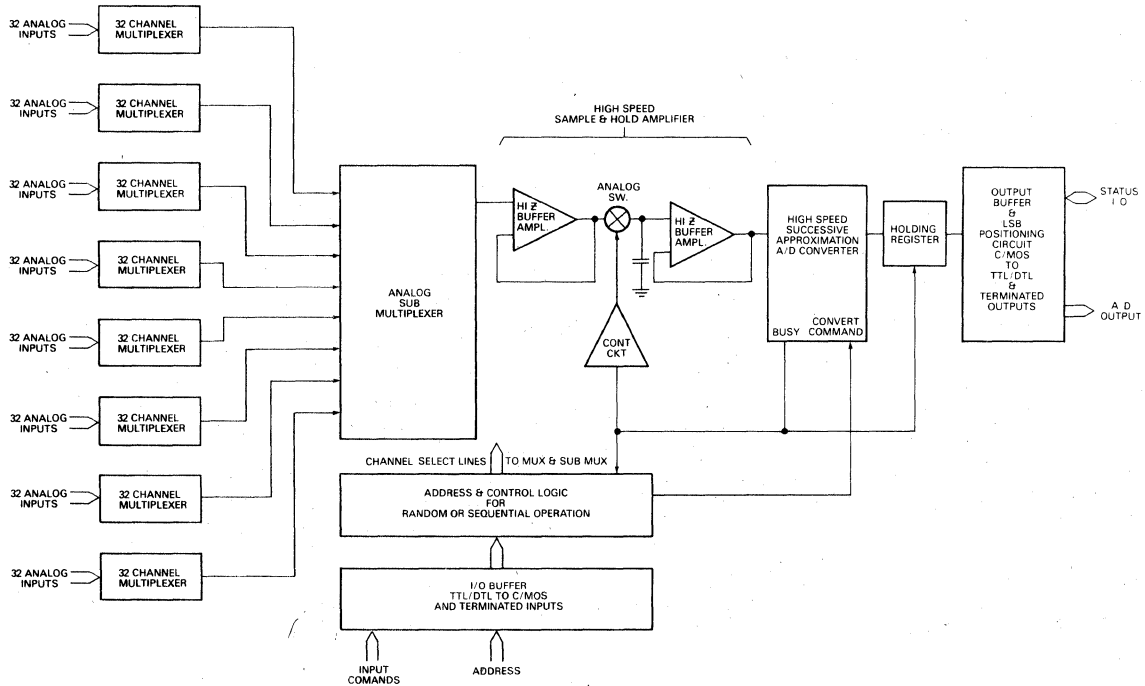
PDAS-250/PDS-32 systems accept a choice of 115 or 230 VAC power, 47-440 Hertz up to approximately 80 Watts typical per housing. Fully loaded maximum system weight is 12 pounds (5,5 kg).

# PDAS-250 BLOCK DIAGRAMS

## DIFFERENTIAL INPUT—128 CHANNELS—A/D SECTION



## SINGLE ENDED INPUT—256 CHANNELS—A/D SECTION



# PDAS-250 SPECIFICATIONS

## DATA ACQUISITION SECTION (Typical at +25°C, dynamic conditions, unless otherwise noted)

### ANALOG INPUTS

#### Number of Channels

Expandable to 256 single-ended or 128 differential channels in 32 (or 16) channel increments.

#### Number of Simultaneous Sample/Hold Channels

Expandable to 64 channels in 2 channel increments.

#### Full Scale Input Voltage Ranges

- 0 to +5V
- 0 to +10V
- 5 to +5V
- 10 to +10V

#### Common Mode Voltage Range

±11V (sig. + CMV) to analog ground.

#### Input Overvoltage

±35V continuous

#### Input impedance

>100 Megohms differential or to ground

#### Common Mode Rejection

60 dB @ 1 KHz } with 1k ohm unbalance  
80 dB @ 60 Hz }

#### Crosstalk

80 dB @ 100 Hz; 45 dB @ 10 MHz

#### Input Bias Current

3 nA typical, 10 nA max.

#### Input Capacitance

5 pF, OFF CHANNEL, 100 pF ON CHANNEL to ground.

### PERFORMANCE

**Output Resolution** 12 Binary Bits

#### Accuracy @ 25°C

Within ±0.04% of FSR ±2 mV (S.E.)  
Within ±0.05% of FSR ±2 mV (Diff.)

#### Nonlinearity

±½ LSB typ.

#### Differential Nonlinearity

±½ LSB typ.

#### Gain Error

Adjustable to zero

#### Offset or Zero Error

Adjustable to zero

#### Gain Temperature Drift

Within ±40 ppm of FSR/°C

### DYNAMIC CHARACTERISTICS

#### Throughput Rate (Overlapped Conversion)

250,000 Samples/Second

#### Aperture Delay Time

20 nanoseconds

#### Acquisition Time

2 µsec. to rated accuracy

#### Simultaneous Sample/Hold Slew Time

50 nanoseconds

### DIGITAL OUTPUTS

#### Output Coding

Straight Binary (Unipolar)

Offset Binary (Bipolar)

2's Complement (Bipolar)

#### Output Logic Levels

All digital outputs are TTL compatible, negative true logic (1 KΩ pullup)

"1" = LO = + 0.2 to + 0.4 Volts

"0" = HI = + 2.4 to + 3.4 Volts

### DIGITAL CONTROL INPUTS

#### Input Logic Levels

TTL Compatible, negative true logic.

"1" = LO = 0 to +0.8 Volts

"0" = HI = +2.0 to +5.0 Volts

### FRONT PANEL CONTROLS

#### Output Data Display

12 Bits of A/D readout

#### Channel Address Switches

9 switches used to address multiplexer in Random Mode

#### Channel Address Indicators

Used to display current multiplexer address

#### A/D Convert Switch

Used to initiate an A/D conversion

#### Reset Switch

Initiates channel address multiplexer to Channel 1

#### Random/Sequential Switch

Selects mode of operation

#### Advance Switch

Selects channel from channel address switches (Random Mode) or advances to next channel for Sequential Mode.

#### Local/Remote

Selects source of system control

#### Last Channel Selector

Used to short cycle the multiplexer in Sequential Mode

#### Power ON/OFF Switch

Applies or removes AC power

### MECHANICAL/PHYSICAL

#### Operating Temperature Range

0°C to +70°C

#### Storage Temperature Range

-55°C to +85°C

#### Relative Humidity

10 to 90% no condensation

#### Physic I Size

3½" H x 19" W x 19" D  
(88.9mm x 483mm x 483mm)

#### Weight

12 lbs (5.4 Kg) typical

#### I/O Connectors

Up to 11, Dual 25-pin PCB

Viking No. 3VH25/1JN5

Datel 31-2076040

#### Input Power

115 VAC ± 10 VAC @ 47 to 440 Hz

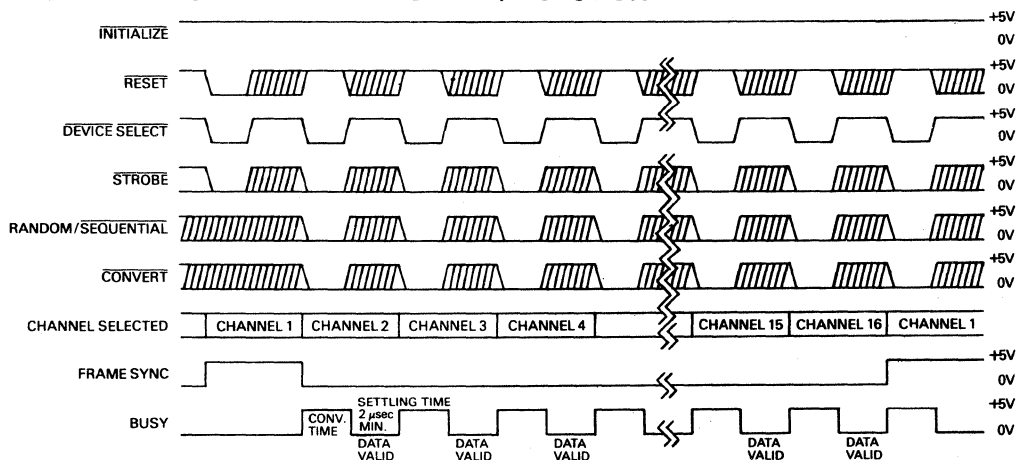
225 VAC ± 15 VAC @ 47 to 440 Hz

80 Watts typical

## PDAS-250 TIMING DIAGRAMS

### TYPICAL TIMING DIAGRAM

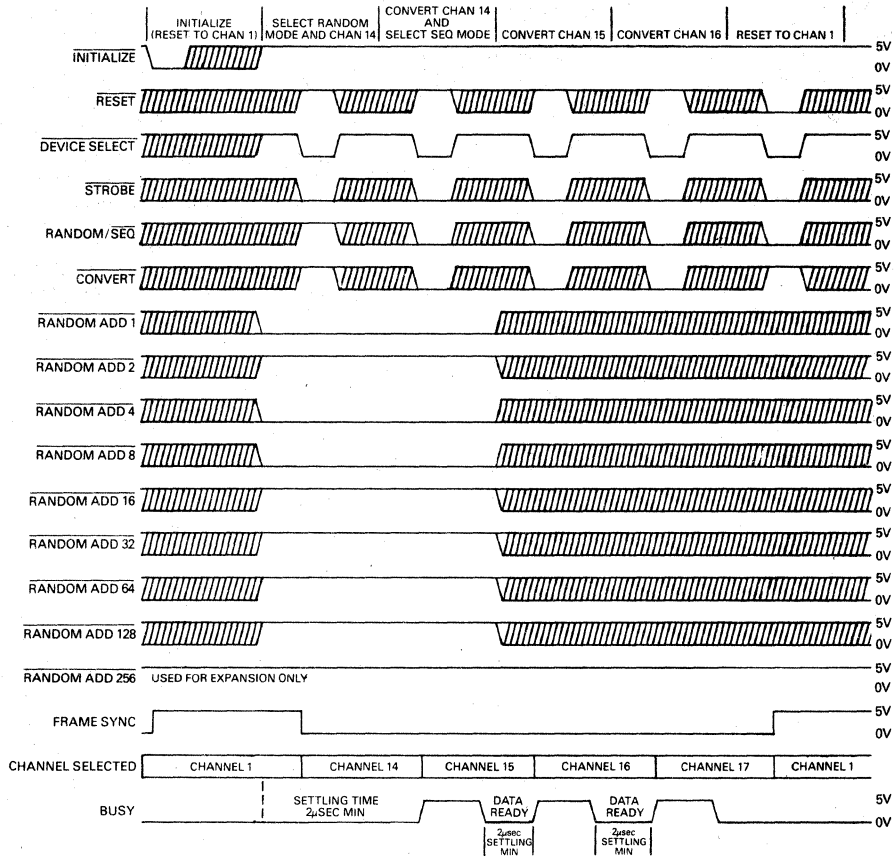
#### SEQUENTIAL SCANNING OF PDAS-250 A/D SECTION



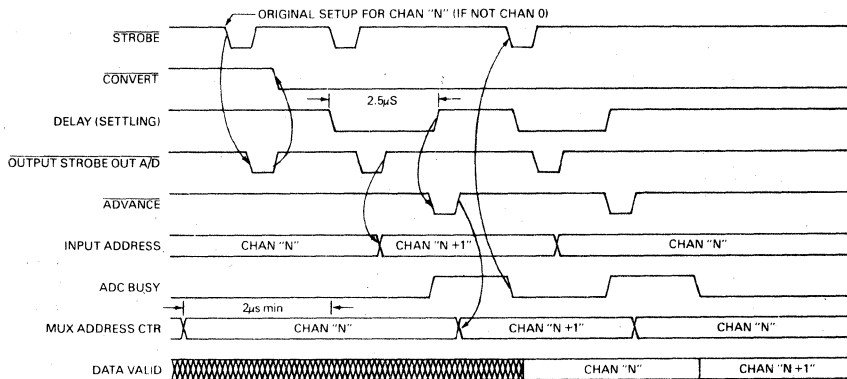
NOTES: 1. Shown as short cycled on channel 16. 2. The state of the random address inputs is immaterial.

# PDAS-250 TIMING DIAGRAMS

## TYPICAL TIMING DIAGRAM FOR COMBINATION OF RANDOM AND SEQUENTIAL OPERATION OF PDAS-250 A/D SECTION



## PDAS-250 RANDOM MODE OPTION 2 TIMING

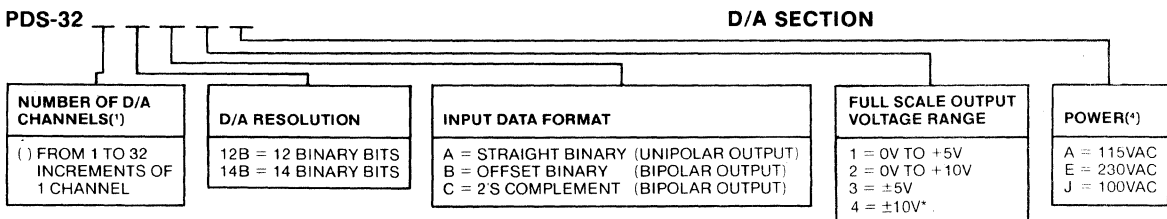
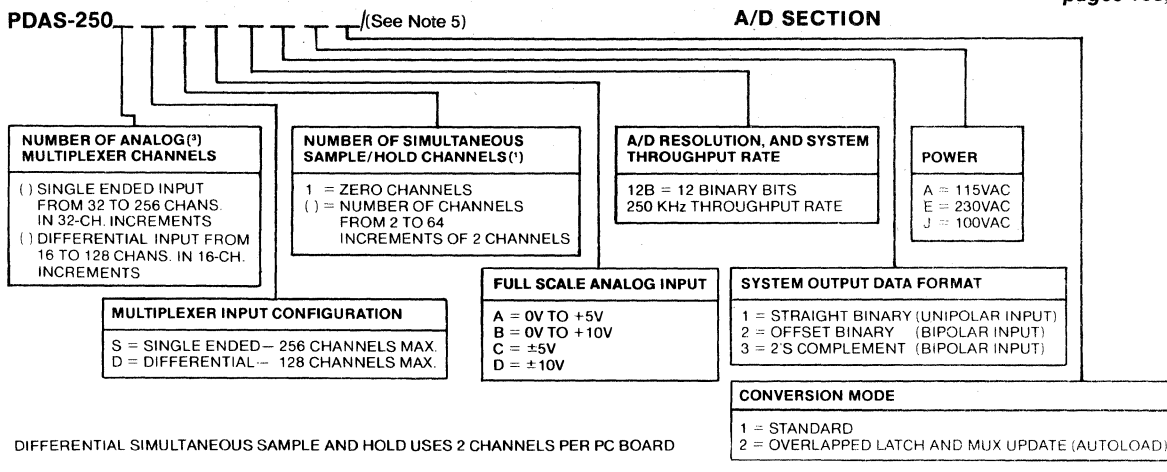


### NOTES:

1. Example shown is for 2 channels: "N", "N + 1", and back to N.
2. If channel zero is to be the 1st channel the setup time is not necessary, providing that the INITIALIZE signal is used to set up channel 0. This takes  $2\mu\text{sec}$  to accomplish.
3. See Sequencer card schematic for jumpering information.

# PDAS-250 MODEL NUMBERING GUIDE

For pricing, see pages 188, 189S



## NOTES:

1. D/A Channels are limited to 16 when any number of Simultaneous SAMPLE/HOLD Channels are ordered. Otherwise up to 32 D/A Channels may be ordered.
2. When both A/D and D/A Sections are required, make the appropriate selection using both ordering numbers.
3. Single Ended inputs and Differential inputs cannot be combined.
4. D/A section power must comply with A/D Section.
5. Add a slash and join the A/D & D/A section model numbers for combined A/D-D/A systems.

\*For 14-bit D/A's, ±10V range is available on special order.

Combined A/D & D/A Sections:  
 PDAS-256-32S1D12B3A/PDS-32-16-12BC4A

## TIMING DISCUSSION

The key to understanding PDAS-250 is to visualize the overlapped conversion method. The traditional route to increasing data acquisition system speed was to shorten the times that each component needed to perform its function. This meant getting the MUX to settle in 2 μS, the Sample/Hold Amplifier to acquire and track signals to rated accuracy in 2 μS and to perform A/D conversion in 2 μS. There was little thought to reorganizing the sequence of events.

PDAS-250 does this by redesigning the timing architecture. An important point in the PDAS-250's overlapped conversion timing is that the controlling computer must keep track of the channel addresses since the address presented to the data acquisition section disappears before the A/D data is available. One way to do this is with staggered files in computer memory. Depending on when data is taken, an offset of one or two channel addresses will yield data which has the proper channel number aligned with its A/D data. For multi-accumulator computers, temporary storage of one or two channel addresses (i.e., using the CPU accumulators as a FIFO buffer) will accomplish the same result. A hardware channel address register will do likewise.

See listing of conventional ("standard") data acquisition timing versus PDAS-250 overlapped timing. Note that a model number designator selects either of these timing options. "Standard" conversion takes 6 μS whereas "overlapped" conversion takes 4 μS.

► PDAS-250 Standard Data Acquisition Timing occurs as follows:

1. Select multiplexer channel
2. Wait 4 microseconds for mux settling and S/H input stage acquisition.
3. Simultaneously switch S/H to Hold and start A/D conversion.
4. At end of conversion, latch A/D data into output registers.

► PDAS-250 Overlapped Latch and Mux Update occurs as follows: Note that we will start at a different point in the timing.

1. Assuming that the mux and S/H input stage have been previously settled for 2 μS min., do the following four things almost simultaneously:

- A. Simultaneously switch the S/H to Hold
- B. Start A/D Conversion

Here's the difference:

- C. Update the mux channel address bits to the next channel. The mux is allowed to settle during A/D conversion. However, the S/H is still holding the previous sample until conversion is completed.
- D. Since the previous A/D sample still held in the A/D converter is about to disappear with the next A/D convert command, and since the computer may not yet have taken the data, the converter's output buffer register switches to latch (hold) the previous A/D data.

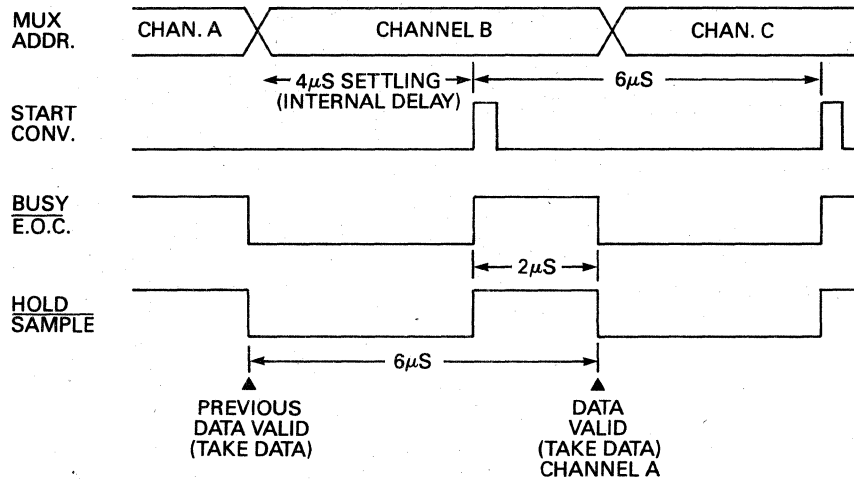
There are two 100 nS delays installed in the circuit. The first delay insures that a clean, glitchless analog signal is stored by the SHM-6 sample/hold amplifier. The second delay insures that a Take Data output isn't presented until sufficient time is allowed to assure that digital data is latched in the output buffer register. This prevents a lightning-fast host computer from taking data before it is definitely latched in the buffer-register.

2. At the end of conversion, the S/H switches to sample the new channel which has been settled in the mux for 2 μS during A/D conversion. The S/H will then take at least 2 μS to acquire the new channel to full accuracy.

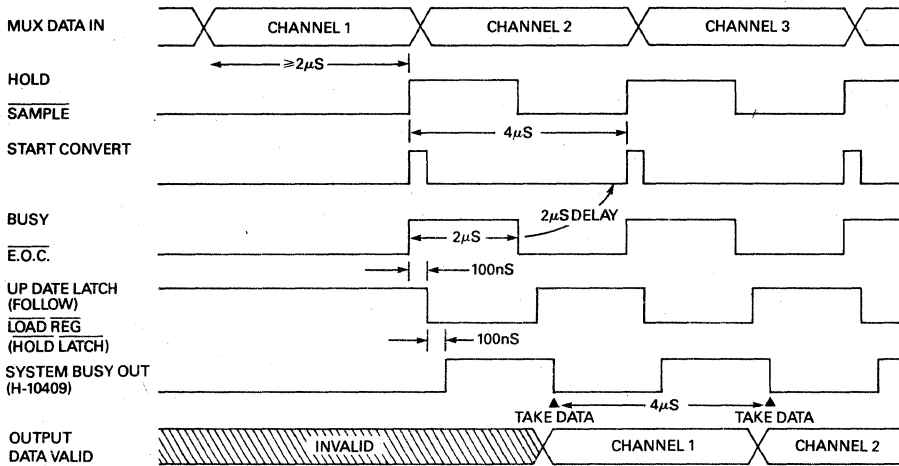
Also at the end of conversion, the output buffer latches are updated with the latest A/D conversion (i.e. the latches switch to follow).

# PDAS-250 TIMING DIAGRAMS CONTINUED

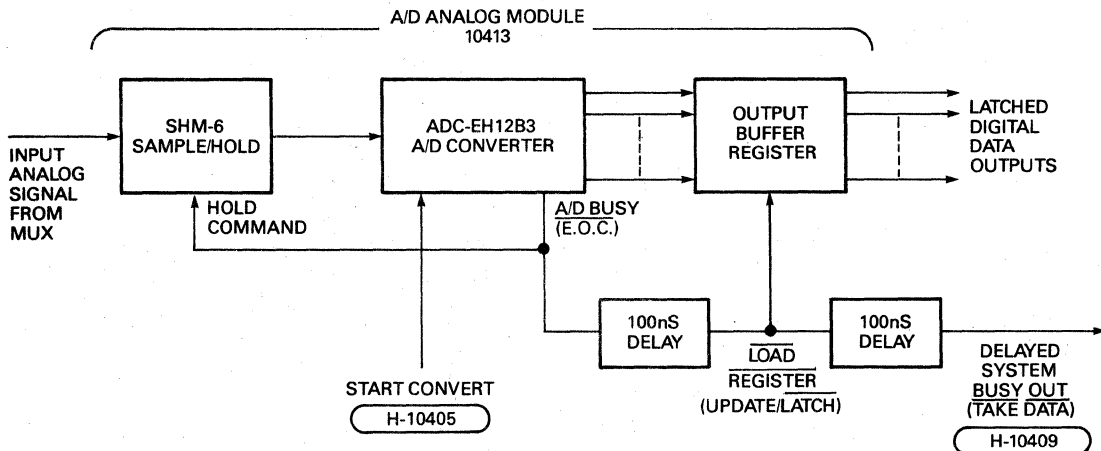
Simplified Timing and Block Diagrams  
(Refer to Timing Diagram on previous page)



**STANDARD CONVERSION MODE (option 1)**  
**SEQUENTIAL OR RANDOM ADDRESSING 166 KHz**



**PDAS-250 OVERLAPPED CONVERSION SEQUENTIAL MODE 250 KHz**  
**(CONVERSION MODE 2)**



**PDAS-250 ANALOG MODULE BLOCK DIAGRAM**

## Model 56-11446-1 50 Conductor A/D-D/A Screw-Terminal Interface Panel

### FEATURES

- Brings connections to front of rack mounting for easy accessibility
- 50 Conductor Analog Signal Input/Output Barrier Screw-Terminal Strips
- Fits into any Standard 19" Wide Rack Mount, 3.5" High
- User supplied ribbon connector for attaching to any desired systems
- Numbered contacts reduce wiring errors
- Ideal for Datel's SineTrac A/D-D/A Boards

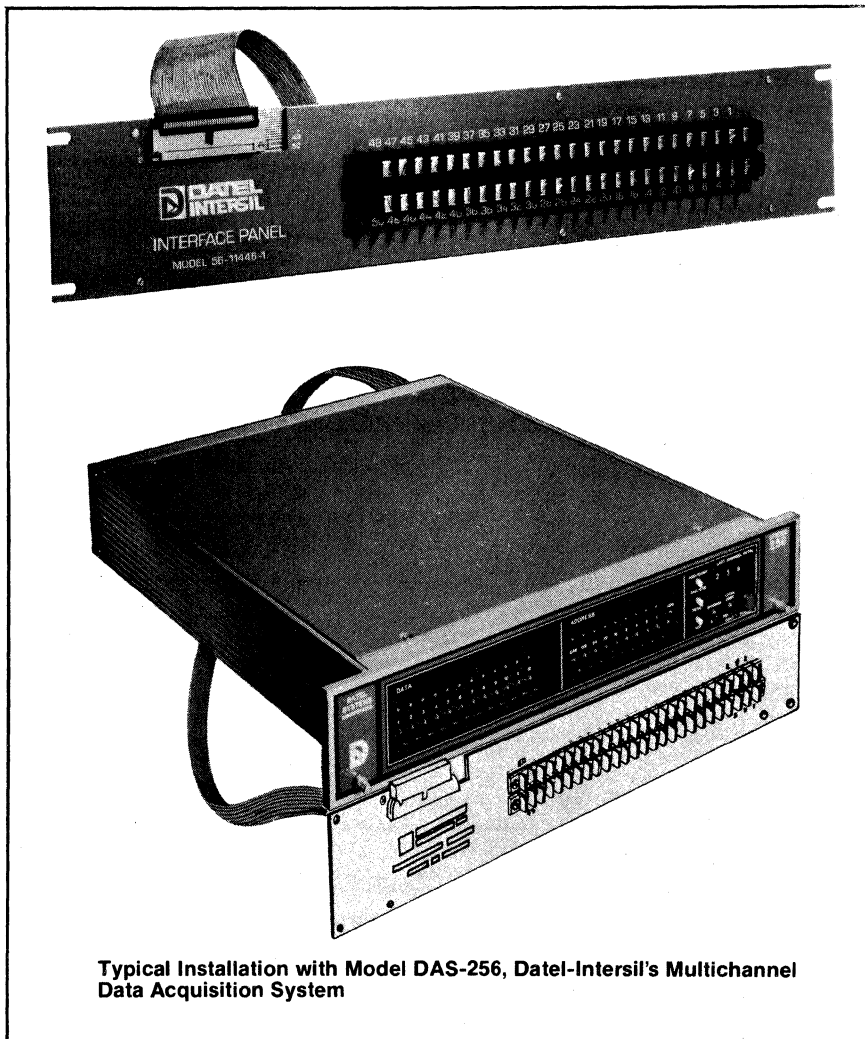
### DESCRIPTION

The Datel Interface Panel Model 56-11446-1 is a rack mounted device for bringing connections from the rear to the front of a rack mount for easy accessibility. It has 50 screw terminals for making quick and sure electrical connections. Also these terminals are numbered 1 through 50 for quick easy reference and these numbers correspond to the numbers on the connectors. Connections are made through a 50 pin or less user-supplied ribbon connector. One of the major advantages of this type of connection is that it does not require soldering of individual wires. For example, ribbon connector suppliers have devised a mass termination method based on the "U" contact principle which displaces insulation from round conductors during terminating to permit multiple connections in a single operation. This method saves considerable labor cost and also greatly reduces the chance of a wiring error.

The Datel Interface Panel finds use in making the pin connections on the back of many of Datel's slide-in data acquisition and computer peripheral boards easily accessible from front panel locations. Specifically, Datel's data acquisition SineTrac A/D-D/A boards are slide-in printed circuit cards that are electrically and mechanically compatible with a variety of computer systems. They expand and make more useful the analog input and output characteristics of the system they are used with. A few specific examples are the SineTrac 6800 series which is used with Motorola's EXORciser microcomputer system and the ST-LSI series used with DEC's PDP-11/03 and LSI-11 microcomputers. Also, ST-800 and ST-711/732 are offered for Intel and MULTIBUS-compatible computers. This Interface Panel can also be used with Datel's System 256, a high performance computer input/output system with 256 expandable A/D and D/A channels. However, the usefulness of this Interface Panel is not limited to these devices for it can be used with any system that can use ribbon cable and connectors.

DEC and PDP are Digital Equipment Corp. trademarks

Intel and MULTIBUS are Intel Corp. trademarks



Typical Installation with Model DAS-256, Datel-Intersil's Multichannel Data Acquisition System

### SPECIFICATIONS MODEL 56-11446-1

- Support** . . . . . Fits into standard 19" (48,2 cm). Rack mounting holes are 18.25" (46,3 cm) apart in length and 3" (7,6 cm) apart in height.
- Terminals** . . . . . 2 rows of 25 screw on terminals which will make easy and sure electrical connections with #6 terminal lugs.
- Connections** . . . . . Ribbon Header connectors and cables. See Ordering Guide.
- Dimensions** . . . . . 19"L x 3.47"H x 1/2"D  
48,2 x 8,81 x 1,27
- Channels** . . . . . 50 Conductors

Model 56-11446-1 Screw-Terminal Interface Panel

Systems

**ORDERING GUIDE**

The Interface Panel is ideal for use with Datel's SineTrac-series A/D-D/A computer peripheral boards. The table below refers to various SineTrac boards and the required ribbon connectors on each board type. Note that some SineTrac boards use PC edgeboard signal connectors instead of ribbon connectors. This will require PCB-to-ribbon adapter connectors (available from 3M and other suppliers). Also, channel address and control signals are passed only **between** various Master, D/A, ADX and DMA SineTracs and need not connect to the Interface Panel (refer to individual SineTrac brochures and users manuals for details).

**PROCEDURE**

Refer to the columns below left to find the SineTrac board used and the number of connectors. The number

of pins will determine the matching female header connector which must be installed by the user on the Interface Panel. The number of connectors will determine how many Interface Panels will be needed. Header connectors are listed in the lower right column.

Then the user must fabricate a ribbon cable using a connector socket selected from the list in the upper right. Cable length will of course be determined by the SineTrac board location in the computer.

**NOTE:** Because of the many pin-number variations, the Interface Panel does not include a right angle header, or socket connector. However, The SineTrac boards include socket connectors ready for ribbon cable fabrication.

**Interface Panel Model 56-11446-1**

**SINETRAC BOARD RIBBON CONNECTORS**

Product	Number of Pins	Number of Connectors Required per Board
ST-800DA Series	20	1
ST-6800ADX Series	20	1
ST-6800 Master Board	20	1
ST-LSI2	26	1
	40	1
ST-LSI2-ADX	26	1
	50	2
ST-LSI Master Board	20	1
	40	2
ST-LSI-DA Series	40	1
ST-LSI-ADX Series	40	2
ST-NOVA A/D Section	40	2
ST-NOVA D/A Section	20	1
ST-PDP A/D Section	50	2
ST-PDP D/A Section	10	1
ST-LSI-RLY	40	1
ST-711RLY, 711, 732**	50	(2) 58-2076061
ST-724**	50	(1) 58-2076061

**CONNECTOR SOCKET FOR SINETRAC RIBBON CABLE**

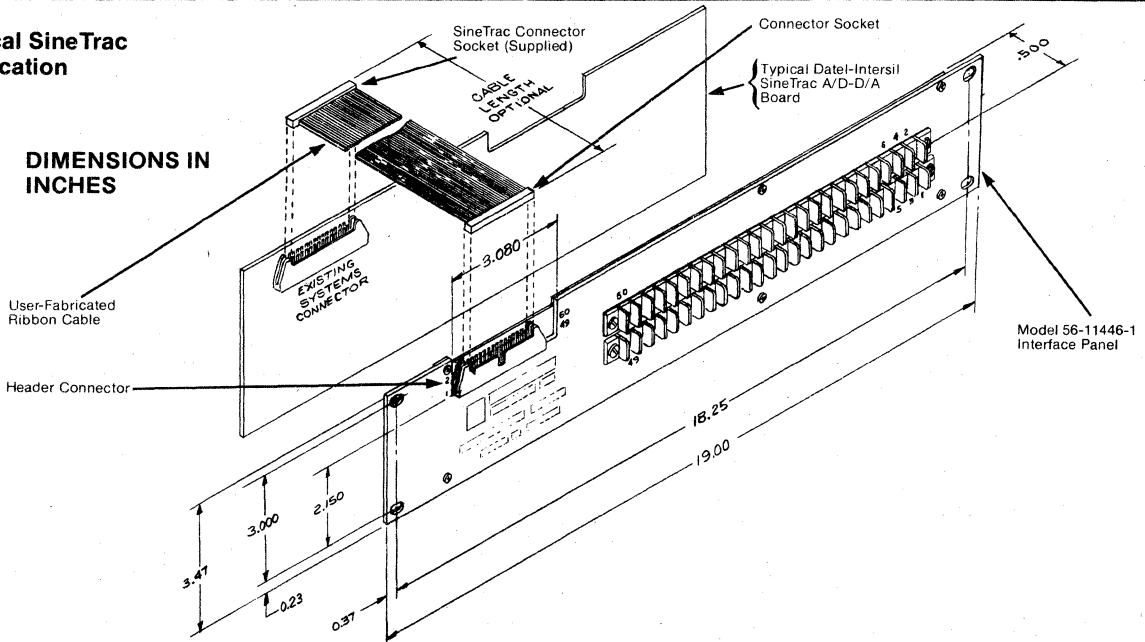
Number of Pins	Datel Part Number
10	58-2079130
20	58-2079135
26	58-2079139
34	58-2079141
40	58-2079143
50	58-2079137

**HEADER CONNECTORS \* FOR DATEL'S INTERFACE PANEL**

Number of Pins	Datel Part Number
10	58-2079020
20	58-2079040
26	58-2079042
34	58-2079045
40	58-2079050
50	58-2079057

\*This chart is for male connectors on the interface panel  
\*\*PCB-to-ribbon connector (solder tab conns. are included)

**Typical SineTrac Application**



Printed in U.S.A. Copyright © 1980 Datel-Intersil, Inc. All rights reserved

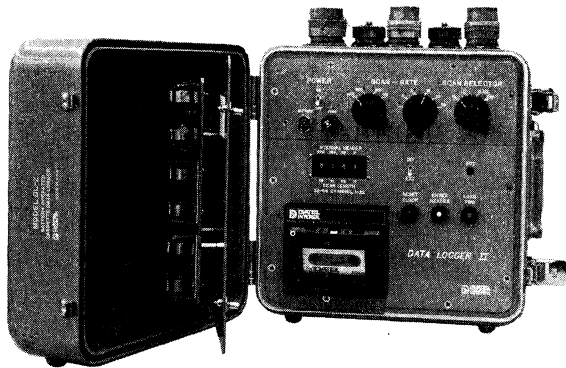


11 CABOT BOULEVARD, MANSFIELD, MA 02048 / TEL. (617)339-9341 / TWX 710-346-1953 / TLX 951340  
 Santa Ana, (714)835-2751. (L.A.) (213)933-7256 • Sunnyvale, CA (408)733-2424 • Gaithersburg, MD (301)840-9490  
 • Houston, (713)781-8886 • Dallas, TX (214)241-0651 OVERSEAS: DATEL (UK) LTD—TEL: ANDOVER (0264)51055  
 • DATEL SYSTEMS SARL 602-57-11 • DATELEK SYSTEMS GmbH (089)77-60-95 • DATEL KK Tokyo 793-1031

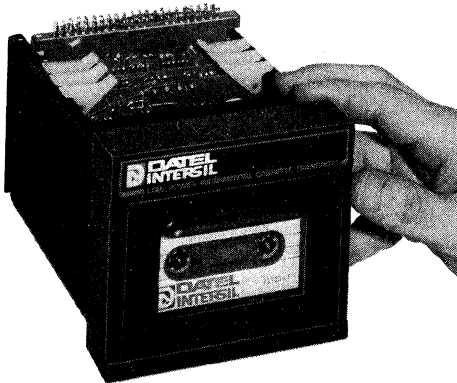
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



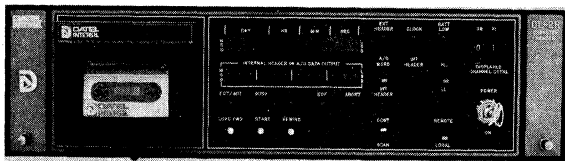
# Low-Power Digital Cassette Data Loggers



DL-2



LPS-16



DL-2R

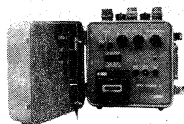
## IN THIS SECTION

SELECTION GUIDE	200S
DL-2	201S-204S
UNCASED DL-2	205S
DL-2T	206S
DL-2R	207S, 208S
LPS-16	209S-211S
LPS-16 INST. AMPL., START CLOCK	212S, 213S
LPR-16	214S-217S
ICT	218S-226S

# LOW POWER CASSETTE DATA LOGGER GUIDE

## LOGGERS (Write-Only)

MODEL & PRICE	TRANSPORT & FORMAT	DATA BIT RATE	BIT DENSITY & CAPACITY	INPUT TYPE	NUMBER OF ANALOG CHANNELS	INPUT RANGES	START CLOCK	POWER REQUIRED	NOTES
DL-2	ICT-WZ2 (Modified). Simultaneous 2-Track, single channel digital complementary NRZ	Writing Rate 100 bits per second. 5 12-bit A/D samples per second, max.	615 bits per inch. 2 Mbits per cassette. 120K A/D samples per cassette.	Analog or 36-bit CMOS digital	32 Differential Low Level or 64 Single-ended High Level	± 5 mVDC FS to ± VDC FS, gain resistor select with optional pre-amp	Preset intervals 1 sec. to 30 hrs., front panel selected. One year calendar clock recorded with each scan	+ 12 VDC 500 $\mu$ A (standby) 70 mA (recording)	Includes weatherproof housing, 10 D-cell battery tray, sealed I/O connectors. Front panel mux short-cycle or manual header write
		Uses LPR-16 Reader/Interface							
Uncased DL-2	Same as DL-2 above less housing but substantially lower cost. Uses DL-2R Reader Interface								Omits connectors, housing and battery tray. Inputs are through PC edgeboard connectors. Readily fits user-supplied NEMA housing.
LPS-16	ICT-WZ2 (Modified). Simultaneous 2-Track, single channel digital, complementary NRZ	Writing rate 100 bits per second. 5 12-bit A/D samples per second	615 bits per inch. 2 Mbits per cassette. 120K A/D samples per cassette.	Analog or serial 1-bit CMOS digital or optional parallel 16-bit CMOS digital	16 Single-ended High Level or optional 8 Differential Low Level	± 10 mVdc FS to ± 5 Vdc FS, gain resistor select with optional pre-amp	Optional Xtal/RC oscillator/binary divider, pin-selected or logic programmable. 400 mS to 4 Hrs. period. No calendar clock.	+ 12 Vdc 10 $\mu$ A (standby) 70 mA (recording)	Panel-mount module. Stored CMOS shared-bus control commands. Automatic channel sequencer records chan. address on tape. No clock recorded. No front panel controls or displays.
		Uses LPR-16 Reader/Interface							
ICT	ICT Series. Simultaneous 2-Track, single channel digital, complementary NRZ.	Writing rate 100 bits per second. 5 16-bit digital words per second.	615 bits per inch. 2 Mbits per cassette. 120K 16-bit words per cassette.	Serial 1-bit CMOS digital or optional parallel 16-bit CMOS digital	No analog channels (Use LPS-16 above instead) ICT is digital recorder only. ICT is an LPS-16 with the analog data acquisition section removed.		None, supplied externally by user or may adapt LPS-16 clock	+ 12 Vdc 10 $\mu$ A (standby) 70 mA (recording)	Panel mount, like LPS-16. 2 spare card slots available.
		Uses LPR-16 Reader/Interface							



See page 201 S



See page 205 S



See page 209 S



See page 218 S

## READERS (Read-Only)

MODEL	OUTPUTS	PRINTOUT	FRONT PANEL
DL-2R	Full Serial 20 mA TTY loop and RS-232-C, 75 to 9600 Baud.	Hexadecimal ASCII (3 char. per A/D sample) Decimal ASCII (9 digits/clock), Octal/Hex. ASCII (Int./Ext. Headers), formatted with spaces and line feeds	LED Hex. 7-Segment display (Headers, Clock) Binary LED (A/D, Int. Header) Transport Controls and Status. Channel Select (octal thumbwheel)
LPR-16	Full serial 20 mA TTY loop and RS-232-C, 75 to 9600 Baud	Hexadecimal ASCII (3 char. per A/D sample, 1 char. per channel number), formatted with spaces and line feeds	Transport controls and status only. (No data display)



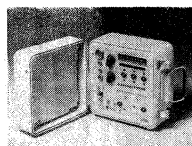
See page 207 S



See page 214 S

## TESTER (For DL-2)

MODEL	POWER SUPPLY	DISPLAY	D/A CALIBRATOR	NOTES
DL-2T	Internal AC supply or internal 6V D-cell batteries or external 6 Vdc	Set/Display Clock, ext. headers, Write External Headers. Display A/D channels. Display internal octal headers.	Optional 12 bits and polarity	Used on DL-2 Only



See page 206 S

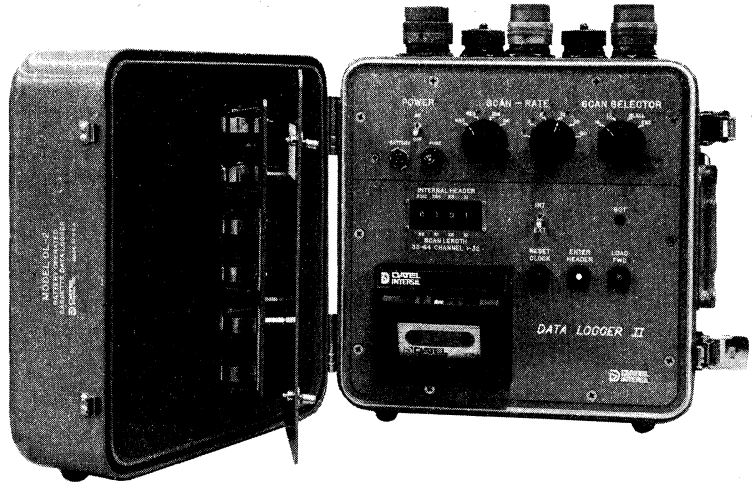
Contact Datel's sales office for full ordering information and pricing



# DL-2 64-Channel Battery-Powered Weatherproof Cassette Data Logger

## FEATURES

- ▶ 64 channel cassette digital tape data acquisition system in a sealed weatherproof, high reliability ruggedized metal case
- ▶ One year lithium battery supply
- ▶  $-10^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  operating temperature range ( $-40^{\circ}\text{C}$  range optional)
- ▶  $\pm 10\text{mV}$ ,  $\pm 5\text{mV}$  or  $\pm 5\text{V}$ , 0 to  $+5\text{V}$  Volt input ranges, 100 megohm impedance, 100dB CMR differential configuration
- ▶ 6mW standby power CMOS design, 1 watt power while scanning,  $+12\text{VDC}$  power
- ▶ 1 second to 30 hour selectable scan rates



## GENERAL DESCRIPTION

For remote environmental recording or long term unattended field measurement of any variable, the battery powered Data Logger 2 will record up to 64 channels of analog data on a Philips-type digital tape cassette. The Data Logger 2 is housed in a sealed, weatherproof ruggedized metal case and will operate for more than a year on its internal lithium battery supply in temperatures from  $-10^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$ . Military type sealed connectors are used for all analog inputs and CMOS circuitry is employed for a low standby drain of 6 milliwatts.

Philips-type digital cassettes with 300 feet of tape are used to record analog data in selectable scan lengths from 1 second to 30 hours. The number of channels to be scanned is preset on front panel thumbwheel switches for efficient use of the tape. The incremental single direction NRZI recording method combined with low power electronics results in a running current of 100mA max. In addition, a header word may be recorded on the tape for later computer identification of that particular tape. A longer 36-bit external header may be entered using the input connectors. In each scan of the selected number of input channels, a 40-bit clock word is recorded before each scan. This 40-bit clock word contains a 36-bit one-year digital clock derived from a CMOS crystal oscillator and having one second resolution. The last 4-bits of the clock word are used to flag a low battery voltage. The system will continue running with a low battery voltage but the user is advised that readings may be unreliable.

A normal scan consists of the clock word, a 12-bit file gap and a string of 14-bit data words up to 64 channels.

The 14-bit data words consist of an analog voltage represented by 12 binary bits and 2 additional high level/low level bits to describe whether full scale is  $\pm 5$  millivolts or 5 volts. A 2-bit character gap begins each word.

The Data Logger 2 can accept up to 64 high level or 64 low level channels or a mix of 32 high level and 32 low level channels. Full external control of the Data Logger 2 is also provided using the input connectors. This includes such flexibility as varied scan rate

for selected inputs by using a second external clock and control circuit.

A long life, 10 Amp-hour lithium battery supply is mounted on the front inside cover of the Data Logger 2. A second set of D-size battery holders allows rewiring to alkaline, mercury or carbon-zinc batteries or for a parallel set of lithium batteries, or any other D cells.

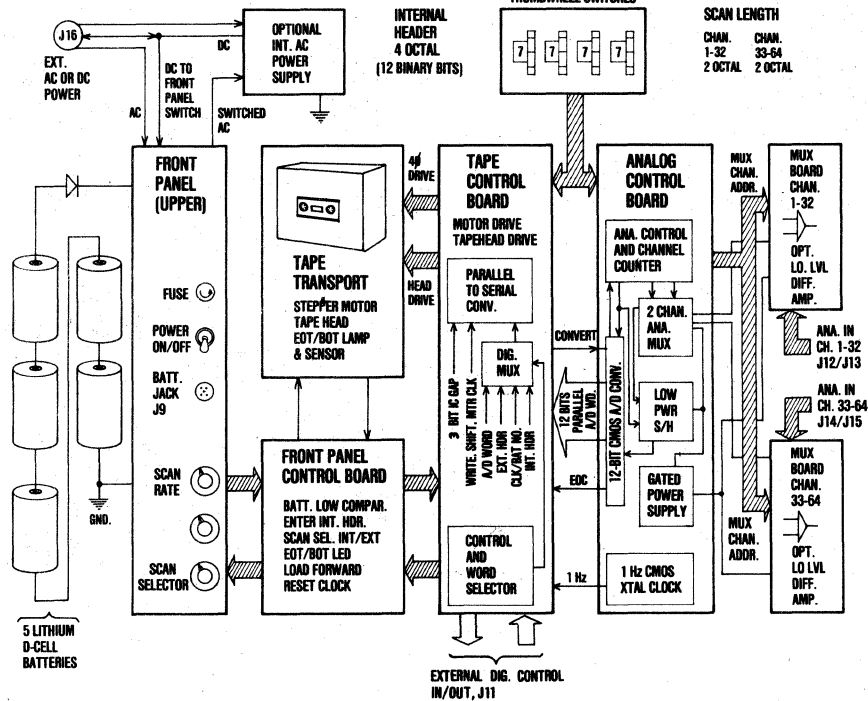
The internal CMOS circuitry of the Data Logger 2 features fast power turn-on initiated by the clock control. An MOS high accuracy analog multiplexer is followed by a differential FET front end instrumentation amplifier for low level inputs. A fast acting sample and hold amplifier is followed by a 12-bit A/D converter at the output. The parallel A/D words are then assembled and formatted into serial information fed to the tape head driver amplifiers. Motor stepper drive circuits, clock and control/addressing systems complete the electronics.

The instrumentation amplifier provides low level differential inputs down to 10 mV span, full scale. Common mode rejection of 110 dB is maintained over  $\pm 5\text{V}$  common mode range for high noise immunity. Overall accuracy (high level—no preamp) is  $\pm 0.04\%$  of Full Scale Range,  $\pm 12$  ppm of FSR/ $^{\circ}\text{C}$  temperature drift. Low level accuracy (with the preamp) is  $\pm 0.3\%$  of FSR  $\pm 1/2$  LSB (8 bits)  $\pm 100$  ppm of FSR/ $^{\circ}\text{C}$  temperature drift (see specifications).

The sample and hold exhibits a 100 nsec. aperture time and A/D settling and conversion occurs within 450 microseconds. The tape is stepped at 100 bits per second so that A/D words are written in 160 msec. (120 msec. for the 12-bit data, 20 msec. for the High Level/Low Level bits and 20 msec. for the intercharacter tape gap). A complete recording of a 64-channel scan takes about 11 seconds. This limits the maximum sampling rate unless a smaller number of channels is selected. Tape capacity is about 2 megabits including all gaps. About six hours is required to fill a tape at continuous running.

The complete system weighs 20 lbs. (9, 1 Kg) with batteries and measures 12"H x 12"W x 10"D (305 mm x 305 mm x 254 mm).

## DATA LOGGER 2 BLOCK DIAGRAM



## DATA LOGGER 2

**Specifications** (Typical over -10°C to +60°C unless otherwise noted)

### Number of Analog Channels:

Selectable up to 64. Can be mixed up to 32 Low Level and 32 High Level channels or up to 64 High Level or Low Level channels.

### Power Supply:

+14.75 Volts DC composed of 4 or 5 D-size Lithium cells, non-rechargeable, 2.8 or 3.4 Volts per cell, 10 Amp-hours per cell. (10) D-size battery holders provided for customer conversion to NiCad, Alkaline or Carbon-Zinc D-cells, or for a parallel set of Lithium batteries.

### Power Supply Requirement:

12V (-.5, +1V):

150mA typ, 200mA max during load forward  
70mA typ, 100mA max during motor stepping  
500µA typ, 1mA max during standby

### Power Supply Operating Range:

+10 Volts to +14.5 Volts DC. Low battery flag is encoded on tape when voltage drops to +11 Volts. However, system will continue operating down to +10 Volts at rated specifications.

### Battery Power Usage:

Approximately 615mA-Hrs. per cassette.

### AC Supplies: (optional)

115VAC ±10%  
100VAC ±10%  
230VAC ±10%

### AC Line Frequencies:

47 to 440 Hz

### External Battery Supply:

Connected through sealed I/O connectors.

### System Weight:

20 lbs. (9, 1Kg)

### Clock Accuracy:

±10ppm (initial), ±10ppm (1 yr. aging), ±15ppm/°C

### Dimensions:

12"H x 12"W x 10"D (305mm x 305mm x 254mm)

### System Temperature Ranges:

Operating: -10°C to +60°C, non-condensing (-40°C optional)  
Storage: -55°C to +70°C

## DATA LOGGER 2:

**Analog Specifications** (Typical over -10°C to +60°C unless otherwise noted)

### Input Ranges:

Low Level differential -5mV to +5mV or 0 to +10mV, (Other LL ranges > 10mV span available on special order). High Level single-ended -5V to +5V or 0 to +5V.

### Input Impedance:

≥ 100 megohm single-ended or differential.

### CMV:

±5V (differential only)

### CMRR:

110dB to 100Hz (differential only with 1K source unbalance).

### Accuracy: (High Level—No Preamp)

±0.4% of FSR ±1/2 LSB (12 bits)

### Temperature Coefficient: (High Level—No Preamp)

±12 ppm of FSR/°C (-10°C to +60°C)

±50 ppm of FSR/°C (-40°C to -10°C)

### Accuracy: (Low Level—With Preamp)

±0.3% of FSR ±1/2 LSB (8 bits)

### Temperature Coefficient: (Low Level—With Preamp)

±0.01% of FSR/°C ±(0.0001% of FSR/°C × Gain\*)

\*Where gain = 10 Volts ÷ Full Scale Low Level Input Span

### Resolution:

12 binary bits

### Aperture Time:

100 nanoseconds max. (sample & hold).

### A/D Conversion Time: (including input settling time)

450 microseconds.

### Sample Time:

150 microseconds.

### Input Connection (Differential, Low Level):

Analog HI, Analog LO and shield ground for each input.

(Single-Ended, High Level): Analog HI and ground

### Overvoltage:

±10V (HL)

±5V (LL) (Must ext. limit current to 5mA)

## DATA LOGGER 2

## Recorder Characteristics

**Storage Media:**

Standard Philips certified data tape cassette 300' length (91 m).

**Storage Method:**

2 channel complementary NRZI, one recording direction.

**Storage Density:**

615 bits per inch.

**Number of Tracks:**

Two, data on Track one, data on Track two.

**Tape Format:**

40-bit digital clock word, 12-bit file gap and one scan of 14 bit binary A/D words (up to 64 A/D words). Internal header 12 bits (4 digit octal) written from front panel push button and 4 digit thumbwheel switch. External header 36 bits written from external source and strobe. (parallel data).

**Gaps:**

3 bit gap written before every 14 bit A/D word, (12 bit A/D word +2 bit HL/LL Channel ID) 12 bit gap written after every clock or header word (Int. or Ext.)

**Tape Storage Capacity:**

2.2 megabits (gaps are considered as bits) per 300 ft. cassette.

**Write Speed:**

100 steps/sec. (one bit (data gap)/step). Incremental.

**Data Format:**

Serial NRZI

**Motor:**

Single 1.5° angle capstan drive stepper motor coupled to take up reel by slip clutch mechanism.

**Capstan:**

.250" diameter

**Step Angle:**

1.5°

**Angular Accuracy:**

±8 min. of arc non-accumulative.

**Tape Motion Control:**

Single capstan pinch roller. Drive head is engaged mechanically during write time.

**Tape Tension:**

0.4 oz.

**Error Rate:**

1 bit in 10<sup>7</sup>

**Type of Cassette Loading:**

Front (after instrument housing sealed front cover is opened).

**Recording Head:**

Dual channel single gap high quality digital type.

**Operating Mode:**

Write only.

**Enter Internal Header: (Int./Ext.)**

Push button switch enters front panel header on tape. (When in the Ext. Mode). Locking toggle switch. When in Int., the Internal Clock has control of the Data Logger via the scan length switches. (Except in between scans, external data may be entered). When in the Ext. position, the logger may be externally controlled; also an Internal Header or External Header may be entered.

**Load Forward:**

Push button switch will light BOT (Beginning of tape) lamp if tape is over clear leader and will move tape forward to oxide while depressed. (When in the EXT. Mode).

**BOT Lamp:**

Will indicate, (when load forward button is depressed) when tape is on clear leader. Lamp is on when over clear leader and off when over oxide coating on tape.

**Clock Reset:**

Push button switch, will reset 1 year internal clock to zero. (When in the Ext. Mode).

**Power On/Off:**

Toggle switch will turn the power on or off.

**Analog Input Selector:**

Four position selector switch selects High Level/Low Level, or High Level and Low Level channels to be scanned.

There is also an Ext. position which is used for optional external control of these functions.

## DATA LOGGER 2

**Digital Inputs**

**NOTE:** CMOS logic levels used. External CMOS driver logic should be used and should track Vdd logic bus from the 3-cell tap or drive through protective external diodes. (Avail. from Ext. connector). 22K ohm pulldowns on all external digital inputs, 1 uSec min.

**Clock Inputs:**

36 lines for pre-setting internal 1 year digital clock or for entering External Header.

**Load Clock:**

1 line presets internal clock to comply with 36 line input.

**Enter Header:**

1 line enters External Header. Must be spaced 500 mSec min. from adjacent scans.

**Start Scan:**

1 line will cause a clock to be written and a word scan to occur (used for external calibration or control). One microsecond minimum duration.

## DATA LOGGER 2

**Digital Outputs****Status Output:**

1 line, indicates when system is busy. This line is used if external data is to be written in between scans. 36 bits of external data may be entered on tape from the external header inputs, provided time is allowed by selecting the proper scan rate position for the number of channels to be scanned, plus the 36 external bits. i.e.: it takes 450 ms to write the 36 bits on tape.

**Clock Output:**

1 line, 1 second time base.

**Head Track 1 & 2:**

4 lines, represent data written on Track 1 and Track 2 respectively. When the Data Logger 2 Tester is used, these lines are used to recover data from the Head to be displayed on the Tester.

## FRONT PANEL CONTROLS;

**Scan Rate:**

1, 2, 5, 10, 20 or 30 seconds, minutes or hours and max. (Max. is maximum rate allowed by the setting of the scan length switches), to nearest second resolution.

**Scan Length:**

Four digit octal thumbwheel switch selects the number of channels/scan. (Two digits for High Level and two digits for Low Level), or (two switches for CH-1-32 and two switches for CH33-64 for all HL or LL channels).

**Header (Octal):**

Four digit octal thumbwheel switch may be entered on tape. (Same switch as scan length).

**Data Logger 2  
Ordering Guide**

Available under GSA Contract

DL-2

**CHANNEL CONFIGURATION**

A = 32 High Level  
 B = 32 Low Level  
 C = 32 High Level and  
     32 Low Level  
 D = 64 High Level  
 E = 64 Low Level

**INPUT RANGES & CODING**

Note:  
 High Level (HL) Inputs are single-ended  
 Low Level (LL) Inputs are differential

1 = Bipolar (offset binary) (not useable if TTY, RS-232-C output is used)  
 LL: -5mV to +5mV  
 HL: -5V to +5V  
 and/or

2 = Bipolar (2's complement)  
 LL: -5mV to +5mV  
 HL: -5V to +5V  
 and/or

3 = Unipolar (straight binary)  
 LL: 0 to +10mV  
 HL: 0 to +5V  
 and/or

4 = Special Low Level Range (contact factory)

Notes: 1 Coding types 1,2,&3 cannot be intermixed.  
 2 Coding must be specified at time of order.  
 3 High level and low level channels may be ordered in the same unit, but all coding must be the same.  
 4 Low level 0 to +5mV is not offered.

**INTERNAL POWER SUPPLIES**

A\* = (10) internal D-cell battery holders installed and internal 115 VAC/60Hz supply  
 E\* = (10) internal D-cell battery holders installed and internal 220 VAC/50Hz supply  
 J\* = (10) internal D-cell battery holders installed and internal 100 VAC/60Hz supply  
 X = External battery connector and (10) internal D-cell holders installed. No internal AC power supply furnished.

Batteries are not included, please order separately below.

Low temperature operation (-40°C to +60°C) available on special order, contact Datel.

**HOUSING, CONNECTORS, AND BATTERY TRAY**

Leave Blank = included  
 1 = not included

For -40°C to +60°C extended temperature version, add suffix -3982

**Data Logger 2  
Prices (single quantity) with Housing**

- DL-2A (32HL)
- DL-2B (32LL)
- DL-2C (32HL/32LL)
- DL-2D (64HL)
- DL-2E (64LL)

**See Page 200S For Prices  
Without Housing (Add "1" suffix)**

- DL-2A (32HL)
- DL-2B (32LL)
- DL-2C (32HL/LL)
- DL-2D (64HL)
- DL-2E (64LL)

Prices include connectors and a cassette but do not include Lithium batteries.

Lithium batteries are D-SIZE "Eternacell" Model 550S-BT manufactured by:

Power Conversion Inc.  
 70 Mac Questen Parkway South  
 Mt. Vernon, NY 10550

or available from Datel, part number 33-12131-2, (5 required)

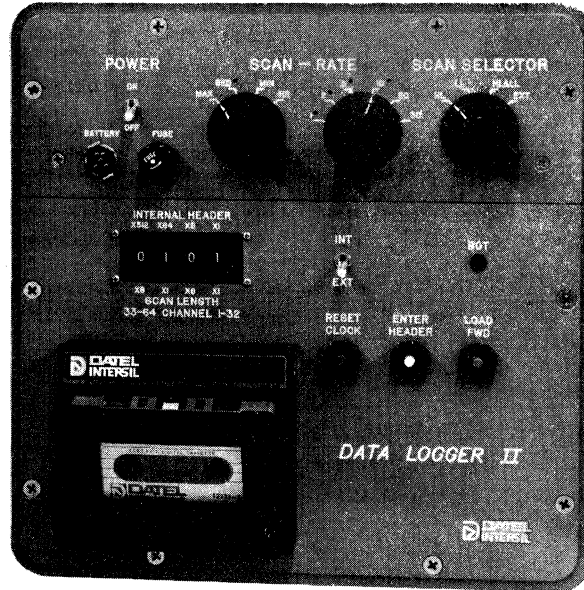
Certified digital tape cassettes, 300 feet (91 m)

Model	Operating Temp.
12123-1	+10°C to +45°C
12123-2	-40°C to +70°C
43-12123-5	450 Ft. Cassette

## Uncased Low-Cost DL-2 Low-Power 64-Channel Cassette Data Logger

### FEATURES

- Model DL-2 Cassette Data Logger less the housing, connectors and battery tray at a *substantial cost saving*.
- Same high performance analog specifications as DL-2:
  - A. 64 HL SE or 32 LL Diff. Channels.
  - B. One-year crystal-controlled recording calendar clock.
  - C. Automatic scan-start clock, 1 second to 30 Hours.
  - D.  $\pm 5$  mVdc FS to  $\pm 5$  Vdc FS input ranges. Resistor-selected high-gain instrumentation amplifier.
- Micro-powered standby operation from any 12-Volt battery: 500 microamps standby between scans, 70 mA while recording.
- Uses DL-2R playback Reader and full serial computer interface.
- Designed for simple mounting in a user-supplied low-cost NEMA housing or for test panel mounting.
- Input connections made through PC edgeboard connectors.



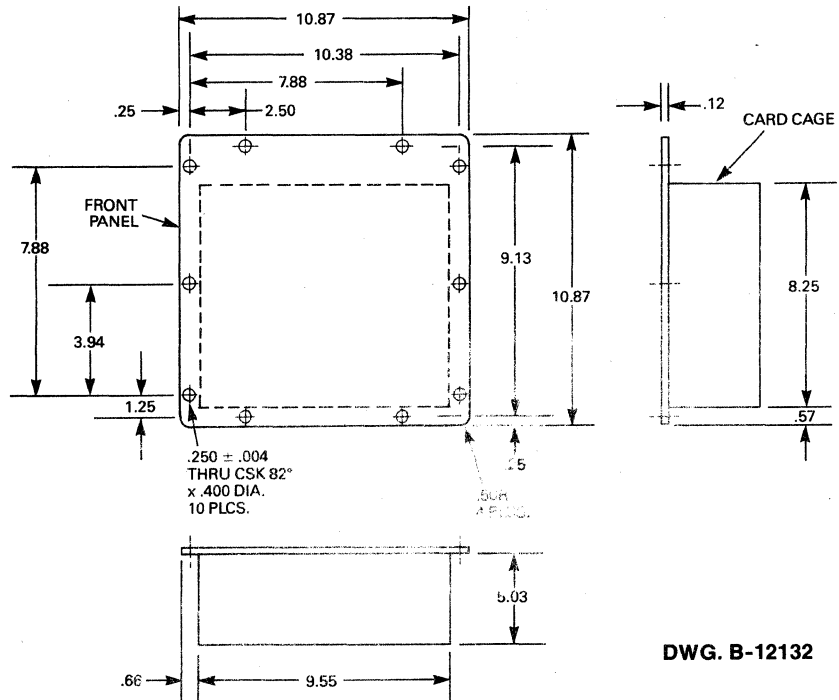
### OUTLINE DIMENSIONS (INCHES)

### DESCRIPTION

Datel-Intersil's high-performance long-term battery-powered DL-2 cassette data logger is available in an uncased version at substantial cost savings. The uncased DL-2 deletes the weatherproof housing, battery tray and sealed connectors. Inputs may be made to the printed circuit edgeboard connectors in the card cage behind the front panel. The uncased DL-2 is a complete front panel assembly which includes an integral rear card cage containing all circuit boards. The outline dimensions are convenient for low cost user-supplied NEMA-housing mounting or for laboratory mounting on a test panel.

### ORDERING INFORMATION

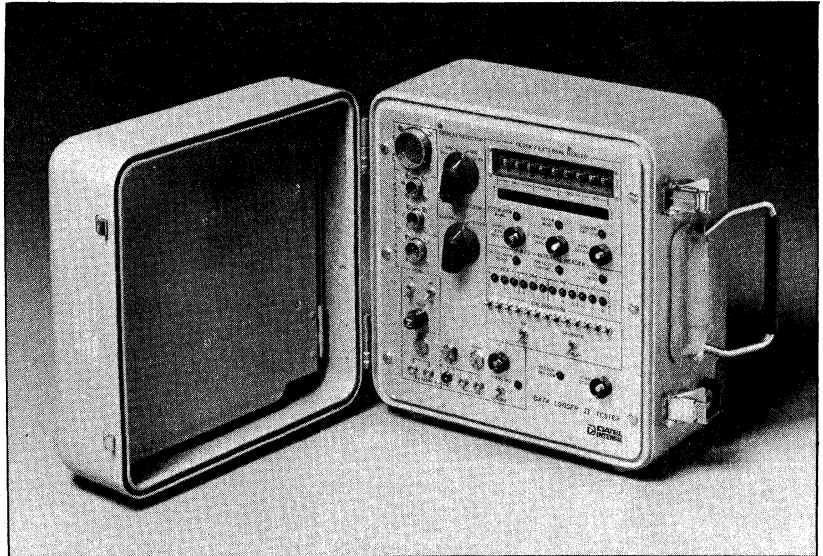
To order the uncased DL-2, simply add a "1" suffix to the regular DL-2 model number. Refer to page 204S for full model numbering.



# DL-2T Weatherproof Portable Tester/Calibrator for the Data Logger 2

## FEATURES

- Completely exercises and calibrates all functions of the Data Logger 2 weatherproof analog cassette recording system.
- Functionally tests all displays and the A/D converter.
- Tests all batteries under full operational load.
- Contains A/D and Digital clock readouts for full calibration and presetting of the Data Logger 2.
- Operates from built-in lithium battery supply or AC power supply.
- Performs a complete self-test to ensure proper Tester operation.



## DESCRIPTION

The Data Logger 2 weatherproof, battery-powered data acquisition and cassette data-logging system will normally require a complete system check-out before committing it to prolonged unattended data monitoring. In addition, the Data Logger 2 will occasionally need on-site field calibration to establish its accuracy. The ideal instrument to perform these tests and calibration is the Data Logger 2 Tester, model DL-2T.

The DL-2T Tester is particularly valuable because it tests the Data Logger 2 and itself. The DL-2T Tester completely exercises the Data Logger 2 on location and performs a self-check to be sure all internal systems are functioning properly in the Data Logger 2.

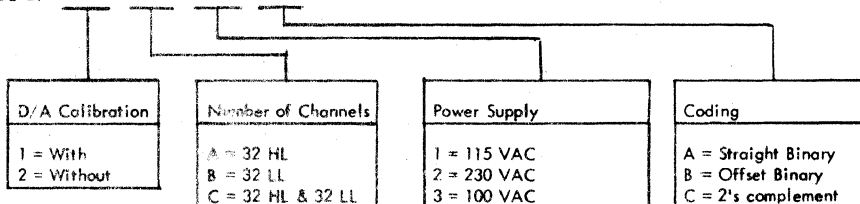
When testing the Data Logger 2, the DL-2T Tester provides input control signals to recover data directly from the head of the cassette transport. Data is displayed on one of two readouts on the front panel of the DL-2T Tester.

To ensure a complete test of all systems, the DL-2T Tester operates from the internal lithium battery power supply of the Data Logger 2 with the exception of display lamps and drivers powered by a separate 6 volt battery in the DL-2T Tester, or from the internal AC power supply.

The Tester has 2 basic operating modes. In the Logger Mode, the Data Logger 2 is tested. In the Tester Mode, the DL-2T tests itself.

## ORDERING INFORMATION

DL-2T



Power Supply and Cables Included  
Batteries are not included (four required)  
Batteries are Datal part 33-12131-1,  
Instruction Manual, part number 58-12140-28 (included)

DL-2T1 Tester with 13-bit D/A calibrator  
DL-2T2 Tester less D/A calibrator

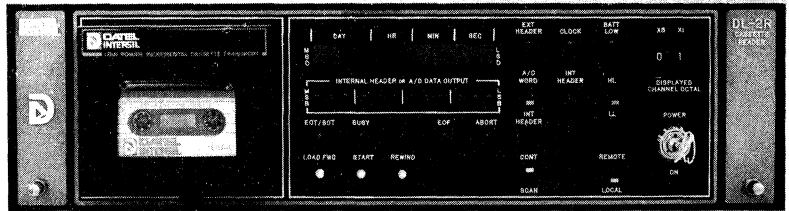
Normal Temp. Range; 0°C. to +60°C.  
Contact Datal for extended range  
(-40°C. to +60°C.) Add suffix  
-3982  
(Example: DL-2T2A3B-3982)



# DL-2R Cassette Tape Reader and Serial Computer Interface for DL-2

## FEATURES

- Digital Cassette Tape Reader for the 64-channel Data Logger 2 (see page 201S)
- Displays digital one-year calendar clock, binary A/D data words, internal octal or external digital header words.
- Includes full serial computer interface:
  1. Teletypewriter (TTY) 20 mA isolated current loop  
**AND**
  2. EIA RS-232-C voltage levels used by computer serial I/O ports and CRT terminals.
- Front panel controls allow manual search for data sample and individual channel data
- Serial I/O controls allow full remote control by computer.
- Preformats ASCII printout into hex/binary A/D characters and decimal clock characters.



## GENERAL DESCRIPTION

Digital cassette tapes written on the Data Logger 2 containing up to 64 channels of analog data may be read directly on the Data Logger 2 Reader, model DL-2R. This reader accepts Philips-type tape cassettes written in Datel's NRZI digital format. Information recorded on tape such as temperature, pressure, rainfall, and wind velocity from external sensors may be transferred directly into a mainframe computer or minicomputer data bus using the DL-2R Cassette Reader.

The Data Logger 2 Reader has two front panel displays, one to list 12 bit binary A/D data words and another decimal display for the calendar clock or external header word. The 9-digit calendar clock in the Data Logger 2 records up to one year of data with one-second resolution. Using clock words, the DL-2R Reader can be stepped through manually or by computer control to find a particular record written at any time. The binary display also shows octal internal headers and the decimal display can be used for external digital header words.

The Data Logger 2 Reader has complete front panel controls to select the channel of interest, to properly start the tape and load data into a computer. A complete serial teletypewriter/RS-232-C interface is included inside the 19" x 19" x 5 1/4" cabinet of the DL-2R.

The serial teletypewriter/RS-232-C interface directly connects to a variety of I/O devices such as CRT terminals, and mainframe computers accessed by remote TTY terminals.

The DL-2R Reader contains special handshaking functions for full computer compatibility. These include word sent and word taken signals and an abort flag which stops the Reader if transmitted words are not accepted 3 times in succession.

Another important feature of the DL-2R Reader is that it connects directly to a variety of data acquisition/processing systems. These include connection to a local, "quick-look" teletypewriter terminal with or without arithmetic capabilities.

The housing of the DL-2R Reader is brushed aluminum and is 5 1/4" high, 19" deep, and 19" wide. It can be rack mounted or set up for stand-alone, table top configuration. The DL-2R Reader is complete and includes AC power supplies for 115/60, 220/50 or 100/60 power voltages.

Cassette tapes are mounted directly on the front panel tape deck. The system can be completely operated through the front panel controls or remotely by computer or teletypewriter terminal.

The complete system weighs approximately 25 pounds.

## SPECIFICATIONS (Typical @ +25°C unless otherwise noted)

### GENERAL

Function	Read Only
Media	Standard Philips-type certified digital tape cassette
Number of Tracks	Two tracks, one's and zero's, read simultaneously
Tape Motion	One direction, capstan stepper motor drive
Tape Speed	2.75 inches per second
Reading Format	Complementary NRZI
Reading Density	615 bits per inch
Bit Rate	1700 bits per second from read amplifier
Bit Capacity	2.2 million bits per cassette (including all gaps)
Record, Word or Intercharacter Gap	3 bits
File Gap	12 bits
Power Required	115/100/230 VAC, 47 to 440 Hz (specify), 65W max.
Mechanical Dimensions	19"D × 19"W × 5.25"H (48,3 cm × 48,3 cm × 13,3 cm)

### TAPE DATA FORMAT

The DL-2R Reader is designed to respond to the tape data format of the DL-2 Data Logger data acquisition/recording system.

The Data Logger 2 normally records a full scan starting with a 40-bit clock word, 12 bit gap and up to 64 channels of 12 bit binary A/D words. The exact tape format of the Data Logger 2 is as follows:

3 bit	Intercharacter gap
36 bit	Calendar clock word (9 BCD digits)
4 bit	Battery low voltage flag
12 bit	File gap
3 bit	Intercharacter gap
12 bit	Binary A/D data word (Channel 1)
2 bit	High Level/Low Level flag
3 bit	Intercharacter gap
12 bit	Binary A/D data word (Channel 2)

Up to 64 12-bit A/D data words and 2 bit HL/LL flags and 3 bit gaps are recorded per scan.

The Data Logger 2 Reader is designed to decode the calendar clock word first and to stop and display this word in the 12-bit file gap. This allows an operator to decide if he wishes to select a particular A/D word in that scan for display.

### FRONT PANEL

Controls - Local/Remote, Continuous/Scan, High Level/Low Level, A/D or Internal Header Word, Start, Rewind, Load Forward, Displayed Channel Select (Octal).

Displays - Internal Header, EOT/BOT, Busy, Rewind, Abort, Clock (ID), External Header (ID), Battery Low, End of File, A/D or Internal Header Readout (12 binary LED's), External Header or Clock Readout (9 Hexadecimal 7-Segment displays).

### SERIAL INTERFACE

Output Type	Full serial optoisolated 20 mA teletypewriter (TTY) current loop and RS-232-C voltage levels (±3V min) Isolation: 300 VRMS, 100 MΩ typical
Baud Rates (Internal jumper selected)	75            1200 110           2400 150           4800 300           9600 600
RS-232-C Signals	Protective Ground Signal Ground Received Data Clear to Send Data Terminal Ready
Parity	Odd, Even or Fixed (Internal jumper selected)
Serial Data Word Format	<b>110 Baud:</b> (11 bits/word) 1 start bit, 7 data bits, 1 parity bit, 2 stop bits <b>All Other Baud Rates:</b> (10 bits/word) 1 start bit, 7 data bits, 1 parity bit, 1 stop bit (1 or 2 stop bits are jumperable for any Baud rate)

### PRINTOUT FORMAT

Note:	Clock Word:
D = Decimal Data	DDD <sub>s</sub> DDSDDSDD <sub>s</sub> CR LF LF
8 = Octal Data	
H = Hexadecimal	DAY HR MIN SEC
S = Space	
P = Internal Parity Error	<b>Front Panel Thumbwheel Header:</b> 8888 <sub>s</sub> CR LF LF
B = Battery Low Flag	<b>Analog Channel Data:</b> HHHS <sub>s</sub> LSHH <sub>s</sub> SHHHS <sub>s</sub> LSHH <sub>s</sub> CR LF
H = High Level Channel	
L = Low Level Channel	12- Chan. Next. Chan. Bit A/D No. (2 LF's for last word in scan)
CR = ASCII Carriage Return	
LF = ASCII Line Feed	(Note: 1 TTY line = four 10-character A/D Channels)
	<b>External Header Word:</b> HHHHHHHHH <sub>s</sub> CR LF

### MODEL NUMBERING

DL-2R2    ∅∅	
<b>Power Supply</b> A = 115 VAC* E = 230 VAC* J = 100 VAC*  *Frequency, 47 to 440 Hz	<b>Baud Rate</b> A = 75      F = 1200 B = 110     G = 2400 C = 150     H = 4800 D = 300     J = 9600 E = 600  (Programmed by internal PCB jumpers)  Note: Word format is 11 bits for 110 baud and 10 bits for all other baud rates

Included with Reader:  
58-2079260 DB-25P TTY Connector (Spare)  
58-2083065 Dataphone Connector Hood (Spare)  
58-12140-7 Instruction Manual

# LPS-16 Miniature Micro-Power 16-Channel Cassette Data Logger

## FEATURES

- 16 Analog channel, write-only battery-powered data acquisition and incremental digital cassette recorder.
- Consumes less than 1 watt (+12Vdc at 80mA) while recording, 120 microwatts in standby.
- Tape moves briefly only while recording.
- A/D resolution is 12 binary bits.
- Stores 120,000 A/D data samples per cassette, 5 samples per second.
- Weighs only 2 pounds. Size: 4" × 4½" × 7½"
- Stored-command, shared-bus multiplexed I/O controls for multiple loggers.
- Optional 8-channel differential low level inputs, selectable to ±50mVFS.
- Optional Scan Start Timer, 200 mS to 2 hours, xtal or RC-controlled.  
Optional 16-bit Parallel Data Input for ident codes, headers, counters, calendar clocks, etc.
- Companion Reader (LPR-16) for playback to computer port, TTY or RS-232-C Terminal

## APPLICATIONS

- Portable Weather Station
- Geophysical and Seismic Monitor
- Oceanographic Probe
- Traffic and Noise Logger
- Pollution, Water, Waste, or Stack Quality Recorder
- Natural Resource Exploration
- RF Field Strength and Transmission Logger
- Remote Utility Load Recorder

## GENERAL DESCRIPTION

Datel's LPS-16 is an ultra-low power A/D data acquisition system and micro-powered digital cassette recorder. Measuring only 4"H × 4.5"W × 7"D (100 × 114 × 178 mm), the 16-channel data logger takes only 134 cubic inches (2200 cu. cm.) of equipment volume and 17.6 square inches (114 sq. cm.) of panel area.

The 2-pound (0,9 kg) module is ideal for portable and unattended data logging applications such as oceanography, environmental monitoring, seismology, meteorology, water and waste quality monitors, traffic and noise loggers.

The entire system is powered by a single +12 VDC external battery supply drawing only 80 mA during brief recording periods and 10 microamps in long-term standby between data scans. Combined with high data density on the cassette, the LPS-16 can operate for months on flashlight batteries.

The write-only LPS-16 is complemented by a companion cassette reader, Datel Model LPR-16, which functions as a serial computer entry system for TTY or RS-232-C interfacing.

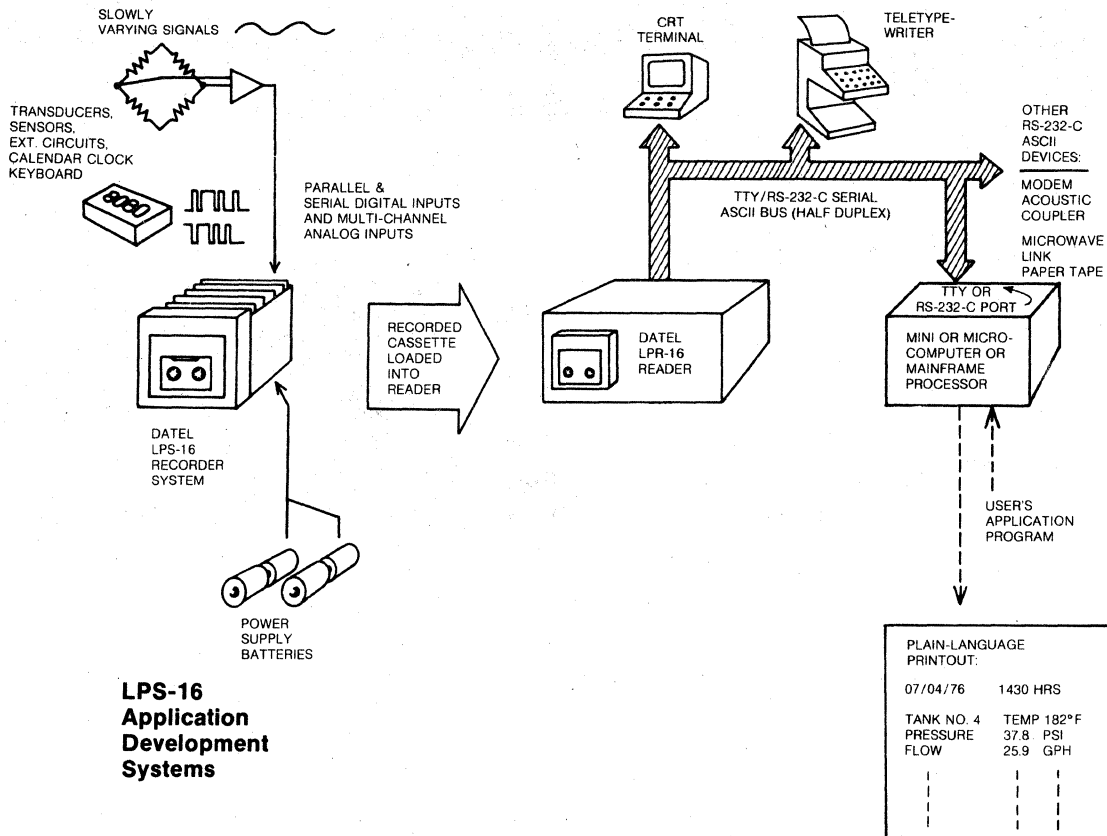
A complete operating system built around the LPS-16 Data Logger and LPR-16 Computer Reader would also include the user's selection of input sensors, cabling, signal conditioners, preamplifiers and transducers which make the conversion from physical variables (temperature, atmospheric pressure, wind speed, humidity, etc.) to



electrical voltage output. And on the playback end, the user must provide his choice of computer and of course the computer program for his unique application to perform arithmetic on the data (integrate data, compute averages, make X-Y plots) and to arrange numerical data and text in tabular form on the printout including engineering units (wind speed MPH, barometric pressure, inches of mercury, relative humidity).

## NEW!! TWO IMPORTANT OPTIONS:

1. **Adjustable-gain Low Level Differential Input Amplifier**  
8 Differential Channels  
Resistor-selectable fixed gain range of ±50mV to ±5V full scale (±50mV supplied standard)  
At ±50mV FSR: Drift ±40ppm/°C, Accuracy ±0.05% FSR  
±½ LSB, CMV±10V, CMR 94dB (100dB, ±10mV FSR)  
Model LPS-16-12B5 — — —
2. **Selectable Start Timer and Parallel Data Input.**  
Crystal or RC-controlled selectable 16-stage binary divider interval start timer  
Range: 5 starts/sec. to 1 start/2 hours or longer  
16-bit parallel CMOS data input, latchable storage register  
Add suffix "-7041" to model number  
(example: LPS-16-12B5-7041,



## OPERATION

The LPS-16 includes CMOS digital electronics for ultra-low power. The 16 single-ended high-level analog input channels are connected to an internal multiplexer using MOS solid-state switches. The output of the multiplexer individually connects each channel to a sample and hold amplifier to hold the analog signal stable for the next stage which is the Analog to Digital Converter. The A/D converter has 12 binary output bits which allow the input signal to be digitized to one of 4096 possible 12-bit codes. This 12-bit parallel digital representation of the selected input is then converted to serial data for timed writing on the cassette tape. An additional 4-bit address is also written along with each A/D data sample to identify the channel number. A unique low-noise, low-power, high density recording method is used where 2 tracks on tape are assigned to zero or one bits, respectively. Data is arranged in files of selectable length, typically 64 A/D samples per file. A/D samples are separated by a 3-step bitless word gap and a 12-step gap separates files. On playback, the Reader may stop tape motion between files for formatting and transmission to the computer.

On the LPS-16 Data Logger, tape moves only while writing A/D data. The tape is stopped at all other times and the system automatically powers down to conserve the batteries and tape.

Channel addressing may be controlled internally from an automatic address sequencer which can be hard-wire short cycled to any channel count or externally controlled from a 4-bit address code supplied by the user. In addition the user may also record synchronous serial 16-bit digit data shifted in from an external shift register. Such digital data might include an externally-generated date-time clock, cassette identification (header), tachometer-counter inputs (wind speed) switch closures, BCD data, etc. The user must also supply various CMOS digital controls such as A/D start commands, random/sequential addressing status, serial digital record mode, serial digital data and others. Various CMOS digital outputs also appear for the user to monitor including the end of A/D conversion, address sequencer outputs, tape motion status, etc.

All operation of the LPS-16 must be made through these digital controls, requiring either hard-wiring, switches or control logic supplied by the user; there are no front panel controls (Datel also offers a full system, Model DL-2, with dedicated front panel controls, date-time clock, low level preamplifier and weatherproof housing — please contact Datel's sales offices).

## PERFORMANCE

The LPS-16 employs a stepping motor cassette transport with a capstan drive operating at 90 steps per second. Since one bit may be written with each step, the maximum recording rate is 90 bits per second. Each A/D data sample takes 16 bits (12 data, 4 address) plus 3 steps for the gap (19 steps total). Therefore, maximum data throughput is approximately 5 samples per second (200 milliseconds per sample). This requires that data be slowly-varying DC (less than 1 Hz bandwidth).

Bit density on tape is 615 bits per inch and one 300-foot cassette can hold about 2.2 million steps or about 120,000 A/D samples, assuming efficiently-long 64-word files.

A/D system accuracy is within  $\pm 0.025\%$  of the full scale range,  $\pm \frac{1}{2}$  LSB where the input ranges are 0 to +5V, 0 to -5V, -5V to +5V, and +5V to -5V (inverted analog coding) with 100 Megohm input impedance. System temperature drift is within  $\pm 40$  ppm of FSR/ $^{\circ}$ C and linearity is  $\pm \frac{1}{2}$  LSB (fully monotonic) over the  $-10^{\circ}$ C to  $+60^{\circ}$ C operating temperature range.

Due to the low power requirement, no rewind motor is provided and users must rewind tapes before insertion into the LPS-16.

The mechanical design consists of a cassette tape transport with a front loading door and mounting plate for panel attachment. The CMOS electronics are contained in five small printed circuit boards and a small card cage, all of which is part of the transport mounting plate.

Analog inputs are through a miniature connector on top of the rear board and digital I/O is provided through a rear motherboard PCB edge-finger connector.

**SPECIFICATIONS, MODEL LPS-16**  
(Typical at +25°C unless noted)

**ANALOG INPUTS** See page 382 for Scan Timer and Parallel Input Information

**Number of Analog Inputs** ..... 16 (8 differential low level LPS-16-12B5)

**Input Channel Configuration** ... Single ended (optional differential)

**Input Voltage Ranges** ..... 0V to -5VFS or ±5VFS, 0 to +5VFS (optional selectable to ±50mVFS)

**Channel Input Impedance** ..... 100 MegOhms "ON" or "OFF"  
NOTE: When the 12VDC system power is turned off each channel has an input impedance of 10K Ohms

**Channel Input Overload** ..... ±10V (max.)

**Channel Mode of Operation** .... Random or Sequential

**Channel Input Acquisition Time** 150 μsec — includes input settling time

**SYSTEM PERFORMANCE**

**System Aperture Time** ..... 50 nsec

**System Accuracy** ..... ±0.025% of FS ±½LSB (±0.05% FSR ±½LSB for ±50mV)

**System Linearity** ..... ±½LSB

**A/D Resolution** ..... 12 Binary Bits

**System Temperature** ..... ±40 ppm of FSR/°C

**Coefficient**

**System Throughput Rate** ..... 200 msec per 16 bit word (12 bit A/D plus 4 bit channel address)

**Input Channel Scan Rate** ..... Up to 5 per second

**A/D Digital Output Coding** ..... Straight Binary — Unipolar Input  
Offset Binary or 2's complement — Bipolar Input

**Cassette Tape Storage Method** ..... Two channel NRZI: Track #1 — Data, Track #2 — Data (Complement)

**Cassette Tape Format (2)** ..... 16 bit words (12 A/D bits plus 4 bits for channel address)

**Cassette Tape Record Gap** ..... 3 bit gap separates each 16 bit word

**Cassette Tape End-of-File Gap** ..... Twelve bit file gap every 64th word, or selectable 1, 2, 4, 8, 16, 32, externally controlled

**RECORDER CHARACTERISTICS**

**Storage Media** ..... Standard Philips certified cassette 300 foot length

**Storage Method** ..... 2 channel NRZI

**Number of Tracks** ..... TWO: Data on track one  
Data complement on track two

**Tape Format** ..... 16 bit words (12 A/D data bits and 4 channel address bits)

**Tape Storage Capacity** ..... 120,000 sixteen bit words including gaps and load forward

**Write Speed** ..... 90 steps per second  
5 sixteen bit words per second (max.)

**Data Input/Output** ..... Serial NRZI or parallel

**Play-Back Speed** ..... See Datel's LPR-16 Reader, 2.75 ips, 1700 bits/sec. optional

**Motor** ..... Single 1.5° angle stepper coupled to take-up reel by slip clutch mechanism

**Tape Motion Control** ..... Single capstan pinch roller drive

**Error Rate** ..... 1 bit in 10<sup>7</sup>

**Recording Head** ..... Dual channel single gap  
High quality digital type

**Operating Mode** ..... Write only

**PHYSICAL-ENVIRONMENTAL**

**Input Power Requirements** ..... +12VDC ±8%  
80 ma when recording (960 mw)  
10μa during standby (120 μw)  
NOTE: Includes tape transport plus all electronics

**Operating Temperature Range** ..... -10°C to +60°C

**Storage Temperature Range** ..... -35°C to +70°C

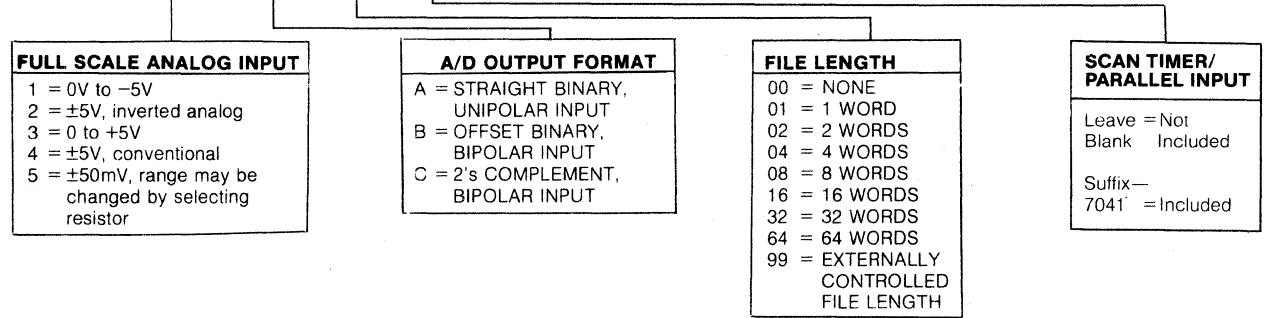
**Relative Humidity** ..... 10% to 95% w/o condensation

**Physical Size w/Electronics** ..... 4" H × 4½" W × 7½" D (6½" deep behind panel)

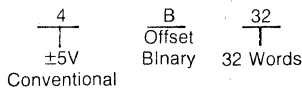
**Weight** ..... 2 lbs. includes recorder and electronics

**ORDERING INFORMATION**

LPS-16-12B-



FOR EXAMPLE:  
LPS-16-12B



**MODEL**

LPS-16-12B  
Low Level:  
LPS-16-12B5  
Scan Timer/  
Parallel Input:  
Add suffix,  
"-7041"  
(Example:  
LPS-16-12B5B64-7041

Connectors are included with each unit.

Spare Connectors:

Digital I/O, Datel 58-2075060  
Analog In, Datel 58-2077000.  
TAPE CASSETTE MODEL 12123-1  
PRERECORDED CASSETTE MODEL 37-6077-1

GSA Contracted: Datel's products are available both direct and through the General Services Administration (GSA). If you are connected with a military or federal agency or receive federal funds, you may be entitled to purchase Datel's data loggers and other products through GSA to expedite requisitioning and order processing.

# LPS-16 Data Logger Optional Low Level Instrumentation Preamplifier

**NOTE:** This LPS-16 option affects only input specifications, as listed below. For complete data logger specifications, see LPS-16 data sheet.

## FEATURES

- 8 Differential Channels
- Resistor-selectable fixed gain for Full Scale Ranges from  $\pm 10\text{mV}$  to  $\pm 5\text{V}$  ( $\pm 50\text{mV}$  supplied standard)
- At  $\pm 50\text{mV}$  FSR, Zero Drift is  $\pm 40$  ppm of FSR/ $^{\circ}\text{C}$ . System accuracy is  $\pm 0.05\%$  FSR  $\pm 1/2$  LSB
- Common Mode Rejection measures 94dB on  $\pm 50\text{mV}$  FSR (100dB,  $\pm 10\text{mV}$  FSR)  
Common Mode Voltage can range up to  $\pm 10\text{dc}$

## APPLICATIONS

- Data logging of remote bridge-type pressure transducers, temperature sensors, or strain gauges
- Logging of any low level signal (to  $\pm 10\text{mV}$  full scale)
- Any remote sensing application where long cables result in common mode voltage to  $\pm 10\text{Vdc}$

## GENERAL DESCRIPTION

Datel-Intersil's miniature LPS-16 battery-powered cassette data logger is now available with a low level instrumentation amplifier which provides high gain and rejection of common mode noise. This option permits the LPS-16 to accept signals directly from many bridge-type transducers and sensors, without requiring external preamps and additional chassis, and without additional power drain. The preamp option is full differential for high common mode rejection from long cables.

The circuit consists of a Datel-Intersil precision AM-201 instrumentation amplifier which is powered up only while writing scans on cassette, to conserve battery power. Input gain is set by a fixed gain resistor installed on the circuit board by the user.

The low level LPS-16 differs from the conventional unit by using a differential Amplifier/Mux/Sample-Hold board in place of the single-ended Mux/Sample-Hold board in a stacked board pair (the stacked pair also includes a sequencer board). Users may purchase the instrumentation amplifier board alone to add differential inputs to any existing LPS-16 at any time.

## ANALOG INPUT SPECIFICATIONS (Typical at $+25^{\circ}\text{C}$ unless noted). (NOTE: For complete specifications, see LPS-16 data sheet).

Number of Inputs . . . 8 Differential  
Input Channel Configuration . . . Differential  
Input Voltage Ranges . . . . .  $\pm 50\text{mV}$  Full Scale (standard)  
Any F.S. Range from  $\pm 10\text{mV}$  to  $\pm 5\text{V}$  can be selected by the user

Channel Input Impedance . . . . . 100 Megohms when converting  
Channel Input Overvoltage . . . . .  $\pm 5\text{V}$  (max., no damage)  
Channel Mode of Operation . . . . . Random or Sequential addressing  
Channel Input Acquisition Time . . . 150 Microseconds (includes input settling time)

### INSTRUMENTATION AMPLIFIER

Input-Offset Voltage Drift . . . . .  $\pm 1.0 \mu\text{V}/^{\circ}\text{C}$   
Gain Temperature Coefficient . . . . .  $\pm 20$  ppm of FSR/ $^{\circ}\text{C}$   
Zero Drift . . . . .  $\pm 40$  ppm of FSR/ $^{\circ}\text{C}$   
Gain Equation . . . . .  $\text{GAIN} = \frac{200,000}{R_2 \text{ (in } \Omega)}$   
Factory selected gain is 100 for  $\pm 50\text{mV}$  Full Scale Range; for  $\pm 50\text{mV}$  FSR,  $R_2 = 2\text{k}\Omega \pm 0.1\%$ , 10 ppm/ $^{\circ}\text{C}$

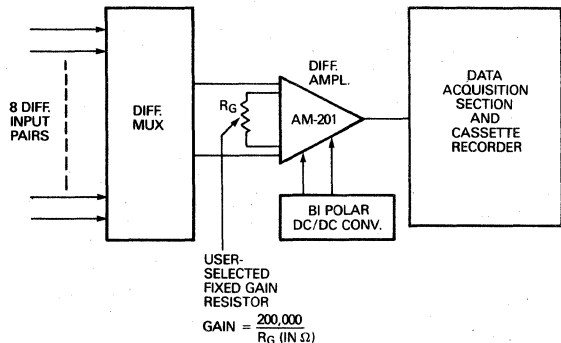
Common Mode Rejection . . . . . 94dB on  $\pm 50\text{mV}$  FSR  
100dB on  $\pm 10\text{mV}$  FSR  
Common Mode Voltage Range . . . . .  $\pm 10\text{Vdc}$  max., 7.1V RMS

## ORDERING INFORMATION

MODEL	DESCRIPTION
LPS-16-12B5 . . . . .	Complete LPS-16 Data Logger with Instrumentation Preamplifier, $\pm 50\text{mV}$ FSR.
43-6731-1 . . . . .	Assembled Amplifier/Mux/Sample-Hold Board alone.
58-2077000 . . . . .	Analog Input Connector, P2, (spare; one provided with LPS-16).

**NOTE:** This LPS-16 option affects only input specifications, as listed below. For complete data logger specifications, see LPS-16 data sheet.

## LOW LEVEL, HIGH GAIN INSTRUMENTATION AMPLIFIER



# LPS-16 OPTION Selectable Start Timer and Parallel Input

**NOTE:** All specifications and operation information for the LPS-16 apply to the LPS-16 with Start Timer and Parallel Input, except Power Requirements as noted below. See LPS-16 data sheet.

## FEATURES

- Crystal or RC-controlled selectable 16-stage binary divider
- Range: 5 Starts/2 seconds to 1 Start/4 Hours or longer
- RC Time Constant may be set to yield nearly any time interval
- 16-Bit Parallel CMOS data input, Latchable Storage Register
- LPS-16 with Start Timer/Parallel Port option draws 4mA with Crystal Oscillator, 210  $\mu$ A with RC oscillator in Standby Mode

## APPLICATIONS

- Automatic Recording of Data at selected intervals - with Time Heading or Identification code.

## SPECIFICATIONS

(Typical at +25° C unless noted)  
(All specifications are as for standard LPS-16, except Input Power below. See LPS-16 data sheet for full specifications).

## INPUT POWER REQUIREMENTS

(Total LPS-16 including Start Timer and Port)

+12 VDC		$\pm 8\%$
Crystal Osc.	RC Osc	
84mA	80.2 mA	Recording
4mA	210 $\mu$ A	Standby

NOTE: Includes tape transport plus all electronics.

## GENERAL DESCRIPTION

This single option is a selectable interval start timer combined with a 16-bit CMOS parallel input register. The timer will automatically start recording of A/D data at preselected intervals from 400 mS to 4 hours. This eliminates the need for an external timer or remote start input. However, these latter options may also be used in addition to the internal timer. The timer consists of an oscillator which may be crystal or RC-controlled and a 16-stage cascaded binary CMOS divider. Intervals are user-selected by combinations of oscillator frequency and divider stage jumper.

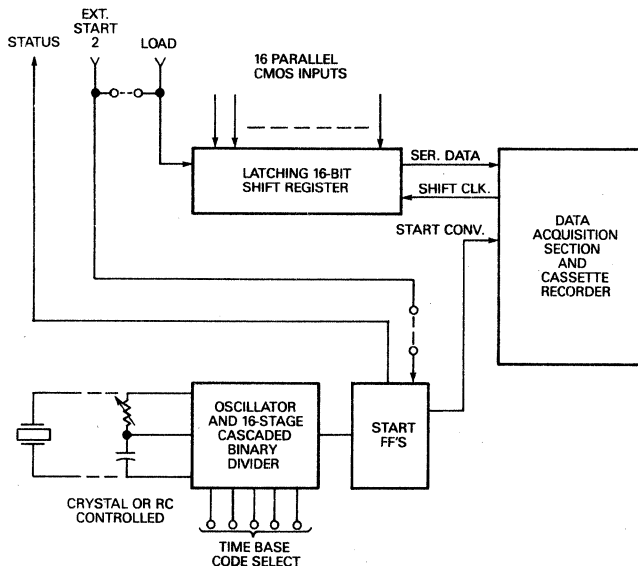
The timer/port option differs from conventional LPS-16's by adding these circuit components to the ADC-HC converter board. The completely assembled board (including the A/D converter) is available for present LPS-16 users.

The 16-bit parallel input port is included with the timer option. The port is ideal for ident codes, headers, calendar (Julian) clock codes, counters, etc. Such paralleled data may be latched and recorded at any time except during an A/D scan recording.

## ORDERING INFORMATION

MODEL	DESCRIPTION
SUFFIX-7041	To designate a complete LPS-16 with Start Timer and Parallel Input, add suffix-7041 to model number. (Example: LPS-16-12B5B64-7041).
43-6945-2	Assembled ADC-HC/Timer/Parallel Input PC Board alone (For existing LPS-16's).

## SELECTABLE START INTERVAL TIMER AND 16-BIT PARALLEL INPUT



# LPR-16 Cassette Tape Computer Interface/Reader for LPS-16 Logger Cassettes

## FEATURES

- Digital Cassette Tape Reader for the 16-channel LPS-16 Data Logger (see page 209S)
- Includes full serial computer interface
  1. Teletypewriter (TTY) 20 mA isolated current loop  
AND
  2. EIA RS-232-C voltage levels used by computer serial I/O ports and CRT terminals
- Serial RS-232-C I/O controls allow remote control by computer
- Preformats ASCII printout into hex/binary A/D characters, external headers, and channel numbers.

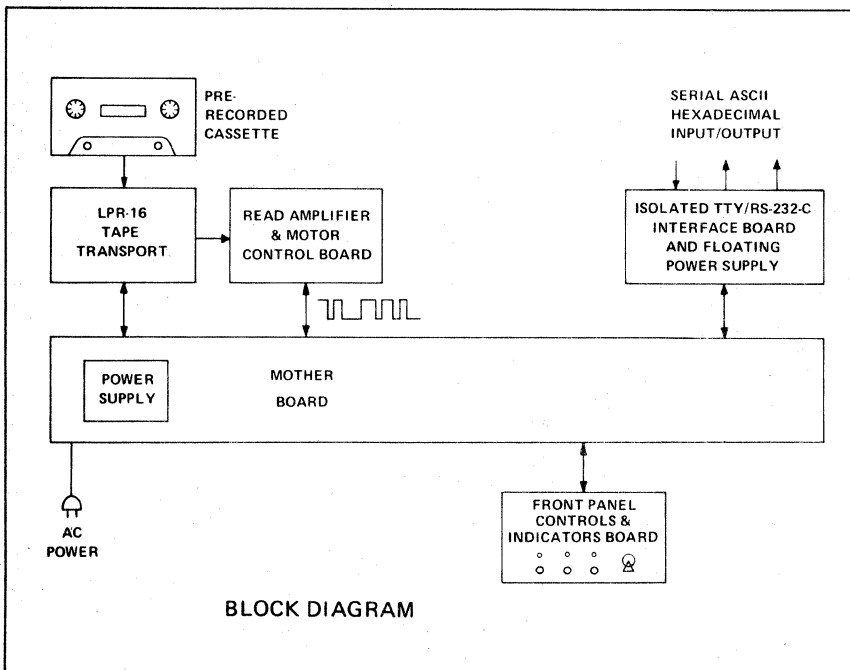


## DESCRIPTION

The LPR-16 Digital Cassette Reader is a combination tape playback reader and serial computer interface unit which is designed to read cassettes written on Datel-Intersil's LPS-16 Cassette Data Logger.

The unique noise-rejecting, single-channel, dual track digital format of the LPS-16 logger tapes are converted into ASCII hexadecimal (16 state) characters which will print out directly on any 20 mA current loop or RS-232-C interface teletypewriter (TTY) or CRT terminal without the aid of an external computer. The LPR-16 reader will also transmit directly to the serial I/O port on most computers. Since raw binary data is first converted by the LPR-16 into hexadecimal ASCII data, the user will normally want to write a reformatting and printout program for his computer to do arithmetic on the data and to present the data in final engineering units and in tabular or graphic form.

The LPR-16 Reader is 5.25 inches high and fits standard 19 inch-width RETMA racks. The read-only LPR-16 includes a 100, 115 or 230 VAC power supply and cassette transport front panel controls. The housing includes rack slides and weighs 25 pounds (11,4 kg).





**SPECIFICATIONS, MODEL LPR-16**  
(Typical at +25°C, unless noted)

**GENERAL**

Function .....	Read Only
Media .....	Standard Philips type certified digital tape cassette
Number of Tracks .....	Two, read simultaneously
Tape Motion .....	One direction, capstan stepper motor drive
Tape Speed .....	2.75 inches per second
Reading Format .....	Complementary NRZI
Reading Density .....	615 bits per inch
Bit Rate .....	1700 bits per second from read amplifier
Bit Capacity .....	2.2 million bits per cassette (including all gaps)
Word Length .....	8, 12, or 16 bits
Intercharacter Gap .....	3 bits
File Gap .....	12 bits
Words Per File .....	1,2,4,8,16,32,64 (standard is 64 words per file)
Power Required .....	100,115 or 230 VAC, 47 to 440 Hz, 60 watts max.
Size .....	19"W × 5.25"H × 19"D
Weight .....	30 lbs. including slides

Baud Rates (Jumper Selected)

75	1200
110	2400
150	4800
300	9600
600	

RS-232-C Signals .....

Protective Ground  
Signal Ground  
Received Data  
Clear to Send  
Data Terminal Ready  
Parity .....

Odd, Even or Fixed (Jumper select)

File Length .....

1,2,4,8,16,32,64 words (Jumper selectable)

Format .....

1 Start bit, 7 data bits, 1 or 2 Stop bits (Jumper selectable)

Printout .....

Alphanumeric hexadecimal (16-state) data representing:

- Channel Address
- Data word (12 A/D bits represented by 3 hex characters)

Carriage Return (CR), Space and Line Feed (LF) characters are automatically issued.

Word Length .....

Automatically formats to 8,10,12,14 or 16 bit words recorded from a Datel LPS-16 or ICT-WZ cassette recorder.

Output Devices .....

Teletypewriters, CRT terminals, computer serial TTY/RS-232-C I/O ports and modem serial couplers.

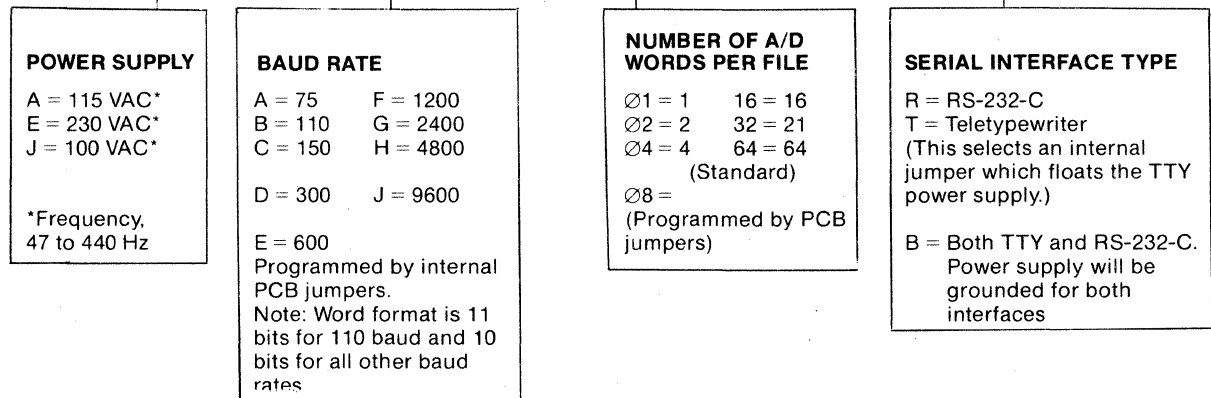
**SERIAL INTERFACE**

Output Type .....	Full serial, both optoisolated 20 mA teletypewriter (TTY) current loop and RS-232-C voltage levels (±3V min)
-------------------	--

**MODEL NUMBERING**

LPR-16-2

∅∅



## TELETYPEWRITER/RS-232-C INTERFACE

### DESCRIPTION

LPS-16 Data Logger tapes may be played back on the LPR-16 Tape Cassette Reader and Interface to teletypewriters and to RS-232-C serial I/O devices. Both of these devices accept serial words using 8-bit ASCII coding. The teletypewriter may be connected by a 2-wire 20mA current loop at fixed speeds of (10) 11-bit words per second or 110 BAUD. RS-232-C devices include CRT terminals and high speed printers with speeds up to 9600 BAUD. The serial TTY/RS-232-C interface for the LPR-16 Reader has a choice of BAUD speeds and with the required floating power supply and optoisolated outputs needed for TTY (teletypewriter) devices. Another very important reason to obtain this interface is that many small computer systems electrically simulate a TTY connection. When the interface is connected to a teletypewriter, paper tapes may be punched off-line while cassette data is being typed out. These paper tapes may be later read back into a computer in on-line mode at higher speeds than the teletypewriter by using a high speed paper tape reader. Since the data rates from the tape cassettes are relatively slow, this would be a more efficient method of transferring data to a high-speed computer or processor.

### HEXADECIMAL OUTPUT

Because of the binary coding of the LPS-16, printout on the teletypewriter and RS-232-C device will be in hexadec-

imal code from 0 to 9 then A through F to indicate 16 states. Thus, teletypewriter output will be alphanumeric up to the letter F. This hexadecimal code can be decoded by computer programming to make a second printout in conventional decimal numbers. Some form of computer programming will normally be required to calibrate analog inputs of the LPS-16. Transducer and other sensor data will normally require computer-corrected offsetting and range manipulation. In some cases non-linear inputs may be linearized using a look-up table in the computer memory. The teletypewriter interface then will allow a "quick-look" at the data using a local teletypewriter operated off-line.

The LPS-16 Data Logger normally records in 8, 10 or 12 bit binary A/D words. Full parallel 16-bit digital words for any purpose from external sources may also be recorded on the LPS-16 if identified by a different file length. External digital words (for time codes, digital identification headers, etc.) are printed out along with the analog words and the printout for both formats is listed below.

Word length is automatic, in that the interface will recognize 8, 10, 12, 14 or 16 bit word lengths (however, all data words must be the same length and all digital words must be the same length for any one file). The logic will adjust the number of characters/line and print the space between the A/D word and channel number automatically. If no channel number is recorded, this space may be eliminated by selecting the no A/D channel number option.

### OUTPUT FORMAT

Data will be outputted in ASCII hexadecimal characters with 0 to 9 and A to F characters (16 states).

The letter symbols are as follows:

- A Address (hexadecimal)
- CR Carriage Return
- D Data Character (hexadecimal)
- LF Line Feed
- S Space

#### 1. 16 bits/word (full four character hexadecimal).

- A. Data file with channel address (12 bit ADC & 4 bit address)

**12345671234567**

**DDDSASSDDDSASS**, etc., for (8 x 7 = 56 characters/line), (64 A/D words/file max.). Each line followed by a CR & LF. Each file followed by a CR, LF & LF.

- B. Data file without channel address

Not applicable (16 bit data file will always have address).

- C. Digital Header File

**1234512345**

**DDDDSDDDDS**, etc. for (5 x 8 = 40 characters/line), (64 16-bit words/file max.) Each line followed by a CR & LF. Each file followed by a CR, LF & LF.

#### 2. 14 bits/word (4 character hexadecimal with MSD limited to 0-3)

- A. Data file with channel address (10 bit ADC & 4 bit address)

Same as 16 bit data file, except MSD will never be more than 3.

- B. Data file without channel address

Not applicable (14 bit data file will always have address).

- C. Digital Header File

Same as 16 bit header file except: MSD will never be more than 3.

#### 3. 12 bits/word (3 character hexadecimal)

- A. Data file with address (8 bit A/D with 4 bit address)

**123456123456**

**DDSASSDDSASS**, etc., for (6 & 8 = 48 characters/line), (64 A/D words/file max.). Each line followed by a CR & LF. Each file followed by a CR, LF & LF.

- B. Data file without address (12 Bit A/D)

(No space in data option required)

**12341234**

**DDSDDDDS**, etc., for 4 x 16 = 64 characters/line,

*(Continued on reverse side)*

## TELETYPEWRITER/RS-232-C INTERFACE

### OUTPUT FORMAT (Continued)

(64 A/D words/file max.). Each line is followed by a CR, LF. Each file followed by a CR, LF & LF.

C. Digital Header File  
**12341234**

**DDSDDDS**, etc., for (4 x 16 = 64 characters/line), (64 12-bit A/D words/file max.). Each line followed by a CR, LF, LF.

4. **10 bits/word** (3 character hexadecimal with MSD limited to 0-3).

A. Data file with address (8 bit A/D & 2 bit address).

This is only applicable if channel scan is limited to 4 channels maximum, i.e.: channel 0-3. (Data is the same as 12 bit data, except the channel address will not exceed 3, i.e., 4 channels.)

B. Data file without address (10 bit A/D)

Same as 12 bit, except MSD will not exceed 3.

C. Digital header file

Same as 12 bit, except MSD will not exceed 3.

5. **8 bits/word** (2 characters hexadecimal).

A. Data file with address

Not applicable: (8 bit A/D is minimum word length).

B. Data file without address (8 bit A/D).

(No space in data option required.)

**DDSDDDS**, etc. for (3 x 16 = 48 characters/line), (64 A/D words/file max.). Each line if followed by a CR, LF. Each file followed by CR, LF & LF.

C. Header File

**DDSDDDS**, etc. (3 x 16 = 48 characters/line), (64, 8 bit words/file max.). Each line if followed by a CR, LF. Each file followed by CR, LF, LF.

Digital/Header words of any length from 1 bit to 16 bits may be recovered by the TTY/RS-232-C card. However, word lengths other than 8, 10, 12, 14 & 16 bits are non-standard on the LPS-16 and require external logic to accomplish the writing of such data. (Consult Datel for applications assistance.)

*Consult LPR-16 System Instruction Manual  
for full details and specifications.*

### LPR-16-2 READER HEXADECIMAL TTY/RS-232C OUTPUT

Data output from the LPR-16-2 TTY/RS-232C Reader is presented in hexadecimal form. This consists of 4-bit binary groups which are designated by 16 single characters from 0 to 9 and A through F. Thus a 12-bit binary A/D word can be represented by 3 groups of 4 bits or 3 hexadecimal characters. After ASCII formatting and sequencing, the analog data appears as hexadecimal printout on a teletypewriter or CRT terminal. The end-user of the raw data will require this information to be in some other form (probably decimal numbers) and appearing in some unique format. That is, instead of channel 4, the printout must say, for example, "TANK NO. 4 TEMP." In addition, the raw voltage must be offset, scaled, linearized or applied to some special function. Finally, the proper units must be applied to the ultimate printout. The net result is that instead of the representation "4F5 B," a user will want to printout "TANK NO. 4 TEMP 182 DEG. F" for example.

This printout formatting and data manipulation is best done in the user's computer program (since each application is unique).

The LPR-16-2 TTY/RS-232-C is brought out in hexadecimal for the following reasons:

1. To simplify the interface electronics and offer the lowest possible cost.
2. To be able to provide *some* sort of TTY/CRT printout just for data verification or very fast manual data calculation before the final printout formatting program is on-line, and without re-

quiring computer connection when first operating the Reader with a TTY.

3. To offer a 4-bit data format with the widest possible bussing utility. The 4-bit hex data can easily be reformatted by the user to suit his particular electronics. 4, 8, and 16-bit microprocessor and minicomputer CPU busses are usually organized in some 4-bit multiple, thus aiding the reformatting design task.

Conversion to decimal printout from the LPR-16-2 hexadecimal output can be done several ways in the final printout formatting program.

1. The tables available from Datel can be manually keypunched and loaded into memory at one time. This then constitutes a look-up table resident in the computer. This method provides high speed, but takes up memory (usually not a problem with a mainframe system).
2. A hex to decimal subroutine can be called up for each data point. Such a "CALL HEX" subroutine for example can be generated from the steps required to manually convert from hex to decimal. In addition, offsetting and scaling factors can easily be programmed for specific data channels.

This technique takes more processing time per data point, but doesn't require the hex table stored in the look-up memory. The "CALL HEX" subroutine, however, would have to be stored and would take a considerable number of steps in assembly language.

## ICT-Series Incremental Ultra-Low Power Digital Cassette Recorder

### TRANSPORT FEATURES

- ▶ Simple, reliable capstan/pinch roller stepping motor drive
- ▶ Ultra-low power (700 milliwatts while writing) using CMOS electronics
- ▶ True standby incremental performance starts writing within 20 milliseconds
- ▶ High data capacity: Up to 2.2 million bits per 300 foot cassette

### RECORDER SYSTEM FEATURES

- ▶ Accepts digitized analog, serial or parallel digital inputs
- ▶ Ideal for +12VDC battery portable digital data recorders
- ▶ Reader Systems available to interface most computer terminals, RS-232-C CRT displays, modems and teleprinters (TTY)



### INTRODUCTION

Datel presents its ICT-series digital incremental cassette tape transport systems. These unique data recorders and reader systems offer a new concept to the instrument designer—miniature, removable ultra-low power, digital data storage. Using a Philips data tape cassette, low power incremental stepping motor and CMOS electronics, these recorders are ideal for portable-battery-powered data collection instruments.

The ICT cassette transport forms the nucleus of your low power, portable data recorder. It is ideal for recording serial or parallel CMOS logic signals for any type of customized data.

A separate rack-mounting reader/interface system, model LPR-16 (see page 213S) is used to play back tape cassettes and includes a full serial interface for convenient computer entry and printout. The companion LPR-16 will connect directly to 20 mA current loop teletypewriters (TTY's) and RS-232-C CRT terminals.

Datel also offers a new concept to the engineer or scientist interested in data recording with tape systems. The ICT-series offers a simplified approach with circuit card modules which are specified in terms familiar to circuit designers who know digital logic. Data entry, retrieval and power-up, power-down considerations are simplified to the point of providing and accepting logic levels at the required times. For a complete system design, details of the transport's flux levels and motor drive are transparent to the designer, requiring only a knowledge of ultimate word size, bit rate and data capacity. Yet Datal's transport and individual card modules are fully specified so that customized systems may be created at any level from transports alone up to fully packaged systems.

With very fast power turn-on, the tape moves only when actually recording data or creating a gap. At all other times when not recording data, the transport and power-multiplexed electronics remain turned off to save tape and batteries. The fast turn-on, turn-off feature means that tape is up to writing speed within 10 milliseconds with no coasting when turned off. Data systems such as seismic recorders may be designed to record only when data is actually present, providing a very large data capacity per cassette. Hand-held stock inventory recorders move the tape only when keyboard data has been entered.

### MODELS AVAILABLE

Datel offers these cassette recorders and companion readers as complete systems or as general purpose component modules for the widest range of applications. The basic ICT-series transports are available with a family of printed circuit cards, parallel-to-serial/formatter cards, writehead amplifier and motor controllers. Transport and PC cards may be purchased separately at any time to build complete customized low power digital recording systems.

### APPLICATIONS

Complete Cassette Data Logging Systems from Datal are available to record up to 16 or 64 analog channels, both as user-mounted modular systems and as stand-alone, weather-proof automatic data acquisition/logging systems (refer to Datal Models LPS-16 and DL-2). Applications include oceanographic buoys and submersible probes, portable air and water quality environmental monitors, traffic and noise loggers, natural resources exploration, vehicular testing, seismic and geophysical measurements, RF field strength and transmission loggers, unmanned weather stations and biomedical loggers.

# DIGITAL CASSETTE TRANSPORT SPECIFICATIONS

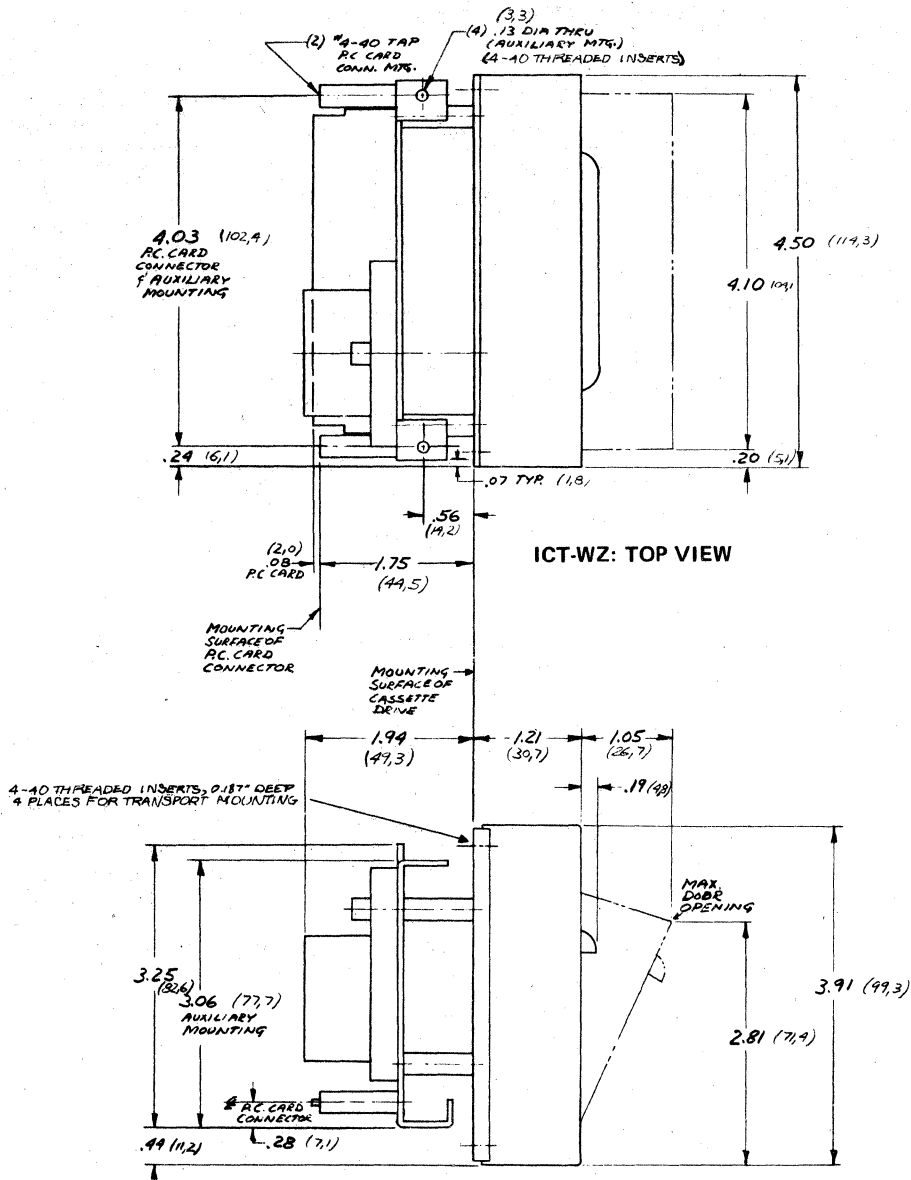
## MODEL ICT-WZ COMPLEMENTARY NRZ FORMAT

GENERAL	
<b>Recording Medium</b>	Philips magnetic tape cassette, certified for digital operation by using a bit-error check for dropouts. The transport is designed to accept cassettes complying with ANSI X3.48, ECMA 34 and ISO/DIS3407 specs.
<b>Number of Tracks</b>	Two half-width tracks, recorded simultaneously
<b>Recording Direction</b>	One direction only
TAPE MOTION	
<b>Motor</b>	4-winding, 24 pole, permanent magnet stepping motor
<b>Equivalent Tape Speed Range</b>	Zero to 0.163 inches per second (4, 13 mm/sec)
<b>Bit Density</b>	615 bits per inch (615 FRPI) 24 bits per mm
<b>Bit Cell Spacing</b>	0.00163 inches per bit (0.0414 mm per bit)
<b>Bit Writing Rate</b>	Zero to 100 bits/second, asynchronous
STEPPING MOTOR CHARACTERISTICS	
<b>Tape Drive Capstan Diameter</b>	0.1246 inches 3,16 mm
<b>Capstan Rotation Step Angle</b>	1.5°
<b>Stepping Rate</b>	Zero to 100 steps per second, asynchronous
<b>Number of Stator Windings</b>	4
<b>Winding Resistance</b>	450 ohms per winding, ±20%
<b>Winding Inductance</b>	335 millihenries per winding, ±20%
<b>Motor Steps per Bit Cell</b>	1
<b>Winding Voltage</b>	±10V min. to ±24V max.
<b>Hub and Capstan Torques and Tape Tension</b>	Suitable for cassettes within ANSI/ECMA/ISO specifications
WRITE HEAD CHARACTERISTICS	
<b>Tape Saturation Current</b>	5mA typ.
<b>Suggested Write Current</b>	7.5mA typ.
<b>D.C. Resistance</b>	50 ohms ±20%
<b>Effective Track Width</b>	0.057 inches (1, 45 mm)
<b>Nominal Space Between Tracks</b>	0.035 inches (0,88 mm) (Tracks are symmetrically spaced)
DATA CHARACTERISTICS USING DATEL'S ELECTRONICS & CASSETTES	
<b>Recording Format</b>	2-track serial complementary NRZ: 1's on Track 1, 0's on Track 2
<b>Connector Type</b>	Dual-readout 44-pin PC edgeboard fingers (male) to connect to card cage. Mates to a Cinch #251-23-30-160 or Viking 2VH-22/-IAN or Datel #36-2075060
<b>Error Rates (Typical)</b>	1 repeatable in 5 cassettes
<b>Character Record Length</b>	8, 10, 12, 14 or 16 bit characters or words

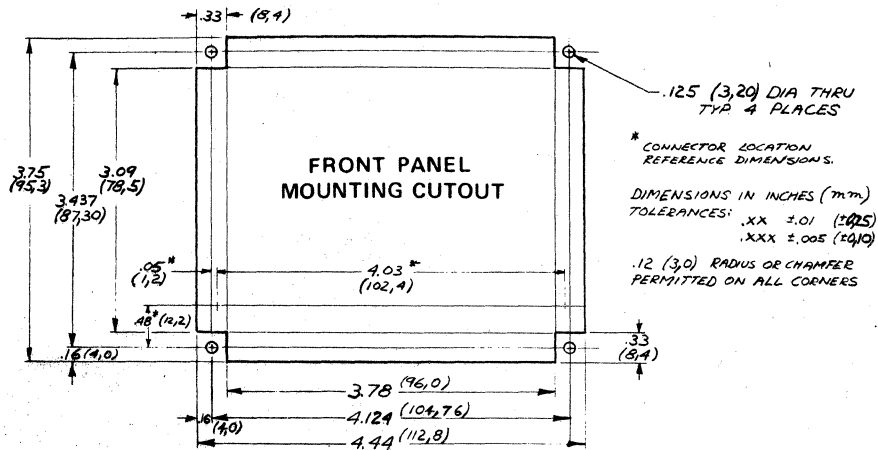
<b>File or Block Length</b>	Files consisting of 1, 2, 4, 8, 16, 32 or 64 characters or words per block or any length
<b>Gaps</b>	3-bit intercharacter, or inter-word gaps added before each character. 12-bit end-of-file gap written after each file.
<b>Gap Stepping Rate</b>	100 steps/sec.
<b>Time to Generate Full Gap Length</b>	0.12 sec.
<b>Power Consumption (Transport &amp; Tapehead only)</b>	700 mW typ. @ 100 steps/sec. (+12VDC @ 60 mA)
<b>DATA CAPACITY</b> (Assuming 64 8-bit characters per block or file, plus non-data characters and 282 feet (86 m) usable recording area)	
<b>Block or File Length including Controls and Gaps</b>	1.06 inches (26, 9 mm)
<b>Block or Files per Cassette</b>	3200 files
<b>Bit Cells per Block or File (including Gaps and Control Characters)</b>	652
<b>Time per Block or File (not including gaps)</b>	6.4 seconds
<b>Time to Fill a Cassette (continuous running at max. step rate)</b>	5.8 hours
<b>Bit Writing Rate</b>	100 bits/sec.
<b>Playback Speed, typical</b>	1700 bits/sec. (LPR-16 Reader, 2.75 ips)
<b>Time to Generate Full Gap Length</b>	0.12 sec. @ 100 steps/sec.
PHYSICAL	
<b>Weight</b>	1.25 pounds (0,567 kilogram)
<b>Dimensions</b>	3.91" High x 4.5" Wide x 4.2" Deep (99,3 x 114,3 x 106,7 mm)
<b>Maximum Extension in Front of Mounting Panel (door closed)</b>	1.40" (35,6 mm)
<b>(door open)</b>	2.26" (57,4 mm)
<b>Maximum Depth Behind Mounting Panel</b>	1.94" (49,3 mm) from panel front surface
<b>Mounting Method*</b>	Front insertion into a panel cutout, secured by (4) 4-40 bolts inserted from the rear into tapped Helicoil thread inserts, 0.187" (4, 75 mm) deep
<b>*Shock or vibration must be negligible while recording</b>	
<b>Mounting Position</b>	Horizontal or vertical. Recommended with cassette vertical, tapehead at top for easy cassette insertion.
<b>Temperature Range (Operating)</b>	-10°C to +60°C (-40°C optional)
<b>Temperature Range (Storage)</b>	-40°C to +70°C (with high temp. cassettes)
<b>Power Consumption (Auxiliary Cards and EOT/BOT Detector)</b>	The Write board and Formatter consume approximately 120 microwatts each (+12VDC @ 10 microamps). The EOT/BOT Lamp and detector consume 900 mW (+12VDC @ 75 mA).
<b>Relative Humidity</b>	20% to 80%, non-condensing

CASSETTE TRANSPORT OUTLINE DIMENSION - INCHES (MM)

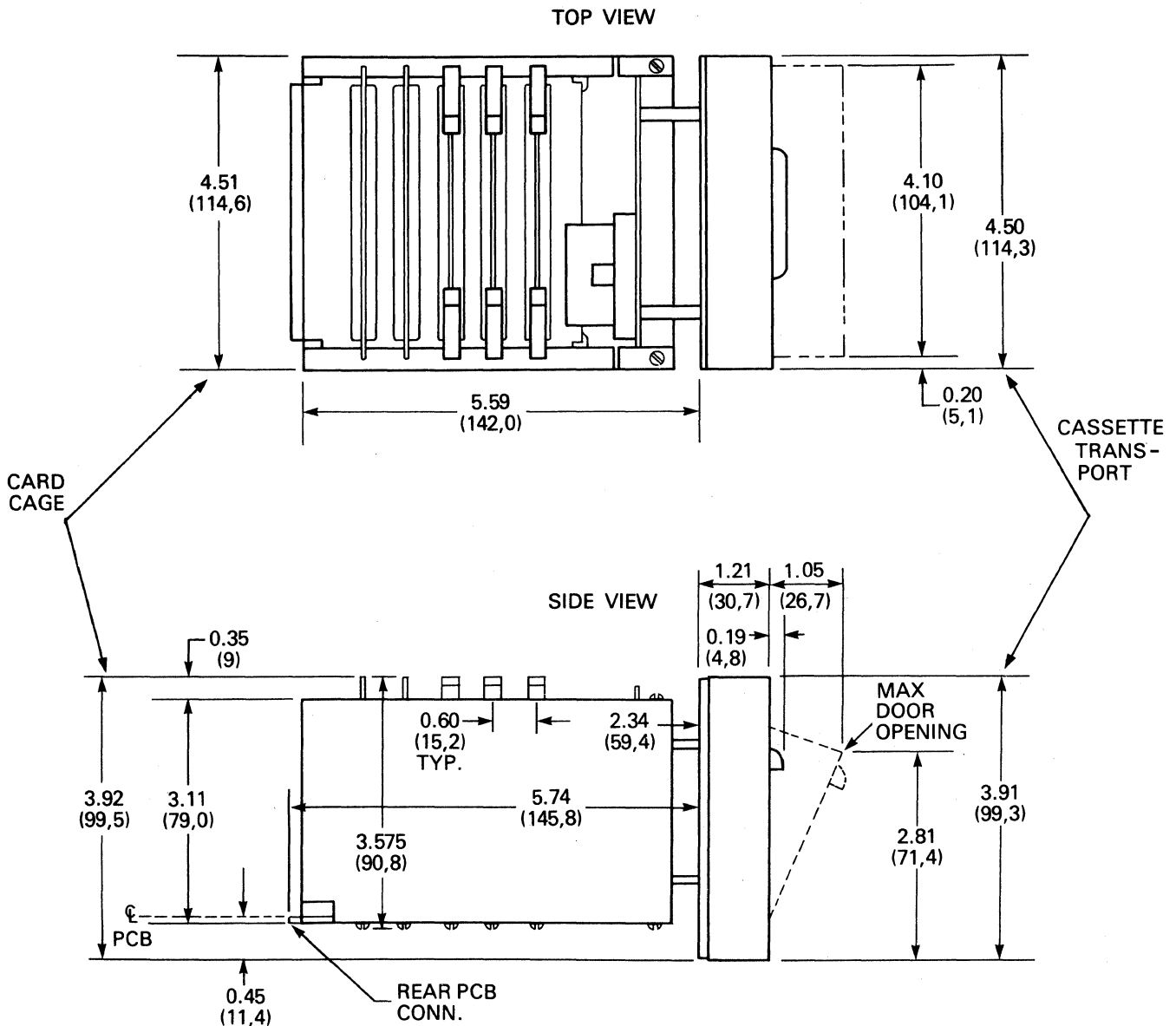
MECHANICAL DIMENSIONS



ICT-WZ: LEFT SIDE VIEW



# RECORDER SYSTEMS CARD CAGE OUTLINE DIMENSIONS — INCHES (MM)



## MODELS AVAILABLE

The ICT series is available in several configurations from transport only to full parallel recorder system.

The basic ICT transport is a panel-mounting assembly which fits through a front panel cutout. The transport includes the stepping motor, write head and optional EOT/BOT clear leader photo-detector.

All electronics are mounted in the optional 5-slot card cage which attaches to the rear of the transport. A motherboard in the bottom of the cage includes PC board connectors and forms a power/data/control bus accessible through a rear I/O PCB connector. See page 223S for full model variations.

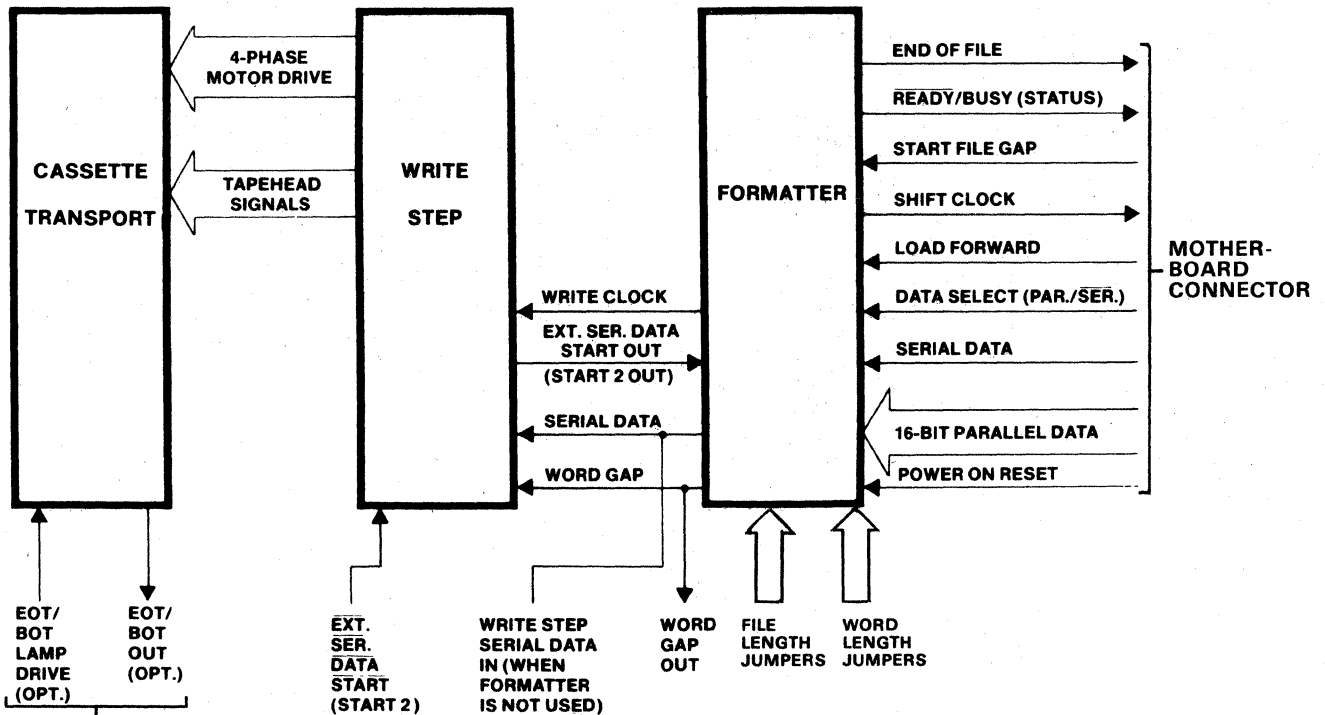
## CASSETTE TRANSPORT FEATURES

Datel's incremental cassette transport features a design simplicity not found in other mechanisms. An elegantly simple tape speed control is provided using a four-winding stepping motor with 48 rotor steps per revolution and

geared down capstan drive. The stepping motor relies on electronically rotating the stator field around permanent magnet multi-pole rotors instead of mechanical brushes and a commutator. A CMOS clock sequences the stepping motor drivers. This avoids the usual method found in continuous recorders employing slotted strobe discs, tachometers or pre-recorded clock tracks. Instead of a second motor to maintain take-up tape tension, a spring belt and friction clutch takeoff from the capstan drive maintain constant take-up hub torque and tape tension.

The ICT-series write-only transports are optimized for ultra-low battery power with bit writing rates within words of 100 bits/second. This bit rates are adequate for a wide variety of portable and long term instrumentation applications. However, on playback, ICT-recorder cassettes may be read at the full speed of most computer cassette readers, typically several thousand bits per second.

## Complementary NRZ ICT-WZ Recorder System Block Diagram



ALSO BUSSED  
TO MOTHER-  
BOARD CONNECTOR

### ELECTRONICS

ICT cassette systems accept serial and parallel digital inputs. These are presented to input terminals at the proper times and are internally stored. DATA ACCEPTED flag signals appear, allowing the user's external electronics to clear and load the input bus with the next group of data. This can occur in parallel or bit by bit in full serial by using the shift clock output.

Since the transport must run at a given tape speed, data bits must be ready fast enough for input to the write electronics. However, the transport is truly character or word incremental so that the tape can stop within a block or file and wait after writing one word for new data that isn't ready yet.

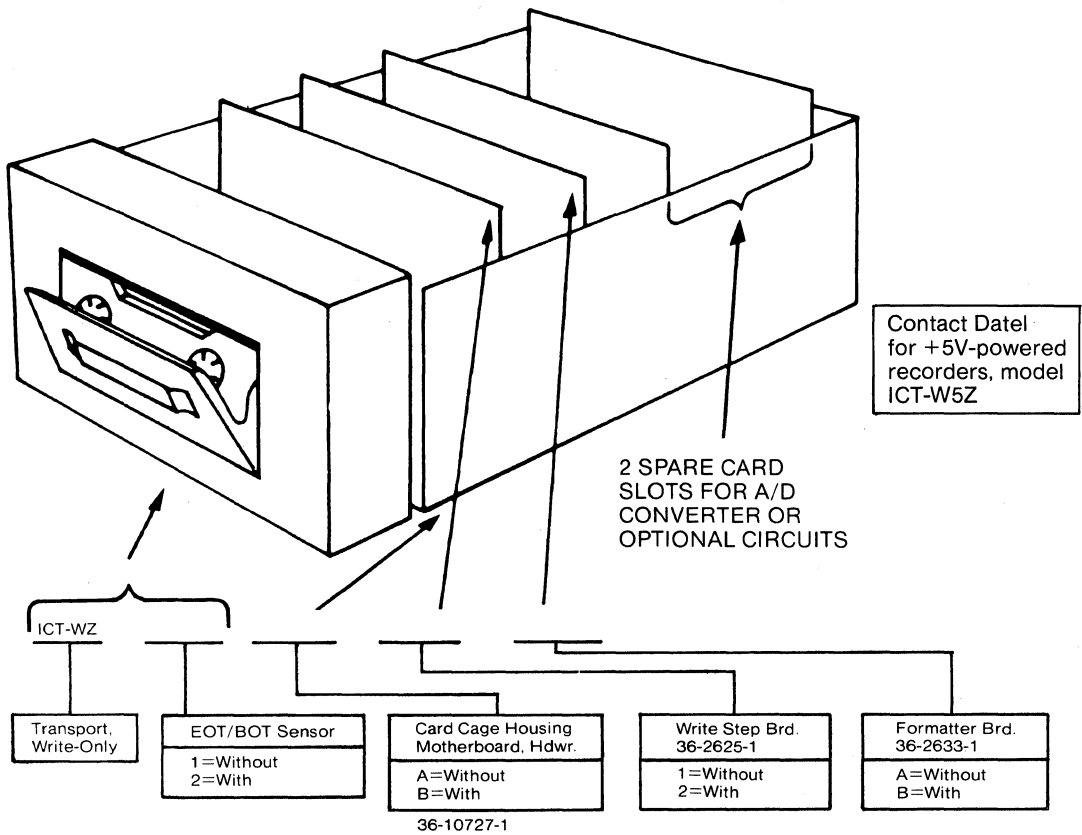
### ICT-WZ COMPLEMENTARY NRZ BOARDS

In addition to the Write Step Board, ICT-WZ Recorder systems have the Formatter Board available. An optional A/D Converter Board, and Sample/Hold, Multiplexer, Channel Sequencer are also available for analog inputs. Refer to complete analog systems specifications under Datel's LPS-16 series.

The ICT-WZ Formatter Board accepts parallel CMOS digital words from 8 to 16 bits long, stores them and shifts them over serially to the Write Step Board. The Formatter also supplies a 3-step bitless gap beginning each word to the Write Step Board and a longer 12 step gap at the end of a file or from external command. Word length from 8 to 16 bits is jumper programmed as is a word counter which automatically generates the 12-step file gap after the jumper-selected number of words per file. File length can also be externally controlled.



## MODEL NUMBERING AND ORDERING GUIDE



### COMPLEMENTARY NRZ WRITE-ONLY CASSETTE TRANSPORT SYSTEMS

- Model ICT-WZ1 Transport only, less EOT/BOT sensor .....
- Model ICT-WZ2 Transport only, with EOT/BOT sensor .....
- Card Cage and Hardware, with Motherboard for Comp. NRZ systems, P/N 36-10727-1 .....
- Write Step PC Board, P/N 36-2625-1 .....
- Formatter PC Board, P/N 36-2633-1 .....
- Cassettes (+10°C to +45°C) P/N 12123-1 .....
- Cassettes (-40°C to +70°C) P/N 12123-2 .....
- Connectors, Dual 44-pin, Datel 58-2075060 (Included) .....

For full analog 16-channel data logging systems (includes A/D converter, mux, sample/hold and channel sequencer), refer to the model LPS-16 numbering and order guide.

- Universal Auxiliary Bread board P/N 36-3267 .....
- Jumper Board, PC Plug to Plug, P/N 36-3269 for access to Formatter inputs .....
- Model ICT-WZ1B2A-3942 Transport less EOT/BOT w/Write Step on standoffs (cage not required) .....
- Model ICT-WZ2B2A-3950 Transport w/EOT/BOT w/Write Step on standoffs (cage not required) .....
- 37-6077-1 Prerecorded Test Cassette .....
- Manual, 58-12140-10 (Included) .....
- Extender Board, PC Jack to Plug, P/N 36-3956-1 .....

## ICT SERIES SELECTION GUIDE

The Model numbering shown in this brochure has been designed so that a user can select exactly the electronics configuration required by the application. Cost requirements and mounting considerations are an important point to consider when ordering. For example, most users will find the optional card cage ideal for mounting the drive and formatting electronics cards. However, these cards or the entire cage may be separately mounted if a user needs shorter front panel depth. This will require a user-fabricated

cable or interconnection scheme, however the cards are small enough (3" x 4" - 76,2 x 101,6 mm) to be self-supporting when mounted in a PC jack.

In particular, users selecting only the Write Step card (ICT-WZ2A2A system) may have the Write Step card attached directly to the transport without requiring the card cage.  
(The WZ version is Model ICT-WZ1B2A-3942

### SEQUENCE OF CARDS

In general, ICT systems should be selected by filling up the card cage from the transport on back. The motherboard wiring on the bottom of the card cage assigns specific cards to particular cage card guides and connector slots. Cards further back from the transport will not work without all the preceding cards.

Users are encouraged to purchase as complete a system as required for the application. Choosing fewer cards or only the transport will generally require user design of electronics

equivalent to those offered by Datel. The ICT electronics are proven designs with efficient packaging at reasonable costs. Datel's ICT electronics will save a designer who is not thoroughly familiar with tape electronics the circuit debugging time and expense required of an original design. This is particularly important as the card level approaches the cassette transport. Experienced users or those with custom formats are, however, encouraged to purchase only the transport and optional write step card and proceed with their design.

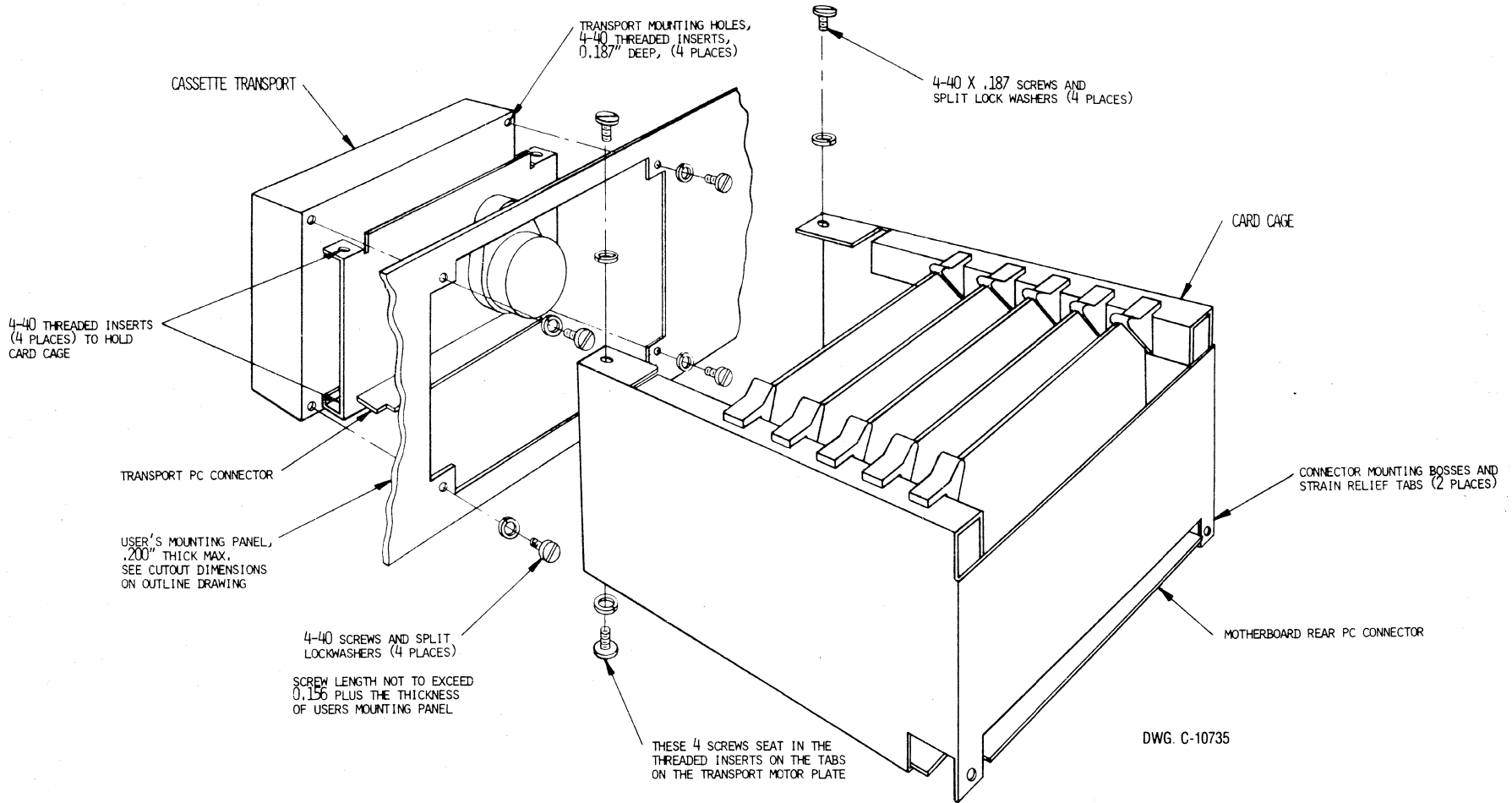
### SIMPLIFIED ICT-WZ COMPLEMENTARY NRZ MODEL SELECTION

Four systems should be selected ranging from transport to full system.

Model Number	Description	Input Type
ICT-WZ1 (Transport System)	Transport Mechanism Only	Direct input to Write-head windings and 4-phase stepper motor windings.
ICT-WZ1B2A (Unformatted Serial System)	Transport, Card Cage, Write Step Card	CMOS logic inputs, unformatted full serial. Write Step requires external write clock timing but codes write-head signals to complementary NRZ coding.
ICT-WZ1B2A-3942	Transport less Cage, with Write Step mounted to transport by standoffs.	Same as above.
ICT-WZ1B2B (16-Bit Parallel System)	Transport, Card Cage, Write Step and Formatter Cards.	Accepts full parallel or serial 8 to 16 bits CMOS data and formats in files of selective word length. Parallel inputs are stored. Files are jumper-selected to any length.

Contact Datel for optional analog input (A/D Converter) to the ICT-WZ system.

# ICT AND LPS SYSTEM MOUNTING DIAGRAM

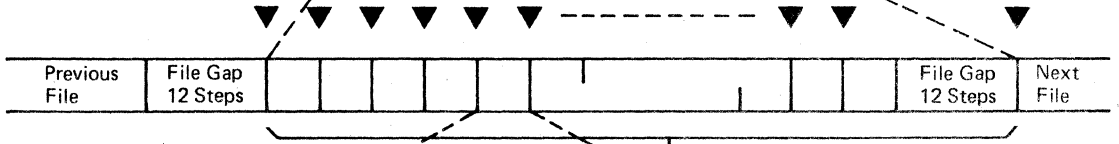
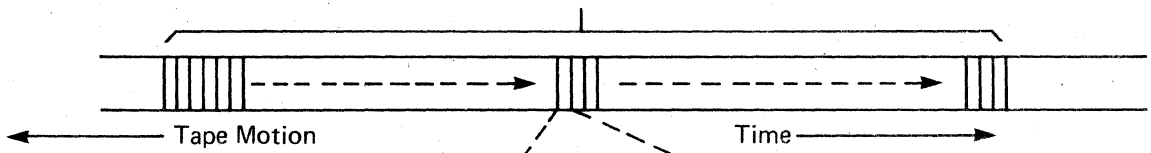


# COMPLEMENTARY NR2 CASSETTE FORMATTING

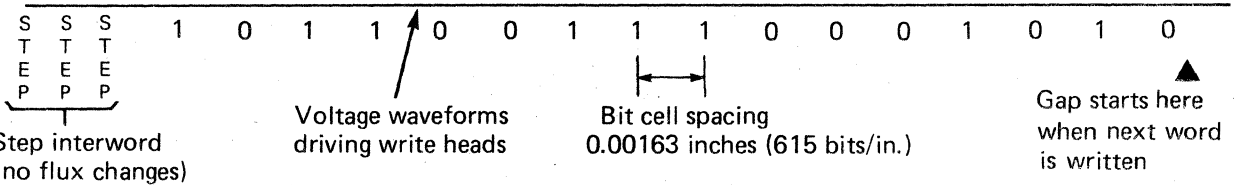
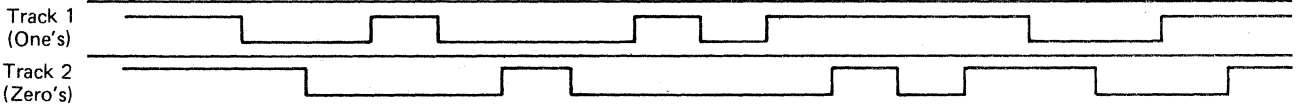
## RECORDING FORMAT

Datel uses a unique digital recording method. A dual-track complementary NRZ (CNRZ) method is used for high noise immunity and self-clocking on playback. This high capacity method uses both tracks of the tape simultaneously and records in only one direction. Using separate 1's and 0's tracks and very small gaps, one cassette can hold up to 2.2 million bits.

**ONE CASSETTE,** 282 feet, MIN. of tape consisting of hundreds or thousands of files



**ONE FILE,** Consisting of 1, 2, 4, 8, 16, 32 or 64 words (64 typical) if controlled by the formatter word counter (jumper select). May be any word count if externally controlled.



**ONE WORD,** consisting of 8, 10, 12, 14, or 16 bits plus three steps before each word (interword gap)

▼ (See above) Tape may stop here indefinitely (between words or files) in long term incremental applications.

3-Step interword gap shown. 2-Step gaps may be used if required.



**END OF  
INSTRUMENTS AND SYSTEMS  
SECTION**

**FOR OUR COMPLETE CATALOG OF  
DATA ACQUISITION COMPONENTS  
INVERT THIS VOLUME AND  
TURN TO PAGE 1C.**

227S

099S

**END OF  
DATA ACQUISITION  
COMPONENTS SECTION**  
**FOR OUR COMPLETE CATALOG OF  
INSTRUMENTS AND SYSTEMS  
INVERT THIS VOLUME AND  
TURN TO PAGE 1S.**

