DATA DISC
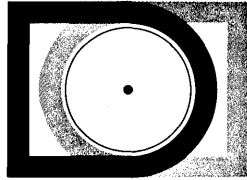INCORPORATED

TDS
(Television Display System)

REFERENCE MANUAL

TDS
(TELEVISION DISPLAY SYSTEM)

REFERENCE MANUAL

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SECTION 1
GENERAL DESCRIPTION

1.1 GENERAL

The Data Disc Television Display System (TDS) is a time-shared display system which:

a) Has up to 128 channels (Display Terminals). The basic TDS has a 32-channel capacity.

b) Displays up to 4080 alphanumeric characters and/or graphic points on each channel. Display matrix is 512 bits wide x 480 bits high. (Figures 1-1 and 1-2.)
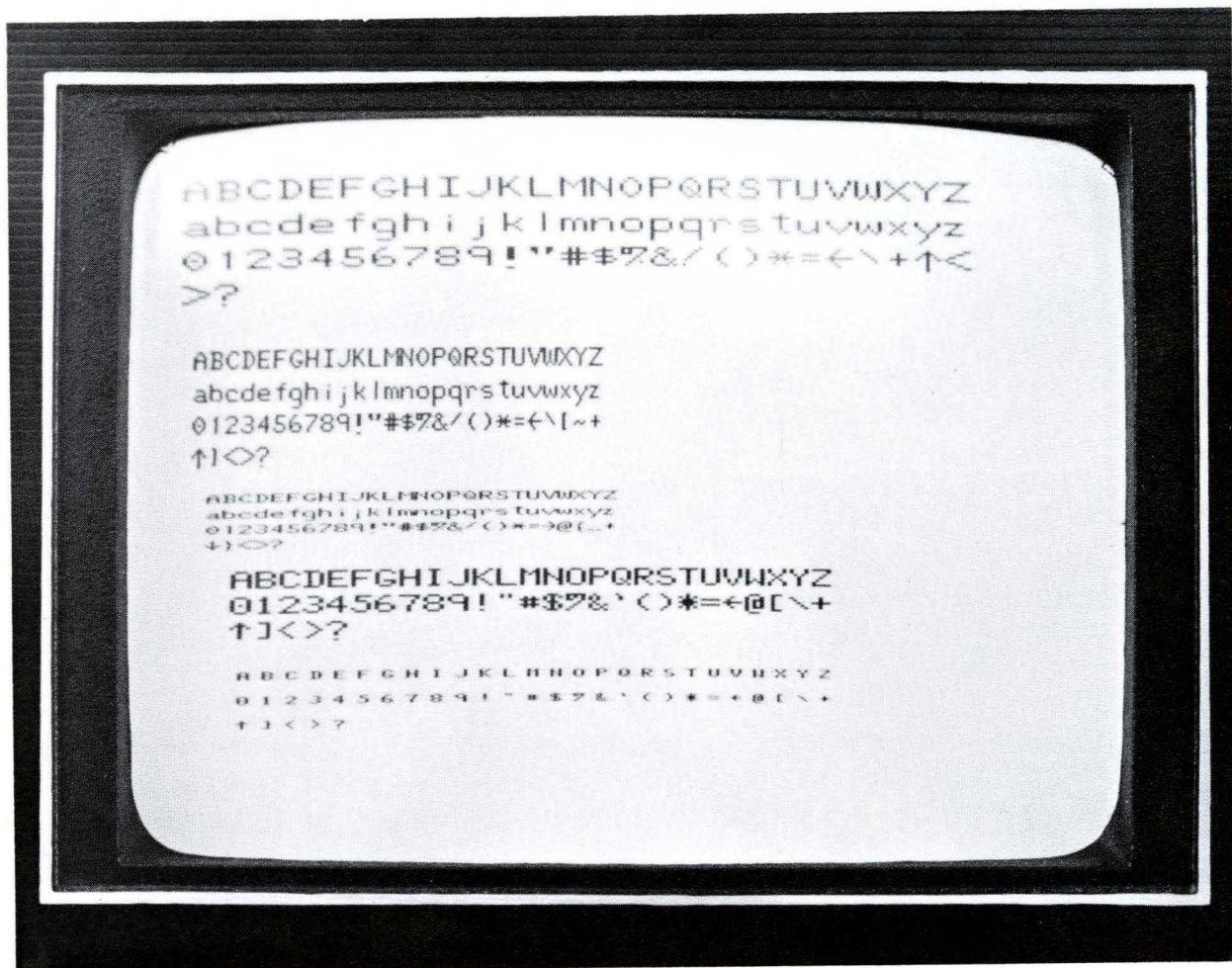
Figure 1-1. Typical TDS Display - Dark on Light
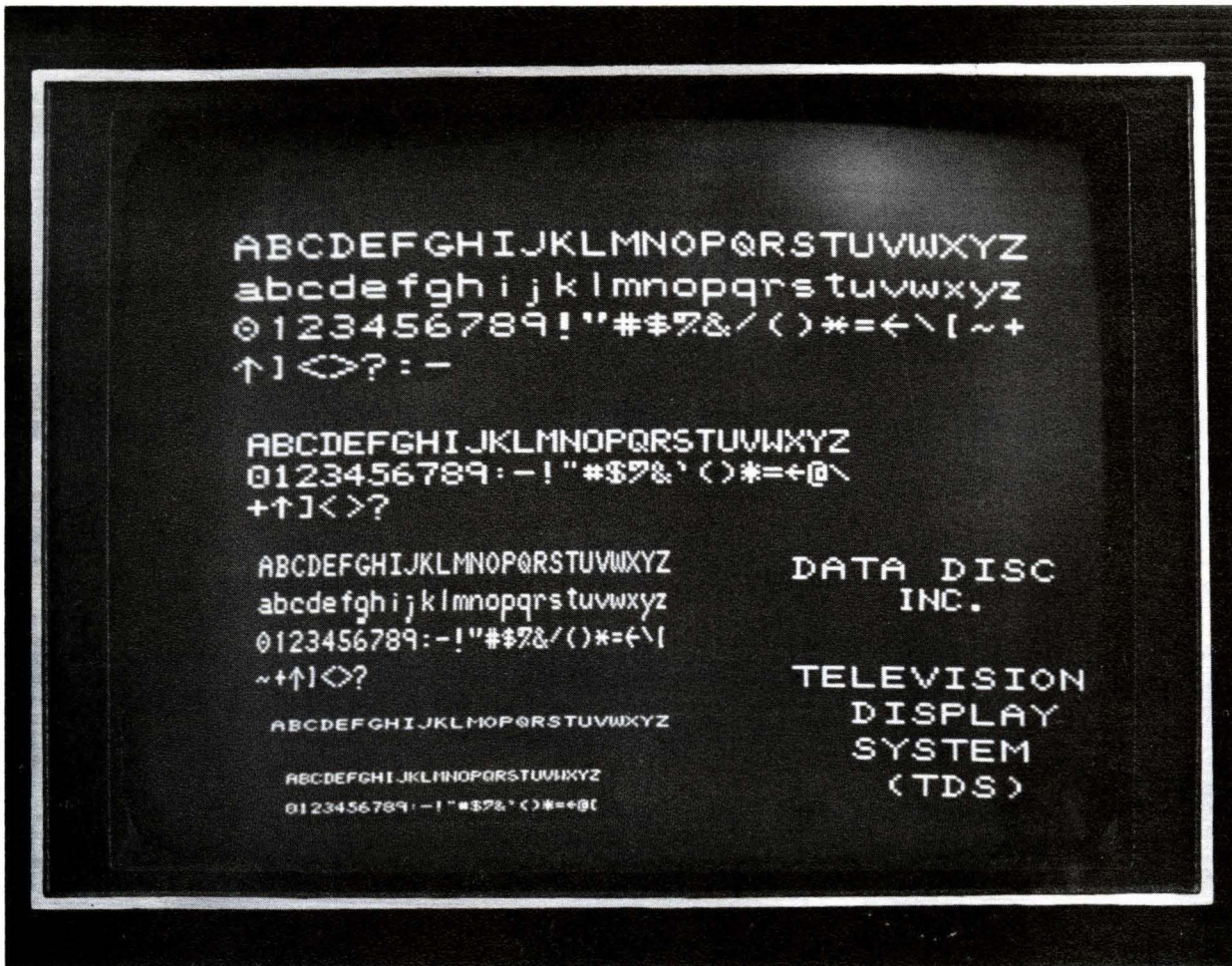
Figure 1-2.   Typical TDS Display - Light on Dark

    c)   Uses television monitor display terminals.

    d)   Operates with any computer as a "soft-copy" printer where ASCII coded alpha-numeric characters are transformed into displayed characters, and graphic points are transformed into bits along a scan line.

The basic TDS (Figures 1-3 and 1-4) consists of a disc memory, a time-shared video generator, a video-distribution unit, one or more display terminals, and an optional control terminal.   A computer interface is not provided with the basic system.

Other system features are:

    a)   Displayed alphanumeric characters or graphic points can be changed individually.

    b)   Dark images can be displayed on a light background, or light images can be displayed on a dark background.   (Figures 1-1 and 1-2.)

Figure 1-3. Data Disc TDS with Control Terminal

c) During writing on one channel, other channels are not disturbed.

d) ASCII characters are converted into either a 7 x 10 or a 5 x 7 picture-element matrix.

e) The 96-character ASCII set is provided. Special characters can easily be added to the TDS character generator.

f) Superscript characters and subscript characters can be written.

g) Characters can be written at rates up to 120,000 characters per second (i.e., up to 30 pages per second).
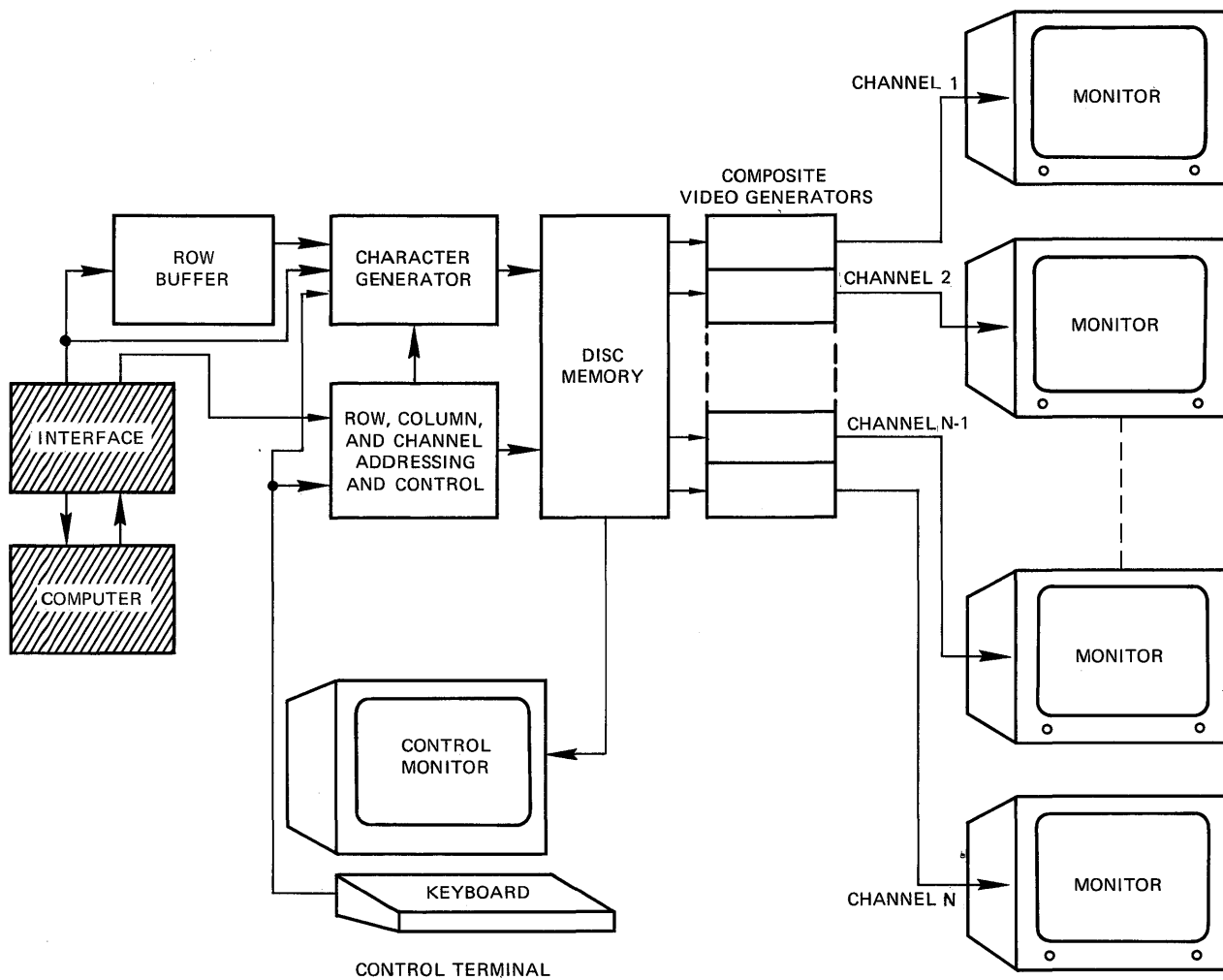
Figure 1-4. TDS - Simple Block Diagram

h)   Several types of computer-generated cursors are available.

i)   The control terminal contains an ASR-33 Teletype and a display monitor.

j)   Graphic images can be superimposed. This enables composition of complex
     graphic displays from a series of images; e.g., grid lines, first curve, second
     curve, alphanumeric data, etc.

1.2   APPLICATION

The primary TDS application is to provide output display and keyboard input as a substitute
for teletypewriter (TTY) in a time-shared computer system. ASCII data which is formatted
for typewriter printout (i.e., ASCII data containing carriage-return and line-feed control
characters) can be processed by the TDS without any reformatting. Data Disc displays can
be supplied with stands which hold a display monitor and a teletypewriter.

1.3 OPTIONAL FEATURES

In addition to the basic system:

a) Data Disc display terminals (Figure 1-5) are also available with solid-state keyboards and keyboard serializers for use with computer systems where typewriter printout is not required. Keyboard outputs are 8-bit parallel ASCII with TTL logic levels. The serializer output is in Teletype format and conforms to EAI Standard RS-232-B.

b) Hard copy of the displayed picture can be obtained by using any of several commercially available printers.

c) The channel outputs can be combined with analog video outputs to form, for example, a display which is a combination of computer-generated and camera-generated data. Analog video source may be a Data Disc analog video disc-memory system or a video tape recorder.

Figure 1-5. TDS Display Terminal

d) A servo-drive system can be supplied for applications where the TDS output must be synchronized to an external signal source such as a television station or a video tape recorder.

e) The TDS channel outputs can be connected to the terminals via a switching network which enables switching of one or all channels to any number of terminals.

1.4 OPERATIONAL ENVIRONMENTS

The TDS operates in the following environment:

a) Operating temperature: 50° F to 105° F.

b) Non-operating temperature: -20° F to +130° F.

c) Operating humidity: 20 to 80% without condensation.

d) Atmosphere: Corrosive atmospheres such as those found in steel mills and chemical plants are not considered normal.

e) Vibration: Floor vibration of 0.15 g maximum from 10 to 65 Hz. The disc package will not be damaged by 5 gs or less of shock in any axis.

1.5 PHYSICAL DIMENSIONS

a) Electronic Assemblies. All electronic assemblies are packaged for mounting in standard 19-inch equipment racks or cabinets. Actual system size depends upon number of channels, optional features etc. See Section 6.

b) Display Terminals. See Figure 1-6.
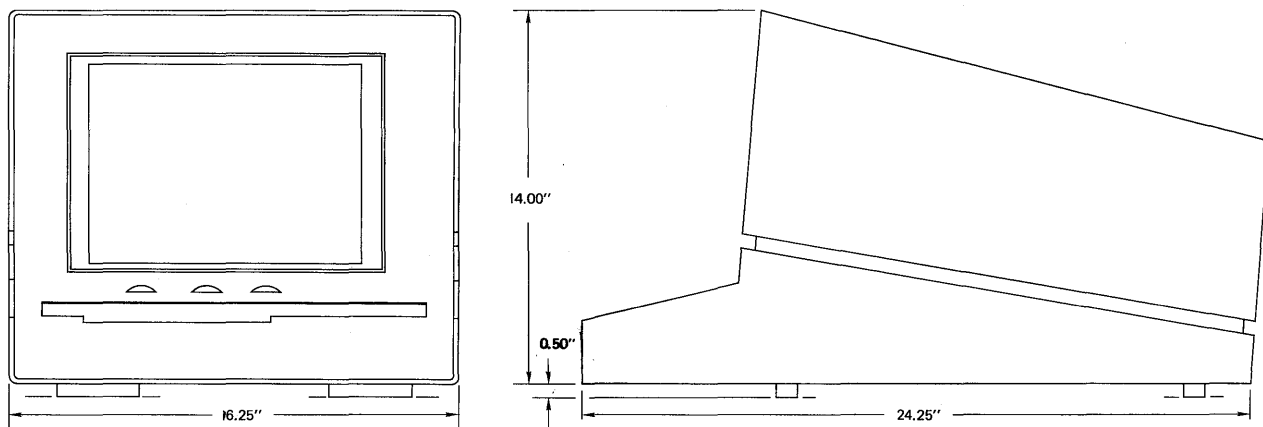
Figure 1-6. TDS Display Terminal Dimensions

SECTION 2
SYSTEM OPERATION

2.1 GENERAL OPERATION

A complete computer system which includes a TDS is shown in Figure 2-1.

Line address, column address and channel address, function code, and text are trans-
ferred into the TDS via an 8-bit data bus. A 4-bit data-routing bus specifies the type of
data on the data bus and routes the data to appropriate registers in the TDS. The line and
column addresses specify the starting display position for subsequent writing and displaying
of text. Addresses and the function code are transferred prior to the text.

The text is then transferred to the row buffer or directly to the display memory. Through
an appropriate function code, an entire frame can be erased in 33 milliseconds without
transferring text. To erase individual rows or portions of a row, text of ASCII-coded space
symbols must be transferred. To erase an individual line or a portion of a line, graphic
bytes 00000000 must be transferred.

Figure 2-1. TDS - Block Diagram

2.2   FUNCTIONS

The 8-bit function code which has been transferred to the function-code register specifies
how the text will be processed.   Functions are:

   a)   Write light images on a dark background.

   b)   Write dark images on a light background.
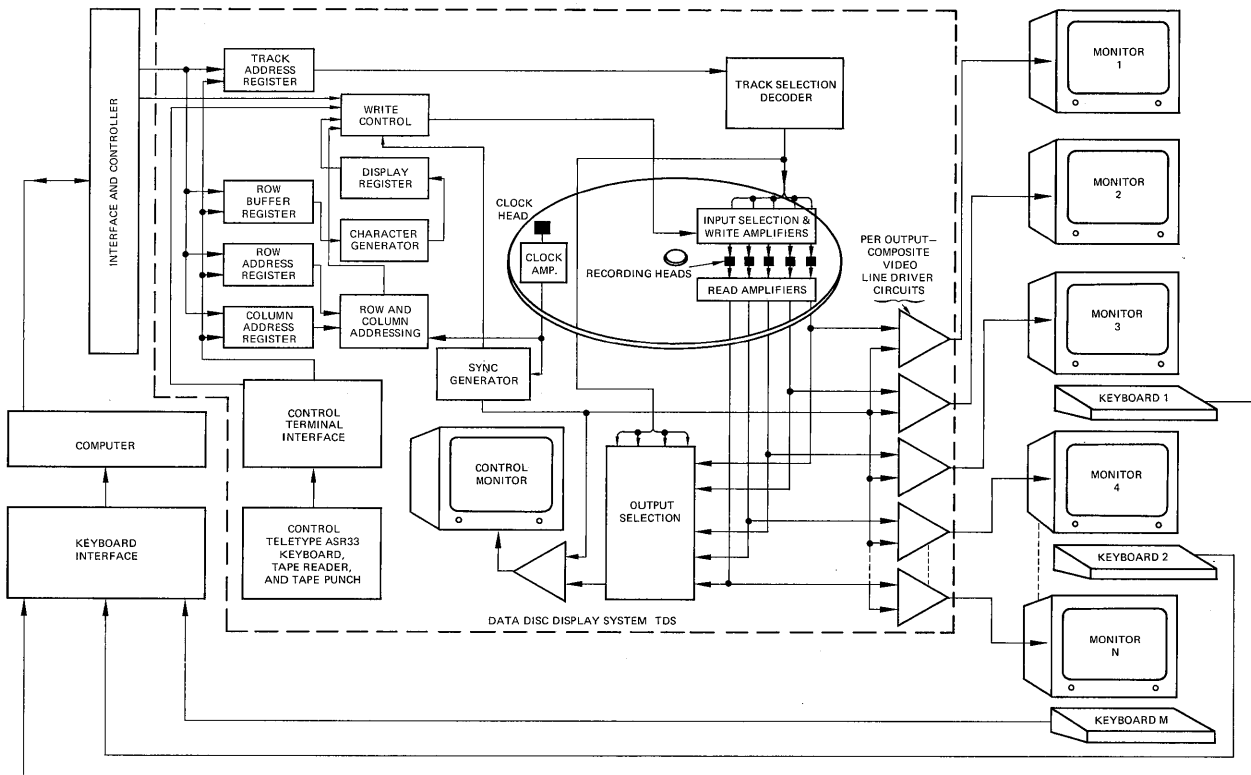
   c)   Write data in the display memory.

   d)   Do not write data, but only display data for one frame duration.   This function is
        used to "blink" an area, a special message, or a special symbol.

   e)   Erase entire frame.

   f)   Write normal-size characters.

   g)   Write double-height characters.

   h)   Write double-height, double-width characters.

   i)   Write with replacement.   Data written at a location replaces previous data.

   j)   Write with addition.   Only "1" bits are written.

2.3   PROCESSING OF ALPHANUMERIC TEXT

   a)   One or more ASCII-coded bytes are transferred into the row-buffer of the TDS.
        These transfers are asynchronous with the disc memory at a rate determined by
        the external processor or by the minimum cycle time of the row buffer (900 nano-
        seconds).

   b)   This buffer is then unloaded to the character generator during the scan lines of the
        addressed row of a field.

   c)   The output of the row buffer is processed by the character generator to create a
        stream of picture elements which is written into the addressed disc-memory
        display channel.

   d)   The display raster is composed of interlaced scan lines (see Figure 2-2).   Because
        of the interlace, adjacent scan lines are separated in time by 16.7 milliseconds
        (the period of a disc revolution).   A displayed character is composed of picture
        elements on adjacent scan lines.   Therefore, a portion of the displayed character
        is generated during one field with the remaining portion of the character being
        generated 16.7 milliseconds later.   Because of this interlace, ASCII text must be
        transferred once when writing a single row of text per frame period, twice to write
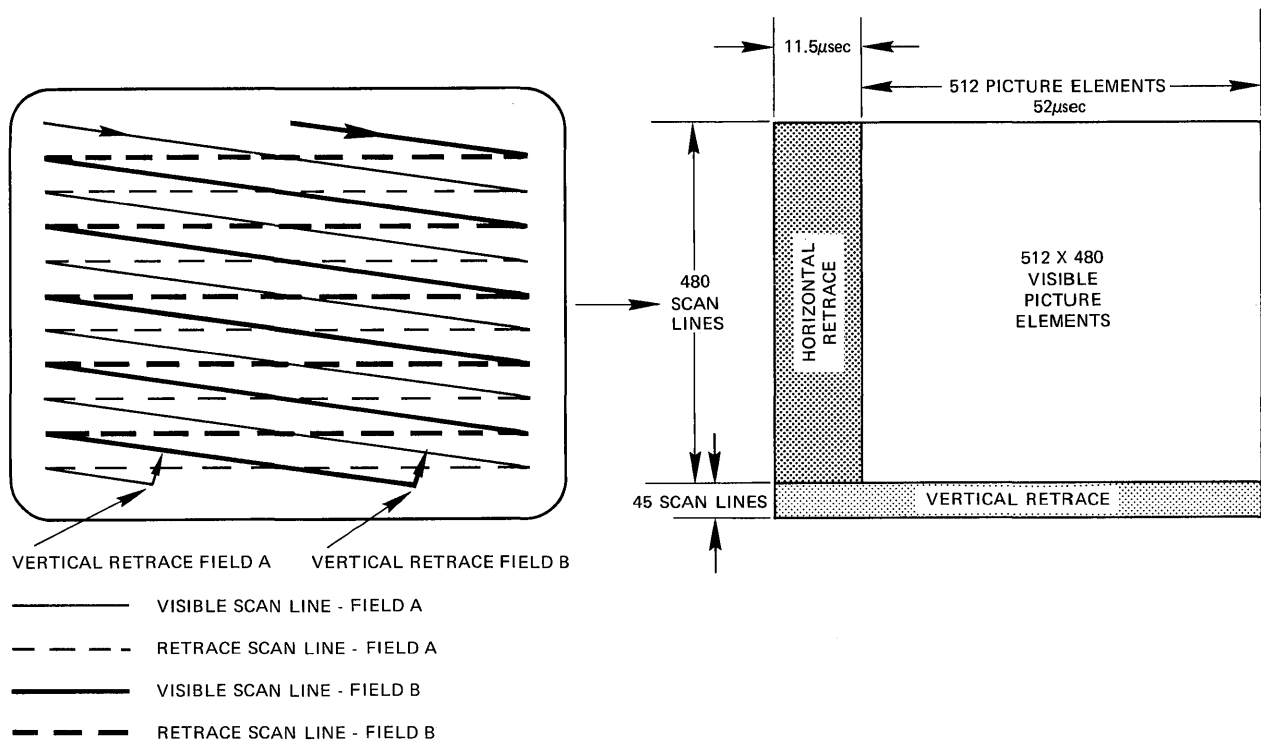   many rows per frame period.

Figure 2-2. Television Raster

e) Only the character positions where characters are read into the row buffer are
    written on the disc; i.e., no writing occurs on the rest of the row storage area.
    From one to 85 characters can be written on each row.

f) A character can be written at any column position and can be positioned vertically
    to an even scan line. This vertical positioning allows the formation of super-
    scripts and subscripts.

g) In writing, previous picture elements at a character position are automatically
    erased.

h) When transfers are made into the row buffer during the scan lines between rows
    of characters, all rows can be written during one frame period. (Reference
    Figures A3 and A4 for number of available scan lines.)

i) After writing on a row, a new line address must be transferred to the TDS.

j) The line-address register is changed by transferring the explicit row address
    over the data bus.

k) The line address refers to the top scan line of a character location; i.e., the
    first scan line of a row.

l) After writing on a row, the column address, the channel address, and the function
    code can be changed. By changing the channel address during a frame period,
    data can be written on many different monitors.

m) The column address can be changed by transferring an explicit address over the data bus.

2.3.1 Writing One Row per Frame Period. The row buffer is loaded and unloaded, and picture elements written during one field. The contents of the row buffer are then held for at least one disc revolution and may again be unloaded during the second field.

2.3.2 Writing Several Rows per Frame Period. The row buffer is loaded and unloaded and picture elements written. The row buffer is again loaded and unloaded during this same field to write a portion of another row. Many incomplete rows are written during one field. During the next field, which interlaces the first field, all ASCII text must be transferred a second time, the row buffer is again repeatedly loaded and unloaded, and picture elements are written to complete these rows.

2.4 PROCESSING GRAPHIC TEXT

a) Graphic text can be transferred either directly to the display memory or through the row buffer to the display memory.

b) In writing a graphic byte with replacement, both "1" bits and "0" bits are added to an 8-bit line segment. This erases previous picture elements on that same segment.

c) In writing a graphic byte with addition, only "1" bits are added to an 8-bit line segment. Polarity of the "1"s can be dark or light. Single picture elements and individual curves can be added. Component images of a display can be combined in the TDS rather than in the external computer. For example, characters can be written into the TDS, followed by grid lines, and then by curves.

d) Adjacent scan lines occur on alternate fields and are therefore separated by 16.7 milliseconds. If line segments on different fields are successively processed, delays up to 16.7 milliseconds may occur. By processing line segments on the same fields successively, these delays are eliminated, and an entire page can be transferred in one frame period.

e) Since the system processes only one scan line at a time, the line-address register must be changed before transferring to another line.

f) Other address and function registers may be changed before transferring to another line.

2.4.1 Direct Transfer of Graphic Text. Transfers occur in synchronism with the disc memory. Up to 64 8-bit line segments are transferred during the 52 microseconds of the visible, addressed scan line. The transfer rate, therefore, is one byte every 800 nanoseconds.

2-4

2.4.2 <u>Transfer of Graphic Text Through the Row Buffer.</u> Up to 64 bytes are loaded into the row buffer. The row buffer is unloaded into the disc memory at the addressed scan line. Transfers into the row buffer are asynchronous with the disc at a rate determined by the external processor or by the cycle times of the row buffer (900 nanoseconds). Successively processing line segments which are on different fields may produce 16.7 millisecond delays. These delays can be eliminated by successively processing lines on the same field. The row buffer is loaded and unloaded on alternate scans; therefore, at best, every other line of a field is processed, and four field periods are required to transfer an entire page.

2.5 CURSORS

Two types of computer-generated cursors are possible in the TDS. The first type is a recorded cursor; i.e., the cursor symbol is written in the display memory with other display data. The second type is an unrecorded cursor; i.e., the cursor symbol is not written but is periodically displayed from computer inputs to the TDS.

2.5.1 <u>Recorded Cursor.</u> The recorded cursor can be either a symbol written on a row of characters or a symbol written above or below the row of characters. The latter is preferable since moving the cursor would not disturb displayed characters. Such a cursor can be a simple underline or overline, or it can be a more complex symbol such as an arrow; it can be created as a superscript or subscript alphanumeric symbol, or it can be created as a graphic image. For example, in using an underline or overline as a cursor, 00000000 is written at the present cursor position and 01111110 is written at another position to form a new cursor.

The recorded cursor is usually adequate for alphanumeric-only displays and also for some graphical displays.

2.5.2 <u>Unrecorded Cursor.</u> The unrecorded cursor is displayed periodically, and, as a result, flickers. This "flickering" is usually desirable since it catches the operator's attention. Because this cursor is never written, it can be positioned anywhere on a display without erasing display data and is, therefore, particularly useful with graphic displays. The cursor can be displayed infrequently; e.g., a few times a second. Since these unrecorded cursors impose an additional burden on the computer, however, the recorded cursor is preferred wherever possible.

SECTION 3

SYSTEM PERFORMANCE

3.1 TRANSFER RATES FROM THE EXTERNAL COMPUTER

In writing alphanumerics, performance during a frame period can range from writing a single character to writing an entire page of 4080 characters. Table 3-1 shows transfer rates on the data bus to write various numbers of rows per frame-period into 4080 character displays. Corresponding tables can be generated for different display formats.

Similarly, in writing graphics, performance for one frame period can range from writing a single point to writing an entire page. Table 3-2 shows byte transfer rates on the data bus necessary to write various numbers of graphic-text lines per frame period. A page can be a combination of alphanumerics and graphics. Rows of alphanumeric text and lines of graphic text can be written into different terminals.

TABLE 3-1. PERFORMANCE CHARACTERISTICS OF A 4080-CHARACTER DISPLAY

(48 ROW X 85 CHAR/ROW)

Rows of Char. Written per Frame Period	Rows per Second	Characters per Second	Peak Transfer Rate on Data Bus (000s Bytes/Sec.)	Average Transfer Rate on Data Bus (000s Bytes/Sec.)
48	1440	122,400	1,470	264
24	720	61,200	1,470	132
16	480	40,800	1,470	88
8	240	20,400	1,470	44
4	120	10,200	1,470	22
1	30	2,550	5.5	5.5

Transfer rates are based on output of 92 bytes per row per field which includes 85 character bytes and 7 control bytes for each row.

TABLE 3-2. PERFORMANCE CHARACTERISTICS FOR THE 512 X 480 GRAPHIC DISPLAY

Graphic Char. Written per Frame Period	Type of Transfer	Graphic Char. Written per Sec.	Peak Transfer Rate on Data Bus (000s Bytes/Sec.)	Average Transfer Rate on Data Bus (000s Bytes/Sec.)
480	Directly Written Synchronous Transfer (One Char/Line)	14,400	113	86.4
480	Directly Written Synchronous Transfer (64 Char/Line)	14,400	1,330	15.5
480	Asynchronous Transfer Through Row Buffer (Up to 64 Char/Line)	14,400	1,120	16.0
240	Asynchronous Transfer Through Row Buffer (Up to 64 Char/Line)	7,200	1,120	8.0
120	Asynchronous Transfer Through Row Buffer (Up to 64 Char/Line)	3,600	1,120	4.0
60	Asynchronous Transfer Through Row Buffer (Up to 10 Char/Line)	1,800	268	3.06
10	Asynchronous Transfer Through Row Buffer (Up to 10 Char/Line)	300	268	.51
10	Asynchronous Transfer Through Row Buffer (One Char/Line)	300	126	.51

3.2 LIMITATIONS IN PROCESSING KEYBOARD-GENERATED TEXT

If several keyboard-generated requests to write characters occur on the same row but on different channels, only one of these requests can be handled during a frame period. The other "character-write requests" are delayed and then processed during subsequent frames. If further key strokes occur during this delay, additional "character-write requests" must

be held in the computer. All these delay characters are then written in a subsequent frame. In this way, no key strokes are missed and all keyboard entries are processed, but with a possible delay between the key stroke and the appearance of the characters on the screen.

Typically, where characters are being entered on many rows, delays are not noticeable; i.e., the display lags the key strokes by not more than five or six frame periods (240 milliseconds). For example, with entries distributed over 12 rows of characters and with five key strokes per second on each of 64 terminals, the writing of displayed characters is delayed only five frames at most -- 200 milliseconds -- and is not noticeable.

In the worst case, all characters are entered on all displays on the same row and delays become noticeable. For example, with simultaneous entries all on the same row on each of 64 terminals, the displayed characters lag the keyboard entry by two seconds. Normally, such events are sufficiently rare to be tolerable.

SECTION 4

INPUT INTERFACE

4.1 GENERAL

The TDS operates with an interface/controller unit which will match the TDS to a particular data channel. Interface circuits and logic levels are shown in Figure 4-1. Pin assignments are shown in Table 4-1.

4.2 BASIC INTERFACE LINES

The following 16 lines are necessary and sufficient for operation of the TDS. The timing for these lines is shown in Figure 4-2.
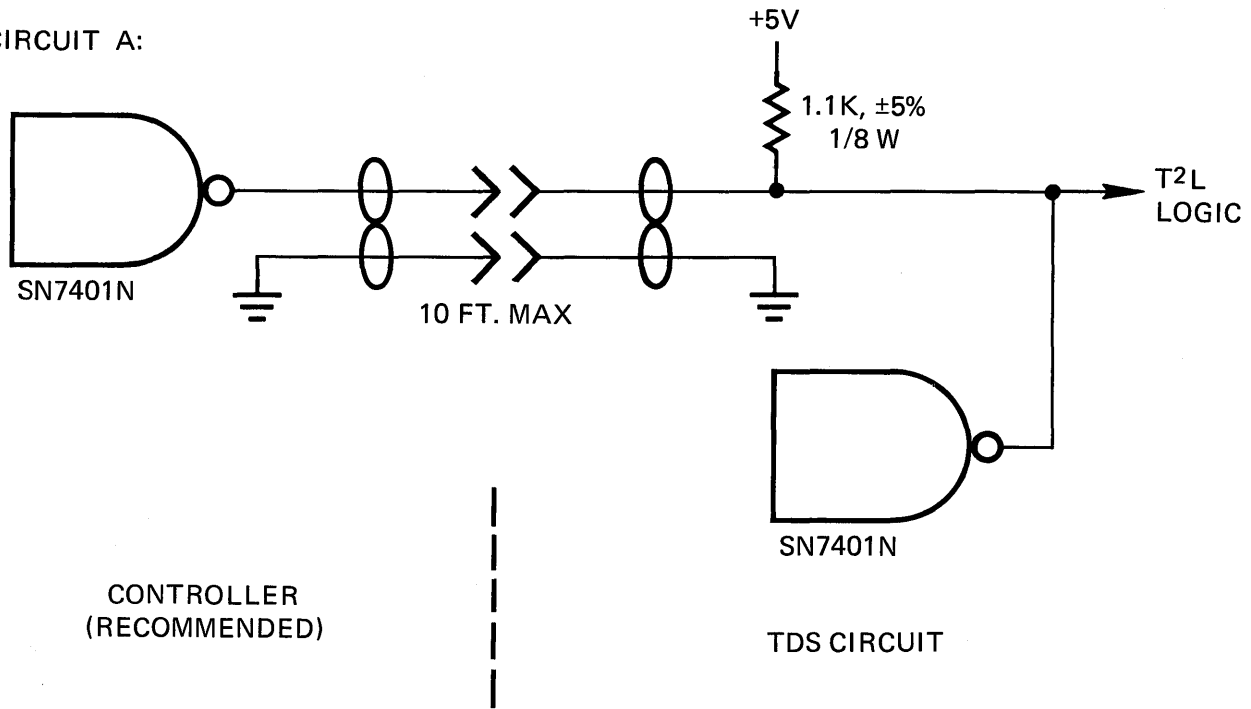
4.2.1 Lines to the TDS from the Interface Unit:

a) D1 through D8. Eight data lines. Data can be a function code, a line address, column address, channel address, ASCII text, or graphic text. Bit assignments are shown in Table 4-2.

b) A1 through A4. Four data-routing lines. These lines specify the TDS register to which the data is transferred, or specify the field into which the contents of the row buffer will be written. Bit assignments for these four lines are shown in Table 4-2.

c) TRQ - Transfer Request. A line carrying a zero-going pulse which initiates the transfer of data to a TDS register or initiates the processing of the contents of the row buffer.

4.2.2 Lines from the TDS to the Interface Unit:

a) TAK - Transfer Acknowledged. A line for a zero-going pulse occurring after a transfer operation. TRQ must be held active until TAK occurs and terminates.

b) BUS1 - Video Generator Busy. When BUS1 line is active, new data cannot be entered into the TDS. BUS1 can be active for up to 33 milliseconds. When the BUS1 line is active, TRQ inputs -- other than row buffer load -- will be ignored and input transfers should not be attempted.

c) BUS2 - Row Buffer Busy. When BUS2 line is active, new data cannot be entered into the row buffer. This line is active from completion of row buffer load until the last character or graphic byte is written (up to 33 milliseconds).
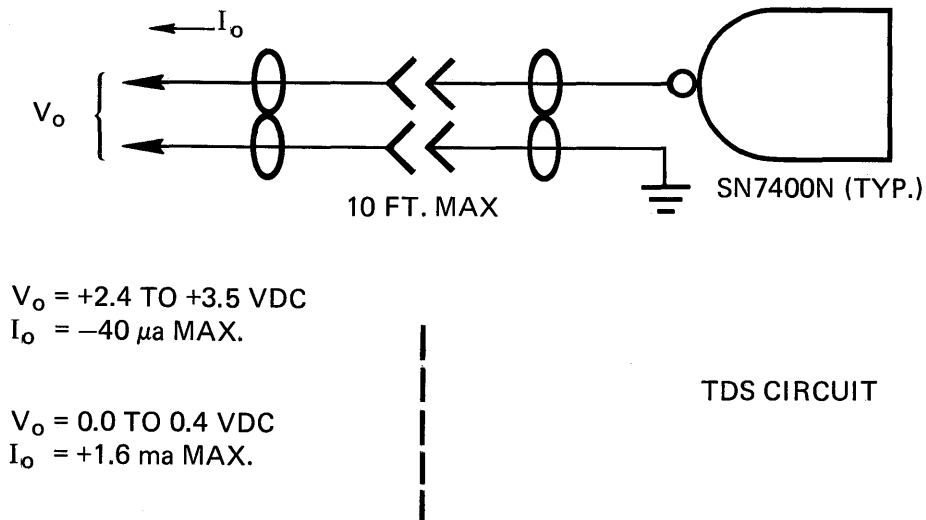
CIRCUIT A:

+5V

1.1K, ±5%
1/8 W

T^{2}L
LOGIC

SN7401N

10 FT. MAX

SN7401N

CONTROLLER
(RECOMMENDED)

TDS CIRCUIT

CIRCUIT B:

I_o

V_o

10 FT. MAX

SN7400N (TYP.)

V_o = +2.4 TO +3.5 VDC
I_o = −40 μa MAX.

TDS CIRCUIT

V_o = 0.0 TO 0.4 VDC
I_o = +1.6 ma MAX.

Figure 4-1. TDS - Interface Circuits

TABLE 4-1. TDS-1 INTERFACE CIRCUITS

Name	Pin (P1)	Circuit Type	Logic* Sense
D1	1	A	NTL
D2	3		
D3	5		
D4	7		
D5	9		
D6	11		
D7	13		
D8	15		
A1	17		
A2	19		
A3	21		
A4	23	A	
FCK	25	B	
LCK	29	B	NTL
CCK	31	B	PTL
ACN	33	B	NTL
ARL	37	B	PTL
TRQ	43	A	NTL
TAK	45	A	NTL
BUS2	47	A	NTL
BUS1	49	A	NTL

Connector Type - 66 Insert Pins, Winchester MRAC 66P JTC6H.
All leads twisted pair. Signal on Pin N, Ground on Pin N+1 located on rear of TDS Unit.

*NTL = Negative-True Logic, Logic 0 = +2.4 to +3.5 VDC
                            Logic 1 =   0.0 to +0.4 VDC

 PTL = Positive-True Logic, Logic 0 =   0.0 to +0.4 VDC
   Logic 1 = +2.4 to +3.5 VDC

SINGLE DATA TRANSFER
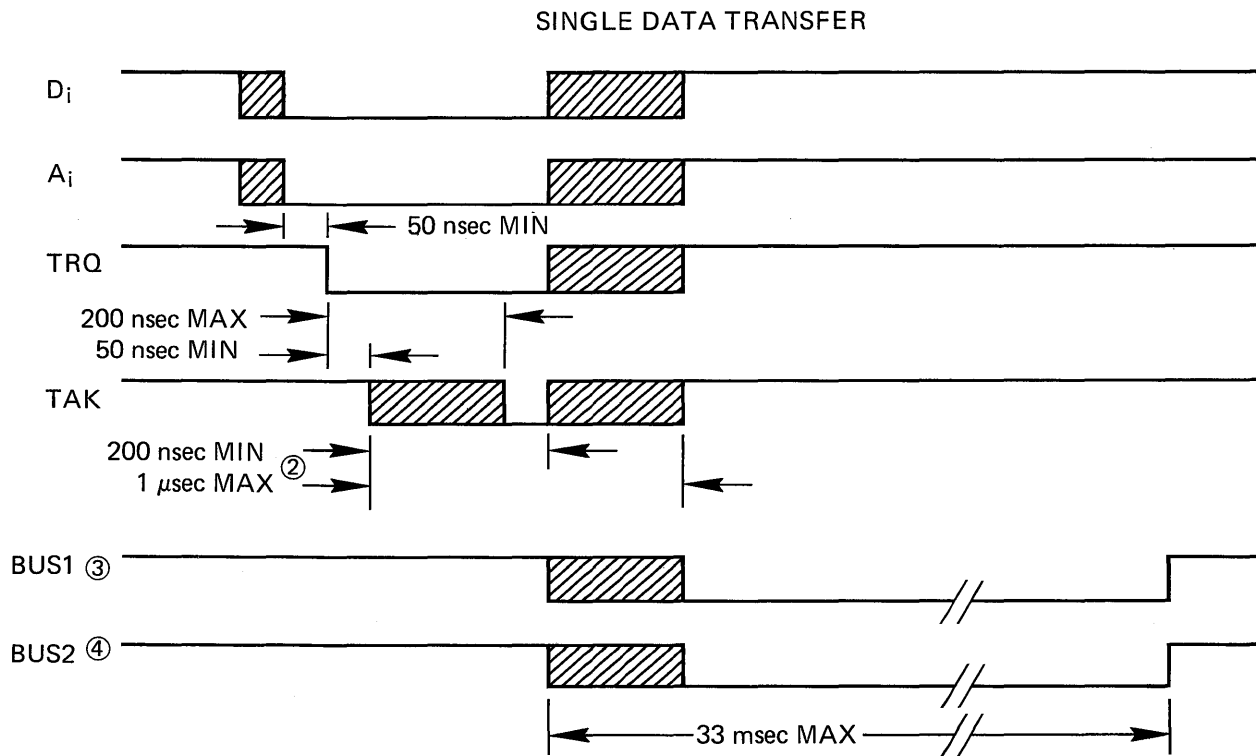
NOTES:

1. Negative level is active (true) level.

② TAK remains active for 1 μsec when a clear-write operation is performed in the Row Buffer.

③ BUS1 becomes active only for TRQ with data routing lines (A4 - A1) = 0110 and erase. BUS1 remains active until the end of the addressed row/line or until completion of the erase operation.

④ BUS2 becomes active only for TRQ with data routing lines (A4 - A1) = 0000. BUS2 remains active until the last data byte is unloaded from the buffer and processed.

Figure 4-2a.   TDS – Interface Timing

4.3 ADDITIONAL INTERFACE LINES

In addition to the lines described in 4.2, five lines are available at the TDS input plug for use with controllers where operation requires closer synchronism with the disc memory. Timing is shown in Figure 4-3. The five lines are used to connect the following functions:

MULTIPLE DATA TRANSFER
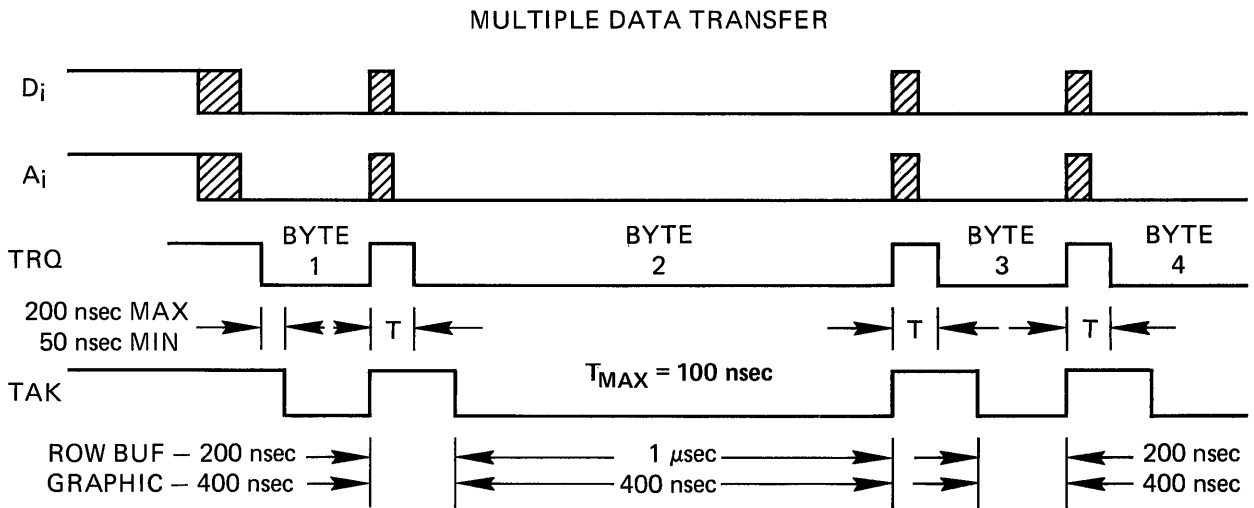
NOTES:

1. Negative level is active (true) level.
2. Timing shown for "real-time" operation of Row Buffer
    loading during single scan or multiple graphics. Maximum
    data rates are required under these conditions.

Figure 4-2b. TDS – Interface Timing

4.3.1 <u>FCK – Field Clock.</u> A frame is composed of two interlaced fields. The field clock is high for field A and low for field B.

4.3.2 <u>LCK – Line Clock.</u> A zero-going pulse, 4.5 microseconds wide, occurring at the beginning of each scan line.

4.3.3 <u>CCK – Character Clock.</u> A positive-going pulse, 300–400 nanoseconds wide (approximately half the width of a column).

4.3.4 <u>ACN – Addressed Column.</u> A zero-going pulse occurring coincidentally with the addressed column along each scan line.

4.3.5 <u>ARL – Addressed Row or Line.</u> A positive-going signal occurring during the addressed line or row. In the alphanumeric mode, row consists of 8 or 10 scan lines; i.e., 4 or 5 scan lines on each of the two fields.

TABLE 4-2. FORMAT: DATA AND ROUTING LINES

Type of Data/ Type of Transfer	Routing Lines	Data & Description

	A4 A3 A2 A1	D8 D7 D6 D5 D4 D3 D2 D1
FUNCTION CODE/	0 0 0 1	⎯ ⎯ FC6 FC5 FC4 FC3 FC2 FC1

Function Code bit descriptions:

- 1 GRAPHICS
- 0 ALPHANUMERICS
- 1 WRITE
- 0 DISPLAY DIRECTLY
- 1 POLARITY, BLACK
- 0 POLARITY, WHITE
- 1 DOUBLE WIDTH CH./ERASE
- 0 SINGLE WIDTH CHARACTERS
- 1 7 X 10 MATRIX/ADDITIVE
- 0 5 x 7 MATRIX/REPLACEMENT
- 1 SINGLE HEIGHT CH.
- 0 DOUBLE HEIGHT CH.

Type of Data/ Type of Transfer	Routing Lines	Data	Description
CHANNEL ADDRESS/	0 0 1 0	⎯ CH7 CH6 CH5 CH4 CH3 CH2 CH1	ADDRESS UP TO 128 CHANNELS
COLUMN ADDRESS/	0 0 1 1	⎯ CO7 CO6 CO5 CO4 CO3 CO2 CO1	ADDRESS 1 of 85 COLUMNS
LINE ADDRESS A/	0 1 0 0	⎯ ⎯ ⎯ L8 L7 L6 L5 L4	ADDRESS LINES (MOST SIGNIFICANT BITS)
LINE ADDRESS B/	0 1 0 1	⎯ ⎯ ⎯ ⎯ L3 L2 L1 L0	ADDRESS LINES (LEAST SIGNIFICANT BITS) A + B = 480 ADDRESSABLE LINES
COLUMN ADDRESS/TO ROW BUFFER	1 1 1 1	⎯ CO7 CO6 CO5 CO4 CO3 CO2 CO1	ADDRESS 1 of 85 COLUMNS
TEXT/WRITE DIRECTLY	0 1 1 0	T8 T7 T6 T5 T4 T3 T2 T1	ASCII CHARACTERS OR
TEXT/LOAD ROW BUFFER	1 0 0 0	T8 T7 T6 T5 T4 T3 T2 T1	GRAPHIC BYTE
EXECUTE	0 0 0 0	TRQ OCCURS WITH THIS ROUTING ADDRESS TO STOP LOADING ROW BUFFER AND EXECUTE	

Figure 4-3. TDS - Timing Diagram

SECTION 5
OUTPUT INTERFACE

5.1   GENERAL

As shown in Figure 5-1, each channel has both a composite video output for direct connection to a display terminal and a digital video output for connection through a switching network.

5.2   COMPOSITE VIDEO OUTPUTS, CVO-1, CVO-2 --- CVO-N

a)   UHF connector at rear of video distribution unit.

b)   Greater than one volt peak-to-peak signal.

c)   Three-level video (synchronized black and white).

d)   Drive up to 2500 feet of RG-11 coaxial cable.

e)   Longer lengths can be driven with addition of cable equalizers which can be supplied by Data Disc.

5.3   DIGITAL VIDEO

Digital Video Outputs, DVO-1, DVO-2 --- DVO-N, and Digital Video inputs DVI-1, DVI-2 --- DVI-N are on the same connector. A TDS system is delivered for operation without switching network; i.e., DVO-N and DVI-N are connected together via an external jumper plug.

a)   Digital Video Outputs DVO-1, DVO-2 --- DVO-N. TTL Output as shown in Figure 5-1. Pin assignments are shown in Table 5-1.

b)   Digital Video Inputs DVI-1, DVI-2 --- DVI-N. Connects to composite video line-driver circuit, TTL logic levels required. Pin assignments are shown in Table 5-1.

c)   Switching Networks. For operation with a switching network, jumper plug is removed from 66-pin digital video connector and replaced by a plug connected to user's switching network. Network inputs and outputs are TTL levels. Switching network can:

1)   Establish continuous connections from one or more of N display channels to one or more of M display terminals; i.e., a single channel can connect to a single terminal, several channels can connect to the same terminal, or several terminals can connect to the same channel.

VIDEO DISTRIBUTION UNIT
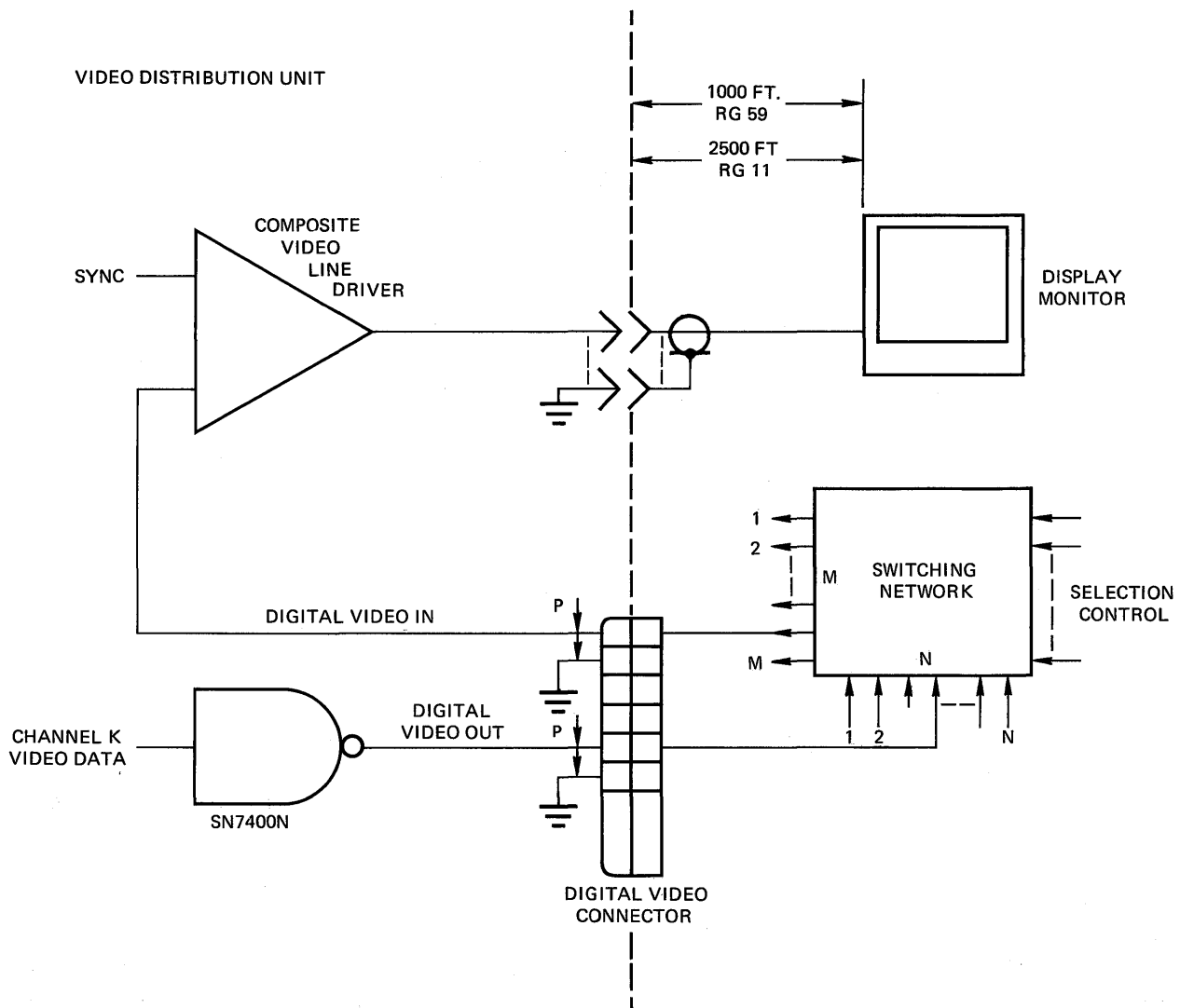
Figure 5-1. TDS - Channel Output Circuits

2) Establish periodic connections from one or more of N channels to one or more
of M terminals; i. e., channel can be multiplexed. For example, by switching
between rows, a 4080-character, 48-row alphanumeric display channel can be
switched to four independent, 1020-character, 12-row alphanumeric display
terminals.

TABLE 5-1. DIGITAL VIDEO CONNECTORS

Signal on Pin (N)

Signal Grounds on Pin (N+1)

Each connector services 16 terminals.

The basic 32-terminal TDS uses connectors P-DV1 and P-DV2.

A. Digital Video Outputs

Pin No.	Connector No.							
	P-DV1	P-DV2	P-DV3	P-DV4	P-DV5	P-DV6	P-DV7	P-DV8
	Channel No. (Octal Coded)							
1	00	20	40	60	100	120	140	160
5	01	21	41	61	101	121	141	161
9	02	22	42	62	102	122	142	162
13	03	23	43	63	103	123	143	163
17	04	24	44	64	104	124	144	164
21	05	25	45	65	105	125	145	165
25	06	26	46	66	106	126	146	166
29	07	27	47	67	107	127	147	167
33	10	30	50	70	110	130	150	170
37	11	31	51	71	111	131	151	171
41	12	32	52	72	112	132	152	172
45	13	33	53	73	113	133	153	173
49	14	34	54	74	114	134	154	174
53	15	35	55	75	115	135	155	175
57	16	36	56	76	116	136	156	176
61	17	37	57	77	117	137	157	177

B. Digital Video Inputs

Pin No.	P-DV1	P-DV2	P-DV3	P-DV4	P-DV5	P-DV6	P-DV7	P-DV8
3	00	20	40	60	100	120	140	160
7	01	21	41	61	101	121	141	161
11	02	22	42	62	102	122	142	162
15	03	23	43	63	103	123	143	163
19	04	24	44	64	104	124	144	164
23	05	25	45	65	105	125	145	165
27	06	26	46	66	106	126	146	166
31	07	27	47	67	107	127	147	167
35	10	30	50	70	110	130	150	170
39	11	31	51	71	111	131	151	171
43	12	32	52	72	112	132	152	172
47	13	33	53	73	113	133	153	173
51	14	34	54	74	114	134	154	174
55	15	35	55	75	115	135	155	175
59	16	36	56	76	116	136	156	176
63	17	37	57	77	117	137	157	177

SECTION 6
PHYSICAL DESCRIPTION

The basic TDS system -- with the exception of the optional control terminal and the display terminals -- is contained in an enclosed rack on coasters as shown in Figure 1-3. The rack for the minimum system, which contains a single disc memory and up to 32 display channels, is 50 inches high. Higher racks and/or multiple racks are used for systems with more channels; i.e., systems which contain several disc memories, video-distribution units, and disc-servo units. The basic TDS system consists of a disc memory unit, a video generator unit, row buffer, a video distribution unit, and a power supply. Each unit can be removed separtely. The units are interconnected by twisted-pair cables and 66-pin Winchester connectors.

SECTION 7
DISPLAY TERMINALS

7.1 GENERAL

Terminals (see Figure 1-5) are available as monitor-only terminals, monitor and keyboard terminals, or monitor, keyboard, and keyboard serializer terminals. Monitor-only terminals operate from 110-volt, 60-Hz, 1.5-amp power. Other terminals operate from 110-volt, 60-Hz, 2.0-amp power. Monitor-only terminals have same capability to display as any other monitor or monitor/keyboard combination.

7.2 MONITOR

    a) 525-line raster.

    b) Solid-state except for CRT.

    c) Typical display area - 9 inches wide by 6-1/2 inches high.

    d) CRT tube phosphor - P-39, a long-persistence green phosphor.

    e) Resolution - greater than 500 lines over the entire display area.

    f) Video bandwidth - ±3 db to 10 MHz.

    g) Width - adjustable to attain a 1:1 screen-aspect ratio as used with graphics.

    h) Linearity - ±3 percent.

    i) Composite video input to a UHF connector.

7.3 KEYBOARD (See Figure 7-1.)

    a) 67 keys - standard ASCII characters plus 15 control keys.

    b) Solid-state.

    c) 8-bit parallel ASCII-coded output at TTL logic levels.

    d) Two-key rollover.

    e) Two-level, alternate action shift-lock key. With shift-lock key in the down level, keyboard is in the upper case mode.
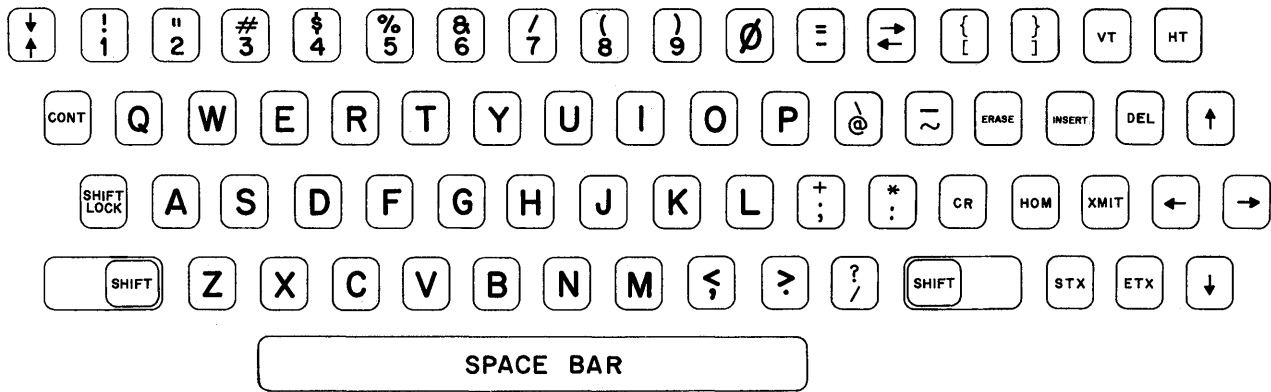
Key caps shown match the standard Data Disc character generator (modified ASCII).
To conform to standard ASCII these three keycaps must be changed:

Figure 7-1. Keyboard

f)   Key-cap legends on the 15 control keys can be changed to meet customer requirements.

g)   Coding of the 15 control keys is shown in Table 7-1. Coding can be changed to meet customer requirements.

7.4 KEYBOARD SERIALIZER

a)   Accepts 8-bit parallel output from keyboard and converts to serial outputs.

b)   Format matches Teletype format so that keyboard can be used in place of TTY keyboard.

c)   Meets EIA RS-232-B specifications as described in d) through h).

d)   Output circuit will not be damaged by either an open-circuit or a short-circuit condition (to either protective ground or signal ground).

TABLE 7-1. KEYBOARD CONTROL KEY CODING

Legend	Code	Legend	Code
	Bit 7654321		Bit 7654321
VT	0001011	HOM	0010010
HT	0001001	XMIT	0010101
CONT	FUNCTION	←	0011010
ERASE	0000110	→	0011000
INSERT	0010111	STX	0010011
DEL	0000101	ETX	0000100
↑	0000011	↓	0001010
CR	0001101		

e) Binary "ONE", more negative than -5 volts into a 3000-ohm load.
    more negative than -3 volts into a 300-ohm load.

f) Binary "ZERO", more positive than +5 volts into a 3000-ohm load.
    more positive than +3 volts into a 300-ohm load.

g) Output impedance - less than 200 ohms.

h) Rise time - less than 10 μsec.

SECTION 8
CONTROL TERMINAL (OPTIONAL)

The control terminal consists of a Model ASR-33 Teletype and a 12-inch television monitor. Any display channel can be selected, displayed, and edited from the control terminal. This terminal is used in testing and maintaining the TDS system and is also used as the data source in freestanding TDS systems. The function code, terminal address, ASCII characters, and graphic characters can be entered from the ASR-33 keyboard. The position where data will be entered on the display is shown by a cursor. The cursor is a "flickering box" slightly larger than a character. It can be moved up, down, right, left, or to the top-left corner of the display from the keyboard. A case shift can be executed from the keyboard so that lower-case characters and other symbols of the 96-character ASCII set can be entered.

All keyboard operations can be recorded via the paper-tape punch and this tape can then be read to construct automatically any or all portions of a display channel. Details of the control-terminal operation are presented in Appendix C.

SECTION 9

DISC MEMORY

The TDS disc memory, located as shown in Figure 1-3, is mechanically identical to the Data Disc FPD memory. The standard FPD memories are very reliable, have long life, and require minimum maintenance. (Detailed description of these memories is available.) The TDS disc memory electrical characteristics differ only slightly from the standard FPD.

Data Disc's FPD Memory contains a shock-mounted aluminum casting on which are mounted the read/write heads, a 12-inch plated disc, drive motor, spindle, and a read/write amplifier for each track. The disc rotates at 3600 rpm, or 60 rps. Thus one disc revolution equals a field period, and two revolutions equal a frame period. The display data for one field of a channel is stored on one track. Therefore, memory for one channel occupies two disc tracks. Each track contains 163,800 bit cells, 122,880 (512 x 240) of which can contain display data. Data rate is 9.8×10^6 bits per second.

Each track read/write amplifier connects to the video distribution unit by three signal lines; i.e., read data, write data, and write enable. Additional disc signals are the bit clock and the track origin (pulse/revolution) clock.

The disc memory contains power supplies which power all of its internal electronics plus parts of the video distribution-unit electronics.

SECTION 10
VIDEO GENERATOR UNIT

The video generator contains a character generator, row-address logic, column-address logic, channel-address logic, a row buffer, control Teletype interface logic, and control logic.

The character generator is a magnetic read-only memory whose contents can be easily modified to meet a customer's special symbol requirements.

The video generator is constructed to permit easy checkout and maintenance. All logic is contained on cards which mount in five pages. The pages and the page support are hinged. Pages can be moved so that all components on all cards are simultaneously accessible without disconnecting cards or using special test hardware. A vacant sixth page is provided for convenient addition of a computer interface.

SECTION 11
VIDEO DISTRIBUTION UNIT

The video distribution unit contains the line driver, sync mixer, write selection, and read selection-to-control terminal circuits for each of up to 32 display channels. Coaxial cables from the display terminals connect to UHF connectors at the rear of this unit.

APPENDIX A

DISPLAY FORMATS

A.1   RASTER FORMAT (Figure 2-2.) (Standard TV Compatible.)

A.1.1   Raster or frame rate of 30 per second.

A.1.2   Field rate of 60 per second.

A.1.3   2-to-1 interlace.

A.1.4   525 total scan lines.

A.1.5   480 visible scan lines.

A.1.6   45 scan lines to accommodate vertical retrace and non-linearities at the start of the vertical sweep.

A.1.7   512 visible elements per scan line.

A.1.8   Scan proceeds from top to bottom and from left to right.

A.1.9   Picture element rate or data rate is 9.8 million elements per second.

A.2   CHARACTER FORMATS

A.2.1   5 x 7 Dot Matrix (Figures A-1 and A-2a)

  a)   64-character ASCII set; i.e., no lower case alphanumeric characters

  b)   Space between characters: 20% of the character width

  c)   Space between rows: typically 45% of character height

A.2.1.1   Page Format with Normal Size Characters (Figure A-3)

  a)   4080 characters per frame

  b)   85 characters per row

  c)   48 rows per frame, typically

  d)   Character aspect ratio: approximately 1:1
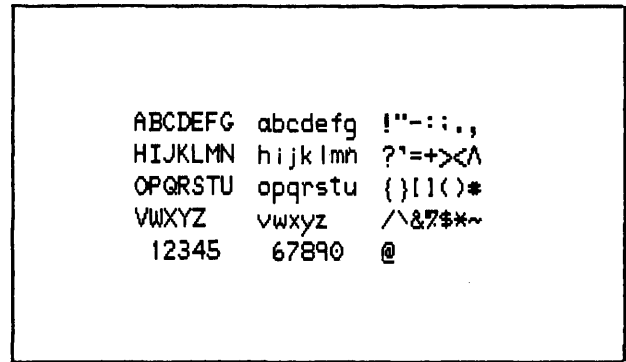
BIT			7	0	0	1	1	1	1
			6	1	1	0	0	1	1
			5	0	1	0	1	0	1
4	3	2	1						
0	0	0	0	Space	⊖	@	P	\	p
0	0	0	1	!	1	A	Q	a	q
0	0	1	0	"	2	B	R	b	r
0	0	1	1	#	3	C	S	c	s
0	1	0	0	$	4	D	T	d	t
0	1	0	1	%	5	E	U	e	u
0	1	1	0	&	6	F	V	f	v
0	1	1	1	'	7	G	W	g	w
1	0	0	0	(	8	H	X	h	x
1	0	0	1	)	9	I	Y	i	y
1	0	1	0	*	:	J	Z	j	z
1	0	1	1	+	;	K	[	k	{
1	1	0	0	,	<	L	~	l	—
1	1	0	1	–	=	M	]	m	}
1	1	1	0	.	>	N	↑	n	↓
1	1	1	1	/	?	O	←	o	→

▓ Differ from standard ASCII as follows:

Data Disc:	~	—	↑	↓	→	←
ASCII:	\	|	∧	~	–	–

Figure A-1. 96-Character Set

(a) 5 x 7 matrix - 64 character set.
Displays 48 rows of 85 charac-
ters per row for 4080-charac-
ter display. (Not to scale.)

(b) 7 x 10 matrix - 96 character set.
Displays 40 rows of 64 char-
acters per row for 2560-charac-
ter display. (Not to scale.)

Figure A-2. ASCII Character Sets

A.2.1.2   Page Format with Double Height Characters

a)   2040 characters per frame

b)   85 characters per row

c)   24 rows per frame, typically
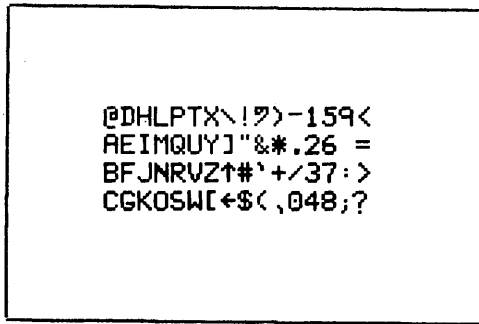
d)   Character aspect ratio: approximately 2:1

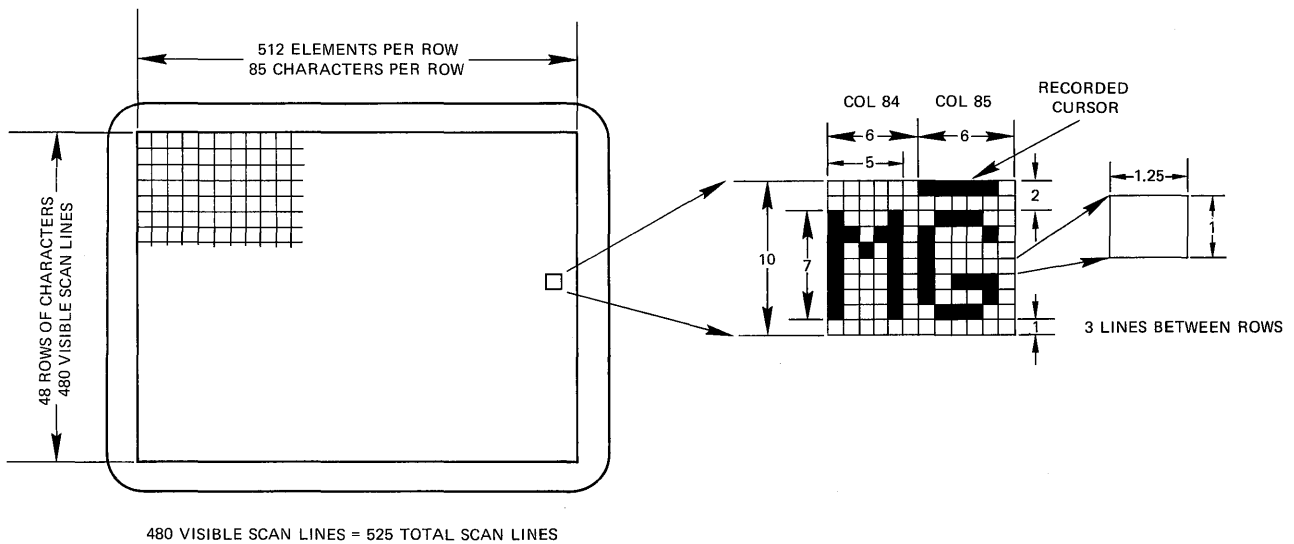

Figure A-3. 5 x 7 Character Format

A.2.1.3   Page Format for Double Height, Double Width Characters

    a)   1008 characters per frame

    b)   42 characters per row

    c)   24 rows per frame, typically

    d)   Character aspect ratio: approximately 1:1

A.2.2   7 x 10 DOT MATRIX (Figures A-1 and A-2b)

    a)   96-character ASCII set.

    b)   Both upper and lower case characters.

    c)   Space between characters: 15% or more of the character width, depending on the specific characters.

    d)   Space between rows: typically 70% of character height.

A.2.2.1   Page Format - Normal-Size Characters (Figure A-4)

    a)   2560 characters per frame.

    b)   64 characters per row.

    c)   40 rows per frame, typically.

    d)   Character aspect ratio: approximately 1:1.

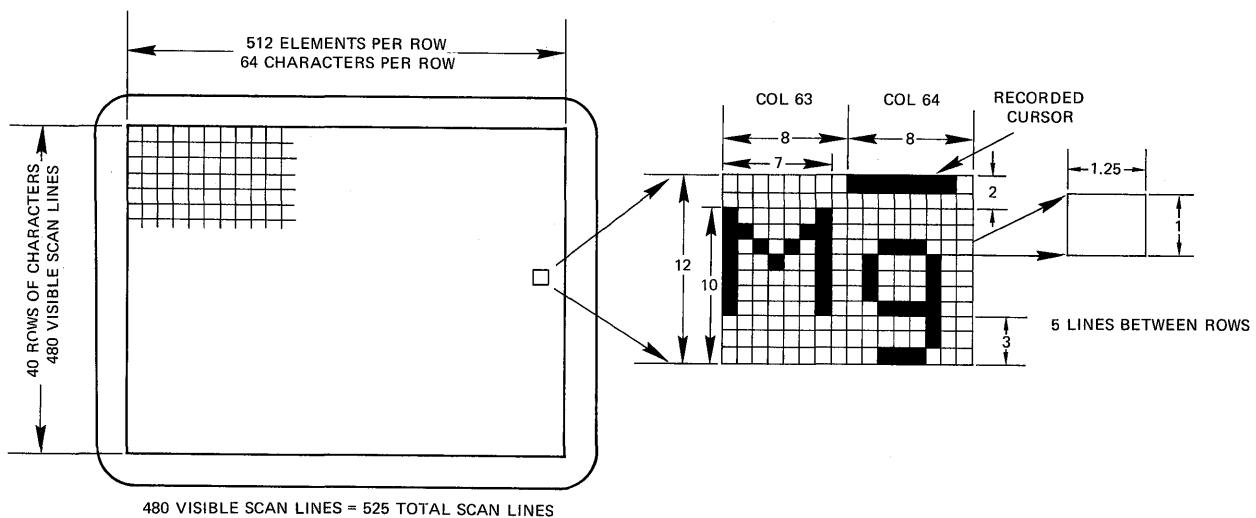
Figure A-4. 7 x 10 Character Format

A.2.2.2 Page Format - Double-Height Characters

a) 1280 characters per frame.

b) 64 characters per row.

c) 20 rows per frame, typically.

d) Character aspect ratio: approximately 2:1.

A.2.2.3 Page Format - Double-Height, Double-Width Characters

a) 640 characters per frame.

b) 32 characters per row.

c) 20 rows per frame, typically.

d) Character aspect ratio: approximately 1:1.

A.3 GRAPHIC FORMAT (Figure A-5)

A.3.1 512 picture elements per scan line.

A.3.2 480 scan lines.

A.3.3 Matrix is addressed by line segments, each of which consists of eight picture elements along a scan line. Therefore, there are 64 segments across a scan line.
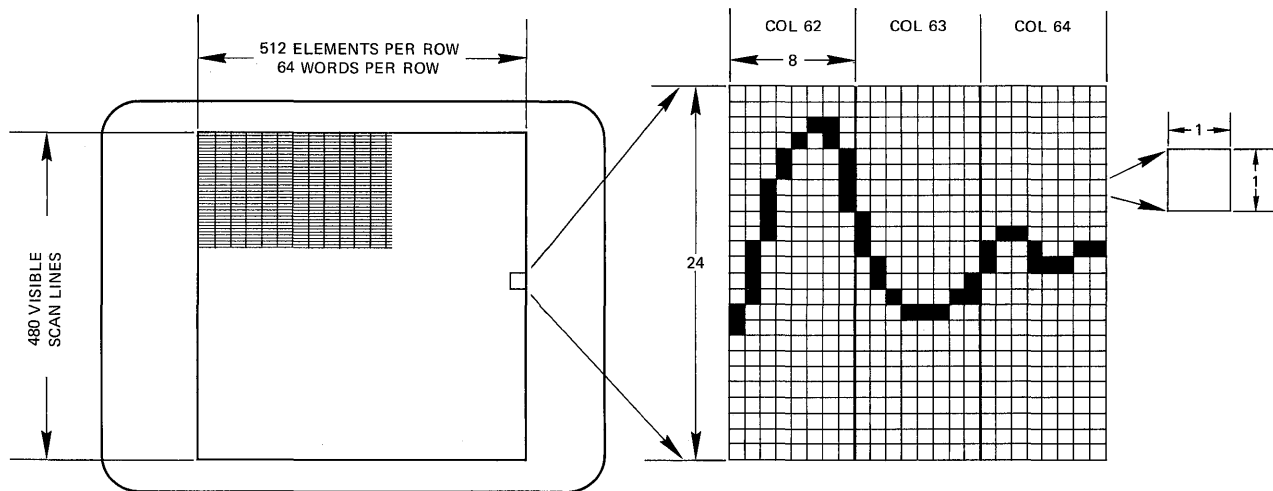
NOTE: TV DISPLAY WIDTH ADJUSTED FOR SQUARE MATRIX

Figure A-5. Graphic Format

APPENDIX B
DEFINITIONS

B.1 PAGE

Refers to that set of information from which a frame originates. In the case of an alpha-numeric frame, a page consists of ASCII code characters. In the case of drawings (graphics), a page will consist of binary transformations of the drawing into raster lines which will be suitable for display at a terminal with no further transformation except that which is necessary to synchronize the individual raster lines.

B.2 CURSOR

A visible mark on the frame which is uniquely distinguishable and can be moved under program control to a subset of raster points.

B.3 FRAME (OR PICTURE)

Refers to a raster scan display and is the precise number of displayable bits in the raster.

B.4 ALPHANUMERIC CHARACTER

An 8-bit word constituting an ASCII code.

B.5 GRAPHIC CHARACTER

An 8-bit word which is transformed directly into eight picture elements along a scan line.

B.6 SCAN LINE

A horizontal string of 512 picture elements traced by the scanning electron beam.

B.7 ROW

The set of scan lines from one field -- or two fields -- which compose the row of displayed alphanumeric characters.

B.8 COLUMN

A vertical strip -- six or eight picture elements wide for 5 x 7 or 7 x 10 character size -- extending from top to bottom of the picture.

B.9 <u>GRAPHICS</u>

Refers to displays that are not generated by the character generator. These displays have the picture elements supplied by the computer.

B.10 <u>PICTURE ELEMENT</u>

The area of the display swept by the display beam during a clock period.

B.11 <u>TEXT</u>

A portion of a page.

APPENDIX C
CONTROL TERMINAL OPERATION

C.1 CONTROL SWITCHES

The panel on the front of the control unit contains ten switches. (See Figure C-1.) Seven are used to manually set a function code into the function register. One is used to switch operation between the control teletype and an external processor, and one applies dc power to the control unit and the output unit. The ten switches are:

SW1 (a) GRPH (Graphics). The input codes are written directly as 8-bit bytes.

(b) A/N (Alphanumeric). Alphanumeric characters are written; i.e., input ASCII codes are converted to display codes.

SW2 (a) WRT (Write). Information is written into the display memory.

(b) DISPLAY. Display information is not written into the display memory, but is shown on the display for a single field.

Figure C-1. TDS Control Panel

SW3 (a) <u>DRK (Dark)</u>. Light images are written or displayed on a dark background.

(b) <u>LGT (Light)</u>. Dark images are written or displayed on a light background.

SW4 (a) <u>ERS/2W (Erase/Double Width)</u>. Display may be erased. Characters are written twice their normal width.

(b) <u>1W (Normal Width)</u>. Characters are written normal width.

SW5 (a) <u>710/A (7 x 10 Dot Matrix/Additive Write)</u>. In the alphanumeric mode, characters are written in a 7 x 10 dot matrix. In the graphics mode, information is written with "1" bits added to the display.

(b) <u>57/R (5 x 7 Dot Matrix/Replacement Write)</u>. In the alphanumeric mode, characters are written in the 5 x 7 dot matrix. In the graphics mode, data replaces previous display data.

SW6 (a) <u>1H (Normal Height)</u>. Characters are written or displayed in their normal height.

(b) <u>2H (Double Height)</u>. Characters are written twice their normal height. Double height is achieved by writing the same image on both fields of an interlaced display.

SW7 <u>ADD/REPL</u> Not used.

SW8 <u>FRST</u>. This switch, when depressed, resets the function register. When it is released, data from Switches 1 through 7 are set into the function register.

SW9 (a) <u>CMPTR (Computer)</u>. The TDS can be operated from the external processor.

(b) <u>TTY (Teletype)</u>. The control teletype can be operated as described in "Control Teletype Keyboard Operation" below.

SW10 <u>POWER</u>. AC power is applied to +5.0-volt power supply which drives the TTL logic of the TDS.

C.2 <u>CONTROL LIGHTS</u>

LIGHT 1: <u>BUS ADR</u>. (On) - The TDS is in the address mode where channels can be selected from the teletype.

(Off) – The TDS is in the normal mode where characters can be written from the teletype.

LIGHT 2:   POWER. (On) – DC power is present in the control unit.

C.3 CONTROL TELETYPE KEYBOARD OPERATION

The teletype can be wired for either full duplex operation or simplex operation. The Standard 64 ASCII characters can be entered from the keyboard. In addition, these functions can be initiated from the keyboard:

RETURN   Moves the cursor to the extreme left column. (Col. 1)

LINE FEED   Moves the cursor to the next row.

ALT MODE (Alternate Mode)   Shift the teletype from the upper case to the lower case character set, or vice versa. The case shift is effective only when the function register is set for the 7 x 10 characters and does not affect the writing of 5 x 7 characters.

C-CT   The C key, together with the control key moves the cursor up one row.

Z-CT   Moves the cursor one column to the left.

X-CT   Moves the cursor one column to the right.

A-CT   Shifts the TDS from the address mode to the normal mode, or vice versa. In the address mode, the track address is entered as a 2-digit octal number by two successive strokes of the numeric keys (most significant digit first). This selects one of 64 channels. A second entry of A-CT returns the TDS to the normal mode.

R-CT   Resets the cursor to the upper, extreme left character position (Col. 1 and Row 0) and also erases the display if the function-register erase bit is set.
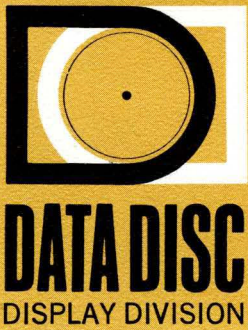
C.4 CONTROL TELETYPE PAPER TAPE OPERATION

The keys BREAK and RUBOUT should not be used in preparing paper tape since they generate printed characters. Use the space bar to generate tape leader. Mistakes on the paper tape can be corrected by entering backspace characters; i.e., C-CT (C key with control key) followed by the correction.

NOTES

DATA DISC's Television Display System combines a high-capacity disc memory and television monitors in a versatile display system which can store and display up to 128 TV pictures. These pictures can be viewed simultaneously on TV display terminals. The displays may be alphanumeric, graphic, or a combination of both.

Basically, the TDS consists of the disc memory, a time-shared control unit containing addressing logic and a character generator, a control terminal, and the display terminals.

Each picture consists of over ¼ million black and white picture elements (a 512 x 480 picture-element matrix) on which alphanumeric and graphic images can be written.

When writing on one channel, other displays are not disturbed. In writing alphanumeric images, individual characters can be changed. Similarly, when the display is used for graphics, single data bits can be altered. The displays may be written with dark images on a light background or with light images on a dark background.

In writing alphanumeric characters, the character generator converts the incoming ASCII character symbols into the picture elements which make up the display characters. These elements are then stored in the display memory. The standard Data Disc character generator contains the 96-character ASCII set. Special characters or symbols are easily added to the generator. The characters can be displayed in various sizes, permitting from 640 to 4080 characters on the full display screen. Standard systems are equipped with two character fonts, 5 x 7 and 7 x 10. Computer can select either font in standard height and width, standard width and double height, or both double width and double height. Characters are written at rates up to 120,000 characters per second.

The graphic display is constructed by writing picture elements along a scan line. The writing is accomplished via an external processor which supplies 8-bit bytes that are processed directly as picture elements. Actual writing may be in the form of either the entire 8 bits or only the individual "1" bits of the byte. The latter method permits single-bit alterations and the superposition of grids, curves, symbols, etc.

Any memory disc channel may be chosen from the control terminal for display or modification. If used with the control terminal only, i.e., no external processor, the TDS functions as a simple, free-standing display system.

Data Disc's display terminals are available with both TV monitors and keyboards or with monitors only. The solid-state keyboards can be supplied with either an 8-bit parallel ASCII output or with bit serial ASCII output with teletype format. Without keyboards, the TDS is used in display-only systems or as add-on displays for existing teletypewriter terminal systems. In such systems the TDS operates as a time-shared "soft copy" printer/plotter.

A very powerful display system consists of the TDS, display terminals with keyboards, and an external processor. The processor can perform the functions of text-editing, keyboard multiplexing, keyboard message composition, vector to raster conversion, etc.
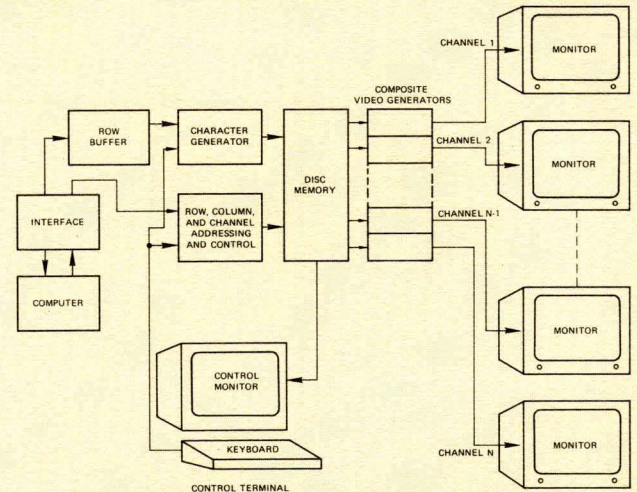
TELEVISION DISPLAY SYSTEM
MAJOR COMPONENT DIAGRAM

TYPICAL APPLICATIONS

Computer-aided instruction terminals.

Terminals for time-shared computer systems.

Hospital display systems, such as intensive-care monitoring and nurses' station terminals, medical-history displays, etc.

Airport displays, including reservations terminals, arrival and departure listings, gate indications etc.

Stock-quotation terminals.

Bank-window terminals.

(a) 5x7 matrix - 64 character set. Displays 48 rows of 85 characters per row for 4080-character display. (Not to scale.)

(b) 7x10 matrix - 96 character set. Displays 40 rows of 64 characters per row for 2560-character display. (Not to scale.)

Turn Around & Tune In to Data Disc's New Alphanumeric/Graphic Display

DATA DISC, INC. introduces a low-cost, high-performance, alphanumeric and graphic display system that displays:

- characters in UPPER and lower case
- black on white or white on black
- super^{script} and sub$_{script}$
- 2560 characters (96 ASCII set)
- 4080 CHARACTERS   (64 ASCII set)
- graphics on a 512 x 480 matrix

This time-shared display system can generate new displays at the rate of 60 pages per second. The control unit and CRT refresh disc memory can serve up to 128 display terminals, which contain standard TV monitors.

DATA DISC, INC.'s Television Display System (TDS), with only a few terminals, costs less than alphanumeric-only systems. With additional terminals even greater economy can be realized.

COST PER TERM.

NO. OF TERMINALS

See this equipment at Booth L-3 during the Fall Joint Computer Conference. Or, contact William Stevens, Vice President, DATA DISC INC./Dispaly Division, 1275 California Avenue, Palo Alto, Calif. 94304
(415) 326-7602