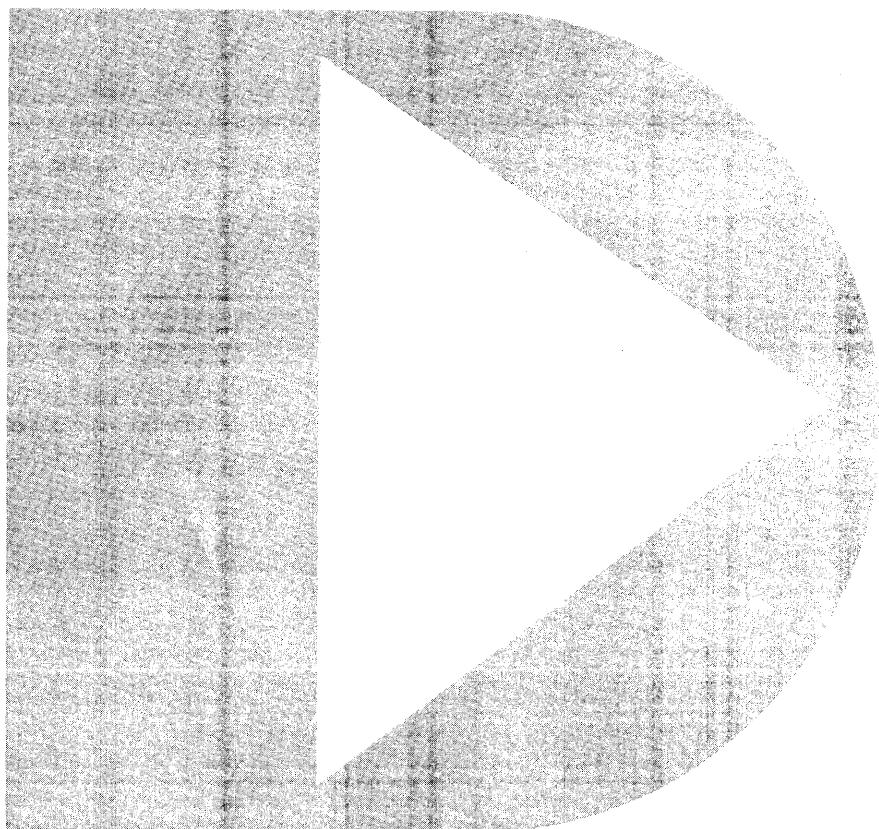# Product Specification

Datapoint

DATAPOINT CORPORATION

PRODUCT SPECIFICATION

September 20, 1972


ASYNCHRONOUS COMMUNICATIONS ADAPTOR/MODEM     2200-401

# 1.0 GENERAL DESCRIPTION

The 2200-401 Asynchronous Communications Adaptor, consisting of a communications interface and integral low-speed modem, provides the Datapoint 2200 user the capability of binary, serial, asynchronous data communication over the switched (DDD) telephone network or dedicated (leased) telephone circuits.

The Adaptor accomplishes the conversion between the internal parallel input/output bus data used by the processor and serial start/stop data in the form of frequency-shift keyed tones used for communication over telephone lines. The frequencies used for transmission and reception make the unit compatible with modems of the Bell System 103 series.

The 2200-401 is capable of full-duplex operation (simultaneous transmission and reception) at data rates to 300 baud.

Character formats and data rates for transmission and reception are completely under program control, as are the automatic dialing and answering operations and selection of operating mode ('Originate' or 'Answer').

# 2.0 SYSTEM REQUIREMENTS

## 2.1 Datapoint 2200

The 2200-401 operates with either Version I or Version II Datapoint 2200 processors of any memory size. A maximum of two adaptor devices such as the 2200-401 may be connected to the input/output bus, since units of this type are supplied power from the Datapoint 2200. Provisions for power and physical housing for more than two devices are available.

## 2.2 Telephone Network

Due to the relatively narrow-band transmission characteristics of the 2200-401, four-wire telephone circuits are not required for full-duplex operation. For this reason, the 2200-401 telephone line interface is two-

wire only. For connection to the switched telephone network, a Data Access Arrangement (DAA) is required. The 2200-401 is designed to operate with the Bell System 1001B (CBT),58118, or equivalent DAA. The DAA should be installed without a power supply since the 2200-401 supplies power for the unit.

For multi-point (polled) communication systems or in cases where continuous operation is intended, dedicated (leased) two-wire telephone circuits are used. These circuits may be type 3002 (unconditioned) for data rates to 300 baud.

## 3.0 TECHNICAL DESCRIPTION

## 3.1 General

Aside from the automatic dialing and answering functions performed by the 2200-401, its main functions are data transmission and reception. These functions are depicted in basic form in Figure 1.

## 3.1.1 Transmission

A character transferred from the 2200 processor via the input/output bus to the Adaptor is first placed in the Transmit Character Buffer. It is then transferred to the Serial Transmit Register, where start and stop bit(s) are appended to the character and conversion to bit serial form occurs.

If a character is presently being processed by the Serial Transmit Register, the next character remains in the Transmit Character Buffer until processing is completed. The output of the Serial Transmit Register (Transmit Data) is applied to the modem transmitter, where it controls the frequency of the tone transmitted on the telephone line. If the modem is in the 'Originate' mode, the state of this line keys the transmitted frequency between 1270 Hz ('mark' or '1') and 1070 Hz ('space or '0'). If the modem is in the 'Answer' mode, the tone is keyed between 2225 Hz ('mark' or '1') and 2025 Hz ('space' or '0').

The modem receiver accepts the telephone line signal which is a combination of tones received from the distant

```
┌──────────────────┐      TRANSMIT DATA      ┌──────────────────┐          ──►  Frequency Shift
│  SERIAL TRANSMIT │      SERIAL BINARY      │      MODEM       │               Keyed Tones
│     REGISTER     │──────────────────────── │   TRANSMITTER    │
└──────────────────┘      START-STOP DATA    └──────────────────┘
         ▲
         │
┌──────────────────┐
│ TRANSMIT CHARACTER│
│      BUFFER      │                                                            Telephone
└──────────────────┘                                                          Line Pair
A-Register ─────►
  Output

┌──────────────────┐      RECEIVE DATA       ┌──────────────────┐
│  SERIAL RECEIVE  │      SERIAL BINARY      │      MODEM       │
│     REGISTER     │──────────────────────── │    RECEIVER      │
└──────────────────┘      START-STOP DATA    └──────────────────┘          ◄── Frequency Shift
         │                                                                      Keyed Tones
         ▼
┌──────────────────┐
│ RECEIVE CHARACTER│
│      BUFFER      │
└──────────────────┘
A-Register ◄────
  Input
```
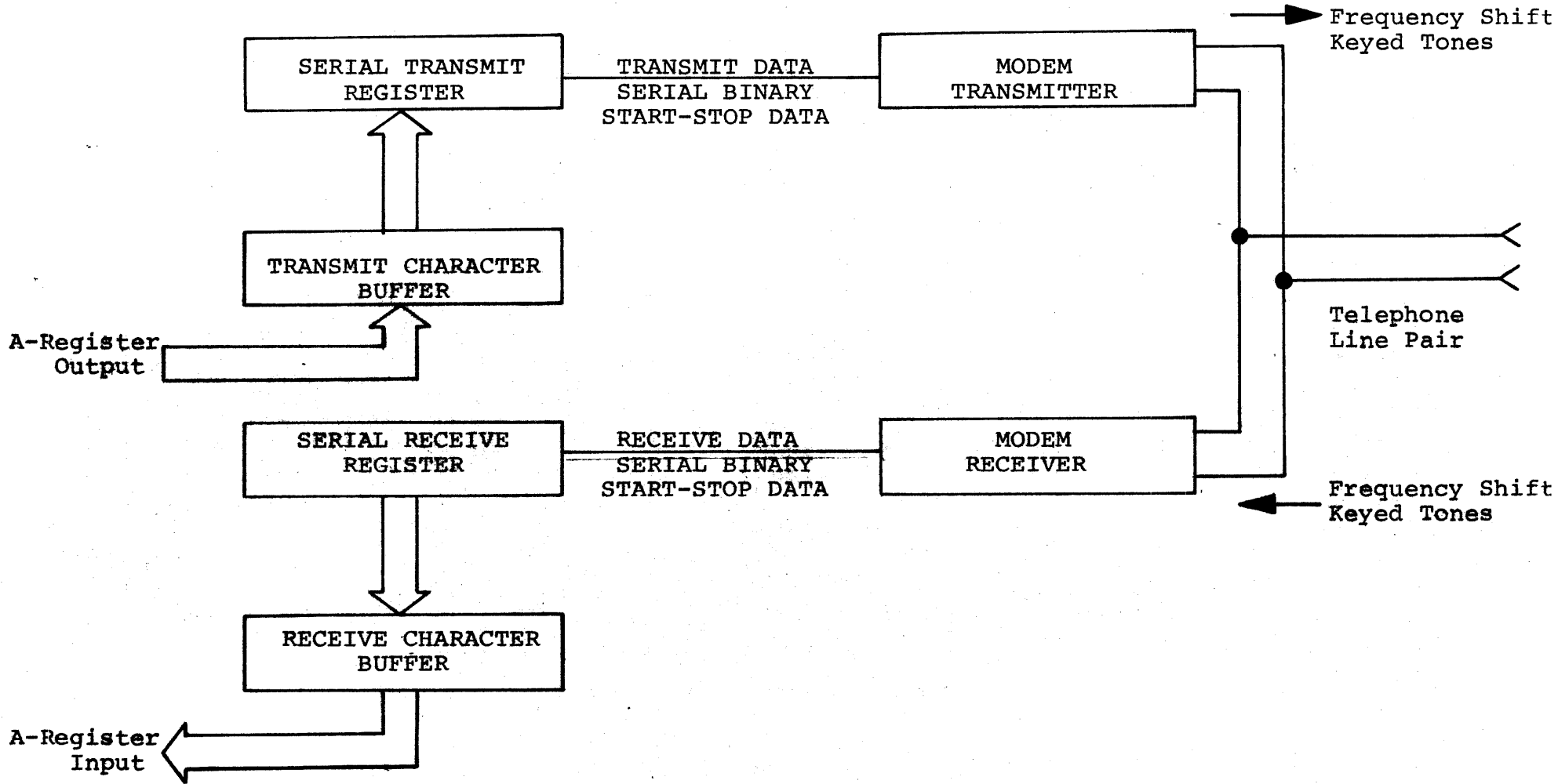
FIGURE 1:  2200-401 BASIC FUNCTIONAL DIAGRAM

2200-401. The receiver then rejects the local transmitter tones and converts tones received from the distant modem into serial, binary data. This serial data line (Received Data) is applied to the Serial Receive Register, where the start and stop bits are stripped and each character is assembled into parallel form. Following this assembly, the character is transferred to the Receive Character Buffer, where it awaits transfer to the 2200 processor via the input/output bus.

## 3.2   Programming

Figure 2 shows the programming interface for the 2200-401, showing sources and destinations of all input, output and command operations.

### 3.2.1   Device Address

Each device connected to the 2200 processor input/output bus is assigned a unique address, allowing the processor to selectively communicate with each device while only that device is addressed. The 2200-401 is factory-wired with an address of 322 (octal) but this strapped address may be modified if required.

The 2200-401 is addressed by the program by setting the A-register to 322 (octal) and executing an EX ADR instruction.

### 3.2.2   Status

After addressing the 2200-401, execution of an INPUT instruction loads the 2200-401 status into the A-register of the processor. Status word bit assignments are as follows:
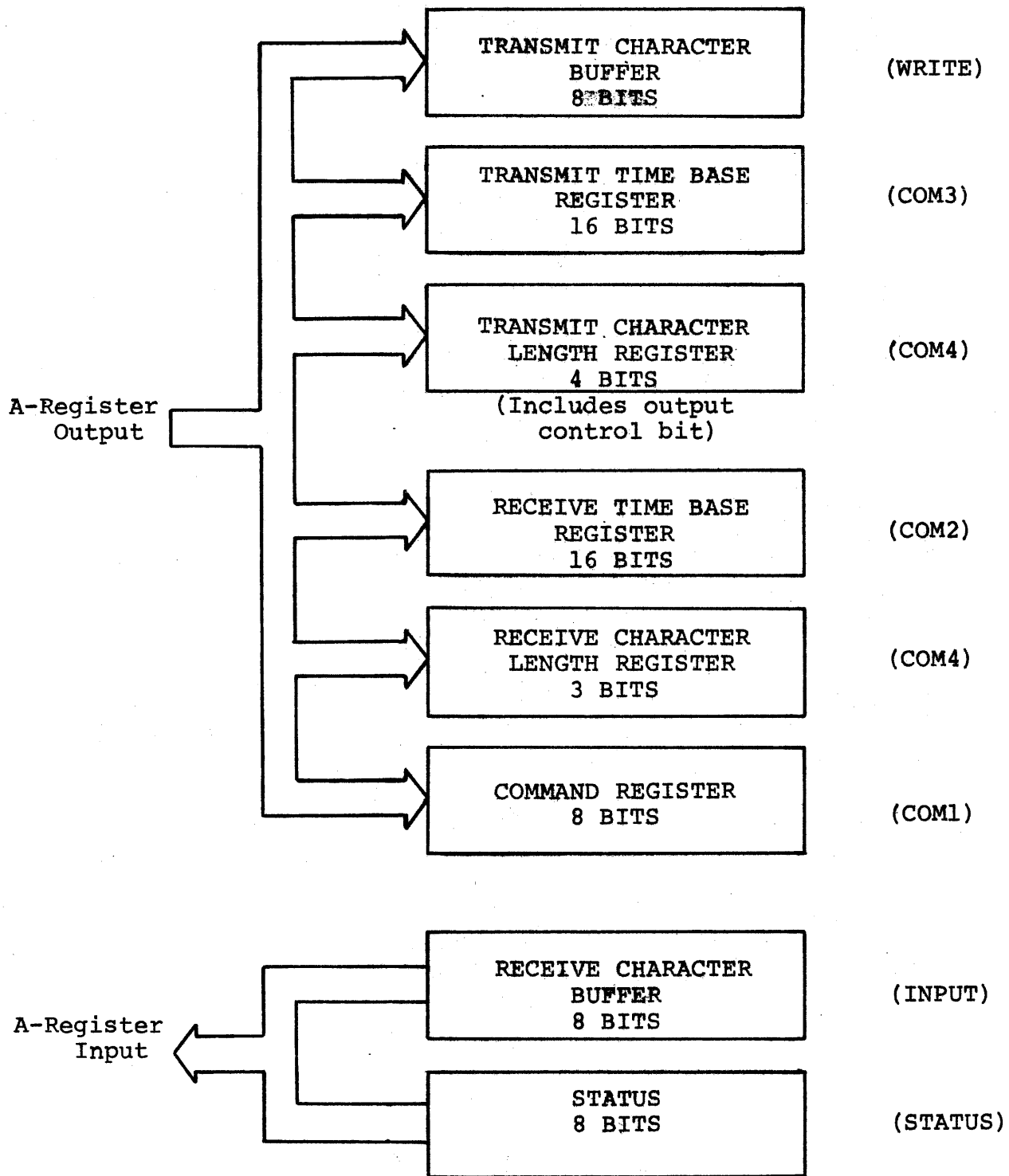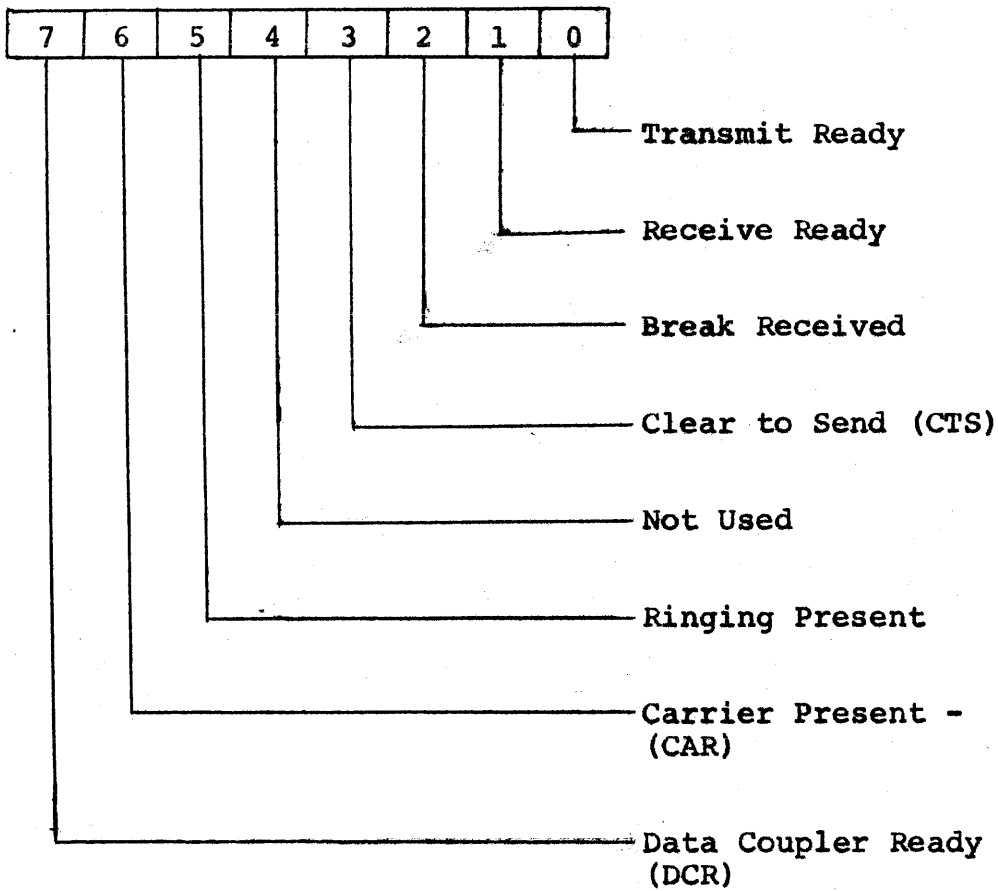
```
                    ┌─────────────────────────┐
             ┌──────→  TRANSMIT CHARACTER      │
             │  ┌───→       BUFFER             │      (WRITE)
             │  │         8 BITS               │
             │  │    └─────────────────────────┘
             │  │    ┌─────────────────────────┐
             │  └────→  TRANSMIT TIME BASE      │
             │  ┌───→       REGISTER           │      (COM3)
             │  │          16 BITS             │
             │  │    └─────────────────────────┘
             │  │    ┌─────────────────────────┐
             │  └────→  TRANSMIT CHARACTER      │
             │  ┌───→   LENGTH REGISTER        │      (COM4)
             │  │          4 BITS              │
             │  │       (Includes output       │
             │  │        control bit)          │
  A-Register │  │    └─────────────────────────┘
  Output ────┤  │    ┌─────────────────────────┐
             │  └────→  RECEIVE TIME BASE       │
             │  ┌───→       REGISTER           │      (COM2)
             │  │          16 BITS             │
             │  │    └─────────────────────────┘
             │  │    ┌─────────────────────────┐
             │  └────→  RECEIVE CHARACTER       │
             │  ┌───→   LENGTH REGISTER        │      (COM4)
             │  │          3 BITS              │
             │  │    └─────────────────────────┘
             │  │    ┌─────────────────────────┐
             └──┼────→  COMMAND REGISTER        │      (COM1)
                └───→       8 BITS             │
                     └─────────────────────────┘


                     ┌─────────────────────────┐
             ┌───────┤  RECEIVE CHARACTER       │
             │  ┌────┤       BUFFER             │      (INPUT)
  A-Register │  │    │        8 BITS            │
  Input  ◄───┤  │    └─────────────────────────┘
             │  │    ┌─────────────────────────┐
             └──┼────┤       STATUS             │
                └────┤       8 BITS             │      (STATUS)
                     │                          │
                     └─────────────────────────┘
```

FIGURE 2:  2200-401 PROGRAMMING INTERFACE

```
┌─┬─┬─┬─┬─┬─┬─┬─┐
│7│6│5│4│3│2│1│0│
└─┴─┴─┴─┴─┴─┴─┴─┘
```

— Transmit Ready

— Receive Ready

— Break Received

— Clear to Send (CTS)

— Not Used

— Ringing Present

— Carrier Present -
  (CAR)

— Data Coupler Ready
  (DCR)

Description of Status Bits:


Bit 0 - Transmit Ready
The true (1) state of this bit indicates that the
transmit character buffer is empty and can accept another
character for transmission. When a new character is
accepted by the 2200-401 for transmission the Transmit Ready
bit goes false (0) until that character is transferred to
the serial transmit register. Characters should not be
transferred to the 2200-401 unless the Transmit Ready bit is
true.


Bit 1 - Receive Ready
The true (1) condition of this bit indicates that the
receive character buffer is full (a character has been
received). If the 2200 processor does not read the
character prior to reception of a new character, the new
character will move into the receive buffer, destroying the
previous character. After execution of an INPUT instruction
while in data mode, the Receive Ready bit will go false (0)
until another character is received.

Bit 2 - Break Received
The true (1) state of this bit indicates that the
Receive Data Line from the modem receiver has been in the
'space' (0) state for more than one character time.


Bit 3 - Clear-to-Send (CTS)
The true (1) condition of this bit indicates that the
2200-401 modem is prepared to accept data for transmission.
Data should not be transferred from the processor to the
2200-401 unless this bit is true.  Further discussion of the
CTS status bit is found in Section 3.2.4.,'Originate/ Answer
Bit'.


Bit 4 - Not Used


Bit 5 - Ringing Present
The true (1) condition of this bit indicates that the
Data Access Arrangement has detected a ringing signal on the
telephone line.  This bit is true during the ringing portion
of a ring cycle (approximately 1 to 2 seconds) and false (0)
during the remainder of the ring cycle (2 to 4 seconds).


Bit 6 - Carrier Present - (CAR)
The true (1) condition of this bit indicates that the
modem receiver has been receiving valid carrier tones from
the distant modem for at least 200 milliseconds.  The CAR
bit returns to the false state if valid tones are not
received for any period exceeding 12 milliseconds.


The Receive Data line from the modem receiver is forced
to the true ('mark') state when CAR is false, to prevent
assembly of characters in the absence of valid received
carrier tones due to random telephone line noise.


Bit 7 - Data Coupler Ready (DCR)
1)  When originating a call the true (1) condition of
this bit indicates that a dial tone is present and the
dialing operation may proceed; during dialing, this bit is
false.  Following dialing this bit returns to the true
condition after a 2 to 5 second delay (this does not
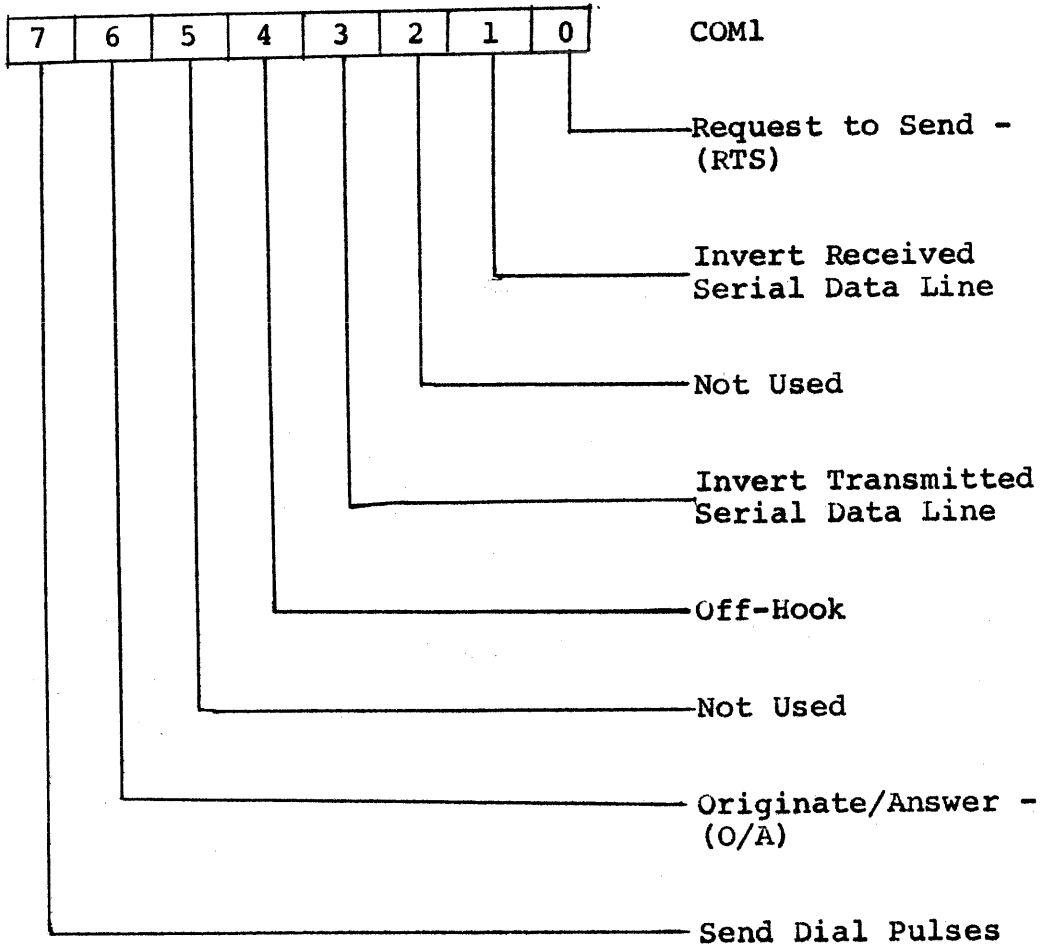necessarily indicate that the called station has answered).


2)  After answering a call, the true condition of this
bit indicates that the modem is connected to the telephone
line through the Data Access Arrangement.

### 3.2.3  Data Input

Addressing the 2200-401 and executing the EX DATA instruction places the Adaptor in data mode and execution of an INPUT instruction then transfers the character in the receive character buffer into the processor A-register. Execution of this data transfer sets the status word Receive Ready bit false until a new character is received.  In order to read 2200-401 status following the data transfer, it is necessary to re-address the Adaptor or execute an EX STATUS instruction while the Adaptor is addressed to return to status mode.

### 3.2.4  COM1 Command

Execution of the EX COM1 instruction while the 2200-401 is addressed causes the 8-bit command register in the 2200-401 to be loaded with the contents of the processor A-register.  The following is a description of the function of each command register bit:

```
 7   6   5   4   3   2   1   0      COM1

                                    Request to Send -
                                    (RTS)

                                    Invert Received
                                    Serial Data Line

                                    Not Used

                                    Invert Transmitted
                                    Serial Data Line

                                    Off-Hook

                                    Not Used

                                    Originate/Answer -
                                    (O/A)

                                    Send Dial Pulses
```

### Bit 0 - Request to Send (RTS)

A true (1) bit in this position conditions the internal modem for transmission using the frequency pair determined by the Originate/Answer Command Register bit. RTS should be set true after the DCR (Data Coupler Ready) status bit comes true either after completion of a dialing operation or after answering an incoming call, and should be left in the true state for the duration of the connection.

At the end of the connection, after the last character has been transferred from the processor to the 2200-401, the connection should not be terminated until time has been allowed for the character to be processed and transmitted. This time may be as long as two character times (at the baud rate in use) plus approximately 5 milliseconds.

### Bit 1 - Invert Received Serial Data

A true (1) bit in this position causes inversion of the Received Data line between the internal modem and the Serial Receive Register. This bit is normally set false (0) unless

inverted data is being received from the distant modem.

## Bit 2 - Not Used

## Bit 3 - Invert Transmitted Serial Data
A true (1) bit in this position causes inversion of the Transmit Data line between the Serial Transmit Register and the internal modem transmitter. This bit is normally set false except during a dialing operation.

## Bit 4 - Off Hook
A true (1) bit in this position initializes and maintains a connection between the 2200-401 and the switched telephone network through the DAA. Resetting this bit to the false state causes the DAA to terminate (hang up) the connection.

## Bit 5 - Not Used

## Bit 6 - Originate/Answer (O/A)
A true (1) bit in this position places the internal 2200-401 modem in 'Originate' mode. The modem is in the 'Answer' mode when this bit is false.

Frequency pairs for transmission and reception are controlled by the state of the O/A bit. When O/A is true (and RTS is true), the 1070 - 1270 Hz pair is used for transmission and the 2025 - 2225 Hz pair is used for reception. When O/A is false, these pairs are reversed.

After completion of a dialing operation, the O/A and RTS bits should be set true, indicating that a connection has been established. The modem is not transmitting at this time and the CTS status bit is false. After answering, the distant modem begins transmission of its 2225 Hz 'mark' tone for approximately 2 seconds. Presence of this tone alone on the telephone line is required to disable any echo suppressors which may be present on the circuit. When this tone has been received for approximately 200 millilseconds, the CAR status bit comes true and the modem begins a 1.5 second timeout during which no transmission occurs. At the end of the 1.5 second period, the modem transmits the 1270 Hz 'mark' tone for 250 milliseconds. At the end of this time,the CTS status bit comes true. The modem is now ready for transmission of data. At the completion of the call, the O/A and RTS bits should be returned to the false state.

When answering a call, the O/A bit should be left in
the false state (Answer Mode). RTS should be set true after
the call has been answered and the DCR status bit has come
true. Setting the RTS bit initiates the 2 second period of
2225 Hz 'mark' tone transmission described above. The CTS
status bit is false before and during this period, coming
true at the end of the 2 seconds. The modem is now ready
for transmission of data. Near the end of the 2 second
period, the CAR status bit comes true, after the modem has
detected the 1270 Hz 'mark' tone from the originating end.
At the completion of the call, the RTS bit is set false.


### Bit 7 - Send Dial Pulses

A true (1) bit in this position places the 2200-401 in
automatic dialing mode. In dialing mode, the transmit
character buffer and serial transmit register are used for
the generation of dial pulses to be applied to the Data
Access Arrangement. The dialing operation proceeds as
follows: After the 'Off-Hook' command register bit has been
set false for a period of time sufficient to insure that any
previous connection is terminated (usually 2 to 5 seconds),
'Off-Hook' is set true, causing the DAA to go off-hook.
After a delay sufficient to acquire a dial tone (the DCR
status bit may be used for this purpose since it comes true
2 to 5 seconds after 'Off-Hook' is set true, but does not
actually reflect presence of dial tone), the 'Invert
Transmit' and 'Send Dial Pulses' command register bits are
set true. When the DCR status bit returns false, the DAA is
ready to accept dial pulses. The digits of the dial number
are generated by transmission of the character 340 (octal) a
number of times corresponding to the digit, i.e., the digit
'5' is dialed by transmission of five 340 characters.
Following a delay of at least 600 milliseconds, the next
digit may be dialed. The transmission rate for this
operation is 100 bits/second and the transmit character
format is 1 start bit, 8 data bits, and 1 stop bit.
Following the dialing operation, the 'Send Dial Pulses' and
the 'Invert Transmit' command register bits should again be
set false.


## 3.2.5 COM2, COM3 Commands


The COM2 and COM3 commands are used, respectively, to
set the 2200-401 receive and transmit time base registers.
These two sixteen bit registers determine the receive and
transmit bit rates. These rates are independent, allowing
data transmission and reception at different rates. Given a
bit rate (bps) the following formula is used to determine
the time base number, N, to be entered into the transmit or
receive register:

$$N = 65,536 - \frac{76,800}{\text{bps}}$$

This number N can be converted to a 16-bit binary number and divided into two 8-bit words.  Th first COM2 (COM3) instruction executed after addressing the 2200-401 transfers the contents of the processor A-register into the most significant 8 bits of the receive (transmit) time base register and the following COM2 (COM3) executed transfers the A-register contents to the 8 least significant bits of the receive (transmit) time base register.
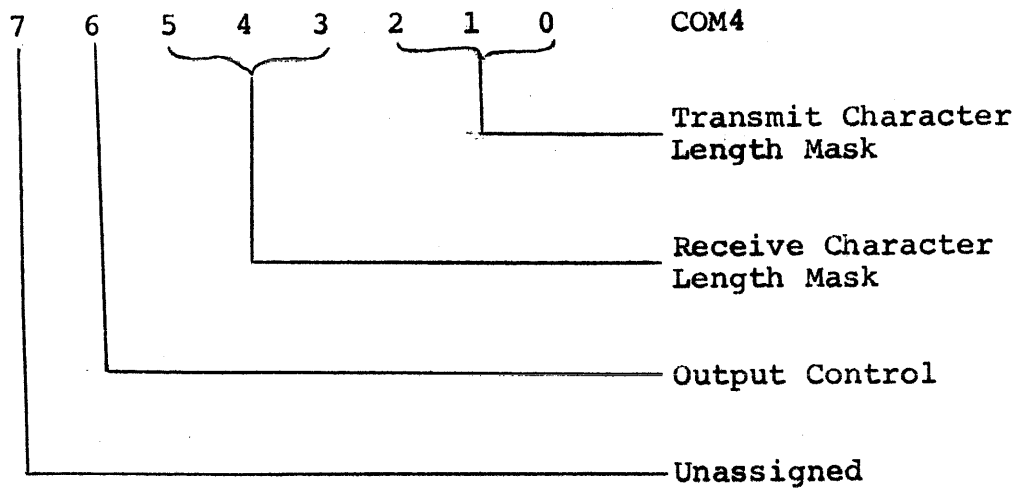
The octal codes for some frequently used rates are listed below:

## TIME BASE TABLE

| RECEIVE | EX COM2 | EX COM2 |
|---|---|---|
| TRANSMIT | EX COM3 | EX COM3 |
| BAUD RATE | 1ST MASK WORD | 2nd MASK WORD |
| 100 | 375 (Dialing) | 000 |
| 110 | 375 | 106 |
| 220 | 376 | 243 |
| 150 | 376 | 000 |
| 300 | 377 | 000 |

### 3.2.6   COM4 Command

Execution of the EX COM4 instruction after addressing the 2200-401 transfers the contents of the processor A-register to the character length register of the 2200-401. The contents of this register determine the transmit and receive character lengths and number of stop bits.

```
7   6   5   4   3   2   1   0     COM4


                                  Transmit Character
                                  Length Mask


                                  Receive Character
                                  Length Mask


                                  Output Control


                                  Unassigned
```

The following tables describe the functions of the mask bits:

### TRANSMITTED CHARACTER LENGTH MASK BITS

| MASK POSITION 210 | START UNITS | INFORMATION UNITS | STOP UNITS | A-REGISTER CODE BIT POSITIONS 76543210 |
|---|---|---|---|---|
| 000 | 1 | 8 | 1 | 87654321 |
| 001 | 1 | 8 | 2 | 87654321 |
| 010 | 1 | 7 | 1 | 7654321 |
| 011 | 1 | 6 | 1 | 654321 |
| 100 | 1 | 5 | 1 | 54321 |
| 101 | - | - | - | -- |
| 110 | - | - | - | -- |
| 111 | - | - | - | -- |

### RECEIVED CHARACTER LENGTH MASK BITS

| MASK BIT POSITION 543 | START UNITS | INFORMATION UNITS | STOP UNITS | A-REGISTER CODE BIT POSITIONS 7654321 |
|---|---|---|---|---|
| 000 | 1 | 8 | 1 or more | 87654321 |
| 001 | 1 | 8 | 1 or more | 87654321 |
| 010 | 1 | 7 | 1 or more | 7654321x |
| 011 | 1 | 6 | 1 or more | 654321xx |
| 100 | 1 | 5 | 1 or more | 54321xxx |
| 101 | - | - | - | - |
| 110 | - | - | - | - |
| 111 | - | - | - | - |

When codes having 5, 6, or 7 information units are to be transmitted, the remaining high-order bits in the character byte must be coded to 1.

When a two-unit stop pulse is required for characters having 5, 6, or 7 information bits, the next larger character length is used; the remaining high-order bits (all coded 1) form the stop pulses.

When received characters contain 5, 6, or 7 information bits, the remaining low-order bits (as shown above) must be disregarded.

Bit 6, Output Control, determines whether characters transferred from the 2200 processor to the 2200-401 (when not in dialing mode) are transmitted by the modem or are transmitted to an attached RS-232 output device such as the Datapoint 3300-200 Thermal Printer. Bit 6 is set true (1) during periods of transmission of data to the RS-232 device and is set false (0) otherwise.

## 3.2.7 EX WRITE Command

Execution of the EX WRITE instruction after addressing the 2200-401 transfers the contents of the processor A-register to the Transmit Character Buffer. This transfer resets the status word Transmit Ready bit until the character is transferred to the Serial Transmit Register. EX WRITE is used to output characters to the 2200-401 for transmission by the modem over the telephone line, to an attached RS-232 receive-only device or to the DAA (for use as dial pulses).

## 3.3 Technical Specifications Summary

Data Rates
(Programmable transmit and receive) Up to 300 bits/second.

Data Format
Serial, Asynchronous; 1 start bit, 5 to 8 data bits, and 1 or 2 stop bits per character (programmable transmit and receive).

Data Modulation Method
Frequency Shift Keying. Frequency Assignments (non-inverted):

|  | ORIGINATE MODE | | ANSWER MODE | |
| --- | --- | --- | --- | --- |
|  | MARK (1) | SPACE (0) | MARK (1) | SPACE (0) |
| Transmit | 1270 Hz | 1070 Hz | 2225 Hz | 2025 Hz |
| Receive | 2225 Hz | 2025 Hz | 1270 Hz | 1070 Hz |

Telephone Line Interface
Transformer coupled 600 ohms resistive (2-wire).


Telephone Line Requirement
Switched Network with Bell System 1001B (CBT) Data
Access Arrangement or Type 3002 unconditioned 2-wire leased
line.


Operating Mode
Full duplex (simultaneous transmit and receive).


Transmit Level
0dbm to -12dbm continuously adjustable.


Receive Level
+4dbm to -40dbm, no adjustment required.


Clear to Send Delay (from Request-to-Send true)
Originate mode:  1.75 seconds following detection of
2225 Hz tone
Answer mode:  2 seconds.


Carrier Detect Delay
Acquisition time:  200 milliseconds; Release (drop)
time:  12 milliseconds.


Receive Data Clamp
Receive Data line forced to mark during periods when
CAR status bit is false.


4.0   PHYSICAL DESCRIPTION


     The 2200-401 is mounted in an injection-molded
high-strength two-part housing. Color and style are
coordinated with the Datapoint 2200.  The rear of the
housing is designed to attach directly to the rear of a
Datapoint console. It can also be wall or surface mounted in
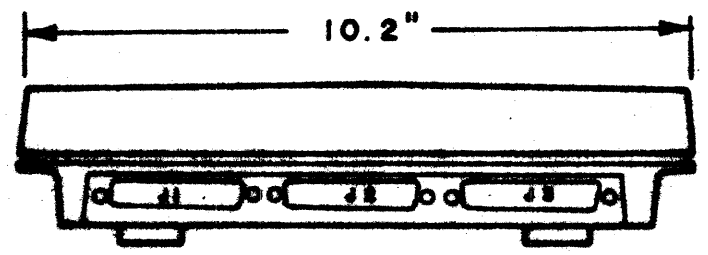any position.  Figure 3 provides complete dimensions.


5.0   ENVIRONMENTAL REQUIREMENTS


     The 2200-401 is designed to operate without special

TOP VIEW

15.5"

10.5"

6.0"

10.0"

REAR VIEW

10.2"
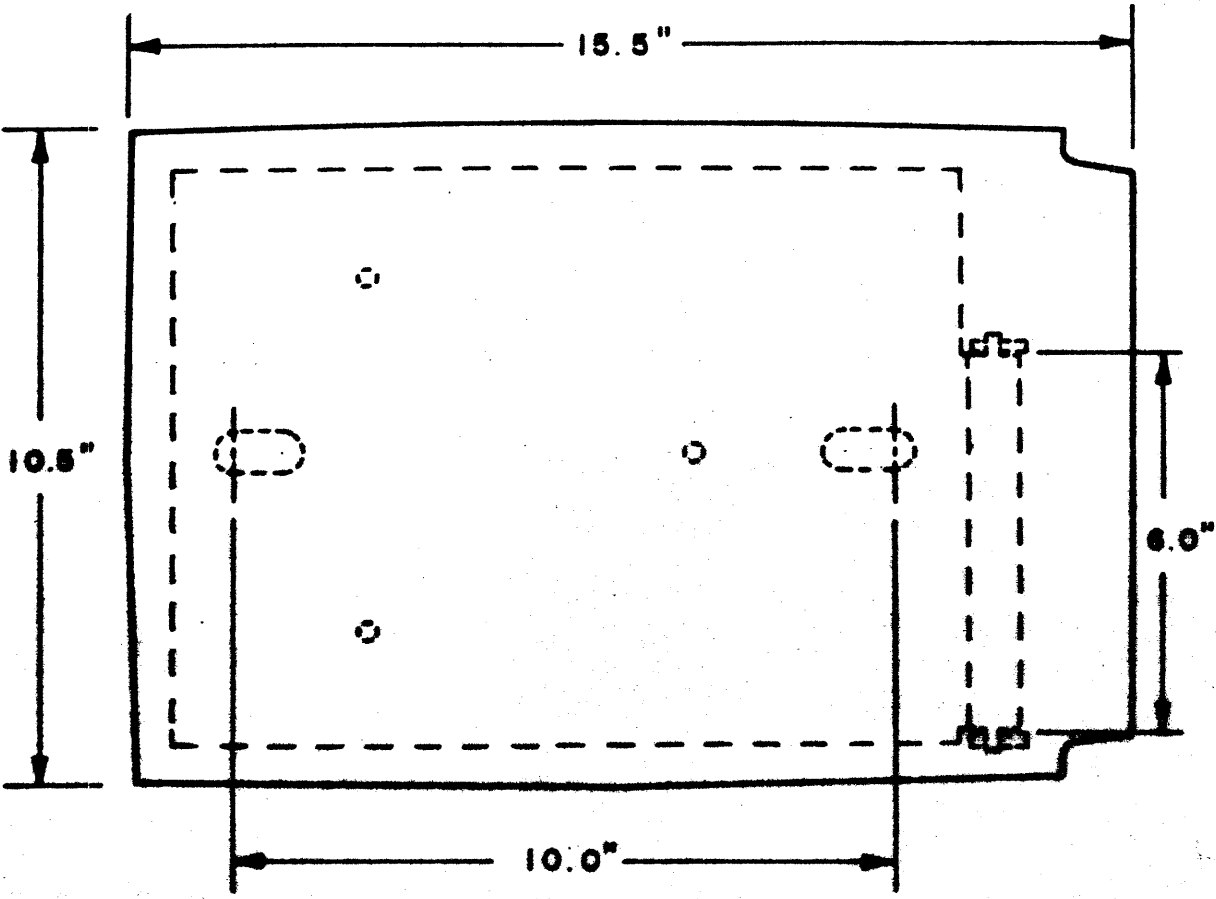
Push here
both sides
to remove
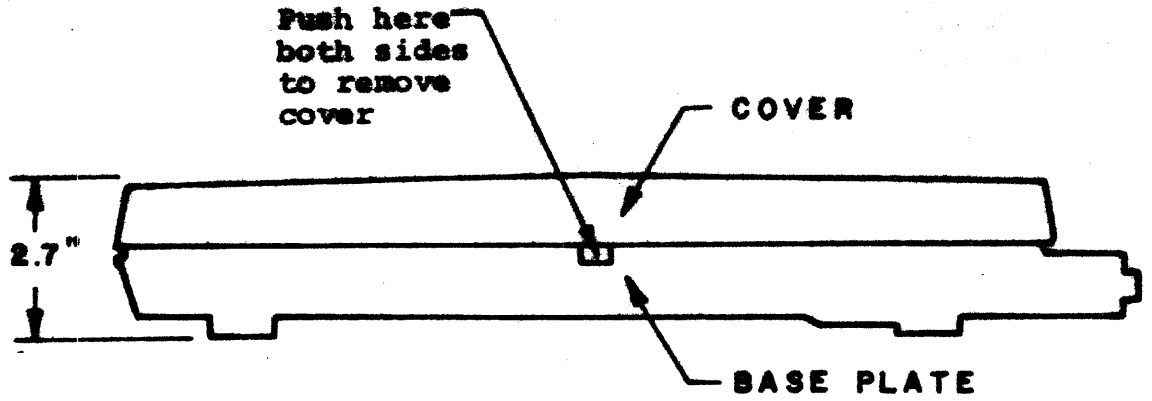cover

COVER

2.7"

BASE PLATE

SIDE VIEW

FIGURE 3:   2200-401 HOUSING

considerations for heating or cooling. The operating range is 0 degrees to 50 degrees (32 degrees to 122 degrees Fahrenheit), 10% to 95% humidity without condensation.


6.0   INTERFACE REQUIREMENTS


6.1   Datapoint 2200 Processor Interface

The 2200-401 interfaces to the 2200 processor input/output bus via the J1 connector. Connection is made from J1 to the processor input/output connector or the J2 connector of another input/output device by means of a 2200-160 or 2200-162 cable. J2 on the 2200-401 is connected in parallel with J1 for connection of additional input/output devices in "daisy-chain" fashion. Operating power is supplied to the 2200-402 from the 2200 processor via the J1 connector.


6.2   DAA Interface

Connection to the DAA is made to the J3 connector on the 2200-401 via a 2200-430, 2200-431, or 2200-432 cable (see Section 7.3). The J3 interface is provided through an Amphenol 17-10500-1 connector. Pin assignment and signal names for DAA connectors are as follows:

| LEAD | FUNCTION | BELL/DAA NAME | COLOR | INPUT/OUTPUT |
|------|----------|----------------|-------|--------------|
| 2 | Ground | -V, C | White | |
| 3 | Off-Hook | OH | Gray | Output |
| 4 | +25 volts | +V | Violet | Output |
| 5 | DA (line connection Requested) | DA | Blue | Output |
| 6 | Ring Indicator | RI | Green | Input |
| 7 | Data Coupler Ready | CCT or DM | Yellow | Input |
| 10,11 | Telephone Line Pair | DT, DR | Orange, Red | Both |

## 7.0 OPTIONS

## 7.1 Address Selection

The 2200-401 is wired at the factory for input/output address 322 (octal). This address may be modified by changing four jumper wires in the communications interface portion of the units.

## 7.2 Multi-Unit Installation

For systems requiring more than two Communications Adaptor type devices (such as the 2200-401) which draw power from the 2200 processor, a card tray which can accommodate up to ten of these units is available under model number 2200-450. In this case, the 2200-452 Communications Adaptor (cards only) is used in place of the 2200-401.

## 7.3  External RS-232 Device

An external RS-232 interface receive-only device such as the Datapoint 3300-200 Thermal Printer may be connected to the 2200-401 through J3 and operated as described previously.  For connection of the 2200-401 to the DAA and a 3300-200, a 2200-431 cable is available.  For connection of the 2200-401 to the DAA and a standard RS-232 interface device a 2200-432 cable is available

Caution:  Damage to the 401 and/or the external device may result if external devices other than the 3300-200 Thermal Printer or cables other than the two specified above are used.  The factory should be consulted to verify that the interface is correct.

## 8.0  PARTS LIST

The following separate parts are part of the 2200-401 Communications Adaptor and are included in each shipment.

| Quantity | Item |
|----------|------|
| 1 | 2200-401 Communications Adaptor |
| 1 | P00010 ASR103 Tape |
| 1 | P00010 ASR103 Listing |
| 1 | 2200-160 (8 feet) Universal I/O Cable |
| 1 | 2200-430 DAA Cable |