

ASYNCHRONOUS COMMUNICATIONS ADAPTOR/MODEM

9401

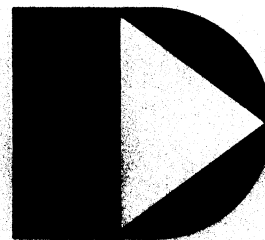
Product Specification

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DATAPoint CORPORATION



The leader in dispersed data processing™

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PRODUCT SPECIFICATION

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ASYNCHRONOUS COMMUNICATIONS ADAPTOR/MODEM

9401

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1.0 GENERAL DESCRIPTION

The 9401 Asynchronous Communications Adaptor, consisting of a communications interface and integral low-speed modem, provides the Datapoint 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 9401 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 Unit Compatibility

The 9401 operates with either the 5500 or 2200/1100 Datapoint processors of any memory size. A maximum of two adaptor devices such as the 9401 may be connected to the input/output bus, since units of this type are supplied power from the Datapoint processor. Provisions for power and physical housing for more than two devices are available.

2.2 Telephone Network

Because of the low baud rates used in the 9401, full-duplex operation is possible with a two-wire telephone circuit. Four-wire circuits are not required.

For connection to the switched telephone network, a Data Access Arrangement (DAA) is required. The 9401 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 9401 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 CHARACTERISTICS

3.1 Specifications

Data Rates

(Programmable transmit and receive) Up to 300 bits/seconds.

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.

3.1.1 General

Aside from the automatic dialing and answering functions performed by the 9401, its main functions are data transmission and reception. These functions are depicted in basic form in Figure 3-1.

3.1.2 Transmission

A character transferred from the Datapoint 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').

3.1.3 Reception

The Modem receiver accepts the telephone line signal which is a combination of tones received from the distant modem. 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 Datapoint Processor via the input/output bus.

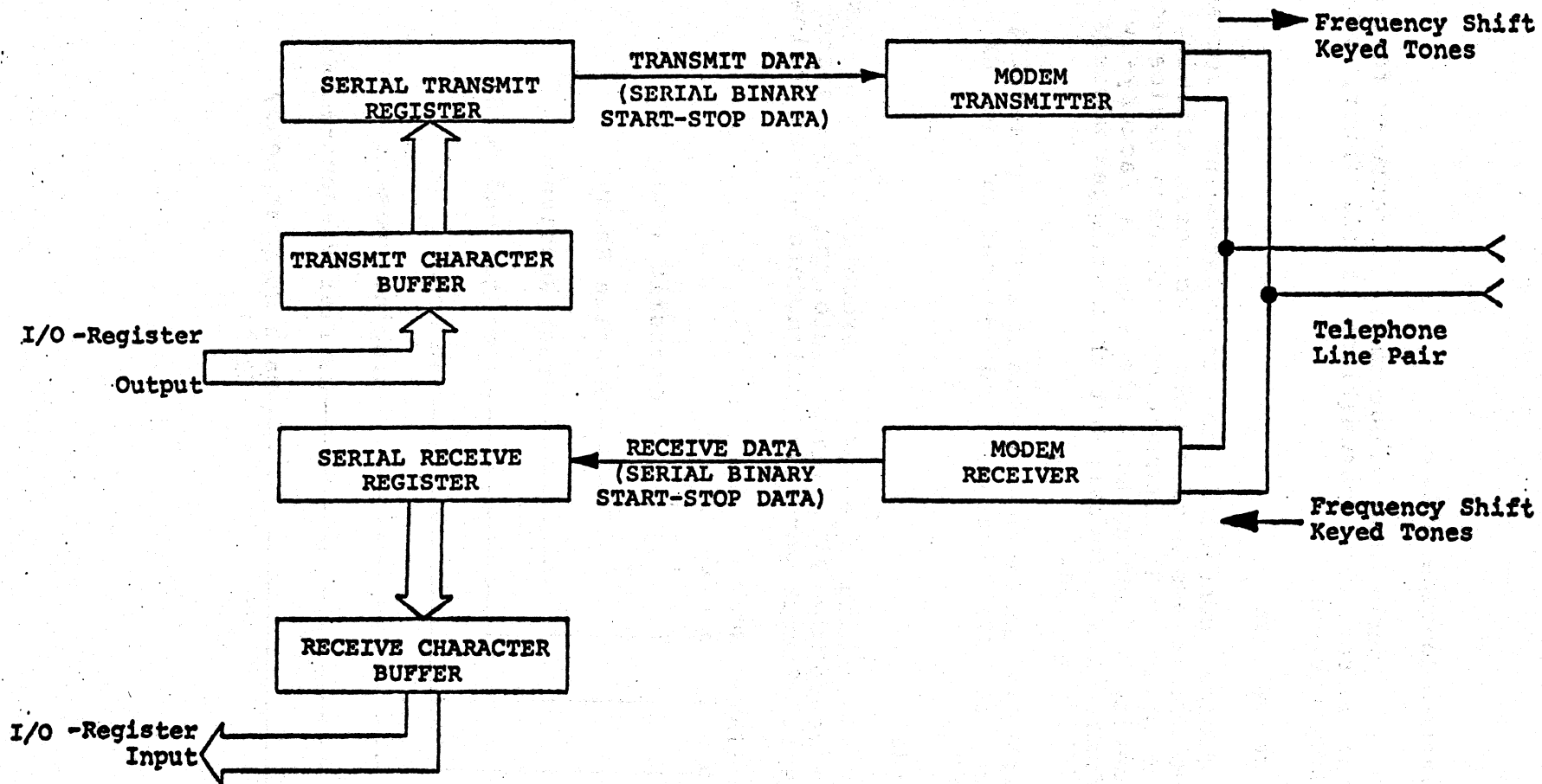


FIGURE 3-1 9401 BASIC FUNCTIONAL DIAGRAM

3.2 Programming Considerations

Figure 3-2 shows the programming interface for the 9401, showing sources and destinations of all input, output and command operations.

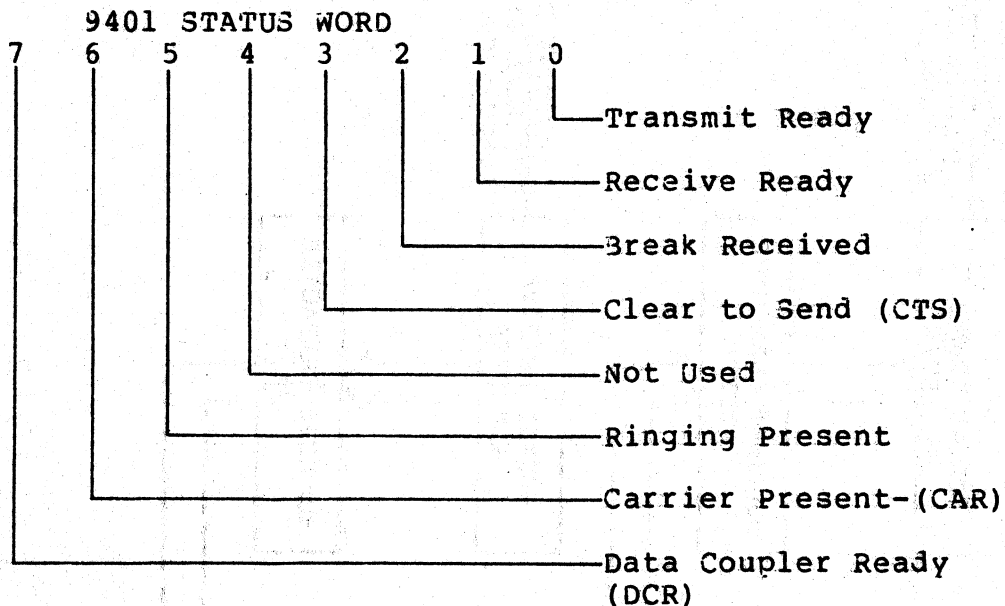
3.2.1 Device Address

Each device connected to the Datapoint 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 9401 is factory-wired with an address of 322 (octal) but this strapped address may be modified if required.

The 9401 is addressed by the program by setting the I/O-register to 322 (octal) and executing an EX ADR instruction.

3.2.2 Status

After addressing the 9401, execution of an INPUT instruction loads the 9401 status into the I/O-register of the processor. Status word bit assignments are as follows:



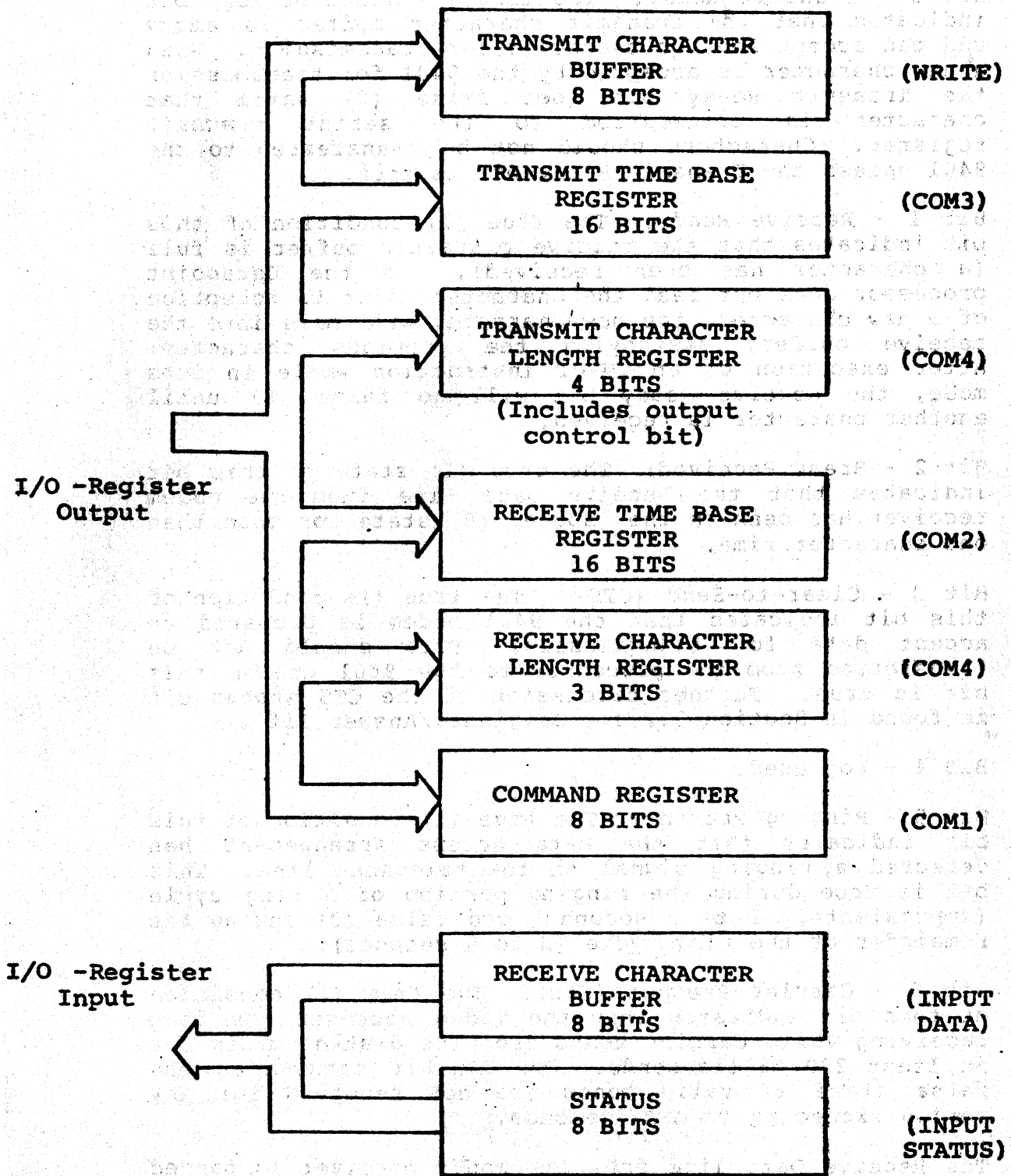


FIGURE 3-2 9401 PROGRAMMING INTERFACE

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 9401 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 9401 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 Datapoint 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 9401 modem is prepared to accept data for transmission. Data should not be transferred from the processor to the 9401 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:

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).

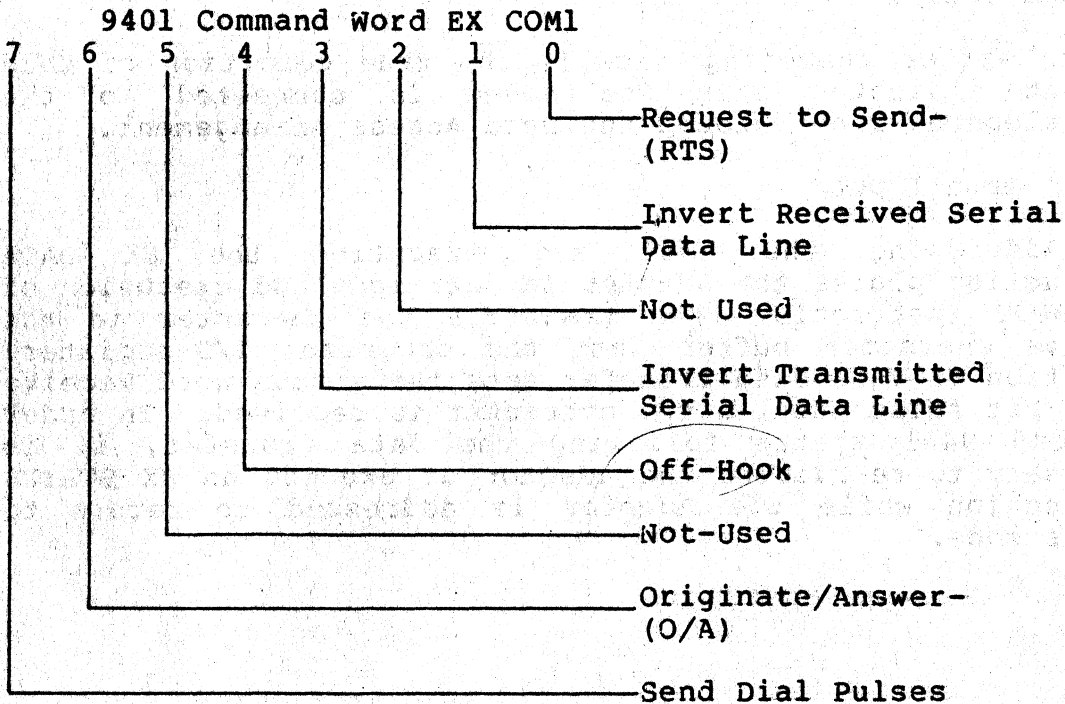
2) After answering a call, the true condition of this bit indicates that the modem is connected to the telephone line through the Data Access Arrangement.

3.2.3 Data Input

Addressing the 9401 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 I/O-register. Execution of this data transfer sets the status word Receive Ready bit false until a new character is received. In order to read 9401 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 9401 is addressed causes the 8-bit command register in the 9401 to be loaded with the contents of the processor I/O-register. The following is a description of the function of each command register bit:



Bit 0 - Request to Send: 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 9401, 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 9401 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 9401 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 2025 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 milliseconds, 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.

Bit 7 - Send Dial Pulses: A true (1) bit in this position places the 9401 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 9401 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:

$$N = 65,536 - \left(\frac{76,800}{\text{bps}} \right)$$

This number N can be converted to a 16-bit binary number and divided into two 8-bit words. The first COM2 (COM3) instruction executed after addressing the 9401 transfers the contents of the processor I/O-register into the most significant 8 bits of the receive (transmit) time base register and the following COM2 (COM3) executed transfers the I/O-register contents to the 8 least significant bits of the receive (transmit) time base register.

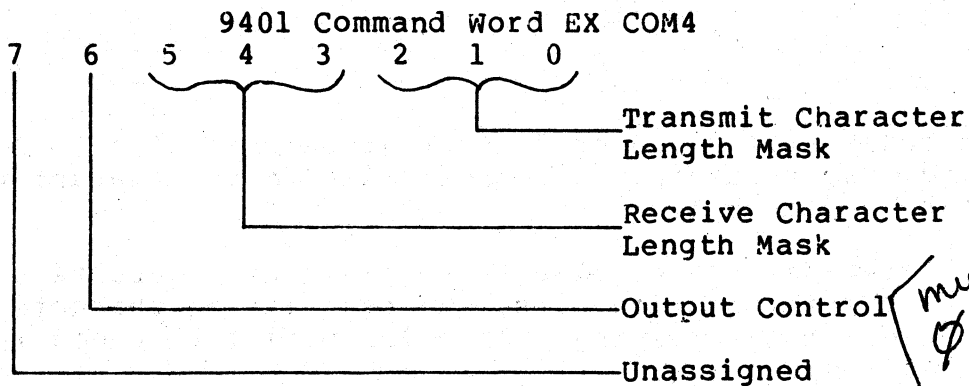
The octal codes for some frequently used rates are listed below:

TIME BASE TABLE

RECEIVE	EX COM2	EX COM2
TRANSMIT	EX COM3	EX COM3
<u>BAUD RATE</u>	<u>1st MASK</u> <u>WORD</u>	<u>2nd MASK</u> <u>WORD</u>
100 (dialing)	375	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 9401 transfers the contents of the processor I/O-register to the character length register of the 9401. The contents of this register determine the transmit and receive character lengths and number of stop bits.



The following tables describe the function of the mask bits:

TRANSMITTED CHARACTER LENGTH MASK BITS

MASK POSITION	START UNITS	INFORMATION UNITS	STOP UNITS	I/O-REGISTER CODE BIT POSITIONS
210				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	START UNITS	INFORMATION UNITS	STOP UNITS	I/O-REGISTER CODE BIT POSITIONS
543				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 must be disregarded.

→ Bit 6, Output Control, determines whether characters transferred from the Datapoint Processor to the 9401 (when not in dialing mode) are transmitted by the modem or are transmitted to an attached RS-232 output device such as the Datapoint 9292 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 9401 transfers the contents of the processor I/O-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 9401 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).

4.0 PHYSICAL DESCRIPTION

The 9401 is mounted in an injection-molded, high-strength, two-part housing. Color and style are coordinated with the Datapoint Processor. 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 4-1 provides complete dimensions.

5.0 ENVIRONMENTAL REQUIREMENTS

The 9401 is designed to operate without special considerations for heating or cooling. The operating range is 4 to 32 degrees C (40 to 90 degrees F), 10% to 95% humidity without condensation. The 9401 generates approximately 70 BTU/HR.

6.0 INTERFACE REQUIREMENTS

6.1 Datapoint Processor Interface

The 9401 interfaces to the 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 9010 or 9011 cable. J2 on the 9401 is connected in parallel with J1 for connection of additional input/output devices in "daisy-chain" fashion. Operating power is supplied to the 9401 from the processor via the J1 connector.

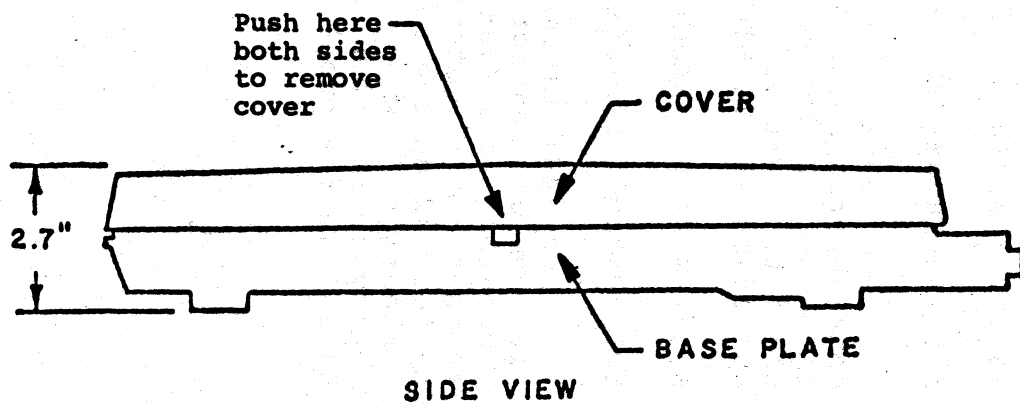
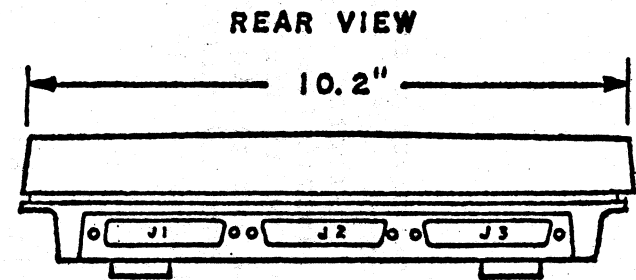
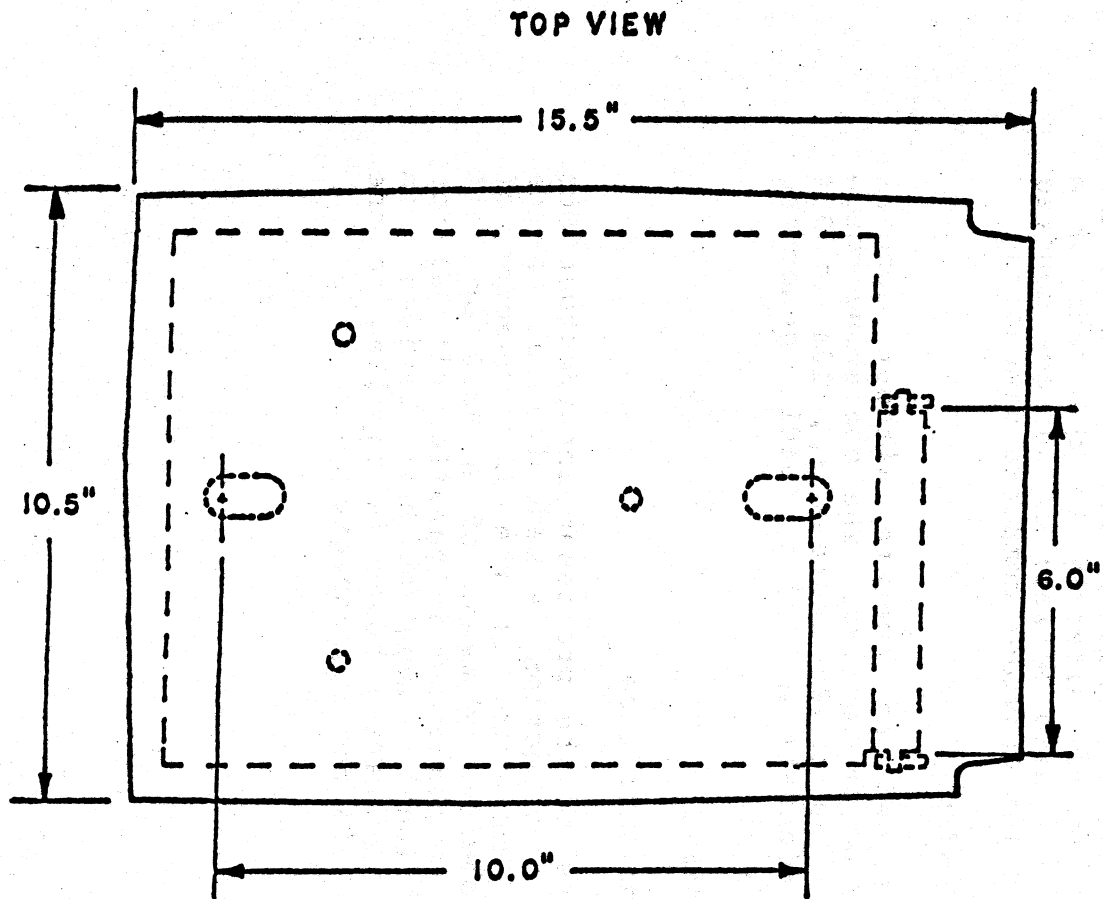


Figure 4-1 9401 Housing

6.2 DAA Interface

Connection to the DAA is made to the J3 connector on the 9401 via a 9430, 9431 or 9432 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				INPUT/OUTPUT
		NAME	COLOR	NUMBER	INPUT/OUTPUT	
<i>J3</i>					<i>sig. or wire</i>	
<i>J3</i> <i>Pin #15 →</i> 2	Ground	-V,C	White	10		
3	Off-Hook	OH	Gray	9		Output
4	+25 volts	+V	Violet	8		Output
5	DA (line connection requested)	DA	Blue	7		Output
6	Ring indicator	RI	Green	6		Input
7	Data Coupler Ready	CCT or DM	Yellow	5		Input
10,11	Telephone Line Pair	DT,DR	Orange, Red	3,4		Both

7.0 OPTIONS

7.1 Address Selection

The 9401 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 9401) which draw power from the Datapoint processor, a card tray which can accommodate up to ten of these units is available under model number 9450. In this case, the 9452 Communications Adaptor (cards only) is used in place of the 9401.

7.3 External RS-232 Device

An external RS-232 interface receive-only device such as the Datapoint 9292 Printer may be connected to the 9401 through J3 and operated as described previously. For connection of the 9401 to the DAA and a 9292, a 9431 cable is available. For connection of the 9401 to the DAA and a standard RS-232 interface device a 9432 cable is available. The 9430 is used for direct connection to the DAA from the 9401.

Caution: Damage to the 9401 and/or the external device may result if external devices other than the 9292 Printer or cables other than two specified above are used. The factory should be consulted to verify that the interface is correct.

8.0 SHIPPING LIST

The following separate parts are part of the 9401 Communications Adaptor and are included in each shipment.

<u>QUANTITY</u>	<u>ITEM</u>
1	Communications Adaptor
1	COM103 Diagnostic
1	COM103 Listing
1	9010 (8') Universal I/O Cable
1	9430 DAA Cable

Note: This parts list is for reference only and is superceded by the current Datapoint Shipping List in use at time of shipment.