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## Section 9. Modem/RS-232C Interface Cards

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## Description

The system board supports the attachment of either a 2400 bps modem card or an RS-232C interface card. Either card attaches to the serial interface connector. Only one or the other is supported dependent on the country. For example, U.S. machines contain the 2400 bps modem.

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## 2400 bps Modem Card

### Description

The 2400 bits per second (bps) modem card is a serial communications adapter that provides an interface between the system and a voice-grade communication line for the transmission and reception of digital data.

The card is connected to the system board through the serial interface connector. Its features are as follows:

- Asynchronous data transfer at 0–300, 1200, and 2400 bps
- Automatic tone or pulse dialing
- Automatic or manual originate and answer operation
- Automatic speed and type identification of the calling modem
- Dial tone and busy tone detection
- All configuration options software selectable
- Direct connection to a telephone line using a standard modular telephone jack.

Compatibility with modems conforming to these protocols:

|                    |                                    |
|--------------------|------------------------------------|
| CCITT V.22 bis     | 1200 bps and 2400 bps asynchronous |
| CCITT V.22 A and B | 1200 bps asynchronous              |
| BELL 212A          | 1200 bps asynchronous              |
| BELL 103           | 0 to 300 bps anisochronous.        |

Attention (AT) command set, compatible with the Hayes<sup>1</sup> command set, controls modem configuration and operation.

The modem has fixed line equalization to compensate for the normal variations in line quality with the addition of adaptive equalization at 2400 bps.

The modem card is registered as the "IBM 2400 BPS Modem" with the FCC to comply with Part 68 of the FCC Regulations. Any modification voids FCC and other certifications of regulatory compliance.

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<sup>1</sup> Trademark of Hayes Microcomputer Products, Inc.

### Connector J1:

A RJ11C phone jack is used to interconnect to telephone lines.

| Pin | Signal Name | Definition         |
|-----|-------------|--------------------|
| 1   | Not used    |                    |
| 2   | Not used    |                    |
| 3   | TIP         | Phone input/output |
| 4   | Ring        | Phone input/output |
| 5   | Not used    |                    |
| 6   | Not used    |                    |

### Connector J2:

A 2 x 10 shrouded keyed male connector and flat cable assembly are used to interconnect to the system board.

| Pin | Name       | Definition  |
|-----|------------|---|
| 1   | + 12 volts | Power to modem.   |
| 2   | AUDIOMOD   | Audio from modem to speaker.  |
| 3   | + 12 volts | Power to modem.   |
| 4   | RESERVED   | Reserved.   |
| 5   | -12 volts  | Power to modem.   |
| 6   | RTS*       | Request to Send indicates that the planar is ready to send data.                                    |
| 7   | + 5 volts  | Power to modem.   |
| 8   | DTR*       | Data Terminal Ready indicates that the planar is ready to send data.                                |
| 9   | + 5 volts  | Power to modem.   |
| 10  | SOUT*TXD   | Serial data to modem.   |
| 11  | Ground     | Power to modem.   |
| 12  | CTS*       | Clear to Send indicates that the modem is ready to send data to the planar.                         |
| 13  | RESET*     | System reset from planar.   |
| 14  | RLSD*      | Received Level Signal Detect is an indication that the modem has received a carrier.                |
| 15  | Ground     | Power to modem.   |
| 16  | RI*        | Ring Indicate is used when the modem detects a valid ring signal.                                   |
| 17  | Ground     | Power to modem.   |
| 18  | DSR*       | Data Set Ready is a status from the modem to indicate that it is ready to transmit or receive data. |
| 19  | Ground     | Power to modem.   |
| 20  | SIN*RXD    | Serial data from modem.   |

### Connector J3:

A 4-pin male connector is used to provide power to the 5.25-inch diskette drive option. The modem card only provides capacitive decoupling for these signals:

| Pin | Name      | Definition                        |
|-----|-----------|-----------------------------------|
| 1   | +12 volts | Power to 5.25-inch diskette drive |
| 2   | Ground    | Power to 5.25-inch diskette drive |
| 3   | Ground    | Power to 5.25-inch diskette drive |
| 4   | +5 volts  | Power to 5.25-inch diskette drive |

## Modem Commands and Operation

The modem has three states of operation: the command state, the data or online state, and the idle state. In normal operation, the modem is in either the command state, waiting to receive a command from the user, or in the data state, performing data transmission and reception.

After a system power on or reset, the modem enters the idle state. When the modem in the idle state receives the 2-character sequence AT from the user, AT serves as the "wakeup" code and the modem enters the command state. In the command state, the modem waits to receive a command from the user.

Appropriate commands make the modem enter the data or online state. The data state is the normal online communication state of the modem. Data is transmitted and received in the data state. If an escape sequence (the characters + + +) is detected, the modem returns to the command state.

When in the data state, the modem is in either the originate mode or the answer mode. In the originate mode, the modem can originate or dial calls. In the answer mode, the modem can receive incoming calls.

### AT (Attention) Command Description

This modem is controlled and configured by the AT (Attention) commands. Each command consists of the following elements:

- The 2-character sequence AT
- A command
- A command parameter
- A carriage return (Enter).

The 2-character sequence AT must be uppercase. The command may be uppercase or lowercase. Spaces are ignored. A command is not performed until a carriage return (Enter) is received. For example, to enter the command "Answer," type **ATA** or **ATa** and press Enter.

Some commands do not have parameters. Any missing parameter in a command is assigned the value zero, which may be a valid parameter for the command. The sequence AT followed by Enter causes the modem to enter the command state. That is, AT without a command serves as the "wakeup" code, and OK appears on the screen.

The modem queues commands in a 40-character command line. The command line begins with AT and can contain several commands. A separator is not required between the commands.

The command line format is:

**AT** *command* [*parameter*] *command* [*parameter*]...Enter

When a carriage return is received, which terminates the line, the commands are performed in the order in which they are sent to the modem. After the commands are performed, an OK is returned to the computer. If more than 40 characters including spaces are sent to the modem, an error occurs and all commands must be reentered.

**Notes:**

1. Allow 3 seconds for the transition between command and data states. This pause allows for the modem operation to complete.
2. Data Terminal Ready (DTR) in the modem control register must be active in order to send commands to the modem.
3. The electronics used in this modem have a general purpose internal microcode that provides capabilities not supported by this design. An OK may be returned in response to a command but the modem will not respond.
4. Supplementary information concerning the AT command definitions may be found in "89024 Reference Manual." See "Bibliography" on page X-19.
5. The different modem hardware/software levels can be identified by using the AT11 Command. For example, 194 = Level 1.6; 123 = Level 2.0.

## AT Commands

| Command   | Command Name and Function  |
|-----------|--|
| <b>A</b>  | <b>Answer</b><br><br>This command takes the modem "off hook" and into answer mode. The modem does not wait for a ring on the line. If no carrier is received after the wait specified in Register S7, the modem returns to the command mode. |
| <b>A/</b> | <b>Re-execute</b><br><br>The command A/ with no preceding AT command and no carriage return causes the most recent command line to be re-executed.   |
| <b>B</b>  | <b>BELL/CCITT Handshake Default</b><br><br>B0 CCITT standards (Supported in Level 2.0)<br>B1 BELL standards. (default)<br><br>This command selects between the CCITT and BELL standards for 300 and 1200 bps data rate connections.          |



**Command****Command Name and Function****D****Dial (D n...n)**

This command takes the modem "off hook" and dials the characters contained in the parameter, and controls the modem during dialing. If **D** is entered with no parameters, the modem goes "off hook" without dialing. The parameter may consist of a combination of these characters:

**0 1 2 3 4 5 6 7 8 9 A B C D # \* ( ) - T P R W , ; ! @ . / S**

- **0 1 2 3 4 5 6 7 8 9 A B C D # \* =** Dialed characters.
- **( ) - . / =** Punctuation, including spaces, used to increase readability.
- **T =** Switches modem to tone dialing. An example using tone dialing T is: ATDT 555-1234 CR. The speed for tone dial is set by Register S11.

The command AT = attention, D = dial, T = tone, 555-1234 = dialed characters, and CR = carriage return or Enter.

- **P =** Switches modem to pulse dialing (default). An example is: ATDP 555-1234 CR.
- **R =** Puts modem in answer mode.

The R is placed at the end of the dial string and is used for communicating with originate-only modems. An example is: ATDT 555-1234R CR.

- **W =** Wait for dial tone.

The W causes the modem to wait for a dial tone for the time specified in Register S7. If no dial tone is detected after this time, the modem hangs up and indicates that no dial tone was received. An example showing this command with a 9 to dial outside a local telephone network is: ATDT 9W555-1234 CR.

- **, =** Modem pause (Default is 2 seconds).

The comma causes the modem to pause for a specified period. An example is: ATDT 9,555-1234 CR.

- **; =** Returns the modem to command state.

The semicolon is placed at the end of a dial string to put the modem in a state that accepts commands after dialing. An example is: ATDT 555-1234;CR.

- **I FLASH =** Causes the modem to go "on hook" for half a second. FLASH is used for transferring calls.
- **@ =** Wait for quiet answer.

The @ causes the modem to wait for the time specified in Register S7 for at least one valid ringback, followed by 5 seconds of silence before executing the next character in the dialing string.

- **S = n.** Dial stored number *not supported*.

| Command | Command Name and Function  |
|---------|--|
| E       | <p data-bbox="306 164 354 180"><b>Echo</b></p> <p data-bbox="343 199 471 215">E0 = Disable</p> <p data-bbox="343 235 556 251">E1 = Enable (default).</p> <p data-bbox="306 271 902 337">This command controls whether characters sent to the modem by the computer while in the command state are echoed back to the computer and displayed on the screen.</p>   |
| H       | <p data-bbox="306 354 423 370"><b>On/Off Hook</b></p> <p data-bbox="343 389 567 406">H0 = On hook (default)</p> <p data-bbox="343 425 481 441">H1 = Off hook.</p> <p data-bbox="306 461 880 527">This command controls the telephone switch "hook." The H0 command forces the modem to go "on hook." The H1 command forces the modem "off hook."</p>   |
| I       | <p data-bbox="306 544 481 560"><b>Identification Code</b></p> <p data-bbox="343 579 684 596">I0 = Returns the product code (249)</p> <p data-bbox="343 615 721 631">I1 = Returns the checksum (194 or 123)</p> <p data-bbox="343 651 503 667">I2 = Returns OK.</p> <p data-bbox="306 686 870 727">This command supplies identification information about the modem.</p>  |
| L       | <p data-bbox="306 743 460 760"><b>Speaker Volume</b></p> <p data-bbox="343 779 513 795">L0 = Low volume</p> <p data-bbox="343 815 513 831">L1 = Low volume</p> <p data-bbox="343 850 630 867">L2 = Medium volume (default)</p> <p data-bbox="343 886 524 902">L3 = High volume.</p> <p data-bbox="306 922 865 987">This command controls the volume of the signal to the speaker. The local volume control on the monitor provides additional volume control.</p>                  |
| M       | <p data-bbox="306 1003 380 1019"><b>Speaker</b></p> <p data-bbox="343 1039 556 1055">M0 = Disable speaker</p> <p data-bbox="343 1075 891 1091">M1 = Enable speaker until carrier acknowledged (default)</p> <p data-bbox="343 1110 742 1127">M2 = Speaker always on when "off hook."</p> <p data-bbox="343 1146 886 1187">M3 = Speaker is on until carrier is detected, but off while dialing.</p> <p data-bbox="306 1206 737 1222">The command controls the computer speaker.</p> |
| O       | <p data-bbox="306 1239 364 1255"><b>Online</b></p> <p data-bbox="343 1274 870 1364">O = Online. This command forces data mode after an established call has been interrupted by the escape sequence. If "on hook," this command puts the modem "off hook" and in the originate mode.</p> <p data-bbox="343 1383 870 1450">O1 = Online and retrain. This command causes the modem to return to the online state and initiate a retrain sequence (in 2400 bps only).</p>             |

| Command       | Command Name and Function  |
|---------------|--|
| <b>Q</b>      | <p><b>Result Codes</b></p> <p><b>Q0</b> = Returned (default)</p> <p><b>Q1</b> = Not returned.</p> <p>This command controls whether result codes are returned to the computer after a command is performed. The result code can be either descriptive words or digit codes. Two other commands also control the result codes (see the commands <b>V</b> and <b>X</b>). See "Result (Return) Codes" on page 9-14.</p>  |
| <b>Sr?</b>    | <p><b>Read Register</b></p> <p><b>r</b> = 0 - 27</p> <p>This command causes the content of the register <b>r</b> to be read. See "Register Summary" on page 9-15.</p>  |
| <b>Sr = n</b> | <p><b>Set Register</b></p> <p><b>r</b> = 0 - 27</p> <p><b>n</b> = 0 - 255.</p> <p>This command causes the register <b>r</b> to be set to value <b>n</b>. See "Register Summary" on page 9-15.</p>  |
| <b>V</b>      | <p><b>Verbose/Terse Result Codes</b></p> <p><b>V0</b> = Terse</p> <p><b>V1</b> = Verbose (default).</p> <p>This command controls the type of result codes returned to the computer from the modem. <b>V0</b> causes the result codes to be sent as digits. <b>V1</b> causes the result codes to be sent as words.</p>  |
| <b>X</b>      | <p><b>Basic/Extended Result Code Set</b></p> <p><b>X0</b> = Connect message, blind dial, no timeout, no busy detect</p> <p><b>X1</b> = Full messages, blind dial, no timeout, no busy detect</p> <p><b>X2</b> = Full messages, dial tone dialing, dial tone timeout, no busy detect</p> <p><b>X3</b> = Full messages, blind dial, no timeout, busy detect</p> <p><b>X4</b> = Full messages, dial tone dialing, dial tone timeout, busy detect (default).</p> <p>This command selects the result code to be returned. See "Result (Return) Codes" on page 9-14.</p> |
| <b>Y</b>      | <p><b>Enable Long Space Disconnect</b></p> <p><b>Y0</b> = Disable option (default)</p> <p><b>Y1</b> = Enable option.</p> <p>This command sets the modem to disconnect when a space of 1.6 seconds duration is received from the remote modem.</p>  |

| Command        | Command Name and Function  |
|----------------|--|
| <b>Z</b>       | <p><b>Software Reset</b></p> <p>This command resets the modem to its default settings and leaves the modem in the command state. Any commands on the command line after the <b>Z</b> command are not performed because the reset clears the command buffer. If the modem is online, the reset breaks the connection. The application should wait 2 seconds before issuing the next command to the modem.</p> |
| <b>&amp;Cn</b> | <p><b>Carrier Signal Control CXR</b></p> <p><b>Received Level Signal Detect (RLSD)</b></p> <p><b>&amp;C0</b> = Sets RLSD bit on—carrier forced on (default in Level 1.6)</p> <p><b>&amp;C1</b> = Allows RLSD to track actual carrier (default in Level 2.0).</p> <p>This command causes the modem to detect and track the carrier signal.</p>  |
| <b>&amp;Dn</b> | <p><b>n = 0..3 (Register S25)</b></p> <p><b>0</b> = DTR ignored</p> <p><b>1</b> = 1 to 0 of DTR toggles command state (default in Level 1.6)</p> <p><b>2</b> = 1 to 0 of DTR toggles on hook (default in Level 2.0)</p> <p>Disabled auto answer, enter command state.</p> <p><b>3</b> = 1 to 0 of DTR toggles reset state.</p>   |
| <b>&amp;F</b>  | Fetch Factory Configuration Profile.   |
| <b>&amp;Gn</b> | <p><b>n = 0..2</b></p> <p><b>0</b> = No guard tone (default)</p> <p><b>1</b> = 550 Hz guard tone</p> <p><b>2</b> = 1800 Hz guard tone.</p>   |
| <b>&amp;Jn</b> | <p><b>n = 0,1 Not supported</b></p> <p><b>0</b> = RJ-11/RJ-41/RJ-45S (default)</p> <p><b>1</b> = RJ-12/RJ-13.</p>  |
| <b>&amp;Ln</b> | <p><b>n = 0,1 Not supported</b></p> <p><b>0</b> = Dialup lines (default)</p> <p><b>1</b> = Leased lines.</p>   |
| <b>&amp;Mn</b> | <p><b>n = 0..3 Not supported</b></p> <p><b>0</b> = Asynchronous (default)</p> <p><b>1</b> = Sync mode 1 async dial</p> <p><b>2</b> = Sync mode 2 DTR dial</p> <p><b>3</b> = Sync mode 3 manual dial.</p>   |

| Command        | Command Name and Function   |
|----------------|---|
| <b>&amp;Pn</b> | <b>n = 0,1</b><br>0 = 39% make/61% break (default) U.S.<br>1 = 33% make/67% break. U.K.   |
| <b>&amp;Rn</b> | <b>n = 0,1</b> <i>Not supported</i><br>0 = CTS responds to RTS synchronous (default)<br>1 = Ignore RTS synchronous; CTS always on in async.   |
| <b>&amp;Sn</b> | <b>n = 0,1</b><br>0 = DSR on (default)<br>1 = DSR to CCITT V.22 bis V.22.   |
| <b>&amp;Tn</b> | <b>n = 0..8</b><br>0 = Terminate test<br>1 = Local analog loopback<br>2 = <i>Not supported</i><br>3 = Local digital loopback<br>4 = Remote digital loopback (default)<br>5 = Inhibit remote digital loopback<br>6 = Local testing<br>7 = Remote digital loopback with self test CCITT V.54<br>8 = Local analog loopback with self test CCITT V.54.                      |
| <b>&amp;W</b>  | Write configuration to NVRAM. <i>Not supported</i>  |
| <b>&amp;Xn</b> | <b>n = 0..2</b> <i>Not supported</i><br>0 = Use transmit clock (default)<br>1 = Use external transmit clock<br>2 = Use data carrier clock.  |
| <b>&amp;Zn</b> | <b>n = 0..9, ABCD#*TPRWI@;</b> <i>Not supported</i><br>Store telephone number in NVRAM.   |
| <b>+ + +</b>   | <b>Escape Sequence</b><br>The escape sequence (three consecutive escape characters preceded and followed by the pause set in register S12) changes the modem from the data state to the command state. The escape character is selectable (see register S2). The plus sign, ASCII 43 (hex 2B), is the default. ASCII 28 (hex 1C) or ASCII 29 (hex 1D) may also be used. |

## Result (Return) Codes

The set of result codes that are returned can be selected (see the command X). Digit codes are followed by a carriage return character. Word responses are preceded and followed by a carriage return character and a line feed character.

| Digit Code | Word         | Description  |
|------------|--------------|--|
| 0          | OK           | Command line executed without errors.  |
| 1          | CONNECT      | Carrier detected at 300 bps.   |
| 2          | RING         | Ringing signal detected (incoming).  |
| 3          | NO CARRIER   | Carrier lost or never connected.   |
| 4          | ERROR        | Error in command line <ul style="list-style-type: none"><li>• Invalid command</li><li>• Invalid parameter in command statement</li><li>• Command line exceeds 40 characters.</li></ul> |
| 5          | CONNECT 1200 | Carrier detected at 1200 bps.  |
| 6          | NO DIALTONE  | No dial tone detected within timeout.  |
| 7          | BUSY         | Busy signal detected.  |
| 8          | NO ANSWER    | No answer within timeout period.   |
| 9          | CONNECT 600  | <i>Not supported.</i>  |
| 10         | CONNECT 2400 | Carrier detected at 2400 bps.  |

## Register Summary

| Register | Range                               | Default | Function   |
|----------|-------------------------------------|---------|--|
| S0       | 0–255 Rings                         | 0       | Number of rings before modem automatically answers. A value of 0 (default) disables automatic answering.   |
| S1       | 0–255 Rings                         | 0       | Number of rings that have occurred. Resets to 0 after eight seconds with no rings (read-only register).  |
| S2       | 0–255 ASCII<br>0–127<br><br>128–255 | 043     | Escape code character. Escape code characters enabled.<br>Escape code characters disabled.   |
| S3       | 0–255 ASCII                         | 013     | Command line terminator. Default is the carriage return character.   |
| S4       | 0–255 ASCII                         | 010     | Line feed character. This character follows the carriage return character in a full-word return code. Default is the line feed character.  |
| S5       | 0–255 ASCII                         | 008     | Backspace character. This character erases the last character in the command line being entered. The default is the backspace character.   |
| S6       | 0–255 seconds                       | 2       | Wait time for dial tone. This is the delay between going “off hook” and beginning to dial if the result code set is X0, X1, or X3. The dial tone is assumed to be present after the delay has passed. With values below 2, the delay is 2 seconds. Dialing begins when the dial tone is detected if the result code set is X2 or X4. If no dial tone is detected within 5 seconds, the modem goes “on hook” and responds with the result NO DIAL TONE. |
| S7       | 0–255 seconds                       | 30      | Wait time for carrier after dialing.   |

| Register | Range                                    | Default              | Function  |
|----------|--|----------------------|---|
| S8       | 0–255 seconds                            | 2                    | Length of pause caused by comma in the dialed characters.   |
| S9       | 0–255 secs/10                            | 6                    | Carrier valid delay. To be detected, the carrier must be present for this time.   |
| S10      | 0–255 secs/10                            | 14                   | Time between loss of carrier and going “on hook.” Setting of 255 disables carrier-loss disconnect.  |
| S11      | 50–255 secs/1000                         | 100                  | Dialing tones duration and spacing. <i>Not supported</i> in Level 1.6.  |
| S12      | 20–255 secs/20                           | 50                   | Escape sequence guard time. The dialed character stream must be silent for this time before and after the escape sequence to enter the command state from the data state. |
| S13      |  |                      | Not used.   |
| S14      |  |                      | Bit-mapped register.  |
| S15      |  |                      | Not used.   |
| S16      |  |                      | Modem test options.   |
| S17      |  |                      | Not used.   |
| S18      | 0–255 seconds                            | 0                    | Test timer.   |
| S19      |  |                      | Not used.   |
| S20      |  |                      | Not used.   |
| S21      |  |                      | Bit-mapped register.  |
| S22      |  |                      | Bit-mapped register.  |
| S23      |  |                      | Bit-mapped register.  |
| S24      |  |                      | Not used.   |
| S25      | 1–255 secs<br>0–2.55 secs<br>0–2.55 secs | 5sec<br>50ms<br>50ms | Delay to DTR.<br>Synchronous mode M1.<br>Asynchronous mode M2.<br>Synchronous mode M3.  |
| S26      | 0–2.55 secs                              | 1                    | RTS to CTS delay.   |
| S27      |  |                      | Bit-mapped register.  |



## Bit-Mapped Registers

**Figure 9-1. S14 Options Register**

| Register | Bit | Value                | Description                     |
|----------|-----|----------------------|---------------------------------|
| S14      | 0   |                      | Not used.                       |
|          | 1   | 0                    | Local echo disabled.            |
|          |     | 1                    | Local echo enabled (default).   |
|          | 2   | 0                    | Result codes enabled (default). |
|          |     | 1                    | Result codes off.               |
|          | 3   | 0                    | Result codes digits.            |
|          |     | 1                    | Result codes words (default).   |
|          | 4   | 0                    | Smart mode (default).           |
|          |     | 1                    | Dumb mode.                      |
|          | 5   | 0                    | Touch tone.                     |
| 1        |     | Pulse (default).     |                                 |
| 6        |     | Not used.            |                                 |
| 7        | 0   | Answer.              |                                 |
|          | 1   | Originate (default). |                                 |

**Figure 9-2. S16 Modem Test Options Register**

| Register | Bit | Value | Description  |
|----------|-----|-------|--|
| S16      | 0   | 0     | Local analog loop disabled (default).                              |
|          |     | 1     | Local analog loop enabled.   |
|          | 1   |       | Not used.  |
|          | 2   | 0     | Local digital loop disabled (default).                             |
|          |     | 1     | Local digital loop enabled.  |
|          | 3   | 0     | Loopback off (default).  |
|          |     | 1     | Loopback on.   |
|          | 4   | 0     | Disable remote digital loop (default).                             |
|          |     | 1     | Initiate remote digital loop.                                      |
|          | 5   | 0     | Disable expanded remote digital loopback with self-test (default). |
|          |     | 1     | Initiate expanded remote digital loopback with self-test.          |
|          | 6   | 0     | Disable local analog loopback with self-test (default).            |
|          |     | 1     | Initiate local analog loopback with self-test.                     |
|          | 7   |       | Not used.  |

**Figure 9-3. S21 Modem Options Register**

| Register | Bit | Value                         | Description  |
|----------|-----|-------------------------------|--|
| S21      | 0   | 0                             | RJ11/RJ14/RJ45 (default).                            |
|          |     | 1                             | RJ12/RJ13. <i>Not supported.</i>                     |
|          | 1   |                               | Not used.  |
|          | 2   | 0                             | CTS follows RTS (default).                           |
|          |     | 1                             | CTS follows carrier signal.                          |
|          | 4 3 | 0 / 0                         | Modem ignores DTR.                                   |
|          |     | 0 / 1                         | Command state on-to-off DTR (default in Level 1.6).  |
|          |     | 1 / 0                         | Hangs on on-to-off DTR (default in Level 2.0).       |
|          |     | 1 / 1                         | Initialize on on-to-off DTR.                         |
|          | 5   | 0                             | RLSD always on (default in Level 1.6).               |
|          |     | 1                             | RLSD indicates valid carrier (default in Level 2.0). |
|          | 6   | 0                             | DSR always on (default).                             |
|          |     | 1                             | Modem off hook in data mode.                         |
|          | 7   | 0                             | Disable long space disconnect (default).             |
| 1        |     | Enable long space disconnect. |  |

**Figure 9-4. S22 Options Register**

| Register | Bit   | Value     | Description                                   |
|----------|-------|-----------|---|
| S22      | 1 0   | 0 / 0     | Undefined.                                    |
|          |       | 0 / 1     | Low speaker volume.                           |
|          |       | 1 / 0     | Medium speaker volume (default).              |
|          |       | 1 / 1     | High speaker volume.                          |
|          | 3 2   | 0 / 0     | Speaker disabled.                             |
|          |       | 0 / 1     | Speaker on until carrier (default).           |
|          |       | 1 / 0     | Speaker always on.                            |
|          |       | 1 / 1     | Speaker on until carrier but off during dial. |
|          | 6 5 4 | 0 / 0 / 0 | 2400 result codes, blind dial.                |
|          |       | 0 / 0 / 1 | Undefined.                                    |
|          |       | 0 / 1 / 0 | Undefined.                                    |
|          |       | 0 / 1 / 1 | Undefined.                                    |
|          |       | 1 / 0 / 0 | Full codes, blind dial.                       |
|          |       | 1 / 0 / 1 | Full codes, dial tone wait.                   |
|          |       | 1 / 1 / 0 | Full, blind, busy detect.                     |
|          |       | 1 / 1 / 1 | Full, wait, busy (default).                   |
|          | 7     | 0 = 39/61 | Make / break (default).                       |
|          |       | 1 = 33/67 | Make / break.                                 |

**Figure 9-5. S23 Options Register**

| Register | Bit | Value               | Description                               |
|----------|-----|---------------------|---|
| S23      | 0   | 0                   | Ignore remote loopback request.           |
|          |     | 1                   | Accept remote loopback request (default). |
|          | 2 1 | 0/0                 | 0 to 300 bps.                             |
|          |     | 0/1                 | 600 bps. <i>Not supported.</i>            |
|          |     | 1/0                 | 1200 bps.                                 |
|          |     | 1/1                 | 2400 bps (default).                       |
|          | 3   |                     | Undefined.                                |
|          | 5 4 | 0/0                 | Even parity (default).                    |
|          |     | 0/1                 | Space parity.                             |
|          |     | 1/0                 | Odd parity.                               |
|          |     | 1/1                 | Mark / no parity.                         |
|          | 7 6 | 0/0                 | No guard tones (default).                 |
|          |     | 0/1                 | 550 Hz guard tone.                        |
| 1/0      |     | 1800 Hz guard tone. |   |
| 1/1      |     | Not used.           |   |

**Figure 9-6. S27 Options Register**

| Register | Bit | Value                              | Description               |
|----------|-----|------------------------------------|---------------------------|
| S27      | 1 0 | 0/0                                | Asynchronous (default).   |
|          |     | 0/1                                | Sync mode 1, async dial.  |
|          |     | 1/0                                | Sync mode 2, DTR dial.    |
|          |     | 1/1                                | Sync mode 3, manual dial. |
| 2        | 0   | Dialup line (default).             |                           |
|          | 1   | Leased line.                       |                           |
| 3        |     | Undefined.                         |                           |
| 5 4      | 0/0 | EIA pin 15 clock source (default). |                           |
|          | 0/1 | EIA pin 24 clock source.           |                           |
|          | 1/0 | Clock from receive carrier.        |                           |
|          | 1/1 | Not used.                          |                           |
| 6        | 0   | CCITT V.22 bis / V.22.             |                           |
|          | 1   | BELL 212A (default).               |                           |
| 7        |     | Not used.                          |                           |

## Specifications

### Dialer Type

- Pulse dialing
- Dual Tone Multifrequency (DTMF).

### Pulse Dialing

- Rate: 10 pulses per second
- Duty Cycle: Relay make/break 39 ms/61 ms, interdigit delay 785 ms.

### DTMF Dialing

#### Modulation

|                    |                                     |
|--------------------|-------------------------------------|
| V.21 and Bell 103: | Frequency shift keying (FSK)        |
| V.22 and 212 Mode: | Four-level phase shift keying (PSK) |
| V.22 bis:          | 16-point QAM                        |

### Transmitter Characteristics

The transmit level in either 103 mode or 212 mode is -11 dbm,  $\pm 2$ dbm.

### Receiver Characteristics

- Carrier Detect Threshold
  - Carrier detect threshold off: -48 dbm
  - Carrier detect threshold on: -43 dbm
  - Maximum input level: -9 dbm.
- Incoming Ring Detection. The modem detects as a ring this range of "on hook" voltages: 40 to 130 volts RMS at 16 to 68 Hz.

### Analog Interface

The modem is provided with one RJ-11 connector. Permissive telephone line connection is made through a detachable 3,048 mm (10 foot) cable terminated at both ends with a modular six-position plug. The plug connects to a USOC RJ11C wall outlet.

- USOC RJ 11C

Both the telephone line and a voice telephone handset can be connected to the modem with a T-adaptor plugged into the jack of the wall outlet. A telephone handset is required only for manually originating and answering calls.

**Note:** Picking up the handset while the modem is processing data causes errors in data transmission or termination of the connection.

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## RS-232C Interface Card

### Description

This card attaches to the serial interface connector on the system board and provides RS-232C (CCITT V.24) voltages to a 25-pin, D-shell connector.

See Figure 3-146 on page 3-148 for pin assignments for connection of the card to the system board.

### Voltage Interchange Information

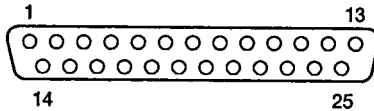
The signal is considered in the marking condition when the voltage on the interchange circuit, measured at the interface point, is more negative than -3V dc with respect to signal ground. The signal is considered in the spacing condition when the voltage is more than +3V dc with respect to signal ground. The region between +3V dc and -3V dc is defined as the transition region and considered an invalid level. A voltage that is more negative than -15V dc or more positive than +15V dc is considered an invalid level.

| <i>Figure 9-7. Voltage Levels</i><br>Interchange<br>Voltage | Binary State | Signal Condition | Interface<br>Control<br>Function |
|---|--------------|------------------|----------------------------------|
| Positive Voltage  | 0            | Spacing          | On                               |
| Negative Voltage  | 1            | Marking          | Off                              |

## RS-232C Connector

The interface uses the standard D-shell connector and pin assignments defined for RS-232C. The voltage levels are EIA only. Current loop interface is not supported.

Figure 9-8 shows the pin assignments for the serial port in a communications environment.



**Figure 9-8. Serial Port Connector Pin Assignments**

| Pin No. | I/O | Signal Name                     | Pin No. | I/O | Signal Name         |
|---------|-----|---------------------------------|---------|-----|---------------------|
| 1       | NA  | Not Connected                   | 13      | NA  | Not Connected       |
| 2       | O   | Transmit Data                   | 14      | NA  | Not Connected       |
| 3       | I   | Receive Data                    | 15      | NA  | Not Connected       |
| 4       | O   | Request to Send                 | 16      | NA  | Not Connected       |
| 5       | I   | Clear to Send                   | 17      | NA  | Not Connected       |
| 6       | I   | Data Set Ready                  | 18      | NA  | Not Connected       |
| 7       | NA  | Signal Ground                   | 19      | NA  | Not Connected       |
| 8       | I   | Received Level<br>Signal Detect | 20      | O   | Data Terminal Ready |
| 9       | NA  | Not Connected                   | 21      | NA  | Not Connected       |
| 10      | NA  | Not Connected                   | 22      | I   | Ring Indicate       |
| 11      | O   | Data Terminal Ready             | 23      | NA  | Not Connected       |
| 12      | NA  | Not Connected                   | 24      | NA  | Not Connected       |
|         |     |                                 | 25      | NA  | Not Connected       |