



# XE2400/XE2400A 2400 bps Component Modem

## Features

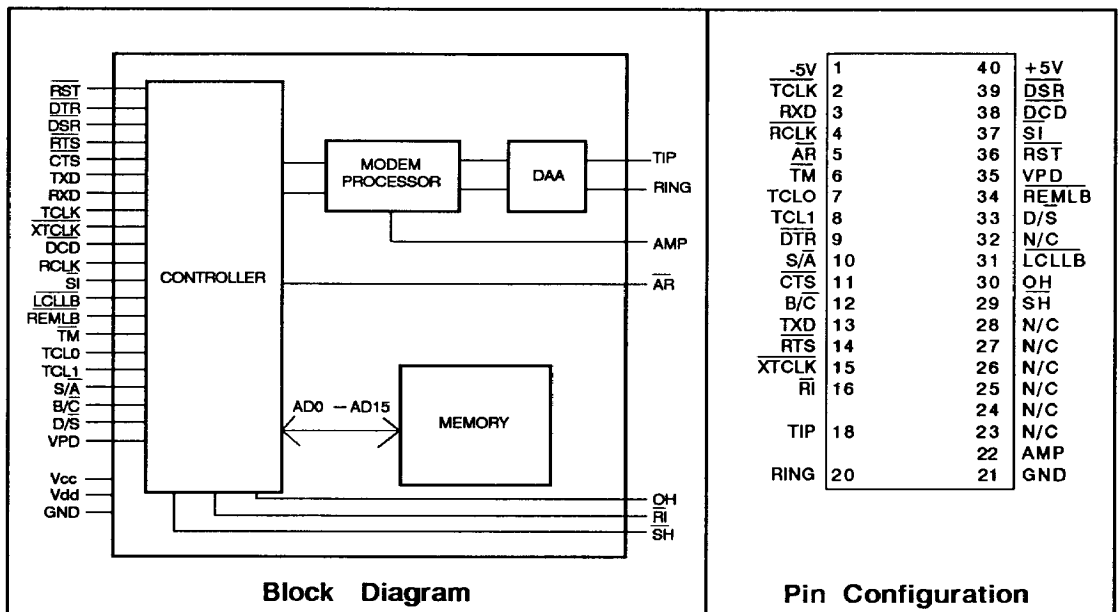
- Small Size - 2.75" x 1.38" x 0.50"
- FCC Part 68 Registered
- Full 2400/1200/300 bps Transmission Capability
- CCITT V.22bis, V.22/V.21 and Bell 212A/103 Compatible
- Synchronous and Asynchronous Operation
- Adaptive Equalization
- Complete Industry Standard "AT" Command Set
- TTL Serial Interface
- Dial, busy, ringback and modem answer tone detection
- DTMF and Pulse Dialing
- Telephone Line Audio Monitor Output
- UL Recognized Component

## Description

The XECOM XE2400 and XE2400A are a complete, CCITT/ Bell compatible, high performance 2400 bps component modems.

They support full CCITT V.22bis operation and contain all circuitry necessary to achieve complete modem functionality, including a user transferable FCC Part 68 registration allowing direct connection to the telephone line.

The XE2400 and XE2400A modems operate with the industry standard "AT" command set and provide full compatibility with all popular communications software written for personal computers. The XE2400A operates in the asynchronous mode, while the XE2400 operates in both synchronous and asynchronous modes.



## Product Description

Included are both auto-dialing and auto-answering functions in either Tone or Pulse modes. A call progress monitor allows detection of dial tone, busy and ringback signals, completed modem connection and loss of carrier, with appropriate messages to the user. The XE2400 and XE2400A can also automatically adapt to the remote modem type (CCITT or BELL) and adjust its transmission speed to that of the calling or answering modem (Refer to compatibility Table 1).

In addition, standard diagnostic tests are provided as recommended in CCITT V.54, including analog, digital and remote digital loopback tests.

## Operation

Upon power up, the modem is configured in accordance with the default options, which are selected and preset at the factory. However, the user may choose to reconfigure the modem to adapt to his unique application. This can be achieved by saving a modified configuration in the external non-volatile memory with the &W command. Saved information is automatically restored when the modem is powered up or when it receives the Z (RESET) command.

In auto-answer mode, the modem goes off-hook and remains silent for the two second billing delay period before it sends back the answer tone. When handshaking is completed and the connection has been established, the modems will be operating with matching speeds and under compatible communication protocols (CCITT or BELL).

If during data transmission the bit error rate is unacceptably high, the modem automatically initiates a retrain sequence in conformance with CCITT V.22bis standard (2400 bps operation).

Call termination can be initiated by either the local or remote DTE. An optional 'long-space' disconnect can also be specified. In this case, a space of 1.6 seconds or more, received from the remote modem, will initiate a disconnect sequence.

**Table 1. Remote Modem Compatibility**

| ORIGINATING<br>XE2400<br>MODEM |           | ANSWERING MODEM   |              |              |              |               |               |
|--------------------------------|-----------|-------------------|--------------|--------------|--------------|---------------|---------------|
|                                |           | BELL<br>300       | BELL<br>1200 | CCITT<br>300 | CCITT<br>600 | CCITT<br>1200 | CCITT<br>2400 |
| Bell                           | 300       | 300               | 300          | -            | -            | 300*          | 300*          |
|                                | 1200      | 1200*             | 1200         | -            | -            | 1200          | 1200          |
|                                | CCITT 300 | -                 | -            | 300          | -            | -             | -             |
|                                | 600       | -                 | -            | -            | 600          | -             | -             |
|                                | 1200      | 1200*             | 1200         | -            | -            | 1200          | 1200          |
|                                | 2400      | 1200*             | 1200         | -            | -            | 1200          | 2400          |
| ANSWERING<br>XE2400<br>MODEM   |           | ORIGINATING MODEM |              |              |              |               |               |
|                                |           | BELL<br>300       | BELL<br>1200 | CCITT<br>300 | CCITT<br>600 | CCITT<br>1200 | CCITT<br>2400 |
| Bell                           | 300       | 300               | 1200         | -            | -            | 1200          | 1200          |
|                                | 1200      | 300               | 1200         | -            | -            | 1200          | 1200          |
| CCITT                          | 300       | -                 | -            | 300          | -            | -             | -             |
|                                | 600       | -                 | -            | -            | 600          | -             | -             |
|                                | 1200      | 300*              | 1200         | -            | -            | 1200          | 1200          |
|                                | 2400      | 300*              | 1200         | -            | -            | 1200          | 2400          |

*\* These data rates may vary if other than XECOM modems are used*

## Configuration

The XE2400 configuration is stored in 28 configuration S-registers. Seven registers are reserved and cannot be modified. The contents of the remaining S-registers may be manipulated by sending configuration commands, which affect specific bits in the associated registers, or by directly writing into the registers. The format of the command which sets the register to a specific value is:

ATS  $n = x$

where  $n$  represents the register number (decimal integer between 0 and 27), and  $x$  represents the value to be written (decimal integer between 0 and 255).

Example: Terminal: ATS0 = 2

Modem: OK

In this example, 2 is written into the S0 register, thus conditioning the modem to automatically answer a call after the second ring. The modem comes back with the message OK - an acknowledgment of successful execution of the command.

Format for reading S-register: ATS  $n$ ?

where  $n$  is the S-register number (decimal integer between 0 and 27).

Example: Terminal: ATS0?

Modem: 002

OK

In this example, the modem comes back with the value which was previously stored in the S0 register.

**Table 2. S-Registers Summary**

| REG. | RANGE/UNITS     | DESCRIPTION                            | DEFAULT |
|------|-----------------|--|---------|
| S0   | 0-255/rings     | Ring to answer                         | 0       |
| S1   | 0-255/rings     | Ring count (read only)                 | 0       |
| S2   | 0-127/ASCII     | Escape code character                  | 43(+)   |
| S3   | 0-127/ASCII     | Carriage return character              | 13(CR)  |
| S4   | 0-127/ASCII     | Line feed character                    | 10(LF)  |
| S5   | 0-32,127/ASCII  | Back space character                   | 8       |
| S6   | 2-255/sec       | Wait for dial tone                     | 2       |
| S7   | 1-255/sec       | Wait for data carrier                  | 30      |
| S8   | 0-255/sec       | Pause time for the comma dial modifier | 2       |
| S9   | 1-255/0.1 sec   | Carrier detect response time           | 6       |
| S10  | 1-255/0.1 sec   | Lost carrier to hang up delay          | 14      |
| S11  |                 | Not used                               |         |
| S12  | 20-255/0.02 sec | Escape code guard time                 | 50      |
| S13  |                 | Not used                               |         |
| S14  | none            | Bit mapped options register            | AA hex  |
| S15  |                 | Not used                               |         |
| S16  | none            | Modem test options                     | 0       |
| S17  |                 | Not used                               |         |
| S18  | 0-255 sec       | Test timer                             | 0       |
| S19  |                 | Not used                               |         |
| S20  |                 | Not used                               |         |
| S21  | none            | Bit mapped options register            | 0       |
| S22  | none            | Bit mapped options register            | 76 hex  |
| S23  | none            | Bit mapped options register            | 7       |
| S24  |                 | Not used                               |         |
| S25  | 0-255/0.01 sec  | Detect DTR transition                  | 5       |
| S26  | 0-255/0.01 sec  | RTS to CTS delay                       | 1       |
| S27  | none            | Bit mapped options register            | 40 hex  |

**Notes:** 1. All default values are decimal numbers with exception of those marked "hex" (hexadecimal). 2. S-registers S0, S14, S18, S21, S22, S23, S25, S26 and S27 can be stored in the external non-volatile memory by issuing the &W command. The preserved configuration data is restored upon power up of the modem, or when the modem receives the Z command. 3. For more information on S-registers refer to the XE2400 Application Note.

## Pin Description

| PIN# | NAME            | I/O                                     | DESCRIPTION   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
|------|-----------------|---|---|------|------|--|---|---|-------------------------------|---|---|---|---|---|----------------------------|---|---|-----------------------------------|
| 1    | V <sub>DD</sub> | -                                       | Negative supply voltage (-5 volts)  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 2    | TCLK            | O                                       | Transmit clock to DTE. The serial synchronous data is read on the rising edge of the TCLK. During asynchronous operation the TCLK pin remains "high".   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 3    | RXD             | O                                       | Serial data output to the DTE. A logic "high" represents a "mark" and a logic "low" represents a "space".   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 4    | RCLK            | O                                       | Receive clock to the DTE. The rising edge of the clock occurs in the middle of each RXD data bit. During asynchronous operation, this pin remains "high".   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 5    | AR              | O                                       | Auxiliary relay control can be used for switching between the telephone handset and the modem, which are connected to the same telephone line. When the modem is taken "off-hook", the AR pin is low and can be used to control an external relay to disconnect the handset from the telephone line.  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 6    | TM              | O                                       | Test mode indicator. A logic "low" indicates a maintenance condition in the modem.  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 7,8  | TCL0,<br>TCL1   | I                                       | Synchronous transmission clock source select:<br><table><tr><td>TCL1</td><td>TCL0</td><td></td></tr><tr><td>0</td><td>0</td><td>From local crystal oscillator</td></tr><tr><td>0</td><td>1</td><td>From the receive synchronous clock RCLK</td></tr><tr><td>1</td><td>0</td><td>From DTE through XTCLK PIN</td></tr><tr><td>1</td><td>1</td><td>Extended hardware option register</td></tr></table> | TCL1 | TCL0 |  | 0 | 0 | From local crystal oscillator | 0 | 1 | From the receive synchronous clock RCLK | 1 | 0 | From DTE through XTCLK PIN | 1 | 1 | Extended hardware option register |
| TCL1 | TCL0            |   |   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 0    | 0               | From local crystal oscillator           |   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 0    | 1               | From the receive synchronous clock RCLK |   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 1    | 0               | From DTE through XTCLK PIN              |   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 1    | 1               | Extended hardware option register       |   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 9    | DTR             | I                                       | Data terminal ready. The function of this pin is determined by the &D command and the value in register S21.  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 10   | S/A             | I                                       | Sync/Async format select. A "low" level enables the asynchronous mode and "high" level enables the synchronous mode.  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 11   | CTS             | O                                       | Clear to Send to the DTE. "Low" on this pin indicates that the modem is ready to accept data signals for transmission.  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 12   | B/C             | I                                       | This pin selects Bell 103 or CCITT V.21 protocols during 300 bps operation. Speeds of 600, 1200 or 2400 are not affected by this pin.   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 13   | TXD             | I                                       | Serially transmitted data from the DTE. A logic "high" represents a marking signal and a logic "low" represents a space. In the synchronous mode, the data is sampled on the rising edge of TCLK.   |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |
| 14   | RTS             | I                                       | Request to Send from the DTE. The function of RTS is determined by the &R command and the values in registers S21 and S26.  |      |      |  |   |   |                               |   |   |   |   |   |                            |   |   |                                   |

| PIN#   | NAME                           | I/O | DESCRIPTION  |
|--|--------------------------------|-----|--|
| 15   | $\overline{\text{XTCLK}}$      | I   | External transmit clock from the DTE. This clock signal is used as "TCLK" in externally clocked synchronous mode.  |
| 16   | $\overline{\text{RI}}$         | O   | Ring indicator from the DAA. A "low" level on this pin indicates the presence of the ring signal.  |
| 18,20  | TIP,<br>RING                   | -   | TIP and RING connections to the telephone line from the internal DAA. In order to preserve the high voltage isolation provided by the DAA, traces from these pins to the RJ11C Jack should have a minimum spacing of 0.15 inches (3.8 mm) between them and any other traces on the PC board. |
| 21   | GND                            | -   | Ground (0 volts)   |
| 22   | AMP                            | O   | Output to monitor speaker. The function of AMP is determined by the L and M commands and the value in register S22.  |
| 29   | $\overline{\text{SH}}$         | I   | Used as a telephone voice to data or data to voice switch.   |
| 30   | OH                             | O   | "Off-hook" - "On-hook" status line. OH high indicates that the hookswitch relay is closed and the modem is connected to the phone line.  |
| 31   | $\overline{\text{LCLLB}}$      | I   | A "low" level sets the modem in the local analog loopback test mode. Logic "low" levels applied simultaneously to REMLB and LCLLB pins will set the modem to the local digital loopback.   |
| 33   | $\text{D}/\overline{\text{S}}$ | I   | Dumb/Smart modem select. "Low" indicates a smart mode in which the modem responds to all Hayes commands. "High" will tell the modem to ignore all the commands.  |
| 34   | $\overline{\text{REMLB}}$      | I   | A logic "low" on this pin initiates a remote loopback condition.   |
| 35   | VPD                            | I   | RAM back-up power. This pin needs to be connected to +5 volts during normal operation.   |
| 36   | $\overline{\text{RST}}$        | I   | Reset. This line needs to be held low for at least 500 ns after power on. It should remain high during normal operation.   |
| 37   | $\overline{\text{SI}}$         | O   | Selects one of the two data rates or ranges of rates in the DTE to correspond to the modem rate. "Low" indicates the higher rate (2400 bps) and "High" indicates low range of rates.   |
| 38   | $\overline{\text{DCD}}$        | O   | Data Carrier Detect. In the synchronous mode, $\overline{\text{DCD}}$ "low" indicates the presence of the carrier signal. In the asynchronous mode, the DCD function is determined by the &C command and the value in register S21.  |
| 39   | $\overline{\text{DSR}}$        | O   | Data Set Ready to the DTE. The function of DSR is determined by the &S command and the value in the register S21.  |
| 40   | $\text{V}_{\text{CC}}$         | -   | +5 Volts   |
| <i>Note: Pins 23, 24, 25, 26, 27, 28 and 32 require no connection and must be left open.</i> |                                |     |  |

### "AT" COMMANDS

The "AT" commands are subdivided into three major groups: configuration, immediate action and diagnostic commands.

Configuration commands, affect the modem configuration by changing the contents of the S-registers. The B command, which selects CCITT or BELL protocols, is an example of this type of command. As a result of the B command, bit 6 of S27 is set or cleared, depending on which protocol is chosen. Immediate action commands instruct the modem to perform an action. The "A" command (go off hook in Answer mode) and the "D" command (dial) are typical commands in this group. Diagnostic commands initiate local analog, and digital Loopback test and remote digital loopback test.

The "AT" prefix begins every command line with the exception of the + + + (escape) and the A/ (repeat) commands. "AT", often referred to as the attention code, delivers information to the modem about the data rate and the parity setting of the local DTE. The XE2400 will adapt to these parameters until a new "AT" command is received. Multiple commands can be placed on a single line and spaces are allowed between commands to improve readability. A command line must be terminated with the ASCII carriage return character (value in registers S3). A line feed character following the carriage return character is optional. The backspace or delete key can be used to delete any character entered from the keyboard, except the "AT" prefix. Upon execution of the command the result code is returned by the modem.

Example:           Terminal:       ATH  
                  Modem:         OK

This example demonstrates the hang up command. This example demonstrates placing the modem 'on-hook'. Upon successful completion of the command, an OK message is returned to the user.

**Table 3. Result Codes**

| SHORT FORM | LONG FORM    | DESCRIPTION  |
|------------|--------------|--|
| 0          | OK           | Command line executed without errors   |
| 1          | CONNECT      | Connected at 300 bps   |
| 2          | RING         | Local telephone line ringing   |
| 3          | NO CARRIER   | Carrier lost, or never received  |
| 4          | ERROR        | Error in command line, invalid command line, command line exceeds command buffer or invalid character format |
| 5          | CONNECT 1200 | Connected at 1200 bps  |
| 6          | NO DIALTONE  | No dial tone received within time-out period   |
| 7          | BUSY         | Called line busy   |
| 8          | NO ANSWER    | Called line not answered within time-out period  |
| 9          | CONNECT 600  | Connection established at 600 bps  |
| 10         | CONNECT 2400 | Connection established at 2400 bps   |

*Note: Long-form results are preceded and terminated with both carriage return and line feed characters. Short-form codes are only terminated with a carriage return.*

## 'AT' Commands Summary

### Basic Commands

|      |  |
|------|--|
| AT   | Attention code that precedes all command lines except + + + (escape) and A/ (repeat)                     |
| A    | Go off hook into answer mode   |
| A/   | Repeat previous command line   |
| B    | CCITT V.22 operation at 1200 bps   |
| B1   | Bell 212A operation at 1200 bps (default)  |
| D    | Dial a number (0-9 ABCD*#)   |
| E    | Turn echo off  |
| E1   | Turn echo on (default)   |
| H    | Go on hook (hang up) (default)   |
| H1   | Go off hook and switch the auxiliary relay   |
| I    | Request product code   |
| I1   | Compute and return checksum (firmware ROM)   |
| I2   | Compute and return checksum with OK or ERROR message   |
| L,L1 | Low speaker volume   |
| L2   | Medium speaker volume (default)  |
| L3   | High speaker volume  |
| M    | Speaker is off   |
| M1   | Speaker is off while carrier is present (default)  |
| M2   | Speaker is always on   |
| M3   | Speaker is disabled while dialing or receiving carrier   |
| O    | Return to on-line mode   |
| O1   | Return to on-line mode and initiate retrain sequence (in 2400 bps only)                                  |
| Q    | Return result codes (default)  |
| Q1   | Do not return result codes   |
| Sn=x | Write x in S-register n  |
| Sn?  | Read S-register n  |
| V    | Enable short form result codes   |
| V1   | Enable full word result codes (default)  |
| X    | CONNECT result code enabled (300 bps operation)  |
| X1   | All CONNECT result codes enabled; dial blind; busy signal is not recognized                              |
| X2   | All CONNECT result codes enabled; wait for dial tone before dialing; busy signal is not recognized       |
| X3   | All CONNECT result codes enabled; dial blind; busy signal is recognized                                  |
| X4   | All CONNECT result codes enabled; wait for dial tone before dialing; busy signal is recognized (default) |

## Product Description

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- Y      Disable long space disconnect (default)  
Y1     Enable long space disconnect
- Z      Reset component and fetch configuration profile contained in external nonvolatile memory  
+++    The default escape code

## Extended Commands

- &C      DCD always ON (default)  
&C1     DCD tracks the state of the carrier signal
- &D      DTR ignored (default)  
&D1     Assume command state on ON-to-OFF transition of DTR  
&D2     Go on-hook, disable auto-answer, assume command state on ON-to-OFF transition of DTR  
&D3     Assume initialization state on ON-to-OFF transition of DTR
- &F      Fetch factory configuration profile from internal ROM
- &G      No guard tone (default)  
&G1     550 Hz guard tone  
&G2     1800 Hz guard tone
- &M      Asynchronous mode (default)  
&M1     Synchronous mode 1 (sync/async modes are supported)  
&M2     Synchronous mode 2 (dial stored number mode)  
&M3     Synchronous mode 3 (manual dial with DTR off)
- &P      Make/Break pulse ratio = 39/61 (USA/Canada) (default)  
&P1     Make/Break pulse ratio = 33/67 (CCITT)
- &R      CTS OFF-to-ON transition follows RTS OFF-to-ON transition (default)  
&R1     CTS always ON; RTS ignored
- &S      DSR always ON (default)  
&S1     DSR operates according to CCITT V.22 bis/V.22 recommendation
- &T      Terminate any test currently in process  
&T1     Initiate local analog loopback  
&T3     Initiate local digital loopback  
&T4     Grant request from remote modem for remote digital loopback  
&T5     Deny request from remote modem for remote digital loopback  
&T6     Initiate remote digital loopback  
&T7     Initiate remote digital loopback with self test  
&T8     Initiate local analog loopback with self test
- &W      Write configuration to nonvolatile memory (external NVRAM required)
- &X      Transmit clock source is modem (default)  
&X1     Transmit clock source is DTE  
&X2     Transmit clock source is derived from received carrier signal
- &Z      Store telephone number



## Dial Modifiers

|   |                               |
|---|-------------------------------|
| P | Pulse dial                    |
| R | Originate call in Answer mode |
| T | Tone dial                     |
| S | Dial stored number            |
| W | Wait for dial tone            |
| , | Pause                         |
| ; | Return to command state       |
| ! | Flash                         |
| @ | Wait for silence              |

*Note: For more information on "AT" commands refer to the XE2400 Application Notes.*

## Factory Configuration

The following is the "preset operating configuration of the modem"

2400 bps communications rate  
Even parity  
Auto answer disable  
Command echo ON  
All result codes enabled  
Wait for dial tone before dialing  
Busy signal detect  
Full word result codes  
Pulse dial make/break ratio 39/61  
Test timer set to zero seconds  
CTS follows RTS after delay of 10ms  
RTS to CTS delay of 10 milliseconds  
Modem ignores DTR  
DCD always On  
DSR always On  
Long space disconnect disabled  
Speaker enabled and off while receiving a carrier  
Speaker volume set to medium  
Local modem will grant RDL request from remote  
Guard tones disabled  
Minimum DTR pulse width is 0.05 seconds  
Ring count to answer is 0 ( auto answer disabled)  
Escape code character is 43 (+)  
Carriage return character is 13 (CR)  
Line feed character is 10 (LF)

### Factory Configuration (con't)

Back space character is 8 (BS)  
Wait for dial tone is 2 seconds  
Wait for carrier after dialing is 30 seconds  
Dial pause (comma) is 2 seconds  
Carrier detect response time is 0.6 seconds  
Lost carrier to hang-up delay is 1.4 seconds  
Escape code guard time is 1 second

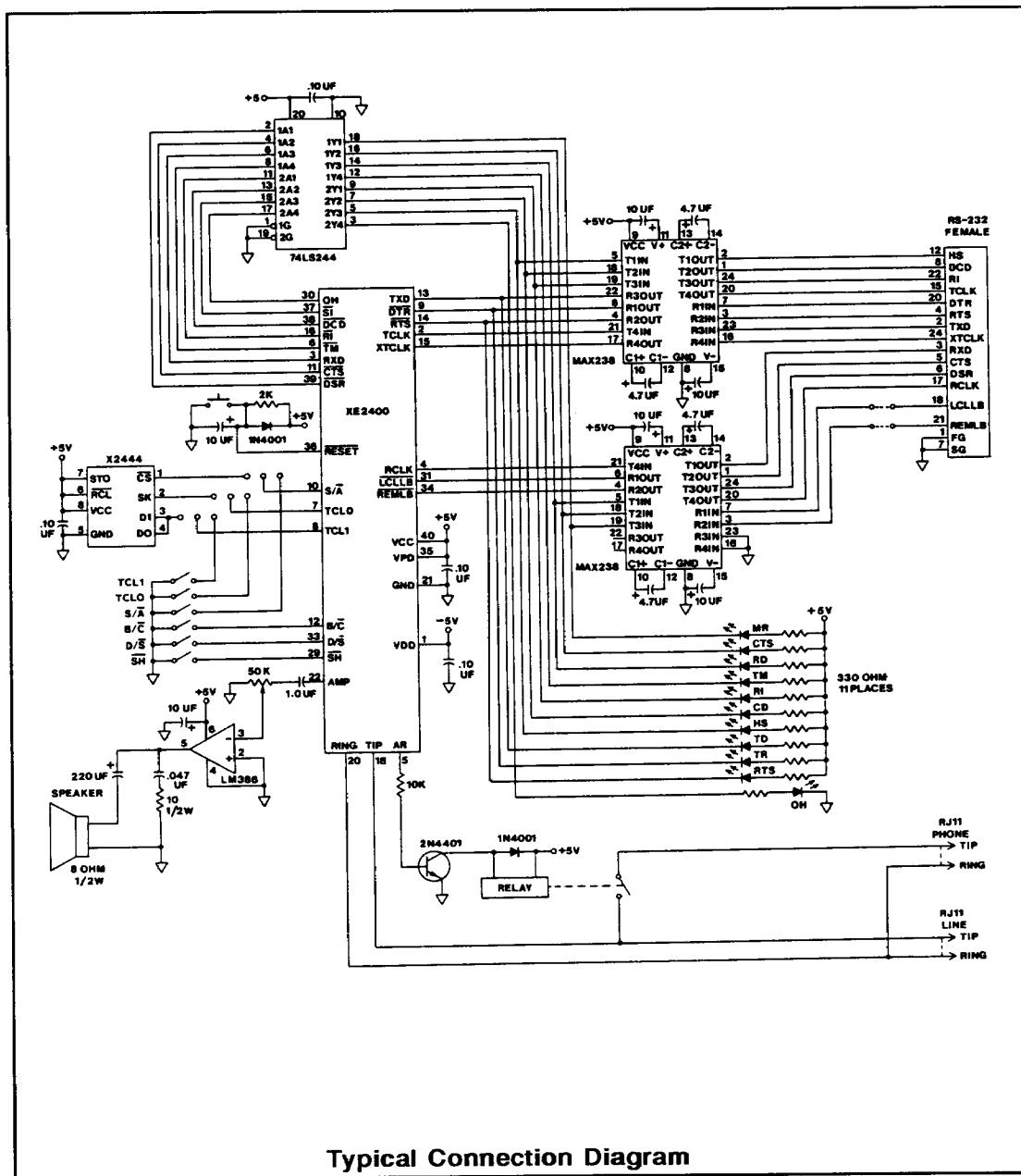
### Programmable Options Not Saved in NVRAM

| Factory Default Value | Option                                     |
|-----------------------|--|
| 0                     | Ring count                                 |
| 43                    | Escape code character                      |
| 13                    | Carriage return character                  |
| 10                    | Line feed character                        |
| 8                     | Back space character                       |
| 2 sec                 | Duration of wait for dial tone             |
| 30 sec                | Duration of wait for carrier after dialing |
| 2 sec                 | Duration of dial pause for the comma       |
| 0.6 sec               | Carrier detect response time               |
| 1.4 sec               | Lost carrier to hang-up delay              |
| 1 sec                 | Escape code guard time                     |

### Programmable Options Saved in NVRAM (*external NVRAM required*)

Baud rate (300, 600, 1200 and 2400 bps)  
Asynchronous parity option (odd, even, mark, space, none)  
Number of ring to answer on (1 to 255)  
Automatic answer (enable/disabled)  
Command echo (enable/disabled)  
Result codes (enable/disabled)  
Result codes (short/full word)  
Dialing (pulse or touch tone)  
Test timer timeout (0 to 255)  
RTS/CTS circuit option  
RTS/CTS delay  
DTR circuit option  
DCD circuit option  
DSR circuit option  
Long space disconnect (enable/disabled)  
Speaker volume (L1, L2 or L3)  
Pulse dial make/break ratio  
Grant or deny remote digital loop  
Guard tone selection (550Hz, 1800Hz, or none)  
Minimum DTR pulse width  
Bell 212A/CCITT V.22 compatibility at 1200 bps

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**Absolute Maximum Ratings**

|                           |  |                           |
|---------------------------|--|---------------------------|
| Supply Voltage            | - V <sub>CC</sub><br>- V <sub>DD</sub> | +6.5 Volts<br>- 6.5 Volts |
| Input Voltage             |  | -0.6 Volts to +6.5 Volts  |
| Storage Temperature Range |  | -25 Deg C to +85 Deg C    |

**DC Characteristics** ( $T_A = 0-70^\circ\text{C}$ ,  $V_{CC} = 5V \pm 5\%$ ,  $V_{DD} = -5V \pm 5\%$ )

| SYMBOL           | PARAMETER   | MIN  | MAX             | UNITS         | COMMENTS                       |
|------------------|---|------|-----------------|---------------|--------------------------------|
| V <sub>IL</sub>  | Input Low Voltage                                   | -0.3 | +0.8            | V             | Except $\overline{\text{RST}}$ |
| V <sub>IL1</sub> | Input Low Voltage, $\overline{\text{RST}}$          | -0.3 | +0.7            | V             |                                |
| V <sub>IH</sub>  | Input High Voltage                                  | 2.0  | V <sub>CC</sub> | V             | Except $\overline{\text{RST}}$ |
| V <sub>IH1</sub> | Input High Voltage, $\overline{\text{RST}}$ Rising  | 2.4  | V <sub>CC</sub> | V             |                                |
| V <sub>IH2</sub> | Input High Voltage, $\overline{\text{RST}}$ Falling | 2.1  | V <sub>CC</sub> | V             |                                |
| V <sub>IH3</sub> | Input High Voltage                                  | 2.4  | V <sub>CC</sub> | V             |                                |
| V <sub>OL</sub>  | Output Low Voltage                                  |      | 0.45            | V             | See Note 1.                    |
| V <sub>OH</sub>  | Output High Voltage                                 | 2.4  |                 | V             | See Note 2.                    |
| I <sub>CC</sub>  | V <sub>CC</sub> Supply Current                      |      | 235             | mA            | All outputs disconnected       |
| I <sub>DD</sub>  | V <sub>DD</sub> Supply Current                      |      | 25              | mA            |                                |
| I <sub>L1</sub>  | Input Low Current                                   |      | -200            | $\mu\text{A}$ | V <sub>IL</sub> = 0.45V Note 3 |
| I <sub>L2</sub>  | Input Low Current                                   |      | -100            | $\mu\text{A}$ | V <sub>IL</sub> = 0.45V Note 4 |
| I <sub>L3</sub>  | Input Low Current                                   |      | -2.0            | mA            | V <sub>IL</sub> = 0.45V Note 5 |
| I <sub>H1</sub>  | Input High Current                                  |      | -100            | $\mu\text{A}$ | V <sub>IH</sub> = 2.4V Note 6  |
| I <sub>H2</sub>  | Input High Current                                  |      | 100             | $\mu\text{A}$ | V <sub>IH</sub> = 2.4V Note 7  |

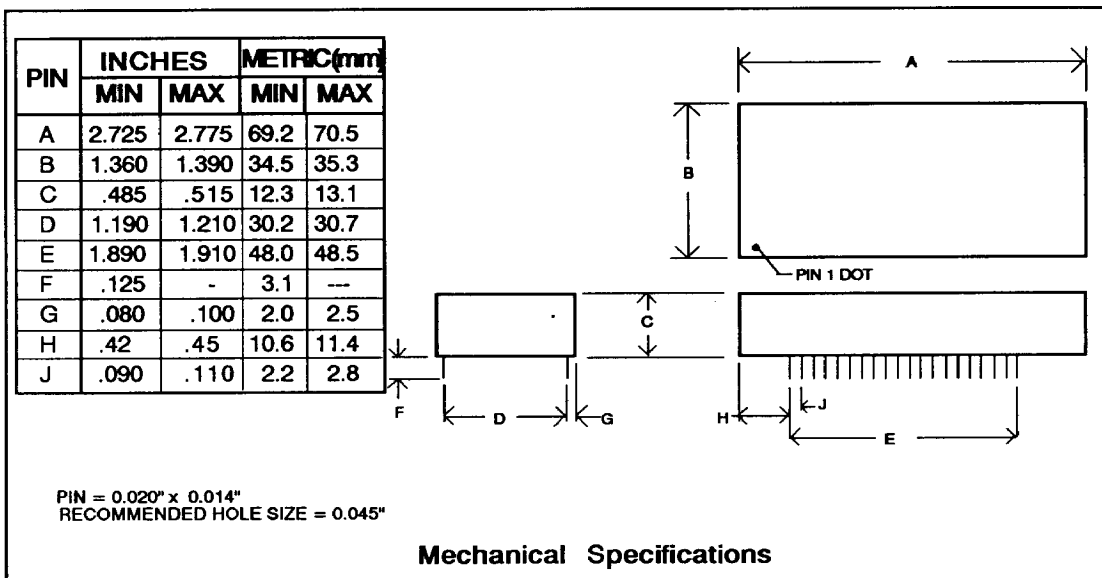
**NOTES:**

1. I<sub>OL</sub> = 0.36 mA for pins  $\overline{\text{CTS}}$ ,  $\overline{\text{DSR}}$ ,  $\overline{\text{DCD}}$ ,  $\overline{\text{SI}}$ ,  $\overline{\text{AR}}$ , OH  
I<sub>OL</sub> = 0.2 mA for pins  $\overline{\text{TCLO}}$ ,  $\overline{\text{TCL1}}$ , S/A  
I<sub>OL</sub> = 2.0 mA for pins  $\overline{\text{TM}}$ ,  $\overline{\text{RXD}}$ ,  $\overline{\text{TCLK}}$
2. I<sub>OH</sub> = -200  $\mu\text{A}$  for pins  $\overline{\text{TM}}$ ,  $\overline{\text{RXD}}$ ,  $\overline{\text{TCLK}}$   
I<sub>OH</sub> = -20  $\mu\text{A}$  for pins B/ $\overline{\text{C}}$ ,  $\overline{\text{RTS}}$ ,  $\overline{\text{CTS}}$ ,  $\overline{\text{DSR}}$ ,  $\overline{\text{SI}}$ ,  $\overline{\text{AR}}$ , OH  $\overline{\text{DCD}}$
3. For pins  $\overline{\text{RTS}}$ , B/ $\overline{\text{C}}$ ,  $\overline{\text{XTCLK}}$ ,  $\overline{\text{LCLLB}}$ ,  $\overline{\text{SH}}$ ,  $\overline{\text{TCL0}}$ ,  $\overline{\text{TCL1}}$ , D/ $\overline{\text{S}}$ , S/ $\overline{\text{A}}$ ,  $\overline{\text{REMLB}}$
4. For pins  $\overline{\text{DTR}}$ ,  $\overline{\text{RI}}$ ,  $\overline{\text{TXD}}$
5. For pins  $\overline{\text{RST}}$
6. For pins  $\overline{\text{RTS}}$ , B/ $\overline{\text{C}}$ ,  $\overline{\text{XTCLK}}$ ,  $\overline{\text{LCLLB}}$ ,  $\overline{\text{SH}}$ ,  $\overline{\text{TCL0}}$ ,  $\overline{\text{TCL1}}$ , D/ $\overline{\text{S}}$ , S/ $\overline{\text{A}}$ ,  $\overline{\text{REMLB}}$
7. For pins  $\overline{\text{DTR}}$ ,  $\overline{\text{TXD}}$ ,  $\overline{\text{RST}}$

## System Compatibility Specifications

| PARAMETER  | SPECIFICATION  |
|--|--|
| Synchronous  | 2400 bps $\pm$ 0.01% V.22 bis<br>1200 bps $\pm$ 0.01% V.22 and 212A<br>600 bps $\pm$ 0.01% V.22  |
| Asynchronous   | 2400, 1200, 600 bps, character asynchronous<br>0 - 300 bps anisochronous   |
| Asynchronous Speed Range                                     | -2.5% to +2.3%<br>in character asynchronous mode   |
| Asynchronous Format  | 10 bits, including start, stop, parity and data bits   |
| Synchronous Timing Source                                    | Internal, derived from the local oscillator<br>External, provided by DTE through XTCLK<br>Slave, derived from the received clock   |
| Telephone Line Interface                                     | Two wire full duplex over public switched network<br>FCC Part 68 registered DAA  |
| Modulation   | V.22 bis, 16 point QAM at 600 baud<br>V.22 and 212A, 4 point QAM at 600 baud<br>V.21 and 103, binary phase coherent FSK  |
| Output Spectral Shaping                                      | Square root of 75% raised cosine, QAM/PSK  |
| Transmit Carrier Frequencies<br>V.22 bis, V.22, 212A<br>V.21 | Originate 1200 Hz $\pm$ .01%<br>Answer 2400 Hz $\pm$ .01%<br>Originate 'space' 1180 Hz $\pm$ .01%<br>Originate 'mark' 980 Hz $\pm$ .01%<br>Answer 'space' 1850 Hz $\pm$ .01%<br>Answer 'mark' 1650 Hz $\pm$ .01%     |
| Bell 103   | Originate 'space' 1070 Hz $\pm$ .01%<br>Originate 'mark' 1270 Hz $\pm$ .01%<br>Answer 'space' 2025 Hz $\pm$ .01%<br>Answer 'mark' 2225 Hz $\pm$ .01%   |
| Maximum Carrier Output Level                                 | -9dBm  |
| Receive Carrier Frequencies<br>V.22 bis, V.22, 212A<br>V.21  | Originate 2400 Hz $\pm$ 7 Hz<br>Answer 1200 Hz $\pm$ 7 Hz<br>Originate 'space' 1850 Hz $\pm$ 12 Hz<br>Originate 'mark' 1650 Hz $\pm$ 12 Hz<br>Answer 'space' 1180 Hz $\pm$ 12 Hz<br>Answer 'mark' 980 Hz $\pm$ 12 Hz |
| Bell 103   | Originate 'space' 2025 Hz $\pm$ 12 Hz<br>Originate 'mark' 2225 Hz $\pm$ 12 Hz<br>Answer 'space' 1070 Hz $\pm$ 12 Hz<br>Answer 'mark' 1270 Hz $\pm$ 12 Hz   |
| Receiver Sensitivity   | OFF to ON threshold -45 dBm<br>ON to OFF threshold -48 dBm   |
| Line Equalization  | Fixed compromise equalization, transmit.<br>Adaptive equalizer for PSK/QAM, receive.   |
| Diagnostics Available  | Local analog loopback<br>Local digital loopback<br>Remote digital loopback<br>Local interface loopback modem   |
| Self Test Pattern Generator                                  | Alternate 'ones' and 'zeros' and error detector, to be used along with most loopbacks.<br>A number indicating the bit errors detected is sent to DTE.  |

## Product Description



## Telephone Line Interface Specifications

| DESCRIPTION                                      | MIN | TYP | MAX | UNITS |
|--|-----|-----|-----|-------|
| Telephone Line Impedance Match                   |     | 600 |     | Ohms  |
| Ring Detect Sensitivity (on hook, Type B Ringer) | 38  |     |     | Vrms  |
| Telephone Line Holding Current                   | 20  |     | 100 | mA    |

## Analog Output: AMP ( $T_A = 25^\circ\text{C}$ , $V_{CC} = +5\text{V}$ , $GND = +0\text{V}$ , $V_{DD} = -5\text{V}$ )

| PARAMETER                     | TEST CONDITION                                      | MIN | TYP              | MAX | UNITS                |
|-------------------------------|---|-----|------------------|-----|----------------------|
| Load Resistance AMP (pin 22)  |   | 10  |                  |     | KOhms                |
| Load Capacitance AMP (pin 22) |   |     |                  | 100 | pF                   |
| Audio Amp Output Level        | Controlled via Ln & Mn commands.<br>No signal input |     | 3<br>1.5<br>0.75 | 30  | Vp<br>Vp<br>Vp<br>mV |

## DTMF Transmit Signals

| PARAMETER          | MIN  | TYP  | MAX  | UNITS |
|--------------------|------|------|------|-------|
| Row 1 Frequency    | 691  | 697  | 703  | Hz    |
| Row 2 Frequency    | 763  | 770  | 777  | Hz    |
| Row 3 Frequency    | 844  | 852  | 860  | Hz    |
| Row 4 Frequency    | 932  | 941  | 950  | Hz    |
| Column 1 Frequency | 1197 | 1209 | 1221 | Hz    |
| Column 2 Frequency | 1323 | 1336 | 1349 | Hz    |
| Column 3 Frequency | 1463 | 1477 | 1491 | Hz    |

## Other Performance Specifications

| PARAMETER                          | MIN  | TYP            | MAX | UNITS  | COMMENTS                                      |
|------------------------------------|------|----------------|-----|--------|---|
| DTMF Level                         |      | -2.2           | 0   | dBm    |   |
| DTMF Twist (Balance)               |      |                | 3   | dB     |   |
| DTMF Tone Duration                 |      | 70             |     | ms     |   |
| Pulse Dialing Rate                 |      | 10             |     | pps    |   |
| Pulse Dialing Make/Break           |      | 39/61<br>33/67 |     | %<br>% | US<br>CCITT                                   |
| Pulse Interdigit Interval          |      | 785            |     | ms     |   |
| Billing Delay Interval             | 2.0  |                |     | sec    |   |
| Guard Tone Frequency               |      | 550            |     | Hz     | referenced to High channel transmit           |
| Amplitude                          |      | -3             |     | dB     |   |
| Frequency                          |      | 1800           |     | Hz     | referenced to Low channel, Guard Tone enabled |
| Amplitude                          |      | -6             |     | dB     |   |
| High Channel Transmit Amplitude    |      | -1             |     | dB     |   |
| Tone Detection Passband Frequency  | 290  |                | 665 | Hz     | 3 dB Point                                    |
| Tone Detection OFF to ON Threshold | -33  |                |     | dBm    | into 600 Ohm                                  |
| Tone Detection ON to OFF Threshold | -35  |                |     | dBm    | into 600 Ohm                                  |
| Dial Tone Detect Duration          | 3.0  |                |     | sec    |   |
| Ringback Tone Detect Duration      | 0.75 |                |     | sec    | OFF/ON Ratio                                  |
| Cadence                            | 1.5  |                |     | sec    |   |
| Busy Tone Detect Duration          | 0.2  |                | 1.5 | sec    | OFF/ON Ratio                                  |
| Cadence                            | 0.67 |                |     | sec    |   |