

**Low-Cost, Low-Speed Surface-Mount Modem**

**Description**

The Xecom XE2422H is a complete 2400 bps modem in a miniature surface-mount module. It permits the designer to easily incorporate dial-up communications in his set top box, vending or point-of-sale application.

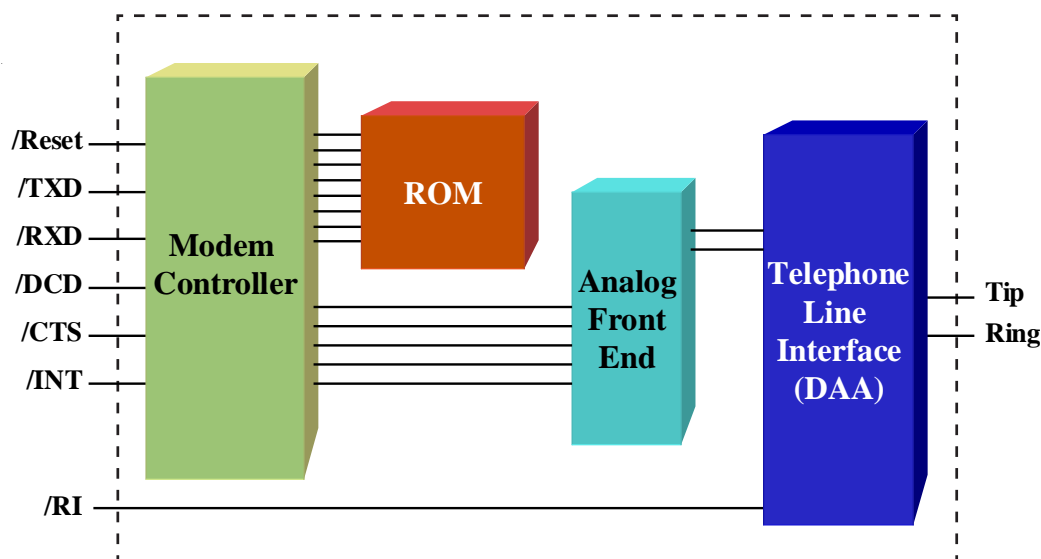
The XE2422H is a complete modem not just a modem chip. Make a connection to the serial port of your micro-controller and to the telephone line and your design is complete. Because it is a complete modem, Xecom can provide the XE2422H with transferable FCC Part 68 Registration. This allows the embedded system designer to add a modem without additional FCC testing.

The low purchase price, complete functionality, surface mount design and small size combine to make the XE2422H the low cost dial up modem solution for embedded systems. prices in volumes of 100,000 pieces are under nine dollars.

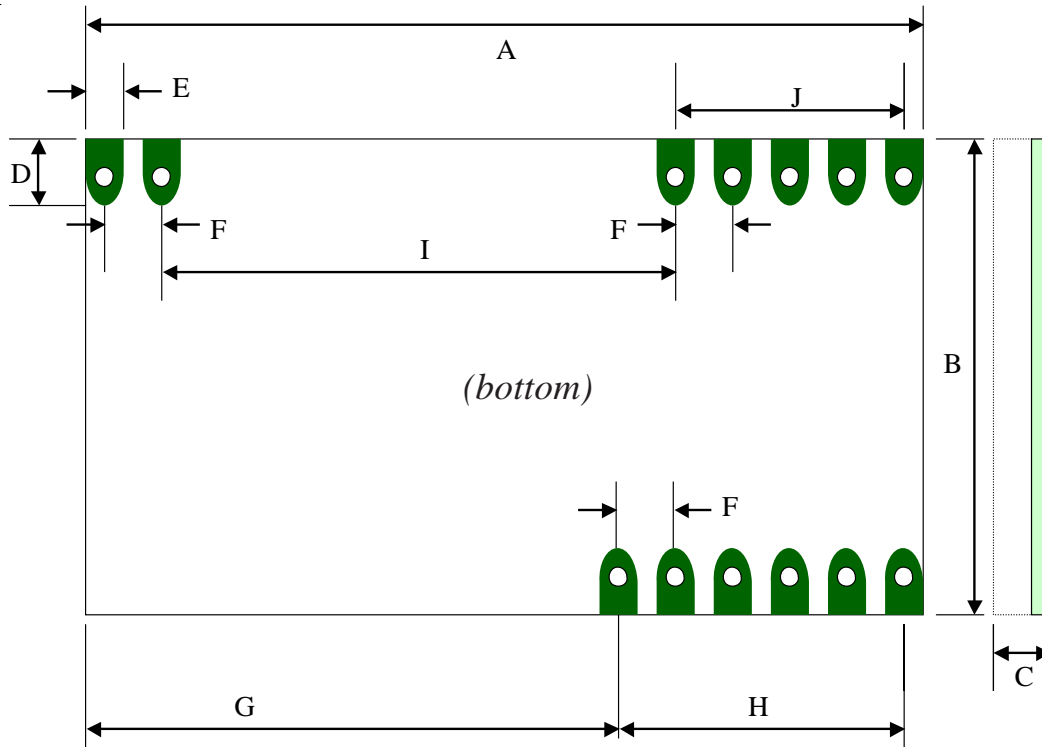
**Features**

- Small Size: 1.60” by 0.80” by 0.152”
- Data transfer at rates from 300 bps to 2400 bps
- Serial data rates to 9600 bps.
- Modem Control and Configuration via AT Commands.
- 3.3 and 5 volt compatible Serial Interface
- Shared Line Features prevent modem operation from interfering with voice communications on an extension telephone.
- Complete integrated DAA.
- User Transferrable FCC Part 68 Registration
- UL60950 Recognition
- Low Operating Power, 3.3 Volts, 50 milliwatts;
- Sleep Mode with Wake on Ring Feature draws just 10 milliamps.
- Power Down operation reduces current draw to just 100 microamps.

**XE2422H BLOCK DIAGRAM**



## XE2422H Mechanical Specifications



Dimension	Inches			Millimeters		
	Min	Typ	Max	Min	Typ	Max
A	1.595	1.600	1.605	40.51	40.64	40.77
B	0.795	0.800	0.805	20.19	20.32	20.45
C	0.147	0.152	0.157	3.73	3.86	3.99
D	0.095	0.100	0.105	2.41	2.54	2.67
E	0.055	0.060	0.065	1.40	1.52	1.65
F	0.095	0.100	0.105	2.41	2.54	2.67
G	1.045	1.050	1.055	26.54	26.67	26.80
H	0.495	0.500	0.505	12.57	12.70	12.83
I	0.995	1.000	1.005	25.27	25.40	25.53
J	0.395	0.400	0.405	10.03	10.16	10.29



## XE2422H Pin Descriptions (continued)

PIN	NAME	DESCRIPTION
3	/DCD	/DCD is an active low output from the modem that indicates the presence of a valid carrier signal. The SE2 register controls /DCD in the XE2422H. The default state is for /DCD to be disabled ATSE2=04 enables /DCD.
4	/DTR	/DTR is an active low input to the modem. The operation of /DTR is controlled by register SE2 and is normally disabled. When enabled, the modem will exit data mode and enter command mode if /DTR is removed while the modem is on-line, .
5	/RI	The /RI signal reports on the presence of an incoming ring signal. When a ring occurs across Tip and Ring, the /RI output goes low and toggles with the cadence of the ring signal. /RI is controlled by register S0D bit 6. The default condition is for /RI to be disabled.
6	Reserved	Reserved for future use
7	Ground	Ground provides the reference voltage for all host interface signals.
8	/TXD	/TXD provides the path for transmitted data and modem commands to be passed from the host controller to the modem.
9	/RXD	/RXD provides the path for received data and modem responses to be sent from the modem to the host controller.
10	/RESET	/RESET is an active low input which initiates a modem hardware reset.
11	/CTS	/CTS is an active low output from the modem. The modem asserts /CTS to indicate that it can accept data from the terminal equipment on /TXD.
12	/INT	/INT provides an active low hardware interrupt signal from the XE2422H. The operation of this interrupt pin is programmable using registers SE2 and S08. /INT can be programmed to indicate Loss of Carrier, Wake-on-Ring, Loss of Loop Current, or Shared Line Activity. Once triggered the /INT line remains active until cleared by the AT:I command.
13	VCC	VCC provides 3.3 volt power to the modem.

## XE2422H Electrical Specifications

Parameter	Min	Typ	Max	Units	Comments
VCC	3.0	3.3	3.6	Volts	
ICC		15		mA	On Line
		10		mA	Sleep
		.1		mA	Power Down
Ring Voltage Detected	26		150	VRMS	Type B Ringer
Ring Frequency Detected	15.3		68	Hz	Type B Ringer
Telephone Loop Current	16	40	120	ma	
Line Impedance		600		Ohms	
Data Transmit level			-9.0	dBm	
DTMF Transmit Level		-2.5	0	dBm	Avg over 3 second interval
Voh	2.4			Volts	
Vol			0.4	Volts	
Vih	2.0		5.0	Volts	
Vil	-0.3		0.8	Volts	

### XE2422H ABSOLUTE MAXIMUM RATINGS

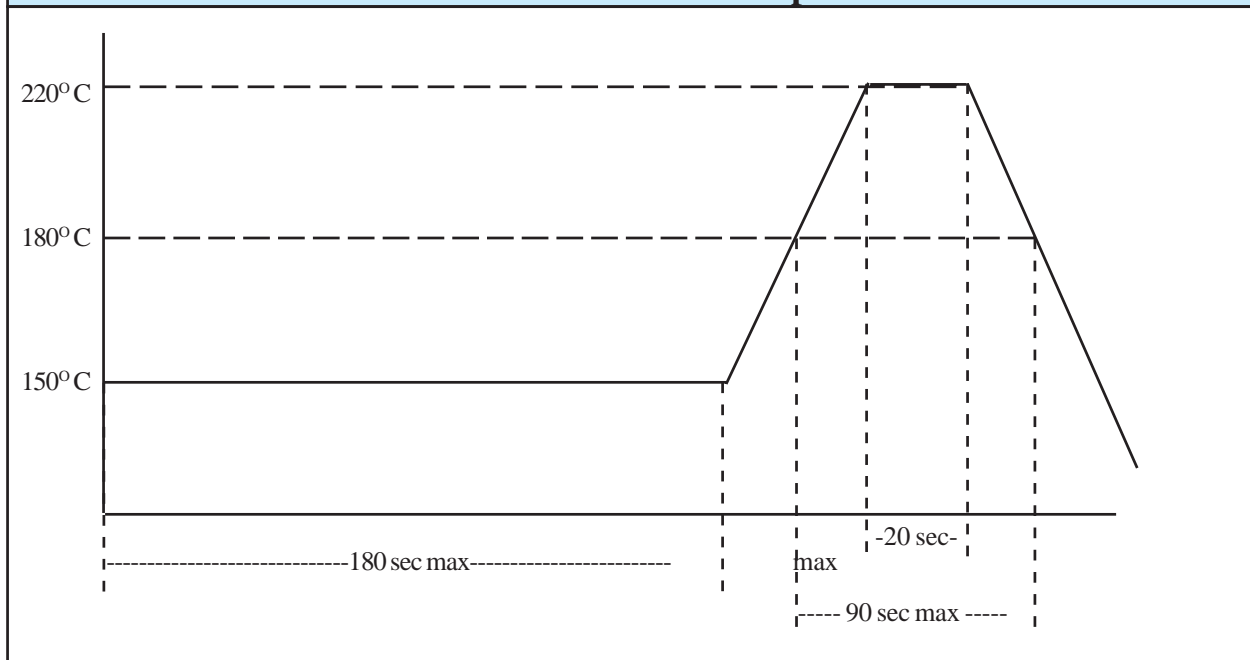
Storage Temperature	-25° C to +85° C
<sup>1</sup> Maximum Operating Temperature Range	0° C to +70° C
Maximum Time Above Eutectic (183° C)	90 seconds
Preheat Dwell Time	120 to 180 seconds

## XE2422H Surface-Mount Soldering Instructions

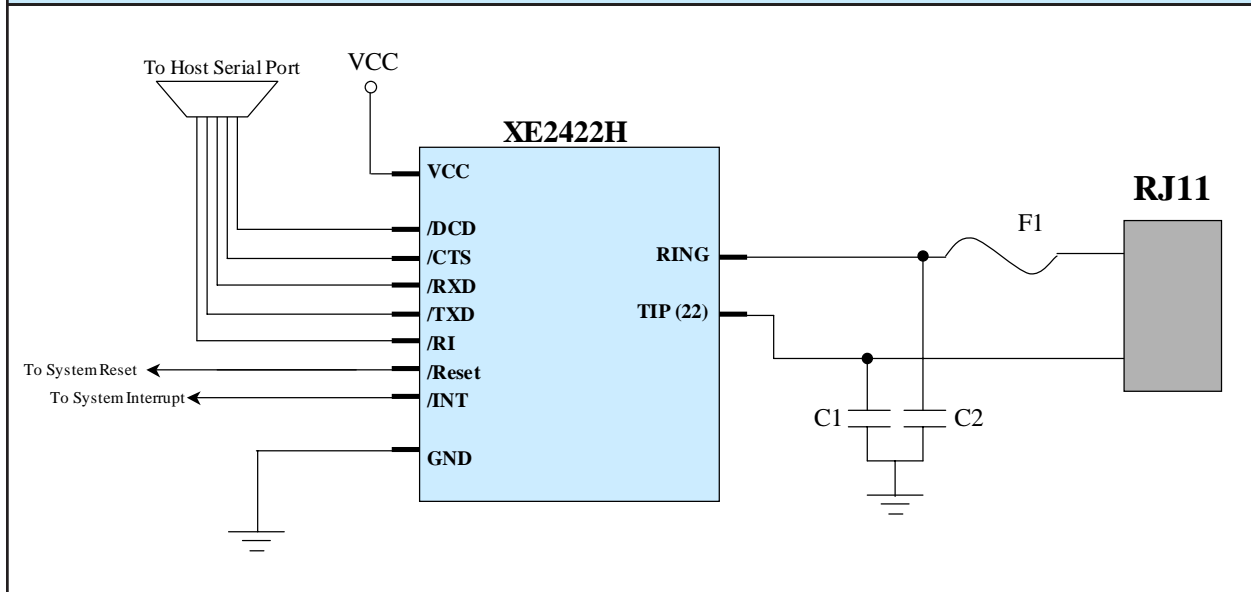
The XE2422H is subject to damage if over-exposed to heat during solder reflow operations. Following the soldering instructions below will ensure that the process of soldering the module to the board does not damage the modem.

Maximum Temperature	220° C
Maximum Time at 220° C	20 Seconds
Maximum Time above Eutectic (180° C)	90 Seconds
Maximum Preheat Dwell Time	180 Seconds

### Maximum Recommended Solder Temperature Profile



## XE2422H Typical Connection Diagram



### Parts List for XE2422H Typical Connection Diagram

Reference Designation	Qty	Description
C1, C2	2	Cap. 1000 pfd, 1500V minimum
F1	1	PTC, TR600-150

#### Notes:

1. Capacitors, C1 and C2, may be required for EMI filtering in your system. Without these components you may experience unintended radiation when the telephone cable is attached. C1 and C2 are high-voltage capacitors. We recommend the Johanson Dielectrics 502S47N102KV6T. This 1000 pfd, 3000 volt capacitor will direct the high frequency harmonics to the system ground. These capacitors must be rated at a minimum of 1500 volts to maintain the isolation required by FCC Part 68 Rules.
3. F1 is a positive thermal coefficient (PTC) device which protects the modem from excessive current flow. These devices are required for your system to pass UL60950. Fuses may be used in place of the PTC's

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## XE2422H Shared Line Features

The XE2422H includes the ability to monitor telephone line conditions before, after and during calls. This allows the XE2422H to avoid conflicts with other equipment connected to the telephone line. There are two modes of operation for the XE2422H Shared Line Features; Connect Detect and Handset Interrupt.

### Connect Detect

The XE2422H register SDB monitors the voltage level on the telephone line when the modem is on-hook. Check the value of SDB before attempting to go off-hook to avoid interrupting a call in progress. The nominal value of loop voltage is typically 48 volts. A reduced voltage level indicates that the line is either disconnected or is currently in use.

Register SDB is an 8 bit register. it stores the loop voltage as a 2's complement number with each bit representing 1 volt. The Most Significant Bit represents the polarity of the loop voltage.

### Handset Interrupt:

Handset Interrupt permits the modem to yield the telephone line to other equipment connected to the telephone line. This prevents the modem from blocking outgoing emergency calls when the line is shared as in a residential application. Handset Interrupt is accomplished by monitoring the loop current through the modem while off-hook. Loop current will drop when another piece of equipment goes off-hook on the same telephone line.

The XE2422H constantly monitors and stores the value in Register SF3. The value of SF3 is then compared to the Handset Interrupt threshold in register S12. If the value of SF3 is lower than the value of S12 by at least the amount of S11 (the Handset Interrupt Differential Current Threshold) The parallel phone is detected off-hook. The modem then issues the Intrusion Detected response "i" and if so configured issues and Interrupt.

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## XE2422H AT Commands

The XE2422H uses "AT" commands for configuration and control. This section describes the AT command format and lists the AT commands, registers and result codes. XE2422H "AT" commands have two operational modes; command mode and data mode. The Data Rate for the XE2422H is set by Register SE0.

**Data Mode:** The XE2422H enters data mode after it connects to a remote modem and issues the appropriate result code. In the data mode the modem sends all data presented on Transmit Data (/TXD) to the remote modem and puts data from the remote modem onto Received Data (/RXD). When the modem exits data mode, it issues a "NO CARRIER" result code.

**Command Mode:** The XE2422H enters command mode on power-up, reset, a lost connection, or receipt of the escape code. In

command mode the modem accepts commands from the host on transmit data. Appropriate result codes are returned on received data.

### Command Line Format

Command lines issued to the modem follow a strict format. Each command line begins with the prefix AT. All commands except the and z command must be entered in upper case characters. The command line is a string of commands between the AT prefix and the carriage return which terminates the command. The command buffer stores the command line and executes it upon receipt of a carriage return. Commands will be executed in the sequence they appear in the command line.

**Result Codes -** The modem issues a result code after each command line. Result codes may be sent as single characters or single characters followed by a carriage return.

## XE2422H AT Commands

An asterisk indicates the factory default

**A - Answer Command -**

**D - Dial Command -**

0-9, A-D, #, \* = Dialing Digits

P = Pulse dial

T = Tone dial

, = Pause for two seconds

I = Pause for 125 milliseconds

; = Return to the command state

**En - Command Echo**

n=0 Do not echo commands

n=1 Enable command echo \*

**Hn - Switch Hook Control -**

n=0 Switch hook relay opens

n=1 Switch hook relay closes

**In - Modem Identification**

**:I Read Interrupt Register -** Read and reset the interrupt status register S09

**O - ReturnOn Line**

**SR? - Read Value of register R**

**SR=n - Write value “n” into register “R”.**

The values of both “n” and “R” are hexadecimal.

**Vn - Result Codes -**

n=0 Single Character Result Codes

n=1 Result Codes followed by a Carriage Return\*

**Z - Reset -**

**z - Wake from Sleep Mode on Ring**

## XE2422H RESPONSES

<u>Result Code</u>	<u>Description</u>
a	British Caller ID Tone Detected
b	Busy Tone Detected
c	Connect
d	Connect 1200
f	Battery Voltage Reversal Detected
I	Parallel Handset Returned On-Hook
i	Handset Interrupt Detected
L	Phone Line Detected
l	No Phone Line Detected
m	Caller ID Signal Detected
N	No Carrier Detected
n	No Dial Tone
O	OK Response
R	Ringing
r	Ringback Tone Detected
t	Dial Tone Detected
x	Over-current Condition Detected
,	Dialing Complete

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## XE2422H REGISTER SETTINGS

XE2422H register values are stored in Hex format. An asterisk "\*" signifies the default setting of a bit-mapped register.

**S00 Answer on nth Ring:** S00 sets the modem to automatically answer on the nth ring. Setting S00 to 0 disables automatic answer.

Range: 00 to 7F (0 to 127 rings)  
Units Rings  
Default 00 (Auto Answer Disabled)

**S01 Wait to Dial:** S01 determines the maximum time the modem will wait to dial

Range: 0 to 6D (0 to 109 seconds)  
Units Seconds  
Default 02 (2 seconds)

**S02 Wait for Dial Tone** S02 determines how long the modem waits for Dial Tone before hanging up.

Range: 00 to 6D (0 to 109 seconds)  
Units Seconds  
Default 03 (3 seconds)

**S03 Carrier Off Disconnect Delay:** S03 determines how long carrier must be lost before modem disconnect.

Range: 00 to 7F (0 to 6.78 seconds)  
Units 0.0533 Seconds  
Default 0E (0.75 seconds)

**S04 DTMF Duration and Spacing:** S04 sets duration and spacing of DTMF dialing tones.

Range: 00 to 7F (0 to 211 milliseconds)  
Units 1.666 milliseconds  
Default 30 (80 milliseconds)

**S05 Duration Off-Hook during Pulse Dialing:** S05 defines how long the hookswitch is active between dialing pulses.

Range: 00 to 7F (0 to 211 milliseconds)  
Units 1.666 milliseconds  
Default 18 (40 milliseconds)

**S06 Duration of Dialing Pulses:** S06 determines how long the modem goes on-hook to generate dialing pulses.

Range: 00 to 7F (0 to 211 milliseconds)  
Units 1.666 milliseconds  
Default 24 (60 milliseconds)

## XE2422H REGISTER SETTINGS

S07 **Modem Protocol Selection:** S07 sets the protocol and speed of the modem connection.

<u>Protocol</u>	<u>Data Rate</u>	<u>Register Value</u>
V.22bis	2400 bps	06 *
V.22	1200 bps	02
V.21	300 bps	03
Bell 212A	1200 bps	00
Bell 103	300 bps	01

S08 **Interrupt Control Register:** S08 is a bit-mapped register which defines the events that will cause the /INT signal to be activated. Default = 00

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7	Issue Interrupt when Carrier Detect is lost	0 = No Interrupt * 1 = Activate Interrupt
6	Issue Interrupt on Ring with Wake-on-Ring selected	0 = No Interrupt * 1 = Activate Interrupt
5	Issue Interrupt on Handset Interrupt Detection	0 = No Interrupt * 1 = Activate Interrupt
4	Issue Interrupt on No Connect Detection	0 = No Interrupt * 1 = Activate Interrupt
3	Issue Interrupt on Ring Detection	0 = No Interrupt * 1 = Activate Interrupt
2	Issue Interrupt on Caller ID	0 = No Interrupt * 1 = Activate Interrupt
1	Issue Interrupt on Over-current Detection	0 = No Interrupt * 1 = Activate Interrupt
0	Reserved	

S09 **Interrupt Status Register:** S09 is a bit-mapped register. The active bit indicates the cause of the most recent interrupt. S09 is cleared when read on receipt of the :I command. Default = 00

<u>Bit #</u>	<u>Definition</u>
7	Interrupt issued when Carrier Detect was lost
6	Interrupt issued when a Ring was detected with Wake-on-Ring selected
5	Interrupt issued on Handset Interrupt Detection
4	Interrupt issued on No Connect Detection
3	Interrupt issued on Ring Detection
2	Interrupt issued on Caller ID
1	Interrupt issued on Over-current Detection
0	Reserved

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## XE2422H REGISTER SETTINGS

**S0C Modem Function Register:** S0C is a bit-mapped register which controls the designated modem functions. Default = 00

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7	Enable Carrier Detect IO pin	0 = No DCD output * 1 = DCD Active
6	Reserved	
5	Enable Caller ID	0 = No Caller ID * 1 = Caller ID Active
4:3	Reserved	
2	Blind Dialing, dialing without detecting dial tone	0 = Dial Tone Required * 1 = Blind Dialing Selected
1:0	Reserved	

**S0D Modem Function Register:** S0D is a bit-mapped register which controls the designated modem functions. Default = 00

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7	Reserved	
6	Enable Ring Indicate IO pin	0 = No RI output * 1 = RI Active
5:4:3	Reserved	
2	Disconnect upon detection of a Busy Signal	0 = Disabled * 1 = Hang-up on Busy Detect
1	Disconnect on Handset Interrupt detection	0 = Disabled * 1 = Enabled
0	Reserved	

**S0E Pulse Dialing Interdigit Delay:** S0E determines the length of the time between numbers dialed using dialing pulses. The minimum time between digits is 64 milliseconds. The value of S0E adds to that 64 millisecond delay in 10 millisecond increments

Range: 00 to 7F (64 to 1374 milliseconds)  
Units 10 milliseconds  
Default 46 (764 milliseconds)

**S0F Escape Character:** S0F defines the character to be used in the escape sequence to move from data mode to command mode. Values of 0 to 127 select valid ASCII characters.

Range: 00 to 7F  
Units ASCII Character  
Default 2B (+)

## XE2422H REGISTER SETTINGS

**S10 Escape Code Guard Timer:** S10 defines the duration of the guard timer surrounding the escape sequence. The guard time is the time preceding and following the escape sequence during which any character received by the modem will abort the escape sequence.

Range: 00 to 7F (0 to 6.78 seconds)

Units 0.0533 Seconds

Default 13 (1 second)

**S11 Handset Interrupt Differential Current Threshold:** S11 sets the differential loop current threshold for the XE24222H handset Interrupt detection algorithm. If loop current falls by the value of S11 below the value of S12, Handset Interrupt is activated.

Range: 00 to 07 (0 to 7 milliamps)

Units 1 Milliamp

Default 04 (4 milliamps)

**S12 Handset Interrupt Current Threshold:** S12 sets the loop current threshold for the XE24222H Handset Interrupt detection algorithm. If loop current falls by the value of S11 below the value of S12, Handset Interrupt is activated.

Range: 00 to 64 (0 to 100 milliamps)

Units 1 Milliamp

Default 00 (0 milliamps)

**S15 Modem Link Control Register:** S15 selects modem guard tones, calling tones and data format..

Default = 04

Bit #	Definition	Action
7	Reserved	
6	Transmit V.25 Calling Tone	0 = Disabled * 1 = Calling Tone Active
5	Transmit 550 Hz Guard Tone	0 = Disabled * 1 = 550Hz Guard tone Active
4	Transmit 180 Hz Guard Tone	0 = Disabled * 1 = 1800Hz Guard tone Active
3	Number of Stop Bits	0 = 1 Stop Bit * 1 = 2 Stop Bits
2:1	Number of Data Bits	00 = 6 Data Bits 01 = 7 Data Bits 10 = 8 Data Bits * 11 = 9 Data Bits
0	Reserved	

**S29 Handset Interrupt Blocking Time:** S29 provides a set duration for blocking the Handset Interrupt feature to avoid false detections. This timer is activated by S82.

Range: 00 to 7F (0 to 63.5 Seconds)

Units 0.5 Seconds

Default 00 (disabled)

## XE2422H REGISTER SETTINGS

**S37 Carrier Detect Recovery Time:** S37 determines how long after being lost the data carrier signal must be detected before the modem recognizes it as being recovered.

Range: 00 to 7F (0 to 211 milliseconds)  
 Units 1.66 milliseconds  
 Default 20 (53.33 milliseconds)

**S39 Carrier Detect Response Time:** S39 determines how long the modem will wait for the initial data carrier signal to be detected before aborting a call..

Range: 00 to 7F (0 to 127 Seconds)  
 Units 1 Second  
 Default 3C (60 Seconds)

**S62 Result Code Register:** S62 allows selection of specific modem result codes. Default = 41

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7	Reserved	
6	Over-current Result code "x"	0 = Result Code "x" supported 1 = Disabled *
5:4:3	Reserved	
2	Handset Interrupt Result Codes "I" and "i"	0 = Disabled * 1 = Support result codes "I" and "i"
1	Connect Detect Result Codes "L" and "l"	0 = Disabled * 1 = Support result codes "L" and "l"
0	Ring Result Code "R"	0 = Disabled 1 = Result Code "R" supported

**S82 Loop Current Register:** S82 allows selection of specific modem result codes. Default = 08

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7:6:5:4	Reserved	
3	Detect Loss of Loop Current	0 = Disabled 1 = Enabled *
2:1	Block Handset Interrupt on initial connection	00 = No Handset Interrupt Blocking * 01 = Blocked during dialing 10 = Blocked unit S29 Time out 11 = Blocked unit Carrier Detect
0	Reserved	

## XE2422H REGISTER SETTINGS

**SDB Line Voltage Status:** SDB is a read only register that stores the value of the loop voltage in two's compliment form. The most significant bit, Bit 7, indicates the polarity of the voltage on Tip and Ring.

Units 1 Volt

Default 00 (Tip and Ring Voltage less than 3 volts)

**SE2 Interrupt Enable:** SE2 activates the XE2422H Interrupt output. Default = 00

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7:6:	Interrupt Output Control	00 = Disabled * 01 = Disabled 10 = Disabled 11 = Interrupt Output Enabled
5:4	/DTR Control	00 = Disabled * 01 = Disabled 10 = Disabled 11 = /DTR Enabled
3:2	/DCD	00 = /DCD Disabled* 01 = /DCD Enabled 10 = /DCD Disabled 11 = /DCD Disabled
1:0	Reserved	

**SF1 Power Down Register:** SF1 allows the XE2422H to be placed in power down mode. The modem draws only about 100 microamps in Power down mode. Default = 0C

<u>Bit #</u>	<u>Definition</u>	<u>Action</u>
7	Reserved	
6	Power Down Mode	0 = Normal Operation 1 = Power Down Selected
5:4	Reserved	
3:2	Forced Active	
1:0	Reserved	

**SF3 Loop Current Status:** SF3 is a read only register that stores the current value of the loop current.

Units 1.1 Volt

Default 00 (no Loop Current Present)

## FCC Instructions

The XE2422H complies with Part 68 of the FCC Rules and Regulations. With each device shipped, there is a label which contains the FCC Registration Number. The FCC Registration number incorporates the Model Number, Manufacturer Identifier, Product Type identifier and Ringer Equivalence Number (REN) for this product. You must, upon request, provide this information to your telephone company. the format of the FCC Registration Number is shown below.

*(pending)*

The mounting of this device in the final assembly must be made in such a manner as to preserve the high voltage protection between the TIP/RING Connection and the rest of the system. Typically, this may be accomplished by maintaining a minimum spacing 100 mils between the TIP/RING Traces to the RJ-11C Jack and low voltage portion of the system. No additional circuitry may be attached between TIP/RING and the telephone line connection, unless specifically allowed in the rules.

The REN is useful to determine the quantity of devices you may connect to a telephone line and still have all of these devices ring when the number is called. In most, but not all areas, the sum of the RENs of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices you may connect to the line, as determined by the REN, you should contact the local telephone company to determine the maximum REN for you calling area.

If your system causes harm to the telephone network, the telephone company may discontinue service temporarily. If possible, they will notify you in advance. If advance notification is not practical, you will be notified as soon as possible.

Your telephone company may make changes in its facilities, equipment, operations or procedures that could affect proper functioning of your equipment. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If you experience trouble with this device, please contact XECOM at (408) 945-6640 for information on obtaining service or repairs. The telephone company may ask you to disconnect this device from the network until the problem has been corrected or until you are sure that the device is not malfunctioning.

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Xecom assumes no responsibility for the use of any circuitry other than circuitry embodied in a Xecom product. No other circuits, patents, or licenses are implied.

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**Life Support Devices or Systems** are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions provided in the labeling, can be reasonably expected to result in significant injury to the user.

**A Critical Component** is any component of a life support device or system whose failure to perform can be reasonably expected to cause failure of the life support device or system, or to affect its safety or effectiveness.

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