

## Blackjack Tele-Controller

80C552 based controller with 2400 bps data modem (send/receive fax optional)

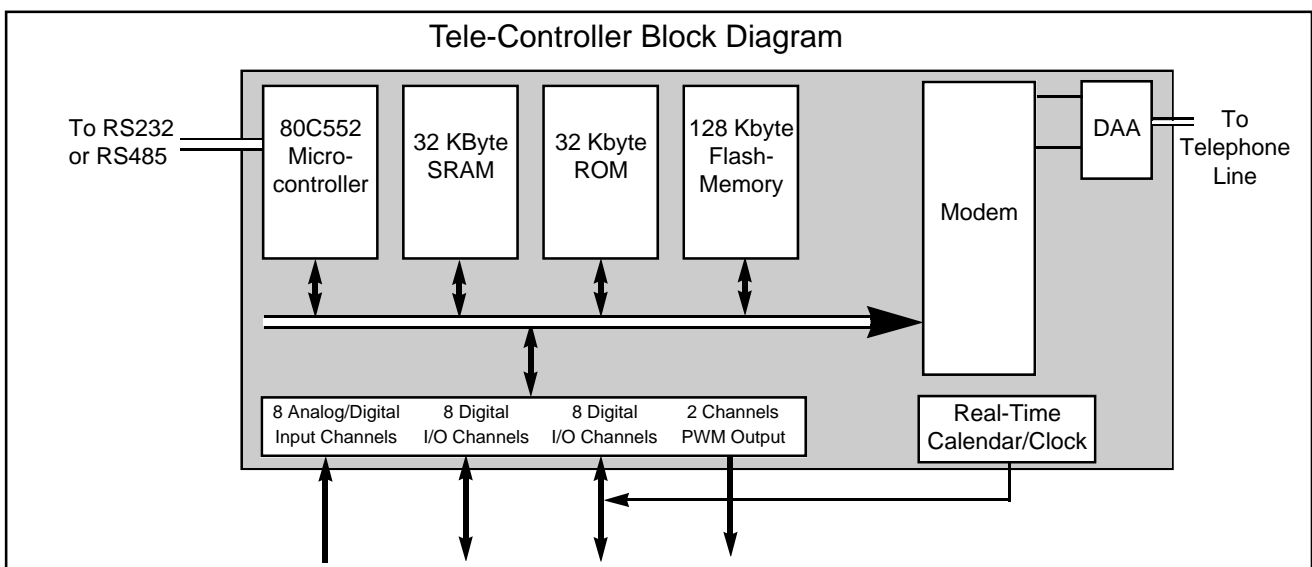


**Description:**

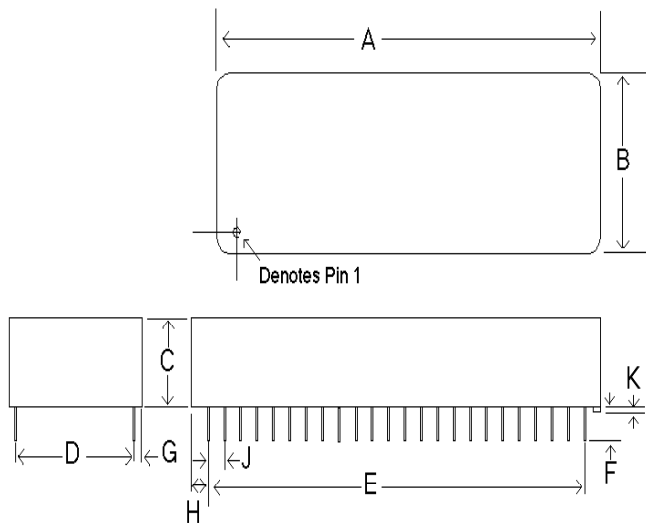
The Blackjack Tele-Controller is a rugged, miniature controller with an integrated modem. Xecom based the Tele-Controller on an 80C552 micro-controller. It provides 32 Kbytes each of ROM and RAM, 128 Kbytes of Flash memory, 26 I/O lines and the modem. The XE5224DM includes a 2400 bit per second data modem; The XE5224FD adds send and receive fax. Firmware embedded in the Tele-Controller provides development tools which allow manipulation of both program and data memory.

**Features:**

- \* Small size: 2.75" x 1.38" x 0.50"
- \* Philips 80C552 micro-controller, at 14.7456 MHz;
- \* 26 I/O lines Includes:  
Two 8-bit Digital I/O Ports;  
Eight I/O lines available as inputs to 10 bit A/D;  
Two PWM outputs;
- \* I/O Compatible with Opto 22/Grayhill series modules;
- \* 32 Kbyte Pre-programmed internal ROM ;
- \* 32 Kbyte SRAM for data storage;
- \* 128 Kbyte Flash memory for program and data storage;
- \* Real Time Calendar/Clock (External battery backup)
- \* 2400 bps data modem, XE5224DM or 2400 bps modem with send & receive fax , XE5224FD;
- \* Typical Power:  
Controller active, Modem idle: +5 Volts @ 55 milliamps;  
Controller and Modem active: +5 Volts @ 95 milliamps;
- \* Serial Port for RS232 or RS485 communications;
- \* Development Kit available;
- \* Sturdy, encapsulated construction seals circuits from harsh environments;
- \* Industrial Temperature Range available;



# Mechanical Specifications



DIM	INCHES		METRIC (MM)	
	MIN	MAX	MIN	MAX
A	2.740	2.760	69.60	70.10
B	1.370	1.390	34.80	35.31
C	0.500	0.510	12.70	12.95
D	1.190	1.210	30.23	30.73
E	1.890	1.910	48.01	48.51
F	0.125	0.200	03.18	05.08
G	0.080	0.100	02.03	02.54
H	0.415	0.435	10.54	11.05
J	0.090	0.110	02.29	02.79
K	0.020	0.025	00.51	00.64

# Pin Configuration & Descriptions

				PIN	SIGNAL	DESCRIPTION
TIP	1	48	VCC (5V)	1	TIP	One of the signals forming the two-wire connection to the telephone line. The Tele-Controller is not sensitive to the polarity of the battery voltage on the telephone line.
RING	2	47	DIO15	2	RING	The second wire of the two-wire connection to the telephone line.
N/P	3	46	DIO14	3	N/P	No Pin
OH	4	45	DIO13	4	OH	Off Hook is an active high output from the Tele-Controller. A high indicates the internal modem has seized the telephone line.
SPKR	5	44	DIO12	5	SPKR	SPKR is the audio output from the Tele-Controller. It permits the user to monitor the activity on the telephone line by connecting a speaker. The load on SPKR must be at least 300 ohms.
/SLEEP	6	43	DIO11	6	/SLEEP	SLEEP is an active low output from the Tele-Controller. A low indicates the modem within the Tele-Controller is operating on reduced power in the "sleep" mode.
N/C	7	42	DIO10	7	N/C	No connection
V.bat	8	41	DIO9			
RXD	9	40	DIO8			
TXD	10	39	DIO7			
RESET	11	38	DIO6			
/EW	12	37	DA1			
/INT0	13	36	DA0			
T0	14	35	A.VCC			
CNFG0	15	34	ADI.7			
CNFG1	16	33	ADI.6			
CNFG2	17	32	ADI.5			
DIO0	18	31	ADI.4			
DIO1	19	30	ADI.3			
DIO2	20	29	ADI.2			
DIO3	21	28	ADI.1			
DIO4	22	27	ADI.0			
DIO5	23	26	STADC			
GND	24	25	A. GND			

## Pin Descriptions (continued)

PIN	SIGNAL	DESCRIPTION	PIN	SIGNAL	DESCRIPTION
8	V.bat	V.bat provides backup power for the real time clock. Battery voltage must be at least 3 volts. A "Super Cap," NEC FYH0H473Z or equivalent, may be used in place of a battery.	25	A.GND	A.GND provides analog ground for the Analog inputs to the Tele-Controller.
9	RXD	RXD is the serial data input to the Tele-Controller. A Mark or Logic 1 is a TTL low; Space is a TTL high.	26	STADC	This active high input initiates an analog to digital conversion. The analog to digital conversion may also be started through software.
10	TXD	TXD is the serial data output from the Tele-Controller. A Mark or Logic 1 is a TTL low; Space is a TTL high.	27-34	ADI.0-7	8-channel Analog or Digital Input port. This input port can be used as an input port for digital data, or as inputs to the analog to digital convertor.
11	Reset	Reset is an active high input to the Tele-Controller. A high on Reset initiates a hardware reset. This pin acts as a Reset output when the Tele-Controller's watchdog timer expires.	35	A.VCC	+5 Volt power for the analog inputs to the Tele-Controller.
12	/EW	This active low input enables the Tele-Controller's watchdog timer and disables Sleep mode. When not used this pin must be tied to VCC.	36-37	DA0-1	Pulse Width Modulation Outputs 1 and 2.
13	/INT0	This active low input acts as an external interrupt to the Tele-Controller.	38-39	DIO6-7	Digital Input/Output Port 1 bits 6-7. Port 1 alternate functions include: bit 6 - I <sup>2</sup> C bus Serial Port Clock Line bit 7 - I <sup>2</sup> C bus Serial Port Data Line
14	T0	This active high input provides the trigger for timer 0.	40-47	DIO8-15	Quasi bi-directional Digital Input/Output Port 2 bits 0-7.
15	CNFG0	CNFG0 selects Tele-Controller development or application mode. A high selects application mode; a low selects development mode.	48	VCC	+5 Volt power for the Tele-Controller.
16-17	CNFG1-2	These inputs select the memory address configuration of the ROM and Flash memory. See the charts on Pages 5 and 6 of this data sheet for details on how these signals interact.			
18-23	DIO0-5	Digital Input/Output Port 1 bits 0-5. These signals are part of an 8-bit digital I/O port. If the real-time clock is to be used, bits 0-2 are needed to support it. Port 1 alternate functions include: bit 0-3 - Capture inputs for timer T2 bit 4 - T2 event input bit 5 - T2 Timer reset			
24	GND	GND provides digital ground to the Tele-Controller.			

# Electrical Specifications

ABSOLUTE MAXIMUM RATINGS*	
SUPPLY VOLTAGE - Vcc	+6.5 Volts
DC INPUT VOLTAGE	-0.5 Volts to +6.5 Volts
STORAGE TEMPERATURE RANGE	-25° C TO +100° C
LEAD TEMPERATURE (Soldering, 2 sec per wave)	260° C
OPERATING TEMPERATURE RANGE	0 TO 70° C (-40 to +85° C available by special order)
*Exceeding these values may result in permanent damage to the device.	

## Power Supply Characteristics ( $V_{cc} = 5V \pm 5\%$ )

Symbol	Parameter	Min	Typ	Max	Units	Comments
Vcc	Supply Voltage	4.75	5.0	5.25	Volts	
Icc	Vcc Supply Current	-----	55	-----	milliAmps	Modem in sleep mode *
			95		milliAmps	Modem On-Line
V.Bat	Battery Voltage	3.0			Volts	Real-Time Clock Battery Backup
I.Bat	Battery Current Draw		0.2	3.0	microAmps	
* The modem in the XE5224DM or XE5224FD will automatically enter sleep mode if no activity is detected on the TXD, DTR, or RI lines for 5 seconds. In sleep mode the modem typically draws less than 10 milliAmps.						

# Tele-Controller Memory Configuration

**Table 1 Development Mode Memory Mapping (CNFG0=0)**

CNFG2	CNFG1	Program Memory 0 - 7FFF	Data Memory		Program/Data 8000 - FFFF
			0 - 7EFF	7F00 - 7FFF	
0	0	ROM	RAM	Peripheral I/Os	Flash Memory, Page 0
0	1	ROM	RAM	Peripheral I/Os	Flash memory, Page 1
1	0	ROM	RAM	Peripheral I/Os	Flash memory, Page 2
1	1	ROM	RAM	Peripheral I/Os	Flash memory, Page 3

## Memory Structure:

Xecom based the memory structure of the Tele-Controller on the 8051 micro-controller. The lower 32 Kbyte memory addresses include separate program and data storage. Program and data storage overlap in the upper 32 Kbytes of memory.

The XE5224DM and XE5224FD Tele-Controllers have 32 Kbytes of ROM, 32 Kbytes of RAM and 128 Kbytes of Flash memory. ROM contains the code for Tele-Controller operation and software design tools; RAM provides space for data storage by the application program; the 128 Kbytes of Flash memory can store data and/or application programs. Flash memory is divided into four, 32 Kbyte pages.

Memory mapping permits shuffling ROM and Flash memories within the standard 8051 memory structure. Reconfiguring the Tele-Controller's memory creates two modes of operation. In development mode the code in ROM runs the system. In application mode the application stored in Flash memory operates the system.

## Memory Mapping:

The Tele-Controller insures maximum flexibility with a configurable memory mapping scheme. Three external configuration pins select how the memory is to be used. These three configuration pins, CNFG0, CNFG1, and CNFG2, can be controlled by output pins of the XE5224 or by board-mounted jumpers or switches.

## Development Mode:

Development mode uses the lower 32 Kbytes of embedded ROM as program memory. ROM addresses are 0 to 7FFFF. The lower 32 Kbytes of data memory are dedicated to RAM except for the small portion reserved for I/O lines. RAM provides the Data memory for addresses 0 to 7EFF.

Addresses 7F00 to 7FFF serve peripheral I/O lines. The upper 32 Kbytes of memory, addresses 8000 to FFFF, access one of the four pages of Flash memory. The CNFG1 and CNFG2 configuration lines selects which page of Flash memory is addressed. Table 1 shows Tele-Controller memory mapping in development mode.

## Application Mode:

In the application mode a page of Flash memory serves as the lower 32 Kbytes of program memory. This page of Flash memory is write protected. As in the development mode, RAM provides the Data storage in addresses 0 to 7EFF. Addresses 7F00 to 7FFF are provided for peripheral I/O lines.

The upper 32 Kbytes of memory, addresses 8000 to FFFF, access page 1 or 3 of Flash memory. If the application program is stored in either of these pages, the user may choose to write protect this page of memory as well. CNFG1 and CNFG2 configuration lines select Flash memory pages and write protection as shown in Table 2 on the following page.

## Tele-Controller Memory Configuration continued

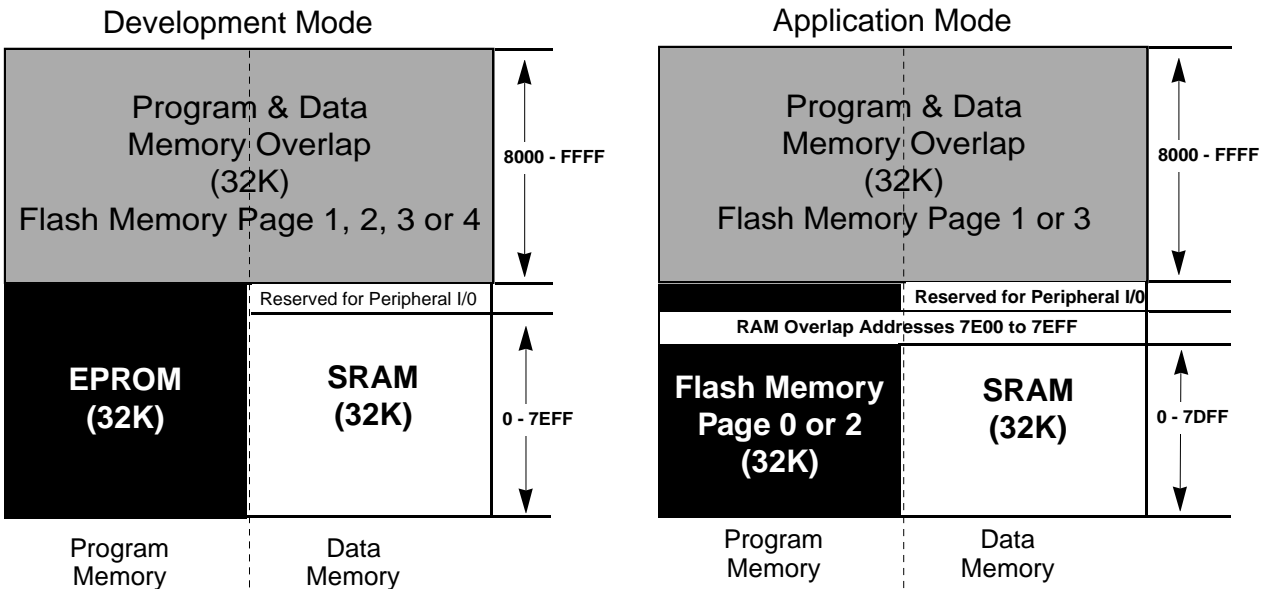
Table 2 Application Mode Memory Mapping (CFG0=1)					
CNFG2	CNFG1	Program Memory 0 - 7FFF	Data Memory		Program/Data 8000 - FFFF
			0 - 7EFF0	7F00 - 7FFF	
0	0	Flash Memory, Page 0 (write protected)	RAM	Peripheral I/Os	Flash Memory, Page 1
0	1	Flash Memory, Page 0 (write protected)	RAM	Peripheral I/Os	Flash Memory, Page 1 (write protected)
1	0	Flash Memory, Page 2 (write protected)	RAM	Peripheral I/Os	Flash Memory, Page 3
1	1	Flash Memory, Page 2 (write protected)	RAM	Peripheral I/Os	Flash Memory, Page 3 (write protected)

### Overlapped Memory:

Data and Program memory share the upper half of the available memory, addresses 8000 to FFFF. This area can be accessed as either Program or Data memory. When downloading Program code into the XE5224, the code must be stored as Data in addresses 8000 to FFFF. When the download is complete, you can access this code as Program memory because of the memory overlap.

Flash memory may store both user data and the application program; however, because all pages of Flash memory are physically located in one device, you cannot simultaneously read and write from Flash memory. When the application program must manipulate stored data, a portion of RAM must be used as program memory. Memory locations 7E00 to 7EFF overlap RAM and Flash memory in the Application mode. Reserve these memory locations for subroutines which require manipulation of the stored data.

### Memory Overlap



## Tele-Controller Memory Configuration continued

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### **ROM:**

Tele-Controller ROM holds the TC-Monitor and Tele-Monitor programs to assist in application development. These programs operate only in Development mode. These design tools permit the user to down-load his application program to Flash memory from either the embedded modem or Serial Port, edit Flash memory contents, run Analog/Digital conversions, set and display the Real-Time Clock, and execute the application program. TC-Monitor and Tele-Monitor operations are described in detail elsewhere in this data sheet.

### **RAM:**

32 Kbytes of RAM are primarily used for data storage by the application program. The addressable range is from 0 to 7EFF. Addresses 7E00 to 7EFF overlap with program memory in the Application mode. These locations should be used for subroutines which need to access data stored in Flash memory. Addresses 7F00 to 7FFF are reserved for peripheral I/O use in both Development and Application mode.

### **Flash:**

Flash memory provides 128 Kbytes of non-volatile storage for data and/or application programs. Flash memory is divided into four, 32 Kbyte pages to fit in the 8051 memory structure. The 128 Kbytes of Flash memory are contained in one memory chip within the XE5224.

In Development mode Flash memory is addressed as the upper 32 Kbytes of overlapped memory, addresses 8000 to FFFF. The CNFG1 and CNFG2 control lines determine which page of Flash memory is being addressed.

In Application mode program code may be stored in any page or pages of Flash memory. Data may be stored only in Flash memory pages 1 and 3. Again CNFG1 and CNFG2 control the configuration of Flash memory. Pages of Flash Memory used for program storage are write protected.

# Tele-Controller ROM Based Monitor/Debugger

The Tele-Controller contains a pair of application debugging tools in ROM. The TC-Monitor permits applications testing and memory alterations through the Tele-Controller's serial interface. The Tele-Monitor permits remote control of many of the same functions via the Tele-Controller's modem link. Both programs operate only in the Development mode.

Both the TC-Monitor and Tele-Monitor use single character commands. The first parameter associated with a command does not require any spacing characters; however, you may insert a comma, space, period or colon to improve legibility. When you enter address locations in either monitor program, any digits missing from the address are assumed to be zeros to the left of the most significant digit shown.

## TC-Monitor Commands

Analog Input	Fill Memory	Kill Memory	Output Data	UART
Change Data	Go To Program	Load Program	Read Format File	Version
Display Program	Help	Move Program	Show	Write Hex File
Examine Memory	Input	Next	Time	

### TC-Monitor

Access to the TC-Monitor is through the Tele-Controllers's serial interface. Connect a PC to the Tele-Controller's and using a terminal emulation program press <Enter>. The Tele-Controller will respond with the prompt "TC-Monitor."

When the TC-Monitor prompt is present pressing <Enter> causes the Tele-Controller to display the TC-Monitor command list. Table 3 provides descriptions of the TC-Monitor commands. Parameters shown in brackets [ ] are optional; parameters shown in parenthesis are required.

## Tele-Monitor Commands

Analog Input	Fill Memory	Kill Memory	Output Data	
Change Data	Go To Program	Load Program	Read Format File	Version
Display Program	Help	Move Program	Show	Write Hex File
Examine Memory	Input		Time	eXit

### Tele-Monitor

Access to the Tele-Monitor is through the Tele-Controllers's internal modem. In development mode you immediately enter the Tele-Monitor when the modem establishes a data link. The Tele-Controller provides a Tele-Monitor prompt when the link is established.

The Tele-Monitor operates the same way as does the TC-Monitor. There are some commands which are unique to the Tele-Monitor. The list of Tele-Monitor commands is shown above. Tele-Monitor commands are described in table 4.



**Table 3: TC-Monitor Commands**

Command	Syntax	Description
Analog Input	A [x]<ENTER>	This command causes the Tele-Controller to read the designated Analog I/O channel. If no channel is designated, all channels are read. The Analog to Digital converter uses a 5 volt reference with 10 bit resolution. A value of 3FFH indicates 5.0 volts is present on the I/O channel. A value of 200H indicates 2.5 volts. Press the space bar to read the analog input. Pressing a C causes the Tele-Controller to continuously read the analog input. Pressing Alt C ends the continuous reading of the analog input.
Change Memory	C (word -- address)<ENTER>	This command allows you to modify the contents of an individual memory cell. When you enter this command, the Tele-Controller displays the byte stored in the selected memory location. Type the new value in this location and press Enter. The Debugger will advance to the next memory location. To exit the change mode without altering the contents of the current address press Enter. To advance to the next address without altering the memory contents hit the space bar followed by Enter.
Display Data	D (Address1)(Address 2) <ENTER>	This command is used to display the contents of an area of data memory. The two addresses define the area. Address 1 is the starting address and Address 2 the ending address. If Address 1 is greater than Address 2, the Tele-Controller will upon reaching Address FFFF return to address 0 and continue to display the memory contents until reaching Address 2. When used to display the contents of a section of overlapped memory, this command acts the same as the "E" command.
Examine Program	E (Address1)(Address 2) <ENTER>	Display the contents of an area of program memory. The two addresses define the area. Address 1 is the starting address and address 2 the ending address. If Address 1 is greater than Address 2, the Tele-Controller will upon reaching Address FFFF return to address 0 and continue displaying the memory contents until reaching Address 2. When used to display the contents of a section of overlapped memory, this command acts the same as the "D" command.
Fill memory	F (Add.1)(Add.2) (Bytes) <ENTER>	This command fills the selected memory area with the listed values.
Go to program	G [=Add][Add.]	This command allows you to execute an application program currently in memory. After this command is entered system control is transferred to the application program. An "LJMP 0" command must be placed in the application program to return to the TC-monitor.
Help Messages	H<ENTER>	The "H" command causes the TC-Monitor to display its help screen as shown below.  <pre> -----   - Press&lt;Enter&gt; for the Command list   - For the correct command syntax insert "?" after the     command, for instance D?. Parameters shown in     parenthesis ( ) are required; parameters shown in     brackets [ ] are optional.   - Memory addresses are in hexadecimal form. ----- </pre>

**Table 3 (continued)**

<b>Command</b>	<b>Syntax</b>	<b>Description</b>
<b>Input</b>	I(Port Address)	Inputs one byte specified by (Port Address). Entering a space inputs one byte; a C causes bytes to be continuously entered. A Carriage Return terminates the continuous mode.
<b>Kill Memory</b>	K(n) <ENTER>	This command erases the designated sector of Flash memory. Only sectors of Flash memory which are not write protected may be erased. The message "Unkown memory section or write protected" will be displayed if you attempt to erase a protected area of memory.
<b>Load Program</b>	L(Source Start Add)(Source End Add) (Target Start Add)<ENTER>	This command loads the data from the designated program memory location into the selected data memory address.
<b>Move Program</b>	M(Source Start Add)(Source End Add) (Target Start Add)<ENTER>	The "M" command moves a block of data from one data memory address to another.
<b>Next</b>	N [Add]<Enter>	This command permits you to step through your application program one instruction at a time. Step from one instruction to the next by pressing the space bar. Enter a Carriage Return to exit single-step operation.
<b>Output Data</b>	O(I/O Address) (byte)<ENTER>	Output the indicated byte to the selected I/O address.
<b>Read File</b>	R[Offset Address] <ENTER>	The "R" command permits .Hex files to be downloaded from the host, normally a Personal Computer. This command may be omitted if a zero offset address is needed.
<b>Show</b>	S[Register]<ENTER>	This command displays the contents of the listed register. If no register value is listed, the contents of all registers will be displayed.
<b>Time</b>	T<ENTER>	This command is used to start the Tele-Controller's Real Time Clock. The TC-Monitor first asks if you wish to Reset the Real Time Clock; enter Y for yes and N for no. If you enter No, you will return to the TC-Monitor prompt. If you select Yes the TC-Monitor will prompt you to enter a new Year, Month, Day, Hour and Minute.
<b>UART</b>	U<ENTER>	This command permits direct communications with the modem. This permits you to enter "AT" modem commands directly to the modem by using terminal emulation software. To end communications with the modem type the # character followed by <ENTER>.
<b>Version</b>	V<ENTER>	This command displays the revision level of the TC-Monitor. The format will be "V 1.00-ROM, Xecom, 10/10/94. Note: If you are using an updated version of the TC-monitor stored in Flash memory the revision level will be shown as V 1.xx-Flash, Xecom, 1/1/95.
<b>Write Hex File</b>	W(Start Add) (End Add) <ENTER>	This command is used to upload the contents of the program memory in the controller to the host. To upload contents of data memory into program memory it must first be loaded into an overlapped memory section. If the listed starting address is greater than the ending address, the TC-Monitor will roll over to address zero when completed with address FFFF and continue until the ending address is reached.

**Table 4: Tele-Monitor Commands**

<b>Command</b>	<b>Syntax</b>	<b>Description</b>
Analog Input	A [x]<ENTER>	Same as TC_monitor
Change Memory	C (word -- address)<ENTER>	Same as TC_monitor
Display Memory	D (Address1)(Address 2) <ENTER>	Same as TC_monitor
Examine Memory	E (Address1)(Address 2) <ENTER>	Same as TC_monitor
Fill memory	F (Add.1)(Add.2) (Bytes) <ENTER>	Same as TC_monitor
Go to program	G(=Add)(Add.)	Same as TC_monitor
Help Messages	H<ENTER>	Same as TC_monitor
Input	I(Port Address)	Same as TC_monitor
Kill Memory	K[n] <ENTER>	Same as TC_monitor
Load Program	L(Source Start Add)(Source End Add) (target start add)<ENTER>	Same as TC_monitor
Move Program	M(Range)(Add.)	Same as TC_monitor
Output Data	O[I/O Address] [byte]<ENTER>	Same as TC_monitor
Read Format File	R[Offset Address] <ENTER>	Same as TC_monitor
Show	S<ENTER>	Same as TC_monitor
Time	T<ENTER>	Same as TC_monitor
Version	V<ENTER>	Same as TC_monitor
Write Hex File	W(Start Add)(End Add) <ENTER>	Same as TC_monitor
eXit	X<ENTER>	This command causes the Tele-Controller to drop the modem link .

## Modem Description

Xecom's Tele-Controller includes an integral modem. The XE5224DM supports data transfer up to 2400 bits per second; the XE5224FD adds 9600 bps send fax and 4800 bps receive fax. Modem control is by industry standard AT commands. The modem includes non-volatile memory for modem configuration storage.

The TC-Monitor's "U" command permits the developer to enter "AT" commands directly to the internal modem through the Tele-Controller's RS232 port. The Tele-Controller accepts the initial input at rates from 300 to 38,400 bits per second. Subsequent commands can only be issued at the same speed as the initial input. Only 10 bit characters will be accepted. Parity may be Even, Odd, Mark, Space or None.

The modem-controller interface is a 16C450 compatible parallel interface. Modem registers 0 through 7 are addressed using addresses 7F00 through 7F07. The chart below describes the register functions.

### Modem Registers

Register	Address	Name	Bit No.							
			7	6	5	4	3	2	1	0
7	7F07	Scratch (SCR)	Scratch Register							
6	7F06	Modem Status (MSR)	Data Carrier Detect (DCD)	Ring Indicator (RI)	Data Set Ready (DSR)	Clear to Send (CTS)	Delta Data CXR Detect (DDCD)	Trailing Edge of RI (TERI)	Delta Data Set Ready (DDSR)	Delta Clear to Send (DCTS)
5	7F05	Line Status (LSR)	0	Transmitter Empty (TEMT)	Transmitter Holding Reg. (THRE)	Break Interrupt (BE)	Framing Error (FE)	Parity Error (PE)	Overrun Error (OE)	Data Ready (DR)
4	7F04	Modem Control (MCR)	0	0	0	Local Loopback	Out 2	Out1	Request to Send (RTS)	Data Terminal Ready (DTR)
3	7F03	Line Control (LCR)	Divisor Latch Access Bit (DLAB)	Set Break	Stick Parity	Even Parity Select (EPS)	Parity Enable (PEN)	Number of Stop Bits (STB)	Word Length Select Bit 1 (WLS1)	Word Length Select Bit 0 (WLS0)
2	7F02	Interrupt ID (IIR)	0	0	0	0	0	Pending Interrupt ID Bit 1	Pending Interrupt ID Bit 0	"0" if Interrupt Pending
1	7F01	Interrupt Enable (IER)	0	0	0	0	Modem Status Interrupt (EDSSI)	Enable Rx Line Status Interrupt (ELSI)	Enable Tx Holding Reg. Empty Int. (ETBEI)	Enable RXD Available Int. (ERBFI)
0 DLAB=0	7F00	Transmit Holding (THR)	Transmitter Holding Register (Write Only)							
0 DLAB=0	7F00	Receive Buffer (RBR)	Transmitter Holding Register (Read Only)							
0 DLAB=0	7F00	Divisor Latch MSB (DLM)	Divisor Latch (MS)							
0 DLAB=0	7F00	Divisor Latch LSB (DLL)	Divisor Latch (LS)							

# Modem Register Descriptions

## Modem Registers

The modem inside either Tele-Controller, XE5224DM or XE5224FD, interfaces to the embedded controller via eight registers. Each of these registers is described below.

### Register 0: Data Holding Register

Register 0 has two functions. It operates as the data buffer and sets the modem's baud rate.

Register 0 acts as the Transmit Holding Register and the Receive Buffer Register. Bit 0 is the least significant bit and the first bit transmitted or received by the modem.

When the Divisor Latch Access Bit (Bit 3) of Register 3 is set, register 0 along with register 1 programs the modem baud rate. Register 0 provides the least significant byte and Register 1 the most significant byte for the divisor latch. The Chart below shows how each baud rate is selected

Divisor Latch			
MS	LS	Divisor (decimal)	Baud Rate
01	80	384	300
00	C0	192	600
00	60	96	1200
00	30	48	2400
00	18	24	4800*
00	0C	12	9600*
00	06	6	19,200**

\* Fax Mode Only

\* Fax Command Mode Only

### Register 1: Interrupt Enable Register

Register 1 also has two functions. It enables various modem interrupts and in conjunction with Register 0 sets the modem's baud rate.

As described above Register 1 works in combination with Register 0 to set the modem baud rate. Note that baud rates above 2400 bits per second can be used only for fax operation.

When Register 1 is used to enable interrupts, Bits 0 to 3 select the modem conditions which will cause an interrupt. The chart below describes these interrupts and indicates which bit selects each of them.

Interrupts Enabled	
Bit	Interrupt Enabled
0	Received Data Available: Indicates that the Receive Buffer Register, Register 0, has data to send to the controller.
1	Transmit Holding Register Empty: indicates Register 0 can accept another byte of data for transmission.
2	Line Status Register: indicates a change in one of the bits of Register 5, Line Status.
3	Modem Status Register: indicates a change in one of the bits of Register 6, Modem Status.

### Register 2: Interrupt Identification Register

Register 2 shows if any interrupts are active and identifies the active interrupt with the highest priority. Bit 0 goes active to indicate the presence of an interrupt. Bits 1 and 2 show the active interrupt with the highest priority. The chart below shows the

Interrupt Priorities			
Bit 2	Bit 1	Priority Level	Active Interrupt
1	1	highest	Receiver line Status
0	1	second	Receiver Buffer Full
1	0	third	Transmitter Holding Register Empty
0	0	lowest	Modem Status

priority code and level for the interrupts.

## Modem Register Descriptions (continued)

### Register 3: Line Control Register

Register 3 determines the asynchronous data format expected by the modem. Format parameters include character length, parity, stop bits, Break transmission and Data Rate.

Bit	Description
0,1,2	Bits 0,1 and 2 select the character length. Bit 2 selects the number of stop bits. Refer to the table below.

Bit 0	Bit 1	Bit 2	Character Format
0	0	0	5 bits, 1 stop bit
1	0	0	6 bits, 1 stop bit
0	1	0	7 bits, 1 stop bit
1	1	0	8 bits, 1 stop bit
0	0	1	5 bits, 2 stop bits
1	0	1	6 bits, 2 stop bits
0	1	1	7 bits, 2 stop bits
1	1	1	8 bits, 2 stop bits

Bit	Description
3,4,5	Bits 3, 4, and 5 select the data parity. The table below illustrates the various parity settings.

Bit 3	Bit 4	Bit 5	Character Format
0	X	X	No Parity
1	0	0	Odd Parity
1	1	0	Even Parity
1	0	1	Parity Bit Equals 1
1	1	1	Parity Bit Equals 0

Bit	Description
6	Bit 6 forces the modem to transmit a break signal or continuous space (logic 0). Bit 6 must be reset to logic 0 to disable break.
7	Bit 7 sets the Divisor Latch which permits registers 0 and 1 to set the modem data rate. (see description on page 13)

### Register 4: Modem Control Register

Register 4 controls the modem-controller interface. It also selects the local loopback diagnostic.

Bit	Description
0	A logic 1 on bit 0 activates DTR
1	A logic 1 on bit 1 activates RTS
2	Bit 2 controls the OUT1 signal.
3	Bit 3 controls the OUT2 signal.
4	Bit 4 selects the local loopback diagnostic. Data written into the Transmit Holding Register will be looped through the modem back to the Receiver Buffer Register.
5-7	not used

### Register 5: Line Status Register

Register 5 provides data status information on the modem. Status of the Transmitter and Receiver as well as error indications are provided.

Bit	Description
0	Bit 0 goes true whenever the Receiver Buffer Register contains a complete received character.
1	Bit 1 indicates data in the Receiver Buffer Register was over written.
2	Bit 2 indicates the occurrence of a parity error in the received character.
3	Bit 3 indicates the received character did not have a valid stop bit.
4	Bit 4 indicate the continuous receipt of a space for more than two word lengths. Continuous space indicates presence of a break signal.
5	Bit 5 indicates the modem can accept the next character for transmission.
6	A logic 1 in Bit 6 indicates both the Transmitter Holding Register and Transmitter Shift Register are empty.
7	Not Used

## Modem Register Descriptions (continued)

### Register 6: Modem Status Register

Register 6 indicates the modem's current status. Data Set Ready, Clear to Send, Ring Indication and Carrier Detect are all monitored.

Bit	Description
0	Delta Clear to Send: A logic 1 indicates the status of the Clear to Send signal has changed since Register 6 was last read.
1	Delta Data Set Ready: A logic 1 indicates the status of the Data Set Ready signal has changed since Register 6 was last read.
2	Trailing Edge Ring Indicate: : A logic 1 indicates Ring Indicate has changed from a 1 to a 0 since Register 6 was last read.
3	Delta Data Carrier Detect: A logic 1 indicates the status of the Data Carrier Detect signal has changed since Register 6 was last read.
4	Clear to Send: When Clear to Send is true, the modem can accept data for transmission.
5	Data Set Ready: Indicates the state of Data Set Ready. Data Set Ready is true when the modem has siezed the telephone line.
6	Ring Indicate: Indicates the presence of a ring on the telephone line.
7	Data Carrier Detect: When Data Carrier Detect is true, a valid carrier signal has been detected on the telephone line.

### Register 7: Scratch Pad Register

Register 7 is not used by the modem. You can both read and write from Register 7. It can be used by the controller for temporary storage.

## AT Commands

### Modes of Operation

The modem within the Tele-Controller responds to standard "AT" commands. It includes three operational modes; Command Mode and Data Modes plus an extension for Fax operation.

**Data Mode:** The modem enters data mode after it connects with a remote modem and issues the "CONNECT" result code. In Data Mode the modem sends all signals on Transmit Data to the remote modem and directs data from the remote modem onto Received Data. When the modem exits data mode, it issues the "NO CARRIER" result code.

**Command Mode:** The modem enters command mode on power-up, reset, a lost connection, or receipt of the escape code. In the command mode the modem accepts instructions from the host on Transmit Data. Result codes are returned on Received Data. "AT" commands allow the host to configure the modem for a specific application.

**Fax Mode:** The command AT+FCLASS=1 puts the modem in the XE5224FD into fax mode. The modem issues fax commands and responses at 19,200 bits per second; 8 data bits and no parity. The modem accepts only Class 1 fax commands. The A/, ATO, AT&T and escape commands are not valid in fax mode.

### Command Line Format

Commands issued to the modem follow a strict format. Each command line begins with the prefix "AT". The modem stores the command line in the command buffer and executes it upon receipt of a carriage return. More than one instruction may be placed in each command line.

**Command Prefix** - Each command, except the A/ command, begins with the "AT" prefix. The "A" and "T" may be either both upper case or both lower case but not mixed cases. The modem examines

the "AT" to determine the speed and parity of the commands. The modem sends the result codes at the same speed and parity as the last "AT" command.

**Command Line** - The modem within the Tele-Controller accepts up to 40 characters in a command line. The modem executes the commands in the sequence they appear within the command line. A carriage return terminates the command line and causes the commands to be executed. Register S3 allows selection of a character other than carriage return to terminate the command line.

**Command Buffer** - No more than 40 characters, including the "AT" prefix, may be loaded into the command buffer. If the command buffer overflows, the modem issues an "ERROR" result code and commands are not executed.

**Command Line Editing** - You can edit the command line any time before it is executed using the backspace character. The backspace erases the previous character in the command line. All of the characters in the command line can be erased except for the "A" and "T." Register S5 allows you to select a character other than a backspace to edit the command line.

**Re-Execute Previous Command** - The A/ command causes the modem to again execute the previous command line. This is the only command which does not use the "AT" prefix.

**Omitted Parameters** - Most commands include a parameter which determines how the functions will be set. Command parameters may sometimes be omitted from the command string. When the parameter is omitted it is assumed to be a 0.



## AT Commands continued

**Escape Characters** - A 3 character escape sequence may be entered from data mode. It switches the modem into command mode without dropping the line. The escape character, set by Register S2, must be entered 3 times in succession within 1 second to execute the escape. The default escape sequence is "+++."

**Result Codes** - The modem issues a result code after each action. The table of result codes appears below. Result codes may be provided as full words, numeric codes or may be disabled. Each result code ends with a carriage return when numeric result codes are chosen. When full word result codes are chosen, a Line Feed and Carriage Return precede and follow each result code. The Line Feed and Carriage Return characters may be altered with Registers S4 and S5.

**Non-Volatile Memory** - The modem within the Tele-Controller is supported by non-volatile memory. Non-volatile memory protects modem configuration and frequently dialed numbers when the modem loses power. The values of the following commands and registers are stored in non-volatile memory; Bn, En, Ln, Mn, Qn, Vn, Xn, &Cn, &Dn, &Yn, and S0. The modem's last speed, parity setting and escape character are also stored in non-volatile memory.

DIGIT	FULL	DEFINITION
0	OK	Successfully executed command
1	CONNECT	300 bps connection established
2	RING	Ring signal detected
3	NO CARRIER	Carrier not detected or lost
4	ERROR	Error found in command line; returns to command mode
5	CONNECT 1200	1200 bps connection established
6	NO DIAL TONE	No dial tone detected within 5 seconds after going off-hook
7	BUSY	Busy signal detected after automatically dialing a call
8	NO ANSWER	5 seconds silence not detected
10	CONNECT 2400	2400 bps connection established
13	DATA	Automatically connected as a data modem.*
	+FX	Fax connect error *

\* XE5224FD only

## AT Command List

An asterisk (\*) indicates the factory default value of each command.

### A - Answer Command -

Immediately initiates answer sequence

### Bn - Select 1200 bps Communications Standard

n=0 Selects CCITT standards  
n=1 Selects Bell standards \*

### D - Dial Command -

0-9, \*, # Dial Digits  
P = Pulse dial following digits  
T = Tone dial following digits  
R = Connect as an answering modem  
Sn = Dial Stored Number, n=0-3  
W = Wait for dial tone  
, = Pause for the duration of S8  
@ = Wait for silence  
! = Switch hook flash  
; = 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 (on-hook) \*  
n=1 The switch hook relay closes (off-hook)

### In - Modem Identification

### Ln - Speaker Volume -

n=0 Low speaker volume  
n=1 Low speaker volume  
n=2 Moderate speaker volume \*  
n=3 High speaker volume

### Mn - Speaker Activity -

n=0 Speaker off  
n=1 Speaker on until carrier received \*  
n=2 Speaker remains on  
n=3 Speaker on from the completion of dialing until carrier detected

### On - On Line

n=0 Return On Line with no retrain  
n=1 Initiate retrain while returning On line.

### Qn - Responses

n=0 Send responses \*  
n=1 No Responses

### Sn? - Interrogate Register n -

### Sn=x - Set Register n to Value x -

### Vn - Result Codes -

n=0 Numeric Result Codes  
n=1 English Word Result Codes \*

### Xn - Result Code Set -

n=0 Connect result code enabled, no busy or dial tone detection  
n=1 CONNECT XXXX result code enabled, no busy or dial tone detection.  
n=2 No busy tone detection, CONNECT XXXX result code  
n=3 No dial tone detection, CONNECT XXXX result code  
n=4 Show all result codes \*

### Zn - Reset -

Perform a soft reset and return to profile n.  
n=0 Return to stored profile 0 \*  
n=1 Return to stored profile 1

### &Cn - DCD Operation

n=0 DCD is forced active. \*  
n=1 DCD indicates a valid carrier signal has been detected

### &Dn - DTR

n=0 DTR is ignored by the modem.  
n=1 Go to command mode if the host revokes DTR.  
n=2 Modem disconnects if the host revokes DTR.  
n=3 The modem performs a soft reset when DTR is revoked.

### &F - Return to Factory Defaults

### &Tn - Test Modes

n=0 Exit test mode  
n=1 Local analog loopback  
n=3 Initiate local digital loopback  
n=4 Respond to remote loopback request \*  
n=5 Deny remote loopback request  
n=6 Initiate a remote digital loopback  
n=7 Remote digital loopback w self-test  
n=8 Local analog loopback w self-test

### &V - View Active Profile -

## AT Command List (continued)

### **&Wn - Stored Active Profile**

- n=0 Store as Profile 0 \*
- n=1 Store as Profile 1

### **&Yn - Active Profile on Power-Up**

- n=0 Recall Profile 0 \*
- n=1 Recall Profile 1

### **&Zn = x - Store number "x" in location "n"**

- n= 0-3

## Class 1 Fax Command List

Below are the descriptions of the Class 1 fax commands, EIA 578. These commands are used to control fax operation in Xecom's send and receive fax & data modems.

### **+FAA = n - Data/Fax Auto-Answer**

- n=0 Answer according to FClass setting \*
- n=1 Automatic determination of data or fax call

### **+FCLASS=n - Set Service Class**

- n=0 Configured as a data modem
- n=1 Configured for Service Class 1.

### **+FCLASS=? - Available Service Class**

### **+FCLASS? - Current Service Classes**

### **+FTS=n - Transmit Silence**

(selectable in 10 millisecond increments)

### **+FRS=n - Receive Silence**

(selectable in 10 millisecond increments)

### **+FTM=n - Transmit Fax**

- n=24 V.27ter at 2400 bps
- n=48 V.27ter at 4800 bps
- n=72 V.29 at 7200 bps
- n=96 V.29 at 9600 bps

### **+FRM<n> - Receive Fax**

- n=24 V.27ter at 2400 bps
- n=48 V.27ter at 4800 bps

### **+FTH<n> - Transmit HDLC Data**

- n=3 V.21 Channel 2

### **+FRH<mod> - Receive HDLC Data**

- n=3 V.21 Channel 2

## S Registers

Some of the modem configuration is stored within registers inside the modem. The contents of these registers can be read with the ATSn? command where Sn is the register being interrogated. The register contents can be modified with the ATSn=x where Sn is the register to be changed and x is the new value. Below are descriptions of the commonly used registers in the XE5224FD and XE5224DM.

### Register Definition

- S0 Answer on nth Ring:** S0 Settings from 1 to 255 cause the modem to automatically answer on that number of rings. If S0 is set to 0 the modem will not automatically answer an incoming call. The value stored in S0 can also be stored in non-volatile memory.
- S1 Ring Count:** S1 is a read-only register. It carries the number of rings detected from 0 to 255. If no ring is detected for 8 seconds, the counter is reset to zero.
- S2 Escape Character:** S2 determines the ASCII character used in the escape sequence. Values of 0-127 are valid ASCII escape characters; values from 128 to 255 disable the escape sequence.
- S3 Carriage Return Character:** S3 determines the ASCII character used as a carriage return to terminate commands and to be used in modem responses.
- S4 Line Feed Character:** S4 determines the ASCII character to be used as a line feed character in modem responses.
- S5 Back Space Character:** S5 determines the ASCII character used as a backspace to edit the command line. Only values from 0 to 32 will be accepted.
- S6 Dial Tone Wait Time:** S6 determines how long the modem waits for dial tone before dialing begins. The value in S6 sets the delay in seconds. Values from 0 to 255 are accepted; however, the modem always waits at least two seconds.
- S7 Wait for Carrier after Dialing:** S7 determines how long the modem will wait to detect a valid carrier signal after dialing is completed. The value in S7 sets the wait in seconds. Values from 1 to 255 are accepted
- S8 Comma Pause Time:** S8 sets the duration of the pause in dialing caused by a comma in the dialing string. The pause is generally used when waiting for a second dialtone. Values of from 1 to 255 set the pause time from 1 to 255 seconds.
- S9 Carrier Detect Response Time:** S9 establishes the length of time the remote modem's carrier must be present to be recognized as valid. Values from 1 to 255 set the response time in .1 second intervals.
- S10 Carrier Off Disconnect Delay:** S10 determines how long the remote modem's carrier must be lost before the local modem disconnects. Values from 1 to 255 set this delay in .1 second intervals. Note: If the value of S10 is smaller than the value of S9, the modem will not automatically disconnect when carrier is lost.
- S11 Tone Dialing Speed:** S11 sets the duration and spacing of the dialing tones. Values of S11 from 50 to 255 set both the tone duration and the interval between tones in milliseconds. Note: the pulse dialing rate is not affected by S11.

## Modem Specifications

PARAMETER	MIN	TYP	MAX	UNIT	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 33/67		% %	USA 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	
	Amplitude	-6		dB	
High Channel Transmit Amplitude		-1		dB	Referenced to low channel guard tone
Tone Detection Bandpass Frequency	290		665	Hz	3 dB point
Tone Detection OFF to ON Threshold	-33			dBm	into 600 ohms
Tone Detection ON to OFF Threshold	-35			dBm	into 600 ohms
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		sec.	OFF/ON Ratio
	Cadence	0.67	1.5	sec.	
Telephone Line Impedance Match		600		ohms	
Ring Detect Sensitivity	38			Vrms	Type B ringer
Telephone Line Holding Current	20		100	mA	

# FCC Instructions

This product complies with Part 68 of the FCC Rules and Regulations. Each device shipped includes a label which contains the FCC Registration Number and Ringer Equivalence (REN). If requested, this FCC information must be provided to the telephone company. A registration label must be affixed to the cabinet's exterior for each device mounted within a closed assembly.

Ringer Equivalence (REN) is used to calculate the number of devices you may connect to one telephone line and still have all of the devices respond to an incoming call. Typically, the sum of the RENs of all devices connected to one line should not exceed five (5.0). Contact your local telephone company to determine the maximum REN for your area.

Mount this device in the final assembly so as to prevent exposure to any hazardous voltages in the system and to preserve the high voltage protection between Tip/Ring and the rest of the system. Installation must provide adequate separation and restraint of cables and cords. Xecom recommends maintaining a minimum of .100 inches between the Tip and Ring traces and all other circuits. No circuitry may be added between Tip/Ring and the telephone line connection unless specifically allowed by the rules.

This device requires use of an RSOC RJ-11C jack for the telephone line connection. The jack selected must be certified to meet FCC Part 68 subpart F requirements.

If you experience trouble with this device, contact XECOM at (408)945-6640 to obtain service. There are no repairs the customer may make to this device. If your system causes harm to the telephone network, the telephone company may discontinue service temporarily until the problem has been corrected or it is demonstrated that the device is not malfunctioning. If possible, you will be notified in advance that service is being discontinued. If advance notice is not practical, you will be notified as soon as possible.

Your telephone company may make changes to their facilities, equipment, or operation that affect proper functioning of your equipment. You will be notified in advance of such changes to give you the opportunity to maintain uninterrupted telephone service.

This device cannot be used on coin operated telephone lines provided by the telephone company. Connection of this equipment to party lines is subject to state tariffs.

Any one using this device for fax transfer must include sender identification information as required in the Telephone Consumer Protection Act of 1991. The Telephone Consumer Protection Act of 1991 makes it unlawful to send a fax without clearly identifying the fax sender (business or individual) and the number of the transmitting fax machine. This information may be provided either on the first page of the fax or in the top or bottom margin of each page. The number listed may not be a 900 number or other number for which charges exceed local or long distance transmission.

The final assembler must provide these FCC instructions to the end user of the equipment.

FCC Registration Number:

XE5224DM      DWEUSA-21876-MD-E      Ringer Equivalence: 0.7B

XE5224FD      DWEUSA-75322-FA-E      Ringer Equivalence: 0.8B

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