XR-2443 Modem Microcontroller with V.42bis

GENERAL DESCRIPTION

The XR-2443 is a dedicated microcontroller that provides command control for the XR-2400 V.22bis modem chip set. The XR-2443 provides control for CCITT recommended V.42 error correction, including LAPM and MNP 2-4 protocols, with V.42bis BTLZ / MNP 5 data compression. Also supported is the complete AT command set and registers used to control these functions.

The system architecture of the XR-2443 allows the actual command sets for the 'AT', MNP, LAPM and V.42bis to reside external to the XR-2443, allowing ease of customization. Exar provides these command sets to use as is, or the customer can modify to the requirements of the design.

The XR-2443 operates from a single +5 volt power supply, offering low power consumption through CMOS technology.

FEATURES *

V.22bis/V.22/Bell 212A /Bell 103 Modem
Error Free Data Transfer: DATA Mode
- LAPM
- MNP 2-4

MNP Class 5 Data Compression
- 4800 BPS Throughput

Increased Data Throughput by V.42bis Data Compression
- 9600 BPS Throughput

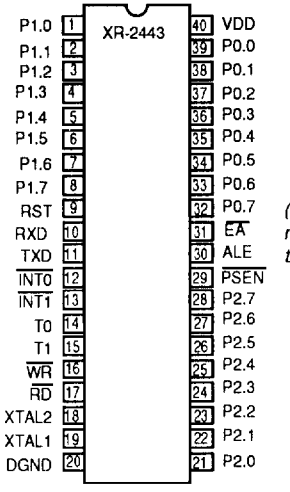
'AT' Command Control
- Easily Modified, Exar Supplied 'AT'/MNP/V.42/V.42bis

(Apply when used with XR-2400 V.22bis modem chip set)

APPLICATIONS

Error Free Data Modem Applications
Stand-Alone Data Modems
Smart Modems
Laptop Modems (Send and Receive error free Data)
Networked Modems

PIN ASSIGNMENT



(For other pin assignment diagrams, refer to the end of this datasheet)

ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-2443CP	40 Pin Plastic Dip	0°C to 70°C
XR-2443CJ	44 Pin PLCC	0°C to 70°C
XR-2443CQ	44 pin QFP	0°C to 70°C

ABSOLUTE MAXIMUM RATINGS

Power Supply	-0.3V to + 7V
Input Voltage	-0.7V to (VDD +0.3V)
DC Input Current (any input)	±10mA
Power Dissipation **(Package Limitation)**	1W
Derate above 25°C	11 mW/°C
Storage Temperature Range	-65°C to +150°C

SYSTEM DESCRIPTION

The XR-2443, when coupled to the XR-2400 V.22bis modem chip set, allows the implementation of a 2400 BPS V.22bis modem. With MNP/V.42/V.42bis operation included, compressed and error-free operation is provided.

The XR-2443 is just one in the family of controller options for the XR-2400 V.22 bis modem chip set, including:

FUNCTION	CONTROLLER
'AT'	8031
'AT'/MNP 2-5	XR-2403B
'AT/V.42/MNP 5	XR-2442
'AT'/V.42/V.42bis/MNP 5	XR-2443

ELECTRICAL CHARACTERISTICS

Test Conditions: T_A = 25°C, V_{DD} = 5V ±10%, F_{CLK} = 11.0592MHz ±0.05%, unless otherwise specified.

SYMBOL	PARAMETERS	MIN	TYP	MAX	UNITS	CONDITIONS
V_{DD}	Power Supply Voltage	4.5	5	5.5	V	
I_{DD}	Power Supply Current		18	22	mA	
V_{IH}	Input High Voltage	1.8			V	Except XTAL1 and RST
V_{IH}	Input High Voltage	3.5			V	XTAL 1 and RST
V_{OH}	Output High Voltage	2.4			V	Ports 1,2,3 I_{OH} = -60µA
V_{OH}	Output High Voltage	2.4			V	Port 0 (External Bus Mode) ALE, $\overline{PSEN}$ I_{OH} = -800 µA
V_{OL}	Output Low Voltage			0.45	V	Ports 1,2,3 I_{OL} = 1.6 mA
V_{OL}	Output Low Voltage			0.45	V	Port 0, ALE, $\overline{PSEN}$ I_{OL} = 3.2 mA
I_{IH}	Input High Current (Leakage)			±10	µA	0.45V ≤VIN ≤V_{DD}
I_{IL}	Input Low Current			-50	µA	V_{IN} = 0.45V

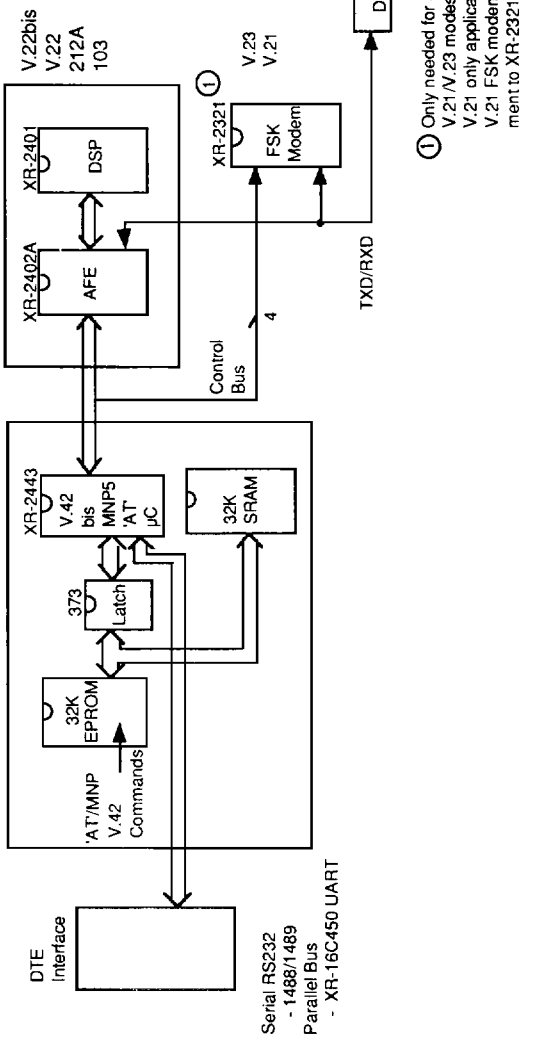


Figure 1. 2400 BPSP Modem with V.42 bis / MNP 5 Block Diagram

SYSTEM OPERATION

A typical application utilizing the XR-2443 to support the XR-2400 V.22bis modem chip set, is shown in Figure 1. The XR-2400 provides the complete modem data pump function for:

CCITT	V.22bis	2400 BPS
	V.22	1200 BPS
	*V.23	1200BPS / 75 BPS
	*V.21	300 BPS
Bell	212A	1200 BPS
	103	300 BPS

** Supported by the XR-2321*

Command control is supported by the XR-2443 for:

MNP 2-4	Microcom Error Correction
MNP 5	Microcom Data Compression
LAPM	CCITT Recommended V.42 Error Correction
BTLZ	British Telecom Lempel Ziv (V.42bis)
'AT'	Industry Standard 'AT'

Although the XR-2443 does provide complete command control, the actual commands for the various modes reside in an external EPROM - 27C256, 32k Byte. With this architecture and an EXAR supplied command set, maximum flexibility is offered. The command set can be used as is, or customer tailored to a particular design.

The unique architecture utilized by the XR-2400 and command controller allow the **same** hardware (Printed Circuit Board (PCB)) to support several different types of Data modems, including an upgrade to FAX/DATA. By changing available pin-to-pin microcontrollers, the Data modem types listed in Table 1 are all possible with the same printed circuit board. As mode types are changed by the µC, EPROM supported command sets and SRAM size change and/or elimination are also required. In each case EXAR provides complete production worthy, command sets which may be used as is, or easily modified to meet specific application requirements. To aid in software modifications, Tables 2, 3 and 4 list the XR-2443 memory mapping, indicating customer usable regions.

External memory modifications requiring µC (XR-2443) support will need entry/re-entry point information. This point is important as the XR-2443 contains program memory with EXAR proprietary V.42bis /V.42/MNP5 functions not accessible externally (fusible link protected) or available to EXAR customers.

2400 BPS Modem Type	Microcontroller Part Number	External Memory Requirements (Bytes)	
		EPROM	SRAM
'AT'	8031 (Generic ROMLESS µP)	16k	NONE
'AT / MNP 2-5	XR-2403B	16k/32k	8k
'AT' / MNP5/V.42	XR-2442	32k	8k / 32k
'AT'/MNP5/V.42/ V.42bis	XR-2443	32k	32k

ENTRY POINTS AND MEMORY MAPPING

Status / Mode Setting Memory Locations

Status	Location	Description
SPD_FLG	20 H.7	Speed Conversion Enable Flag.
BK_PRE	51 H	Break Prescaler Timer
BK_TMR	52 H	Break Timer (Only in Normal Mode)
MRCVP2	803BH	Disconnect to Check Auto-Reliable Fallback Mode.
PASS_ B	9D14H	Escape Code Checking Byte in Speed Conversion Mode.
SPEED	9D15H	Speed Indicator For All Modes. 0-19200 BPS (not used) 1 - 9600 BPS 2 - 4800 BPS 3- 2400 BPS 4 - 1200 BPS 5 - 300 BPS
Z_BUF	9D16H	Auto Reliable Fallback Character.
BACK_RAM	9D1AH	Starting Address for Command Buffer Back-up.
OPT_P	9D50H	Output Port Selection Option (F0FF H to 40 FFH).This Parameter is Initialized Immediately After Power On and constantly monitored by MNP Module.
MNP_S	9E22H	Reliable Link Indicator
RETRAN	24H.0	Retransmission Bit

Function Call Locations - V.42bis/V.42/ MNP 5

Function	Location	Description
SCTINT_1	0006H	Interrupt 0 Jump-In Point.
SCRINT_1	0016H	Interrupt 1 Jump-In Point.
SPINT_1	0026H	Serial Port Interrupt Jump-In Point.
MSG_CP	0030H	Exar Copyright Message.
P_ECRAM_1	0060H	After Escape MNP Re-Entry Point.
MSG_CPY	0063H	Exar Copyright Calling Subroutine.
MNP_IN	0066H	MNP Program Immediate Re-Entry Point for modifying MNP Program.
SPD_INM	0069H	Speed Conversion Program Jump-In Point.
INI_SPDM	006CH	Speed Conversion Initialization Routine.
V21_IN_1	006FH	300 BPS Speed Conversion Timer Set-Up.
EC_MAIN	0080H	Calling Main MNP Program. This is the only location which will initiate the MNP program.

XR-2443 Re-Entry Points

Function	Location	Description
PWR_ONS	C000H	Power On
OUT_SCT	C003H	Interrupt 0
OUT_T0	C006H	Timer 0
OUT_SCR	C009H	Interrupt 1
OUT_T1	C00CH	Timer 1
OUT_SP	C00FH	Serial Port Interrupt
OUT_T2	C0012H	Timer 2
MNP_OUT	C0015H	MNP Program Intermediate Point
CHK070S	C01BH	MNP 'ESC' Jump Out Point
DISCONNECT	C01EH	MNP Disconnect
ON_LOOPS	C021H	Auto-Reliable Fallback Point
SPD_OUTS	C024H	Speed Conversion Jump Out Point.
V21_INS	C027H	Call Speed Conversion ASM for 300 BPS.
SPD_TXD	C02AH	Put TXDATA to Modem Chip
SPD_RXD	C02DH	Get RXDATA From Modem Chip
I_TXSYNTTQ	C030H	GET TX CRC-CCITT CALCULATION ROUTINE
I_RXSYNTT	C033H	GET RX CRC-16 CALCULATION ROUTINE
I_TXASYN16	C036H	GET TX CRC-16 CALCULATION ROUTINE
I_RXASYN16	C039H	GET RX CRC-16 CALCULATION ROUTINE
I_SNDREL	C03CH	GET SENDING RESULT CODE SUBROUTINE
I_MNPINIT	C03FH	MNP PARAMETER INITIALIZATION ROUTINE
I_V42INIT	C042H	V42 PARAMETER INITIALIZATION ROUTINE
I_SETURMNP	C045H	UART SETTING ROUTINE
I_ENCODE	C048H	BTLZ ENCODING ROUTINE
I_DECODE	C04BH	BTLZ DECODING ROUTINE
I_BTFLUSH	C04EH	BTLZ DATA FLUSHING ROUTINE
I_BTINIT	C051H	BTLZ COMPRESSION INITIALIZATION

RAM Locations

The stack in the 'AT' program starts from 0C0H on page 1 and occupies 64 bytes of space. Internal RAM on page 0 has 23 bytes and page 1, 64 bytes of free space.

The external RAM data memory is as follows:

1)	Error Control	8000H-8FFFH
2)	Data Compression Buffer	9000H-93FFH
3)	FAX/Remote Access	9400H-99FFH
4)	Available for use	9600H-97FFH
5)	V.42 / V.42bis	9800H-99FFH
6)	Break Buffer	9A00H-9AFFH
7)	DTE TX Buffer	9B00H-9BFFH
8)	DTE RX Buffer	9C00H-9CFFH
9)	Misc. Registers	9D00H-9DFFH
10)	MNP Program RAM Backup Buffer	9E00H-9EFFH
11)	'AT' Program RAM Backup Buffer	9F00H-9FFFH
12)	BTLZ Compression Dictionary	C000H-FFFFH

Note: For program control, the XR-2443 backs up the entire 256 bytes of internal RAM into external RAM before jumping into or out of the MNP program. The 'AT' program RAM is from 9F00H to 9FFFH and MNP program RAM is 9E00H-9EFFH.

The miscellaneous register function list is provided below. The option code control allows the firmware engineer to change the factory defaults in source code and then reassemble.

Interrupt Vectors

The XR-2443 brings out all interrupt vectors to the external program. This allows easy customer modification of service routines to suit a particular application. The interrupt vectors of the XR-2443 are as follows:

```
        ORG   0
        LJMP  PWR_ONS;Jump to Power
                      On Set Up Routine
        ORG   3H
EXT_INTO:             ; Interrupt 0 for SCT
        LJMP  OUT_SCT
SCTINT1:
        LJMP  SCTINT
        ORG   0BH
T_INTO:               ;Timer 0 Interrupt
        LJMP  OUT_T0
        ORG   13H
EXT_INT1:             ;Interrupt 1 for SCR
        LJMP  OUT_SCR
SCRINT_1:
        LJMP  SCRINT
        ORG   1BH
T_INT1:               ;Timer 1 Interrupt
        LJMP  OUT_T1
        ORG   23H
INT_SER:              ;Serial Port Interrupt
        LJMP  OUT_SP
SPINT_1:
        LJMP  SPINT
        ORG   2BH
        T_INT2:       ;Timer 2 Interrupt
        LJMP  OUT_T2
```

XR-2443 PROGRAM/DATA MEMORY MAPS

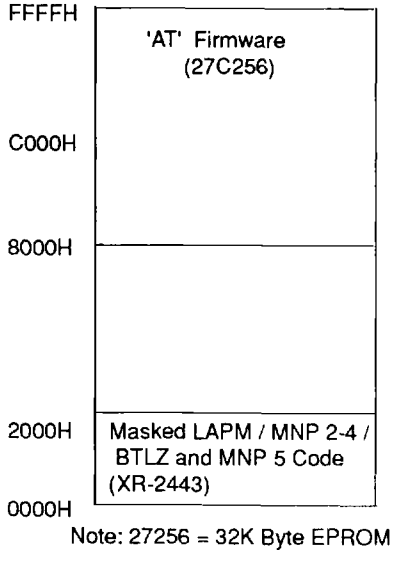
Tables 2, 3 and 4 show the ROM and RAM memory maps for XR-2443. It should be noted that without the use of separate CS (Chip Select) for the XR-2402A and the XR-2321, there would be an overlap of address locations.

As it is indicated in Table 2, 32K bytes of EPROM is assigned to 'AT' command firmware. This section of the ROM is located between 8000H and FFFFH, where chip select pin is connected to A15.

BTLZ, LAPM, MNP 2-4 and MNP 5 code is masked in the microcontroller (XR-2443), and resides in the 8K bytes of memory, between address locations 0000H and IFFFH.

Table 3 shows the RAM map, in which the space between 0000H and 002CH address locations is used for modem chip address. Table 4 shows the modem chip (XR-2402A) address assignment. Included is addressing for the XR-2321 and XR-2100. These chips are optional to the system design, but may be added where V.21 or V.23/V.21 standards are required. The XR-2321 provides both V.23 and V.21 FSK data standards, while the XR-2100 only V.21. See XR-2321 or XR-2100 datasheets for details.

Also RAM space between 8000H and FFFFH is assigned for the V.42bis dictionary and MNP 5 data. RAM locations between 002DH and 7FFFH are available for I/O ports such as LED, EIA, etc.



Note: 27256 = 32K Byte EPROM

Table 2. XR-2443 ROM Map

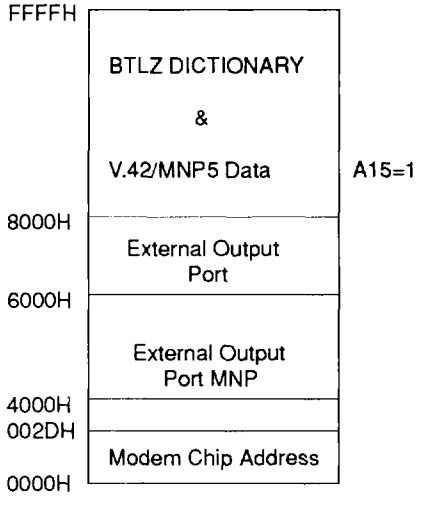


Table 3. XR-2443 RAM Map

MODEM CHIP	RAM ADDRESS	$\overline{CS}$
XR-2402A	0000H - 0003H	A15=0
XR-2321	0028H - 002CH	A5=1 and A15=0
XR-2100	0028H - 0029H	A5=1 and A15 =0

Table 4. Modem Chip Address

V.42 / MNP OPERATION

The XR-2443 when coupled with the XR-2400 V.22bis modem chip set allows the implementation of an **error-free, increased throughput** 2400 BPS data modem. To gain an understanding of V.42bis/V.42/MNP 5 modes for data operation, the following basic information has been included. A basic understanding of error correction techniques, flow control, speed buffering, and data compression will allow the designer to better understand a V.42bis/V.42/MNP5 modems capabilities and how to best utilize them. One excellent introductory book on the subject of data compression for both fax and data modes is DATA COMPRESSION by Gilbert Held. The publisher is WILEY.

V.42 is a **CCITT** recommended error correction protocol which allows asynchronous DTE's (Data Terminal Equipment) to communicate error-free with other such equipped modems.

The actual error detection protocol used in V.42 is an **HDLC** (High-level Data Link Control) based protocol called LAPM, for **Link Access Procedure for Modems.** For additional detailed information beyond the following basic description, refer to the CCITT Recommendations, Series V, 'Data Communication Over the Telephone Network'. The latest version is known as the **'Blue Book'** (Blue Covers) or Series, dated 1988 (Melbourne), a recent update from the **'Red Book'.**

V.42 Basic Operation/Features

- **HDLC**-based error correction protocol-LAPM
- Asynchronous (Async or 'start/stop') DTE Communication - error free
- Actual line transmission is synchronous (sync)- no start or stop bits (stripped from data), however initial handshake, subsequent to modem handshake is asynchronous
- Error Detection
  - Data sent in 'frames' or blocks with a nominal size (default) of 128 Octets (Octet - 8 bit) data frames.
  - Start/Stop bit elimination from data creates an actual data throughput improvement, roughly 120% of nominal. 2400 BPS becomes about 2900 BPS.
  - Encoded information added to data frame for receiver to 'decode' and determine if the block was error free. 16-bit cyclic redundancy check (CRC) methods are used for data encoded information to (1) indicate correct data and (2) recognize imperfect data frame.
  - Retransmission (automatic) of determined imperfect frames to ensure perfect data is received.

V.42 operation is found to be virtually identical (specifically to variable parameters) to that of MNP reliable or normal modes of operation. For this reason the MNP command set is also used for V.42 variables control.

DATA COMPRESSION

Two general families exist of data compression techniques. The first is logical compression, which is limited to a defined file type. It is called logical because fixed defined paths exist for the compression and decompression; e.g. year, month date, or the type of account: savings or checking. This technique would substitute a number 4 for April placing in 3 bits what would require 40 bits (7 bits and parity per character). To allow the inclusion of other months (above July, the seventh month) would require an additional bit, but the net number of bits being sent is reduced.

For compressing the type of account, a single bit would allow the encoding of either 'checking' or 'savings', rather than using the ASCII representation which would require up to 64 bits to transfer the two words. Both of these examples would require positioning limitations or the use of packets, where the location in the packet determines what logical decompression technique should be used to decode the information stored. This result is in an overhead of bits being needed to allow reliable decompression of the information.

The second technique is physical compression. This technique does not limit itself to certain types of information and files, but is more complicated to be implemented. Physical encoding compresses redundant characters substituting coded characters. As an extreme example, a page full of the letter 'a' could be sent as 'a5610', noting the fact that 5,610 'a's appear on the page. In this example the throughput would be 1122 times normal. Unfortunately, the situation to send such a large amount of compressed data does not occur too often. In addition to the encoded data, a start encoding symbol is needed to inform the decoder on the receiving side that the standard decoding technique should be used.

The two sub groups of physical compression is block encoding and stream encoding. Block encoding in general is a slower process, for it requires the entire file to be processed before sending. The use of stream encoding allows the mix of on-line information (entered by keyboard for example) and stored data. The default for the XR-2443 is stream mode. This is controlled by the \L command.

BTLZ® OPERATION

BTLZ is a patented technique to increase throughput to nearly 4 times an uncompressed file. To produce this greater performance BTLZ uses an adaptive dictionary that is partially reset from time to time to adapt to the possibly changing file. This 2-Dimensional dictionary allow for a greater compression ratio than the 1 Dimensional technique used by MNP® 5 which take ASCII codes and provide a *shortened code.*

The dictionary is created using data that is transmitted, therefore, no transmission time is needed to exchange dictionary data. The resetting , presetting or updating of the dictionary is under lock-step, where each deletion is predefined. Either a full reset to the first level occurs (most common letters and space character found in files), or removal of dead ends. This adaptive process provides two things. If not done, the dictionary would need to be infinite in size, for all possible data combinations (words) would have a path. In a repetitive data pattern situation this is ideal. For example, "THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG" repeated over an over would be learned by the XR-2443 using BTLZ and compression would reach the maximum set between the DTE and DCE (9.6 kBPS). However, in a real life situation such files have limited usefulness. With a typical text file, random for the short term the compression ratio is around 3.4:1.

It is this randomness that Mr. Jacob Ziv and Mr. Abraham Lempel based their compression theory upon. The idea that for short duration data transfer, a repetitive pattern can be seen, however for longer term data transfer, editing of the dictionary is needed. Their introductory paper: On the Complexity of Finite Sequences (IEEE Transactions on Information Theory, Volume IT-22 Number 1; January 1976; PP 75-81) goes into some detail as to how their compression technique was developed. This information is not needed to use the XR-2443.

British Telecom Lempel Ziv is a patented Data Compression technique used in the V.42bis standard.

MNP® OPERATION

MNP, or Microcom Networking Protocol was developed by Microcom, Inc., a modem manufacturer. Since conception, it has been in a constant state of update/improvement. For this reason 'classes' of operation emerged to signify each major update or improvement.

Relative to the V.22bis or 2400 BPS modems, up to class or level 5 has become the 'standard'. As mentioned before HDLC framing techniques are used.

MNP CLASSES

*(Throughput data is based on **2400 BPS** line speed).*

Class 1. A half duplex protocol and not included in many new designs. Throughput was about 70% or 1690BPS. The XR-2443 does not support this class.

Class 2. Asynchronous operation with byte oriented data formatting. Throughput is roughly 84% of nominal or about 2000 BPS.

Class 3. Conversion to synchronous, bit oriented data handling is transmitted in blocks consisting of 1 to 64 characters. Throughput is about 108% or 2600 BPS.

Class 4. Basic characters are the same as Class 3, but block size is dynamic, up to 256 Bytes, (flexible size is based on data transmission quality). Throughput is 120% or 2900 BPS.

Class 5. Includes Class 3 and 4 with data compression techniques added. The compression effectiveness is dependent on the type of data, but typical throughput enhancements of a text file are up to 200% or 4800 BPS.

ERROR CORRECTION

Modem users have come to expect sophisticated circuitry like adaptive equalization for varying phone characteristics and retrain modes for ensuring continued optimal performance. These techniques dramatically improve performance characteristics which is quantified by BER vs S/N measurements, the probability of errors when the modem signal is in the presence of noise.

The previously mentioned techniques are aimed at improving the modem data pump through analog (or digitally synthesized) circuitry. Techniques are becoming popular for not only improving, but virtually eliminating data errors through protocols implemented in the modems command microcontroller (µC). Prior to these 'hardware' based schemes, error correction provided in the applications software was available, such as X-MODEM or Kermit for asynchronous file transfer. In mainframe environments, SDLC or HDLC schemes were used.

Software based error correction schemes do however have their disadvantages. One important one being reduced data throughput. The throughput performance varies, but all schemes reduce data transfer below its nominal rate. Typical values of 30% are common, equating to only about 800 BPS for a 2400 BPS connection.

The hardware based error correction protocols supported by the XR-2443 for data mode are those as specified by the **CCITT LAPM, and MNP.** These schemes convert asynchronous data to be transmitted to a synchronous format (start and stop bits are stripped) for a packet-oriented protocol. Throughput values again vary, however typical values of 108% for the lower MNP Class 3 and 120% for MNP Class 4 or LAPM. These equate to roughly 2600 - 2900 BPS for 2400 BPS modems.

Actual error correction is based on adding information to the block-oriented data, through a 16-bit CRC (Cyclic Redundancy Check) calculation. The receiving side calculates CRC values for each block and if found to be incorrect, a retransmission of that block will be requested.

Typical frame sizes for LAPM are 128 Octets (8-bit start/stop bit stripped characters).

DETERMINATION OF BLOCK SIZE SETTING

The block size adjustment allows the user to compensate for situations where a high probability of errors exists. This condition occurs when the signal to noise ratio is extremely low. The XR-2400 provides performance curves for 2400 BPS(V.22bis) operation and single points BER data for 1200 and 300 BPS. As a rule of thumb, under typical dial-up telephone connections, the negotiate block size feature of MNP and V.42 provides satisfactory results (generally 256 characters/block). However, if the signal to noise ratio is much less than 15 dB S/N (at 2400 BPS) the probability of receiving data with an error is much greater, which would require retransmission of the entire block. By reducing the block size, the amount that is needed to be retransmitted is reduced, which increases the throughput. Under poor line conditions, the throughput would be reduced for a greater number of link acknowledgments would be needed.

For BTLZ 2 dimensional encoding, the maximum number of character setting (register S90) can help in obtaining a higher throughput earlier than if the straight learning mode of BTLZ is used. If it is known that a certain number of characters are repetitive, that setting will provide an increase in throughput. However, if the file contents change, become more random, a reduction in throughput will occur. The default setting of 32 characters is a compromise for a typical text file.

DATA COMPRESSION

The CCITT recommendation for V.42bis specifies data compression modes, as provided by British Telecom Lempel-Ziv (BTLZ). Modem controller protocols have advanced to the point where in addition to providing error-free data transfer with the use of LAPM or MNP 2-4, they can also offer data compression operation.

These data compression schemes are BTLZ and MNP 5. Although MNP 5 is not specifically part of the V.42bis recommendation, it has been included in the XR-2443 to serve only as a further enhancement to the XR-2400 based modems and ensure data compression compatibility with the established MNP 5 modems.

MNP Class 5 is the protocol for **data compression.** It is by far the most accepted protocol for this function. CCITT recommendations have updated the V.42 standard to include the BTLZ data compression technique. This new standard is **V.42bis**.

MNP 5 data compression offers the XR-2400 V.22bis modem chip set roughly an 100% increase in throughput (in data mode), or 200% of nominal. This translates to a maximum modem throughput of 2400 BPS x 2 = 4800 BPS for a text file.

XR-2443 V.42/MNP FUNCTIONS AND COMMANDS

The XR-2443 with external EPROM provides control for the following major functions:

FUNCTION	DESCRIPTION
• 'AT' Command Control	Provides 'AT' Command Set Control
• MNP Level 2-4	Provides error correction for 100% perfect data transfer.
• MNP Level 5	Allows roughly a 100% increase (4800 BPS for V.22bis mode) in data throughput, through data compression techniques.
• V.42bis (BTLZ®)	Using 2-dimensional adaptive coding a 400 % or more improvement in data throughput is possible.
• V.42 (LAPM)	100% perfect data transfer
• Speed Conversion	Maintain up to 9600 BPS DTE (terminal speed) for 300 BPS to 2400 BPS connect speeds, both for LAPM/MNP non-error correcting connections.

MNP 5 techniques utilize a scheme which abbreviates redundant data characters for a much higher transmission efficiency or throughput increase. Because of its dependency on redundant characters, the amount of improvement will vary. Typical improvement values are in the range of 75 to 125%, or 4200 to 5400 BPS for a 2400 BPS modem link.

FLOW CONTROL

A method for regulating the flow of data to be transmitted is necessary when DTE data rates exceed line rates. Figure 2 illustrates a basic modem connection and helps illustrate where flow controls fit in.

Flow control can be under **hardware** or **software control.**

HARDWARE FLOW CONTROL

Hardware Flow Control allows the modem to lower or raise its CTS (Clear to Send) line to the DTE. This provides an ON/OFF control of data flow from DTE to modem. If the modem data buffer becomes full it lowers the CTS line to stop transmit data flow to allow the modem to "catch-up".

SOFTWARE FLOW CONTROL

An alternative to hardware flow control is control by software, known as **Xon/Xoff.** This is accomplished by special characters inserted into the data stream to start and stop data flow. **Control Q (^Q)** is used to start or restart data flow and **Control S (^S)** to stop data flow.

Three different variations of Xon/Xoff control modes are:

- Send Only
- Normal
- Pass through

Application Software Interface

The firmware of the XR-2443 (combined masked and supporting code) will work with a variety of software programs on the market, as well as with dumb terminals. The largest factor that can affect throughput is the speed of the Data Terminal Equipment (DTE). It has been found that both hardware and software flow control cannot occur quickly enough on a 4.7 MHz PC to prevent corruption of data. For this reason, 9.5 MHz or faster XT and AT computers are recommended for best results and to compare the throughput values given in this data sheet.

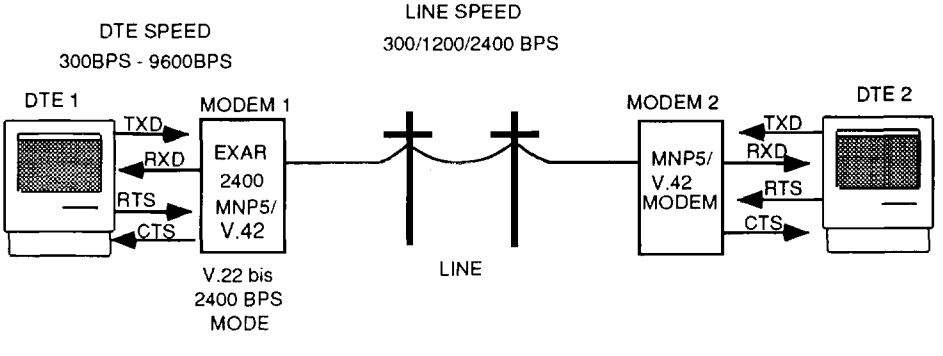


Figure 2. Basic Modem Test Configuration for Throughput

PROTOCOL NEGOTIATION

The XR-2443, for data mode, supports error correcting or reliable modes of operation for not only LAPM, but also MNP type protocols. Also, since data compression operation is specified by the CCITT V.42bis specifications, BTLZ has been included along with the industry standard MNP® 5 for increased compatibility. Because of these multiple protocols supported,and to simplify the command process the XR-2443 offers two temporary protocol negotiation commands:

1) **AT\M0 Default** Mode. This command selects an automatic protocol negotiation mode. **First LAPM** negotiation will be attemped. If not possible, MNP operation will be negotiated. The highest possible class of MNP operation will be negotiated (Compression negotiation will be attempted depending upon the setting of the %C command). If the remote modem does not support error correction, normal 2400 BPS (or1200/300 BPS) operation will be supported.

2) **AT\M1.** This command will **disable LAPM** operation. Here only MNP 2-5 and non-error correcting modes of operation will be supported.

It is recommended that the default conditions be used when first starting to use the sophisticated features of the XR-2443. The default conditions have been selected to provide effortless use of the XR-2443.

The following is a command set summary for the XR-2443. Provided are:

Data Mode

1) Basic Connection/Dialing Commands
2) Dialing Modifiers
3) Standard Hayes 'AT' Command Set
4) 'S' Register Descriptions/Functions. These registers are used for controlling the value or function of various 'AT' commands.
5) BTLZ/MNP/LAPM Commands. The entire list represents the MNP command set. Most of the MNP commands also apply to LAPM, with the exceptions indicated.

COMMAND	DESCRIPTION / RANGE - SIZE
A/	Execute previous command, without striking <CR> key
AT	Attention
ATA	Answer Immediate
ATB0	CCITT V.22 mode
ATB1	Bell 212A mode **DEFAULT**
ATB2	V.23 mode
ATD	Dial Command
ATDP	Dial Using pulse dial
ATDT	Dial Using DTMF tone dial **DEFAULT**
The following 8 modifiers will dial using the previously used technique (pulse or tone), or the T or P command can be added after the D (dial) command. 0-9 A B C D * #	
ATDW	Wait for Dial Tone for Period Set by S7 Register
ATD@	Quiet Answer: Wait for 5 Seconds of Silence Before Dialing
ATD!	Hookflash: Commonly Used PBX Systems
ATDR	Reverse Answer Mode
ATDS=n	Dial Stored Number when n= 0-3
ATD/	Wait 0.125 Seconds
ATD;	Return to Command Mode After Dialing
ATD,	Pause for Time Set by S8 Register
ATE0	Command Echo Disabled
ATE1	Command Mode Echo Enabled **DEFAULT**
ATH0	Go On Hook (Open Relay)
ATH1	Go Off Hook (Close Relay)
ATI0	Identification Code
ATI1	Identification Code
ATI2	"OK" Response if Checksum Verifies
ATI3	EXAR EPROM Revision Date
ATL0	Lowest Volume Setting
ATL1	Same as ATL0
ATL2	Medium Volume Setting **DEFAULT**
ATL3	Maximum Volume
ATM0	Speaker Always Off
ATM1	Speaker On Until Carrier Is Detected **DEFAULT**
ATM2	Speaker Always On
ATM3	DTMF Tones are not Heard, but Speaker is on Until Carrier Detected
ATO	Originate Immediate or Return to Data Mode
ATO1	Request a Retrain When in V.22bis Mode
ATQ0	Provide Result Codes **DEFAULT**
ATQ1	Disable Result Code
ATSn?	Provide S Register Value
ATSn=	Set S Register Value
ATV0	Terse (and Verbose) Responses, affected by \Vn

NUMERIC	DESCRIPTION / RANGE - SIZE	
		\V1
0	OK	Command Executed
1	CONNECT	Connection at 0 to 300 BPs
2	RING	Ring Signal Detected
3	NO CARRIER	Carrier Signal not Detected
4	ERROR	Error
5	CONNECT 1200	Connection at 1200 BPS
6	NO DIALTONE	No DialTone Detected
7	BUSY	Busy Signal Detected
8	NO ANSWER	No Silence Detected
10	CONNECT 2400	Connection at 2400 BPS
11	CONNECT 4800	Connection at 4800 BPS
12	CONNECT 9600	Connection at 9600 BPS
14	CONNECT 19200	Connection at 19200 BPS
		\V1
22	CONNECT 1200/REL 4	MNP Class 4 Link
22	CONNECT 1200/REL 5	MNP Class 5 Link
23	CONNECT 2400/REL 4	MNP Class 4 Link
23	CONNECT 2400/REL 5	MNP Class 5 Link
22	CONNECT 1200/V.42	V.42 Link
23	CONNECT 2400/V.42	V.42 Link
22	CONNECT 1200/V.42bis	V.42bis Link
23	CONNECT 2400/V.42bis	V.42bis Link

COMMAND	DESCRIPTION / RANGE - SIZE
ATV1	Verbose Response **DEFAULT**. See ATV0 for Responses
ATX0	Enable Result Codes 0-4
ATX1	Enable Result Codes 0-5, 10
ATX2	Enable Result Codes 0-6, 10
ATX3	Enables Result Codes 0-5 and 7 and 10
ATX4	Enables Result Codes 0-10 **DEFAULT**
ATY0	Disable Long Space Disconnect **DEFAULT**
ATY1	Enable Long Space Disconnect
ATZ0	Software Reset, Restore S Register from profile location 0 in NVRAM
ATZ1	Restore S Registers From Profile Location 1 in NVRAM
AT&C0	EIA Carrier Line Always Forced on **DEFAULT**
AT&C1	EIA Carrier Line Follows Data Carrier
AT&D0	DTR Always on **DEFAULT**
AT&D1	Modem Goes to Command Mode When DTR Goes Off
AT&D2	Modem Goes on HOOK and Returns to Command Mode When DTR Goes Off
AT&D3	Modem Initializes When DTR Goes Off
AT&F	Fetch S Registers From EPROM for Factory Default
AT&G0	No Guard Tone **DEFAULT**
AT&G1	550 Hz Guard Tone Enabled
AT&G2	1800 Hz Guard Tone Enabled
AT&J0	RJ-11 Select **DEFAULT**
AT&K0	Flow Control Disabled
AT&K1	No Function
AT&K2	No Function
AT&K3	RTS/CTS Flow Control **Default**
AT&K4	Xon/Xoff Flow Control
AT&K5	Xon/Xoff Pass Through
AT&L0	Switched Line Select **DEFAULT**
AT&L1	Leased Line Select
AT&M0	Asynchronous Mode **DEFAULT**
AT&M1	Synchronous Mode With Asynchronous Dial
AT&M2	Synchronous Mode and Dial the Stored Number Immediately
AT&M3	Synchronous Mode With DTR Controlling Data/Talk
AT&P0	US Make/Break Ratio For Pulse Dialing **DEFAULT**
AT&P1	UK Make/Break Ratio For Pulse Dialing
AT&Q0	Direct mode (same as Hayes)
AT&Q1	Same as &M1
AT&Q2	Same as &M2
AT&Q3	Same as &M3
AT&Q5	Error Control Mode
AT&Q6	Normal Mode
AT&R0	Clear To Send (CTS) Follows RTS **DEFAULT**
AT&R1	CTS Always On
AT&S0	Data Set Ready (DSR) Always on **DEFAULT**
AT&S1	DSR Normal
AT&T0	Terminate Test in Progress **DEFAULT**
AT&T1	Initiate Local Analog Loopback For Time Set by Register S18
AT&T2	Not Defined
AT&T3	Initiate Digital Loopback for Time Set by Register

COMMAND	DESCRIPTION / RANGE - SIZE
AT&T4	(Not Supported)
AT&T5	Disable Remote Digital Loopback (RDLB) Response
AT&T6	Initiate RDLB
AT&T7	Initiate RDLB with Self Test
AT&T8	Initiate ALB with Self Test (for Direct / Normal Mode only)
AT&W0	Write User Profile 0 into NVRAM
AT&W1	Write User Profile 1 into NVRAM
AT&X0	Modem Provides Transmit Clock
AT&X1	DTE Supplies Transmit Clock (Not Supported)
AT&X2	Slave Clock Mode (Not Supported)
AT&Y0	Power Up Recall User Profile 0
AT&Y1	Power Up Recall User Profile 1
AT&V	List Configuration both Active and Stored
AT&Z m=An	Store Telephone Number into NVRAM (XL93C46) where: *m* is the number location (0-3) *A* is *P* or *T* (pulse or Tone) *n* is the telephone number

COMMAND	LAPM Yes/No	DESCRIPTION/RANGE - SIZE	FUNCTION
AT \ M0	Y	LAPM Enabled	Attempt LAPM Negotiation
AT \ M1	N	LAPM Disabled	Do Not Attempt LAPM Negotiation
AT \ N0	Y	Normal	
AT \ N1	Y	Direct	
AT \ N2	Y	MNP 2-5/Reliable	
AT \ N3	N	MNP 2-5/Auto Reliable	
AT \ N4	Y	V.42 Mode	
AT \ N5	Y	V.42 Mode Auto Reliable	
AT \ N6	Y	V.42 / MNP 2-5 Reliable	
AT \ N7*	Y	V.42 / MNP 2-5 Auto Reliable	
AT \ A0	N	64 Characters	Transmit Block Size
AT \ A1	N	128 Characters	
AT \ A2	N	192 Characters	
AT \ A3*	N	256 Characters	
AT%An	Y	n = 0-127 ASCII	Auto-Reliable Fallback Character
AT \ L0*	N	Stream Link	Block MNP Link
AT \ L1	N	Block Link \L1 = \L0	(Stream Mode)
AT \ O	N	Initiate Reliable Link After Escape Command Independent of Modem Initial mode (ANS or ORG)	Originate Reliable Link
AT \ U	N	Accept Reliable Link after Escape Command request from Initiator of Link	Accept Reliable Link
AT \ Y	N	Establish Reliable Link after Connecting in Normal Mode	Switch to Reliable Mode
AT \ Z	N	Switch to Normal Mode After Establishing a Reliable Link	Switch to Normal Mode
AT % C0	Y	Compression Disabled	Compression On/Off Control
AT % C1*	Y	Compression Enabled	
AT \ V0	Y	Standard Non-MNP Result Codes	Result Code Form
AT \ V1*	Y	Modified MNP Result Codes (As Listed Below)	
AT \ Bn	Y	N = 0 - 9 (100ms Increments) Used in Normal Mode Default = 3, Error Control Mode Always 300ms	Transmit Break for Normal Data Mode
AT \ C0*	Y	Does not buffer Data Default	Set Auto-Reliable Buffer Break Control
AT \ C1	Y	Buffers All Data on Answering Modem until 200 Characters (Non-Sync) are Returned	
AT \ C2	Y	Does Not Buffer Data on Answering Modem, according to % An to fall back	
AT \ K1	Y	"Destructive" signaling regardless of its sequence in data sent and received; data in process at time is destroyed	Break Control for Reliable Data Mode

COMMAND	LAPM Yes/No	DESCRIPTION / RANGE - SIZE	FUNCTION
AT \ K3	Y	"Expedited" signaling regardless of its sequence in data sent and received; data integrity maintained	
AT \ K5*	Y	"In sequence" signaling as data is sent and received; data integrity maintained ahead of and after break	
AT \ K0,2,4	-	Not Supported (Will be equal to AT \ K5 if selected)	
AT \ Tn	Y	N = 0-90 min N* = 0 (disable)	Inactivity Timer
%D0*	Y	Hang up without clearing buffer	
%D1	Y	Clear the receive buffer before hang up	
- Cn	Y	Maximum String Length (BTLZ) Range: 6-250 Characters Default: 32 Characters	
- Dn	Y	Dictionary Size and One / Two-way Mode(BTLZ), - Dictionary size options 0-512 entries, 1-1024(1K) entries, *2-2048(2K) entries, 3-4069(4K) entries	
AT \ I	-	Not Functional	Interface Protocol
AT \ J0*	Y	BPS Rate Adjust Disabled	Speed Conversion Control Disable
AT \ J1	Y	BPS Rate Adjust Enabled	Modem Port Rate Adjustment
AT \ S	Y	List Profiles	
AT \ G0*	Y	Disables Modem Port Flow Control	Set Modem Port
AT \ G1	Y	Sets Modem Port Flow Control to Xon / Xoff	Flow Control
AT \ X0*	Y	Does Not Pass Xon / Xoff to Remote Modem	Xon / Xoff Pass Through Control
AT \ X1	Y	Passes Xon / Xoff to Remote Modem	
AT \ Q0	Y	Disable Flow Control	Serial Port Flow Control
AT \ Q1	Y	Bidirectional Xon / Xoff Enabled	
AT \ Q2*	Y	Unidirectional Hardware Control by CTS	
AT \ Q3	Y	Bidirectional Hardware Control by RTS / CTS	
AT \ Q4	Y	Unidirectional Xon /Xoff Send Only	
AT \ Q5		Keep CTS off until connect unidirectional hardware flow control	
AT \ Q6		Keep CTS off until connect for bidirectional hardware flow control	
AT % U	Y	Not Functional	Clear Serial Port Speed Serial Port
AT - P0*	Y	Ignores Parity for Special Characters	Check Parity
AT - P1	Y	Processes Special Characters Only if they have Correct Parity	

*Note: * Denotes Default Condition*

See Command AT \ V1 Above

STANDARD RESULT CODES\V0		MODIFIED RESULT CODES \V1	
Verbose	**Numeric**	**Verbose**	**Numeric**
CONNECT	1		
CONNECT 1200	5	CONNECT 1200 / REL 4 or 5	22
CONNECT 2400	10	CONNECT 2400 / REL 4 or 5	23
CONNECT 4800	11		
CONNECT 9600	12	CONNECT 1200/V.42	22
CONNECT 19200	14	CONNECT 2400/V.42	23
		CONNECT 1200/V.42bis	22
		CONNECT 2400/V.42bis	23

S	REGISTER FUNCTION
S0	Number of Rings to Answer: **Default** = 0 (no answer)(stored)
S1	Ring Count: Stores Number of Rings: Resets After Every Call
S2	Escape Code Character: **Default** = 043 (ASCII for "+")
S3	Carriage return Character: **Default** = 013
S4	Line Feed Character: **Default** = 010
S5	Back Space Character: **Default** = 008
S6	Wait for Dial Tone: **Default** = 002 (seconds) (minimum setting)
S7	Wait for Carrier After Dial: **Default** = 030 (seconds)
S8	Duration of Delay for Comma: **Default** = 002 (seconds)
S9	Carrier Detect Response Time: **Default** = 0.6 (seconds)
S10	Loss of Carrier Response Time **Default** = 1.4 (seconds)
S11	Touch Tone Duration: **Default** = 095 (milliseconds)
S12	Escape Code Guard Time: **Default** = 1 (second)
S13	Reserved
S14	Bit Mapped Register: Stored in NVRAM (XL93C46) Bit 0 Reserved Bit 1 Echo Bit 2 Result Codes Bit 3 Numeric Result Codes Bit 4 Always 0 Bit 5 Tone/Pulse Dialing Bit 6 Reserved Bit 7 Answer/Originate
S15	Reserved
S16	Test Register Bit 0 ALB Bit 1 Reserved Bit 2 Local Digital Loopback Bit 3 Remote Digital Loopback (Not Supported) Bit 4 Initiate Remote Test Bit 5 Initiate Remote Test With Self Test Bit 6 Analog Loopback With Self Test Bit 7 Reserved
S17	Reserved
S18	Test Time Stored in NVRAM (XL93C46) Default = 000 (seconds)
S19	Reserved
S20	Reserved
S21	Bit Mapped Register Stored in NVRAM (XL93C46) READ ONLY Bit 0 0 = RJ11 Jack Bit 1 Not Used Bit 2 CTS RTS Function Bit 3 DTR Function Bit 4 DTR Function Bit 4 / Bit 3 / Function 0 / 0 / DTR Always True Default 0 / 1 / DTR Off, Forces Command State 1 / 0 / DTR Off, Forces Modem Offline 1 / 1 / Modem Initializes With DTR OFF (ATZ)

REGISTER NUMBER	REGISTER FUNCTION
S22	Bit 5 EIA Carrier Status Bit 6 Bit 7 Guard Tone Select Bit 7 / Bit 6 / Function 0 / 0 / No Guard Tone Default 0 / 1 / 550 Hz Guard Tone 1 / 0 / 1800 Hz Guard Tone 1 / 1 / Reserved Option Bit - Mapped Register Bit 0 Determines Speaker Volume Bit 1 Bit 1 / Bit 0 / Speaker Volume 0 / 0 / Low 0 / 1 / Low 1 / 0 / Medium Default 1 / 1 / High Bit 2 Determines the Speaker Status Bit 3 Bit 3 / Bit 2 / Speaker Status 0 / 0 / Always Off 0 / 1 / On Until Carrier is Detected Default 1 / 0 / Always On 1 / 1 / As '01', Except Off for Dialing Bit 4, 5 and 6 Determine Response Messages Bit 6 / Bit 5 / Bit 4 / Message 0 / 0 / 0 / Basic Message Set 1 / 0 / 0 / Extended with Connect 1200 and Connect 2400 1 / 0 / 1 / Extended with 'No Dial Tone' 1 / 1 / 0 / Extended with 'Busy' 1 / 1 / 1 / Extended with All Messages Default Bit 7 Determines Off Hook/On Hook (Make/Break) Ratio for Pulse Dialing Bit 7 / Ratio 0 / 39/61 (USA and Canada) Default 1 / 33/67 (Uk and Hong Kong)
S23	Option Bit Mapped Register (LSB) Bit 0 Not Supported Bit 3 / Bit 2 / Bit 1 0 / 0 / 0 / 300 0 / 0 / 1 / Not Used 0 / 1 / 0 / 1200 0 / 1 / 1 / 2400 1 / 0 / 0 / 4800 1 / 0 / 1 / 9600 1 / 1 / 0 / 19200 1 / 1 / 1 / 38400(reserved) Bit 4 Determines the Parity for Transmitting and Receiving Data

REGISTER NUMBER	REGISTER FUNCTION
	Bit 5 Bit 5 Bit4 Parity 0 0 Even Default 0 1 Space/None 1 0 Odd 1 1 Mark Bit 6 Determines Guard Tone Frequency Bit 7 (Used in European Applications) Bit 7 Bit 6 Guard Tone (Hz) 0 0 Disabled Default 0 1 550 1 0 1800 1 1 Reserved
S24	Not Used
S25	Delay to DTR (Stored in NVRAM) Default = 005 (seconds)
S26	RTS to CTS Delay (Synchronous Mode Only) Default = 1 (milliseconds)
S27	Bit Mapped Register STORED IN NVRAM Bit 0 Bit 1 Transmission Mode Bit 1 Bit 0 Function 0 0 Asynchronous Mode Default 0 1 Synchronous Mode 1 1 0 Synchronous Mode 2 1 1 Synchronous Mode 3 Bit 2 Reserved Bit 3 Reserved Bit 4 Bit 5 Transmission Mode Bit 5 Bit 4 Function 0 0 Internal Modem Clock Used Default 0 1 DTE Supplied Clock 1 0 Slave Clock Mode 1 1 Same as 00 Bit 6 CCITT or Bell Handshaking Standard 0 CCITT 1 Bell (including CCITT V.22bis) Default Bit 7 Reserved
S28-35	Reserved
S36	Negotiate Failure Fallback (Affected by %C and \N) Bits 0 Hang Up 1 Attempt a standard asynchronous connection (&Q0) 3 Attempt an asynchronous connection using automatic speed buffering (&Q6) 4 Attempt a V.42 Alternative Protocol connection (MNP compatible); if negotiation fails, attempt a standard asynchronous connection 5 Attempt a V.42 Alternative Protocol connection (MNP compatible); if negotiation fails attempt a standard asynchronous connection
S37	Not Supported

REGISTER NUMBER	REGISTER FUNCTION
S38	Not Supported
S39	Reserved
S40	Not Supported
S41	Not Supported
S43-45	Reserved
S46	Protocol Selection: Bits 136 LAPM only (V.42)
S47	Not Supported
S48	Feature Negotiation Action 0 Negotiation disabled; presume the remote modem is configured for and has the capabilities necessary for the connection selected with S46 3 Negotiation enabled, but originating modem remains silent during detection phase. For connections with MNP modems; defeats connection sequence with other V.42 modems 7 Negotiation enabled 128 Negotiation disabled; forces fallback options specified in S36 to be taken immediately
S82	Break Handling: Affected by \K commands 3 "Expedited" signaling regardless of its sequence in data sent and received; data integrity maintained 7 "Destructive" signaling regardless of its sequence in data sent and received; data in process at time is destroyed 128 "In sequence" signaling as data is sent and received; data integrity maintained ahead of and after break
S86	Not Supported

Special Notes regarding the use of S registers above S27 and AT/n Commands.

1. Changes of S register values above S27 will effect the profile display for AT/n Commands. AT/n Commands however, do not modify the setting of S registers.

2. It is intended that a user or application software package will use only one method (S register \ n Commands) to effect the error control functions. Use of a combination could result in unpredictable behavior.

APPLICATIONS INFORMATION

The XR-2443 is shown in the XR-2400 modem schematic. The XR-2443 provides the command controller function for the XR-2400 V.22bis modem chip set. For data operation the modem operates error-free through LAPM or MNP 2-4 modes and can offer increased throughput with V.42bis or MNP 5. The XR-2321 device included adds CCITT V.21 and V.23 FSK modes, it is optional and can be eliminated for designs not requiring these modes.

Detailed information for the XR-2400 is available in XR-2400 V.22bis modem chip set datasheet.

Layout Hints

In order for the XR-2443 to provide optimal support for best performance of the modem, some design hints/rules should be followed.

- Locate the XR-2402A AFE near the DAA section - provide for a short transmit / receive carrier input path, away from any digital control lines.

- Maintain separate analog and digital ground / power lines back to the power supply.

- Bypass (capacitor decouple) the XR-2401, XR-2402A, XR-2443 and op amp power supplies with both 0.01μF ceramic and 0.47μF tantalum capacitors near their actual pins. Ensure analog/digital supplies are by-passed to their respective ground.

- Crystal - parallel resonant type. Typical loading capacitors are 18pF.

SYSTEM PERFORMANCE

Performance for an error-correcting modem has two major areas.

1) DATA PUMP PERFORMANCE
With error-detection capabilities turned off, the integrity of the data pump to pass data in the presence of impairments. Most often the major specification measured here is the probability of data errors with the receive carrier impaired by noise, or BER (bit error rate) vs S/N (Signal-to-Noise ratio).

Figure 3 shows BER vs S/N for the XR-2400 modem, as measured with the test set-up in Figure 4.

2) ERROR CONTROLLER PERFORMANCE
The XR-2443, when in LAPM or MNP modes provides the control and detection required to yield perfect data transfer (Data Modem mode).

Beyond error correction, throughput, or data transfer rate, is another important parameter to the modems overall performance.

LAPM and MNP 2-4 Modes are not specifically provided for increased throughput. However an additional benefit of their error-detecting schemes is roughly a 20% increase in throughput. Using the 'Quick Brown Fox....' pattern, both LAPM and MNP 4 modes yielded better than a 20% throughput increase. V.22bis mode was used for this test, with an actual throughput of better than 2900 BPS measured.

MNP 5 Data Compression Included in the XR-2443 allows roughly a 100% throughput increase over the modems nominal data rate. As previously discussed, the throughput performance of MNP 5 varies with different types of data. (Figure 5 shows data for various data patterns). (Figure 6 illustrates the test set-up used for the measurement).

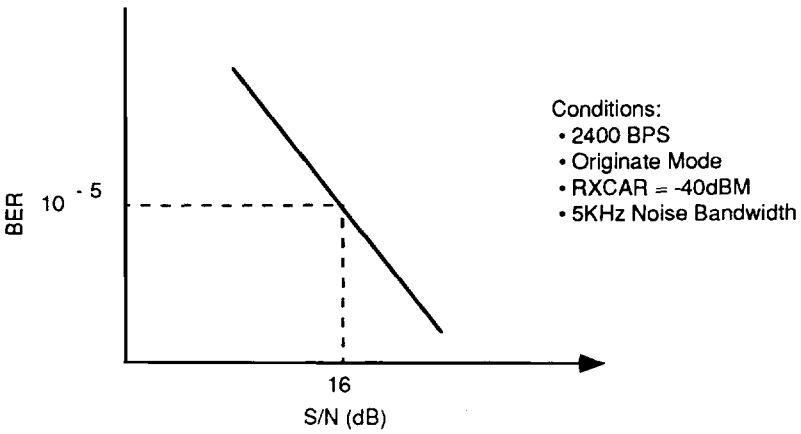


Figure 3. 2400 BPS Ber vs. S/N (Non-Error Correcting)

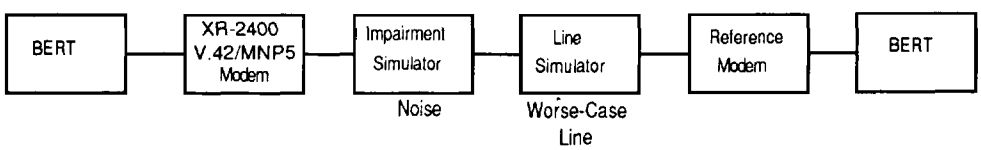


Figure 4. Data Quality Test Set-Up

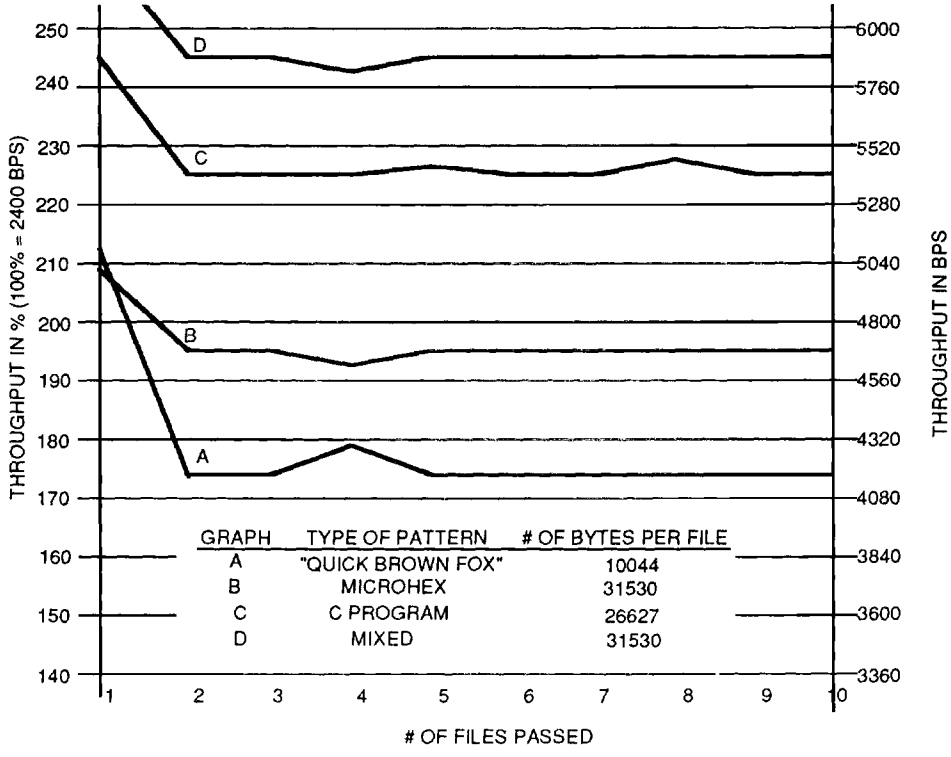
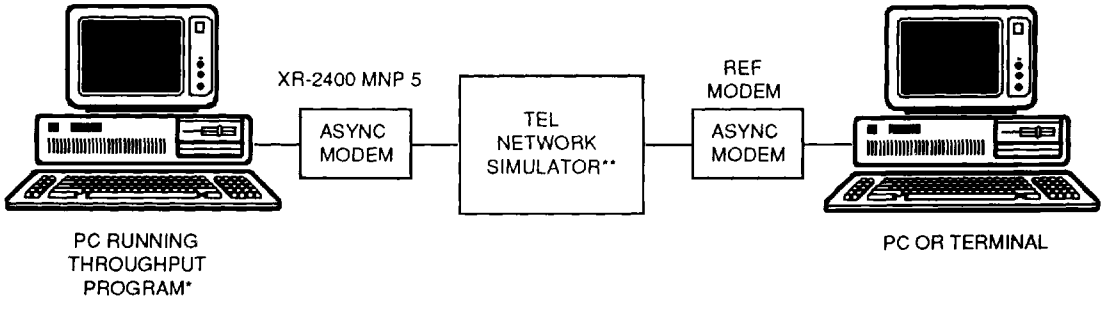


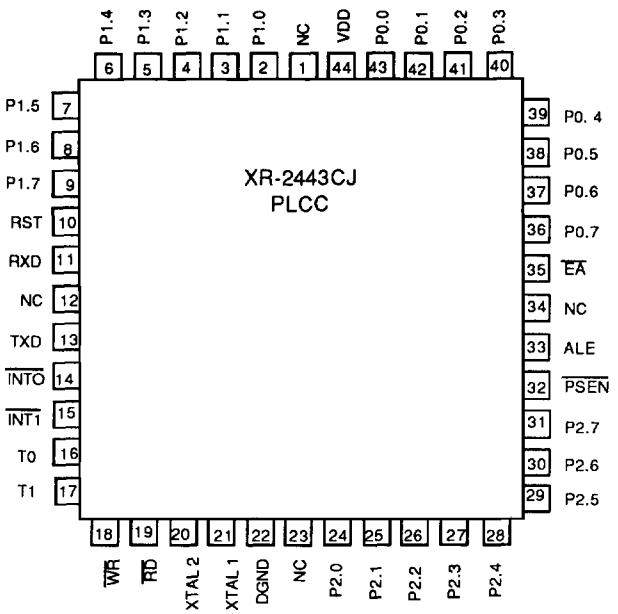
Figure 5. Effective Data Throughput

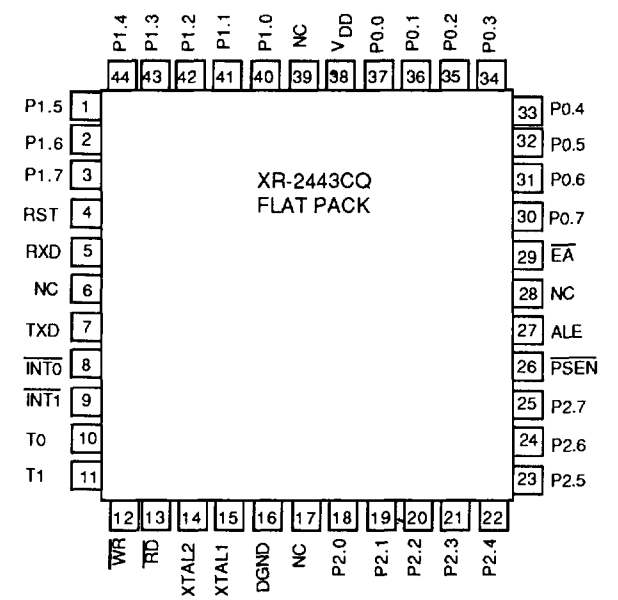


* APT (Asynchronous Performance Tester), also contains data or files to be used during measurement. Product of Concord Data Systems.

** Simulates line impairment and attenuation conditions.

Figure 6. MNP5 Throughput Measurement Test


XR-2443CJ
PLCC
P1.4 6
P1.3 5
P1.2 4
P1.1 3
P1.0 2
NC 1
VDD 44
P0.0 43
P0.1 42
P0.2 41
P0.3 40
P1.5 7
P1.6 8
P1.7 9
RST 10
RXD 11
NC 12
TXD 13
INT0 14
INT1 15
T0 16
T1 17
39 P0. 4
38 P0.5
37 P0.6
36 P0.7
35 EA
34 NC
33 ALE
32 PSEN
31 P2.7
30 P2.6
29 P2.5
18 WR
19 RD
20 XTAL 2
21 XTAL 1
22 DGND
23 NC
24 P2.0
25 P2.1
26 P2.2
27 P2.3
28 P2.4


XR-2443CQ
FLAT PACK
P1.4 44
P1.3 43
P1.2 42
P1.1 41
P1.0 40
NC 39
VDD 38
P0.0 37
P0.1 36
P0.2 35
P0.3 34
P1.5 1
P1.6 2
P1.7 3
RST 4
RXD 5
NC 6
TXD 7
INT0 8
INT1 9
T0 10
T1 11
33 P0.4
32 P0.5
31 P0.6
30 P0.7
29 EA
28 NC
27 ALE
26 PSEN
25 P2.7
24 P2.6
23 P2.5
12 WR
13 RD
14 XTAL2
15 XTAL1
16 DGND
17 NC
18 P2.0
19 P2.1
20 P2.2
21 P2.3
22 P2.4