



**Telebit T2500**  
Reference Manual  
90100-03 Rev. D

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## FCC Standards

This equipment generates and uses radio frequency energy, and if not installed and used in strict accordance with the instructions in this manual, may cause interference to radio and television reception. It has been tested and found to comply with the limits for a Class A computing device under Part 15 of the FCC Rules, which are designed to provide reasonable protection against such interference in a commercial installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the modem on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna.
- Move the modem away from the receiver, or relocate the receiver with respect to the modem.
- Plug the modem into a different outlet so that the modem and receiver are on different branch circuits.

If necessary, you should talk to your dealer or any experienced radio/television technician for additional suggestions. You may find a booklet prepared by the FCC entitled "*How to Identify and Resolve Radio-TV Interference Problems*" helpful in resolving any problems. This booklet is available from the U.S. Government Printing Office, Washington DC 20402, Stock Number 004-000-00345-4.

## **FCC Notice to Users**

1. Upon request only, you must notify your telephone utility company (telco) of your intentions to install or permanently remove an FCC Part 68 registered device, and provide them with the following information:
  - The telephone number to which the equipment will be connected.
  - FCC registration number ER95W5-17716-MD-E.
  - Ringer equivalence numbers 0.2A and 0.3B.
  - Modular jack number USOC RJ11C or RJ45S.
2. The equipment may not be used on telco coin-operated telephone lines. Party lines and privately owned coin-operated telephone lines are subject to local and state regulatory policies, and possible additional state special features.
3. The telephone company has the right to make changes to their network which may affect the operation of your equipment, provided you are given adequate advance written notice to permit correct operation.
4. In the event of operational problems, disconnect your unit by removing the modular jack from the telco's termination. If your regular phone still works properly, your modem may need to be returned for repairs in or out of warranty. If after disconnecting the equipment, your regular telephone does not operate correctly, notify your telephone company that they may have a problem, and request prompt service at no cost to you the user. If a problem is found in premises wiring not telco-installed, you will be subject to an authorized service charge. If a fault is found in telco-installed wiring, you may be subject to a charge for the service call.

5. Except as instructed in the *Diagnostics and Service* chapter of this manual, the user may not under any circumstances (in or out of warranty) attempt any service, adjustments or repairs on this unit. It must be returned to the factory or authorized service agency for all such work. Refer to your *Warranty Registration and Customer Service Information* at the end of this manual for instructions on returning your modem for repair.
6. If the equipment is to be placed behind a PBX or KTS system, it comes under a special FCC category requiring the written approval of the PBX/KTS owner as well as additional FCC registration.



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# Chapter 1

## Introduction

This manual provides a comprehensive guide for setting up and using the Telebit T2500 modem. The manual is intended for computer and terminal users who have a basic understanding of data communications.

You can save time by following the instructions in the *T2500 Fast Start Guide*, which is a separate booklet provided to help you get started using your modem as quickly as possible. If you have special requirements or experience any problems while using the *T2500 Fast Start Guide*, refer to this manual for additional information.

The T2500 modem overcomes the limitation of dial-up telephone lines by using Packetized Ensemble Protocol™ (PEP) modulation. PEP analyzes the quality of the connection at 511 separate frequency points and compensates for line impairments which may exist. The modem's advanced design is ideally suited for high speed file transfer operations. Accordingly, you will gain the most benefits in line costs and time savings when transferring large files.

Some of the major features offered by the T2500 modem are discussed in the following sections:

### **V.42 Error Control Protocol Support**

The T2500 modem supports V.42 error correction and detection protocol standard that provides error-free transmission over a standard full-duplex, V.32, V.22bis, V.22, and Bell 212A connection.

**1** V.42 includes the Link Access Protocol for Modems (LAP-M), which is the main protocol used between two V.42 modems. In addition, V.42 includes an alternate protocol, the Microcom Networking Protocol (MNP), up to class 4. The inclusion of MNP provides backward compatibility between V.42 and existing MNP modems.

### **V.42bis Data Compression Support**

The T2500 modem supports the V.24bis data compression protocol. V.42bis is a high-performance data compression algorithm that increases the speed of data throughput by a ratio of up to 4 : 1. V.42bis data compression is possible only if a connection is established in LAP-M, and both connected modems are configured for data compression. The V.42 protocols are supported by both Conventional and Enhanced Command Modes.

### **MNP™ Support**

The modem can be configured to support MNP Classes 1 through 5 while operating in 300-9600 bps modes. When a connection is established, the modems at each end can negotiate the highest MNP class supported by both modems.

### **V.32 Support**

The T2500 modem can operate in either asynchronous or transparent synchronous V.32 mode. When operating in V.32 mode, the modem will utilize a speed of 9600 bps (with Trellis Coded Modulation), with a selectable fallback of 4800 bps.

### **Two Modes of Software Compatibility**

For maximum flexibility, the modem supports two user interface modes: Conventional and Enhanced Command Modes. In Conventional Command Mode, the modem works with data communications software configured for Hayes® V-series™ modems.

The Enhanced Command Mode allows you to take advantage of the modem's advanced features used by software designed for Telebit modems.

These are the Telebit TrailBlazer Plus, T1000, T1500, T2000, and T2500 modems. The Enhanced Command Mode also gives you access to both asynchronous and transparent synchronous V.32 operation.

## **Packetized High Speed Data Transmission**

Using the PEP data communications protocol, the modem can transmit or receive asynchronous data at speeds of up to 18,000 bps over dial-up telephone lines, or up to 19,200 bps when data compression is enabled.

## **Compatibility with Slower Modems**

For use with lower speed modems, the T2500 is compatible with the 9600 bps V.32 standard, the 2400 bps V.22bis, 1200 bps, the V.22 standards, the 1200 bps Bell 212A and 300 bps Bell 103J standards.

## **Automatic Transmission Mode Selection**

At the time a telephone connection is made, the modem automatically selects the correct transmission speed by matching the transmission mode of the remote modem. If the remote modem is a PEP modem, the modem operates in PEP mode using the Packetized Ensemble Protocol.

This provides maximum data throughput for any given telephone connection. If the remote modem is not a PEP modem, the modem automatically determines the correct transmission mode to use while communicating with the remote modem.

## **Automatic Error Detection and Correction**

**1** While operating in PEP mode, the modem assembles packets of data and adds to each packet a 16-bit Cyclic Redundancy Check (CRC) for the purpose of error detection.

If the receiving modem detects an error, it requests a retransmission of data. All error detection and correction is completely transparent to the user and does not require any additional computer resources.

## **Adaptive Duplex™ for Maximum Throughput**

In order to improve overall system performance, the modem provides an Adaptive Duplex capability while operating in PEP mode. This feature allows the modem to optimize overall throughput by dynamically varying the allocation of transmission capacity and rate of data flow between modems to match the bidirectional traffic load.

## **Real -Time Line Analysis and Adaptation**

Each time a connection is made in PEP mode, the modem performs a line analysis and determines the operating parameters of the transmission. The line characteristics are monitored by the modem during the entire connection, and operating characteristics are adjusted as required for optimum data transmission.

## **Self Test, Internal Diagnostics and Line Monitoring Data**

Each time you turn on the modem, a series of internal logic tests, memory tests, and internal loop back checks are performed. In addition, the modem provides data transmission statistics, such as line quality analysis, signal-to-noise ratios, frequency offset measurements, data flow analysis and error rates.

## Call Progress Reporting and Monitoring

After placing a call using the modem, a message provides the status of the call. The report format is selectable and can be presented in either text or numeric mode. A built-in speaker provides audio feedback of call progress.

## Auto-Dial and Auto-Answer

The modem's Dial command allows you to place the modem off-hook, have it wait for a dial tone, and then automatically dial a telephone number presented by the computer or terminal.

The modem can also be configured to allow your computer or terminal to automatically dial the first number in the number directory via the DTR control signal. Both pulse and tone dialing are supported.

When configured in auto-answer mode, the modem automatically answers an incoming call, allowing you to leave the modem unattended.

## Security Features

The callback security feature protects the host computer from unauthorized access. It allows an originating modem user to dial a predefined number listed in a number directory of the answering modem. The answering modem prompts a password from the originating modem.

If the password, which is entered by the originating modem and corresponds to the password listed in the number directory, is correct, the answering modem hangs up the phone, waits 10 seconds, and calls back the appropriate number indexed in the directory. To implement the callback security feature, the answering modem's number directory is loaded with callback numbers, (0 to 9) and corresponding passwords.



**1** Password security is also available. The originating modem calls the answering modem and prompts for a password. If the password is correct, the originating modem is immediately connected to the DTE.

## **Hardware and Software Flow Control**

The modem lets you specify the method of data flow control when transmitting information. You can select a software protocol such as XON/XOFF and/or hardware flow control using the RS-232 RTS/CTS control signals.

## **File Transfer Protocol Support**

The modem contains protocol support firmware to optimize file transfers while operating in PEP mode. It can be configured to support Kermit, X/Ymodem or UUCP protocols. Protocol support is negotiated between the modems at each end during the PEP initialization sequence. Both modems must agree on the protocol supported, otherwise no protocol is supported during the communications session.

## **SDLC Support**

The T2500 modem can be configured to operate in SDLC Mode when using PEP modulation in SNA/SDLC environments. While operating in SDLC Mode, the T2500 modem automatically determines if it is acting as an SDLC primary or secondary link station during the initial SDLC protocol sequence.

# Chapter 2

## Installation

The T2500 modem is designed to be used with a computer, terminal or other serial device via an asynchronous RS-232C serial interface port. The instructions presented in this chapter describe procedures for connecting the modem between your equipment and the telephone line.

If you have already installed the modem by following the instructions in your *T2500 Fast Start Guide*, you do not need to use this chapter.

*Note: Before powering up your modem, please carefully read Chapter 3, Using the Modem, to determine which command mode should be selected to ensure compatibility with your computer's data communications software.*

### Equipment Checklist

Before installing the modem, make sure that you have the following equipment:

- An AC power cord and transformer provided with your modem.
- The 7-foot telephone cable supplied with your modem.
- A shielded RS-232C cable with a DB-25 male connector for the modem. Your computer dealer can assist you in obtaining the appropriate cable for your requirements. Pin assignments for the RS-232C connectors are provided in Appendix B.
- A small flat-blade screwdriver.

If you do not have the items listed above, obtain them before proceeding.

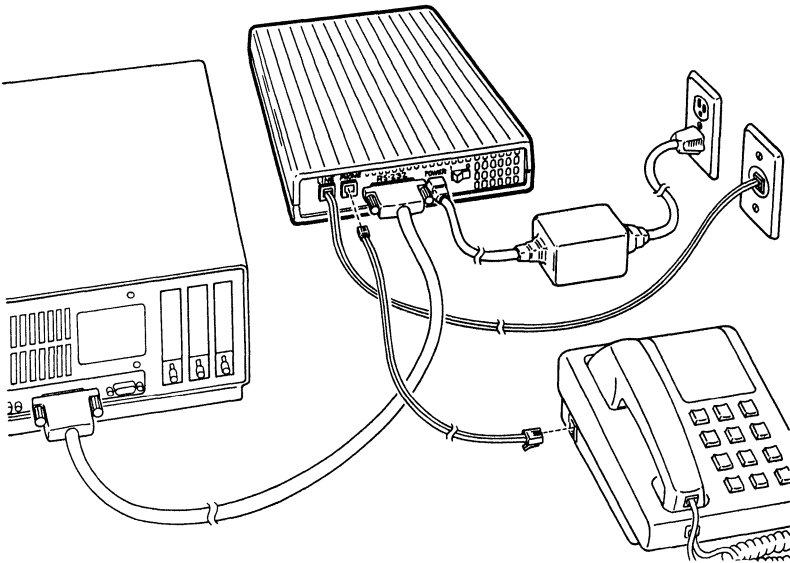
## Installation Checklist

This section summarizes the sequence of steps you should follow to install the modem. For specific instructions on performing the procedures listed, refer to the specified page in this manual.

2

- Before installing the modem in its final position, you may need to first connect it to a terminal (or personal computer with a terminal emulation program), and preconfigure it for your system. See Chapter 3, *Using the Modem*.
- Verify that the modem's power switch is turned off, then connect the AC power cord. *Page 2-3.*
- Connect a shielded RS-232C cable between the modem and your equipment. *Page 2-4.*
- Connect the telephone line from the wall jack to the TO LINE connector on your modem. *Page 2-5.*
- If desired, connect your telephone to the TO PHONE connector on the modem. *Page 2-5.*
- Determine which command mode (Conventional or Enhanced) is appropriate for your specific requirements. *Page 3-7.*
- Power up and initialize the modem in either Conventional or Enhanced Command Mode. *Page 3-2.*

If you have completed the preceding checklist, the modem should be ready for use. Read Chapter 3 for information on configuring and using the modem. Figure 2-1 shows the T2500 cable connections.



**Figure 2-1. T2500 Cable Connections**

## Connecting the AC Power Cord

An AC power cord with a transformer assembly is supplied with the modem.

### Warning

To avoid damaging the modem, only use the AC power cord and transformer provided with your T2500 modem. *Pour utiliser avec BASLER ELECTRIC Model BE117125BBB010 source d'alimentation.*

Refer to Figure 2-1 while connecting the AC power cord to your modem:

1. Verify that the power switch (1/0) on the rear of the modem is turned off (0).
2. Attach the power cord to the connector labeled POWER on the rear panel of the modem. The beveled edge of the plug should be facing up so that it mates with the retainer clip on the connector.
3. Plug the other end of the power cord into a grounded AC wall outlet.

## Connecting the RS-232C Cable

A 25-pin RS-232C connector, located on the back of the unit, is used to connect the modem to your computer or terminal. You must provide a shielded RS-232C cable. Pin assignments for the connectors are listed in Appendix B.

Refer to Figure 2-1 while connecting the RS-232C cables as described below:

1. Attach the male connector of the RS-232C cable to the female connector on the rear panel of the modem labeled RS-232C, and tighten the connector screws until snug.
2. Attach the other end of the RS-232C cable to the correct RS-232C connector on your DTE equipment. Consult your equipment manual for the location of this connector.

## Connecting the Telephone Line

A 7-foot telephone cable is provided with your modem. You should use this cable to connect the modem to the telephone line as shown in Figure 2-1.

Attach one end of the provided RJ11 telephone cable to the connector labeled TO LINE on the rear panel of the modem. Attach the other end to your telephone wall jack.

## Connecting a Telephone

If you wish, you can connect your telephone to the modem. This allows you to make normal telephone calls while your modem is not in use. Simply connect the cord from your telephone to the connector labeled TO PHONE on the rear panel of the modem.

**2**

## After Completing the Installation

Before powering up your T2500 modem, read Chapter 3, *Using the Modem*, to determine which command mode should be selected to ensure compatibility with your computer's data communications software.

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# Chapter 3

## Using the Modem

This chapter presents a general overview of the modem's operating characteristics, and shows you how to enter commands to set parameters and control the modem's operation.

Proceed with this chapter after the modem has been installed by following the instructions in your *T2500 Fast Start Guide* or Chapter 2 of this manual.

If the modem is connected directly to a terminal, you can simply input the commands from the keyboard. When the modem is connected to a computer, you must use its data communications software or a terminal emulation program to configure and use the modem.

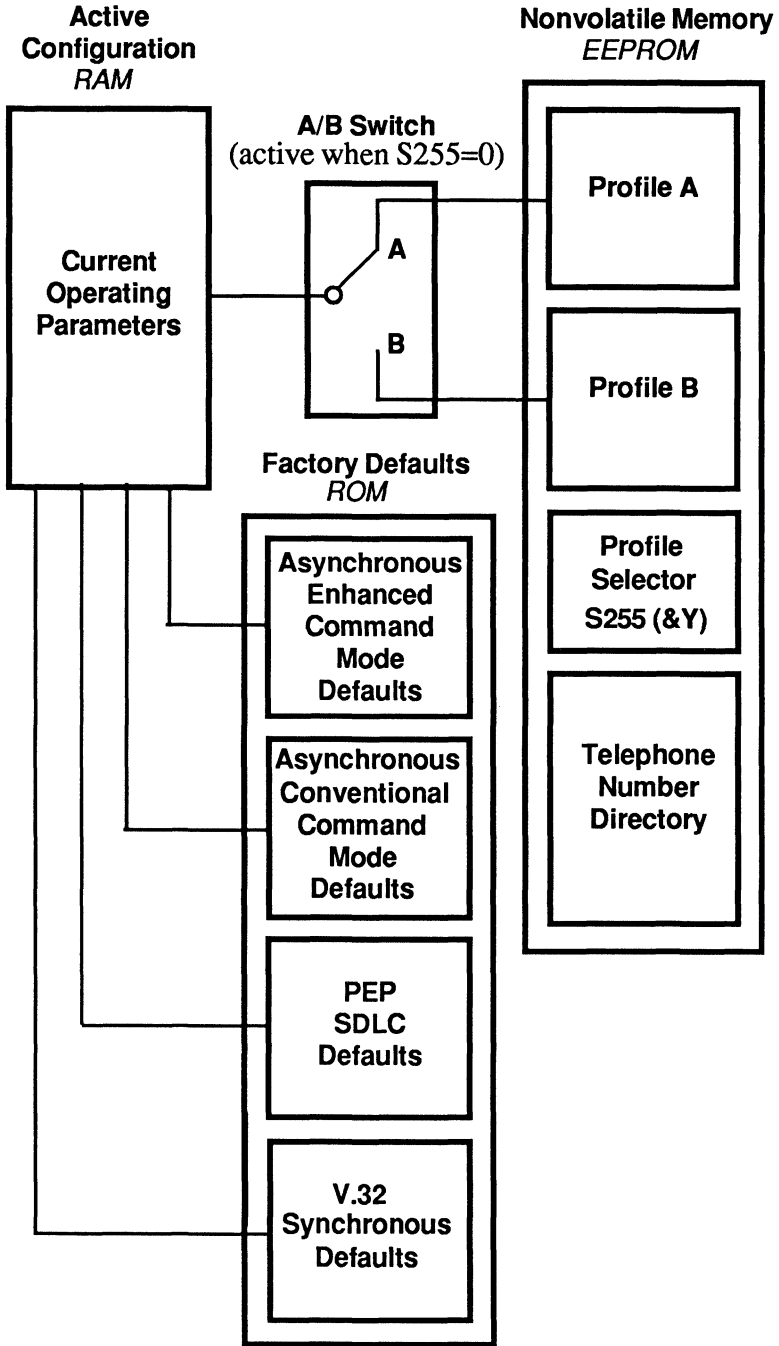
If you intend to use the modem with a mainframe computer or other serial device that will only be accepting incoming calls, you can use a terminal (or personal computer with a terminal emulation program) to preconfigure the modem's operating parameters and save them in nonvolatile memory.

### Memory Organization

Figure 3-1 shows the relationship between the active configuration, the factory defaults and the nonvolatile memory. The active configuration stored in RAM defines the current operating characteristics of the modem.

The factory defaults are the operating parameters most commonly used for data communications that are permanently stored in ROM. These parameters can be restored to the active configuration by issuing an `&F(n)` command or by following the procedures described in the following sections. The Command `AT~&F0` restores Enhanced Command Mode, `AT~&F1` restores Conventional Command Mode, `AT~&F2` restores Enhanced Command Mode, SDLC, and `AT~&F3` restores V.32 Synchronous Mode.





3

Figure 3-1. T2500 Memory Organization

The current operating parameters can be modified and saved in nonvolatile memory as Profile A or Profile B via the &W command in Conventional Command Mode, or &W0 or &W1 commands, respectively, in Enhanced Command Mode.

When a new Profile is selected, its settings replace the current operating parameters. A new profile can also be restored by issuing an &E(n) command (n=0,1, or 2) in Enhanced Command Mode, or by issuing a Z(n) command (n=0 or 1) in Conventional Command Mode.

The S255 register determines which profile is used when the modem is powered up or reset, or when one of the above commands is issued without an (n) parameter. When S255 is set to 0, pressing the A/B switch resets the modem and loads the new profile into the active configuration.

## Default Configuration Selection

The T2500 modem is supplied with four factory default configurations:

- Enhanced Command Mode - Asynchronous
- Conventional Command Mode - Asynchronous
- Enhanced Command Mode - SDLC
- Enhanced Command Mode - V.32 Synchronous

Each default set of the modem can be selected via the Talk/Data and A/B switches. The LED's provide a visual display of the modes selected.

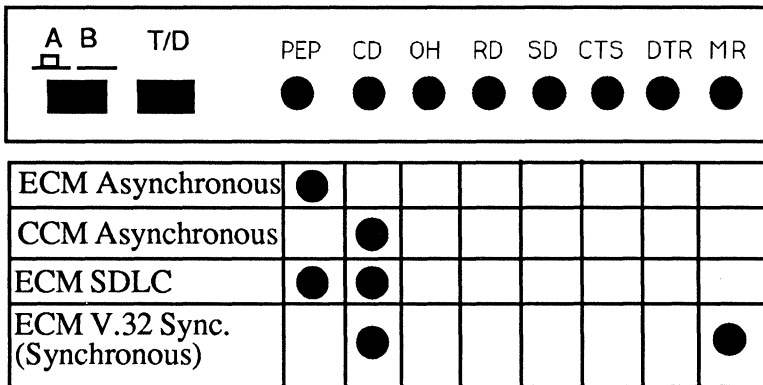
To load a default set into the T2500, follow the steps below. Figure 3-2 shows the various LED displays encountered while selecting a default set.

*Note: If you are unsure about which mode is appropriate for your application, try the Conventional Command Mode - Asynchronous first.*

1. Determine the EEPROM Profile in which the selected operating mode is to be stored. If the operating mode is to be stored in Profile A, set the A/B switch to position A. If the operating mode is to be stored in Profile B, set the A/B switch to position B.

2. Enter the configuration select mode by holding down the Talk/Data switch while turning the power on. Release the Talk/Data switch when the *PEP*, *CD*, and *MR* LED's are flashing.
3. View the operating modes by tapping the Talk/Data switch for less than two seconds. The LED's will step through the various configurations (refer to Figure 3-2).

*Telebit T2500 (Front Panel)*



● = LED ON

**Figure 3-2. Default Set Display**

4. When the LED's indicate the desired operating mode, make your selection by holding down the Talk/Data switch for more than two seconds. When your choice is accepted, the LED's corresponding to the selected operating mode will flash. Release the Talk/Data switch when the LED's flash. The operating mode is written to the Profile selected in Step 1.

Registers S0, S45, and S255 are set automatically as follows:

S0 = 1 (Auto Answer Enabled)

S45 = 255 (Remote Access Enabled)

S255 = 0 (Default User Profile Select)

When mode selection is complete, the LED's go out, and the *MR* LED light. The RAM and EEPROM memory is updated, and the modem is configured for the selected operational mode.

## Front Panel Switches and Indicators

The modem's front panel contains two switches and eight LED indicators that determine the current operating status of the modem (see Figure 3-2). Table 3-1 provides a functional description of the front panel control switches. The status indicators are described in Table 3-2.

**Table 3-1. Front Panel Control Switches**

Switch	Description
A/B switch	This switch is used to select one of two possible sets of operating profiles.
T/D	<p>When the modem is powered up or reset, Profile A or B operating parameters are loaded from the nonvolatile memory depending on the position of the A/B switch. If the switch is in the A position, Profile A is loaded, whereas if the switch is in the B position, Profile B is loaded.</p> <p>Changing the position of the A/B switch resets the modem and loads the new configuration from nonvolatile memory. Note that the A/B switch should not be pressed while a communications session is in progress as this will prematurely disconnect the call.</p> <p>The modem is shipped with Profiles A and B set to operate in Enhanced Command Mode (ECM). Either Profile, however, can be modified by changing the current operating parameters and saving them in nonvolatile memory as Profile A or B via an &amp;W command.</p> <p>This switch controls the modem's connection to the telephone line much like the hook switch on your telephone.</p>

**Table 3-1. Front Panel Control Switches (Continued)**

Switch	Description
T/D switch	This switch controls the modem's connection to the telephone line similar to the hook switch on your telephone.
	<p>If the T/D switch is pressed while the modem is on-hook (OH indicator is OFF), the modem goes off-hook and attempt to connect in either originate or answer mode depending on the setting of the S100. This allows you to manually place a call using the telephone set then switch to Data Mode when the call is established.</p> <p>If you set the S104 register to 3, pressing the T/D switch automatically dials the first or second number in the Number Directory depending on the current setting of the A/B switch. When the A/B switch is in the A position, the first number (N0) is dialed, whereas if the switch is in the B position, the second number (N1) is dialed.</p> <p>If the T/D switch is pressed while the modem is off-hook (OH indicator is on), the modem will go on-hook allowing you to either disconnect the call, or to switch to voice communications provided the telephone handset has been lifted off-hook before the switch is pressed.</p> <p>If the T/D switch is pressed while switching on the power, the modem enters the Configuration Selection Mode.</p>

**Table 3-2. Front Panel Status Indicators**

Status	Description
PEP	<b>PEP Mode</b> - Indicates that the modem is operating in Fast Transmission Mode using the PEP communication protocol, which flashes during a retraining sequence.
CD	<b>Carrier Detect</b> - Indicates that the modem has established a connection with another modem.
OH	<b>Off Hook</b> - Indicates that the modem is using the telephone line.
RD	<b>Receive Data</b> - Indicates that the terminal or computer connected to the modem is receiving data from the modem.
SD	<b>Send Data</b> - Indicates that the terminal or computer is sending data to the modem.
CTS	<b>Clear to Send</b> - This RS-232C signal indicates whether or not the modem is ready to accept data from the terminal or computer. When the indicator is lit, the modem will accept data from the DTE for transmission.
DTR	<b>Data Terminal Ready</b> - This RS-232C signal indicates whether or not the terminal or computer connected to the serial port is ready to transmit or receive data.
MR	<b>Modem Ready</b> - Indicates that the modem is operational.

The power switch (1/0), mounted on the rear of the modem, is used to turn the modem ON or OFF. Each time the modem is turned on, it runs a series of power up diagnostic tests. After successfully completing the tests, the default configuration parameters previously stored in the modem's nonvolatile memory are loaded into the modem's registers, and the MR (Modem Ready) indicator is turned on.

## Selecting Conventional or Enhanced Command Mode

Before using your modem, you should determine which command mode will assure compatibility with your computer's data communications software.

3

Enhanced Command Mode enables the modem to be compatible with software designed for PEP modems. If your application provides support of the advanced features of PEP modems, such as the Telebit T1000, T2000, T2500, or TrailBlazer Plus, then Enhanced Command Mode is the preferred choice.

The same holds true for data communications software that supports other PEP modems, e.g. DCA Fastlink™, Racal-Milgo RM-1822D, or Ven-Tel Pathfinder™.

Conventional Command Mode is designed for software that does not have the ability to utilize the special features of your PEP modem. This is typically indicated by the absence of modem-specific setup options, or applications that assume general Hayes® command compatibility. Conventional Command Mode should be compatible with any data communications software that supports Hayes V-series™ modems.

### Enhanced Command Mode

To ensure that the modem is operating in Enhanced Command Mode with the A/B, you can reset the modem by performing the steps given in this *Default Configuration Selection* section. This stores the Enhanced Command Mode factory default settings in Profile A or B of nonvolatile memory. These default settings are also loaded into the modem's current operating parameters, except that, the S45 register is set to 255, which enables remote access. This allows Technical Support to remotely access your modem. If, however, you turn the modem power off, remote access is no longer enabled.

If you will be using data communications software which supports PEP modems such as the T1000, T2000, T2500, or TrailBlazer Plus, follow the instructions in your software manual to configure and use your modem. Configuration guidelines and descriptions of the commands and registers are presented in Chapter 4, Conventional Command Mode, and Chapter 5, Enhanced Command Mode.

## Conventional Command Mode

If you have decided that Conventional Command Mode is preferable, then follow the procedure described in the *Default Configuration Selection* section, to load the factory default Conventional Command Set. This stores the Conventional Command Mode default settings in either Profile A or B of nonvolatile memory.

These defaults are also loaded into the modem's current operating parameters except that the S0 register is set to 1 and the S45 register is set to 255.

This allows the modem to automatically answer an incoming call (S0=1) with remote access enabled (S45=255), thereby providing a means for Technical Support to remotely access your modem. However, if you turn the modem power off then on, the remote access and auto-answer functions are no longer enabled.

To take advantage of the T2500 features, which normally are not available character (~), allows you to use Enhanced Command Mode commands while remaining in Conventional Command Mode.

If you will be using data communications software which supports PEP modems such as the T1000, T2000, T2500, or TrailBlazer Plus, follow the instructions in your software manual to configure and use your modem. Configurations guidelines and descriptions of the commands and registers are presented in Chapter 4, *Conventional Command Mode*, and Chapter 5, *Enhanced Command Mode*.



## PEP SDLC Mode

PEP SDLC operation allows the fastest IBM Systems Networking Architecture (SNA) SDLC synchronous dial-up connections possible, while providing the error immunity features of Packetized Ensemble Protocol™ (PEP) operation. To initialize the modem for PEP SDLC operation, refer to *Default Configuration Selection*, page 3-3.

3

### SDLC Configuration Procedure

If you need to change the SDLC Mode operating parameters, perform the following steps :

1. Start with the modem turned off, and the A/B switch in the desired profile position.
2. Turn the modem on.
3. Issue the following command line to the modem:

**AT~&F2**

This allows you to access and modify the profile in the Enhanced Command Mode.

4. Configure the modem for your specific requirements. Refer to Table 3-3 for information on configuring your modem.
5. Save the current configuration in the desired profile by issuing the following commands:

**AT~&W**

This sets the configuration in profile A.

**AT~&W2**

This sets the configuration in profile B.

You can now connect the modem to your SDLC equipment. The next time you turn on the modem with the A/B switch in the desired profile position, it will start up in SDLC Mode.

Table 3-3. SDLC Configuration Cross Reference

ACF/NCP/VS Macro	T2500 Register Setting
<b>GROUP</b> or     ,DIAl=YE <b>S</b> ,DIAl=NO ,LNCTL=SDLC ,MODE=PRI ,REPLYTO=10 ,TYPE=NCP	<b>S152=1</b> <b>S152=0</b> <b>S150=1</b>
<b>LINE</b> or     ,ANSTONE=NO ,AUTO=address (AUTO omitted) ,CALL=IN or     ,CALL=INOUT or     ,CALL=OUT or     ,CLOCKING=EXT or     ,CLOCKING=INT or     ,DUPLEX=HALF or     ,DUPLEX=FULL ,LPDATS=NO ,MAXPU=1 ,NEWSYNC=NO ,NRZI=NO ,NRZI=YE <b>S</b> ,RETRIES=10 ,RING=YE <b>S</b> ,SPEED=19200 or     ,SPEED=9600 or     ,SPEED=4800 or     ,SPEED=2400 or     ,SPEED=1200 or     ,SPEED=1200	<b>S102=2</b> <b>S102=0</b> <b>S0=1</b> <b>S0=1</b> <b>S0=0</b> <b>S154=0</b> <b>S154=1</b> <b>S153=1</b> <b>S153=0</b>  <b>S155=0</b> <b>S155=1</b>  <b>S151=5</b> <b>S151=4</b> <b>S151=3</b> <b>S151=2</b> <b>S155=1</b> <b>S151=1</b>

(Boldface values are defaults)

## Command Mode Operation

In command mode, the modem processes data received through the serial interface port as instructions to perform various functions. The command set used by the modem is compatible with applications that expect either a Hayes V-series™ or PEP modem.

The modem is placed in command mode when:

- The power is turned on, and the modem has completed the power up diagnostic tests.
- A data call is disconnected and the modem is placed on-hook.
- The modem cannot successfully complete a call, or the remote modem's data carrier is dropped.
- The modem receives a defined escape sequence or break signal.
- A semicolon (;) is entered at the end of a dialing string.

You may enter a command line of up to 80 characters in uppercase or lowercase with the first command preceded by an AT (or at) and the last command followed by a carriage return. Spaces can be inserted for readability. If you make an error when typing a command, simply backspace over the mistake then retype the line. You cannot backspace over the AT, because it is interpreted immediately after being typed.

To ensure that the modem recognizes the AT prefix, one of the following data formats should be used while issuing commands to the modem:

- 8-bit data with no parity
- 7-bit data with even/odd parity
- 7-bit data with mark/space parity

If the S63 register is set to 0, the AT should not be entered. In this case, the modem treats all characters as commands and operates on the AT as two separate commands.

Temporary switching from Conventional to Enhanced Command Mode is accomplished through a special access character (~) to allow you to make use of enhanced functions that are not normally available in Conventional Command Mode. This access character is particularly useful for selecting file transfer protocol support or for displaying PEP statistics.

*Note: The modem uses only one set of active operating parameters regardless of the command mode being used. Every Conventional Command Mode function has an equivalent in Enhanced Command Mode. Changing an operating parameter in either command mode will alter its equivalent in the other mode. For example, entering &Q5 S36=1 is identical to entering ~S95=2. Appendix C summarizes the command and register equivalents.*

## Result Codes

Normally, result codes are sent through the modem's serial port indicating the current status of a call or the modem's response to a command. These result codes can be set to either numeric or text mode by issuing a Verbose (V) command to the modem. The text mode is intended for viewing by a person, whereas the numeric mode is better suited for use by a computer program. Appendix D shows the result codes in both formats.

In cases where it is undesirable to receive a result code, the Quiet Enable (Q) command can be used to prevent the modem from sending result codes.

## Using the Dial Command

The Dial (D) command is used to place a call through the modem. When this command is issued, the modem stops processing commands, dials the number indicated, and waits for a connection. If no connection is made within a specific period of time, defined by the S7 register, the command is cancelled and the modem returns to command mode.

The following example shows you how to call another modem using tone dialing:

**AT DT 555-6789**

The next example shows you how to have the modem dial through a PBX using pulse dialing (DP9), wait for an outside line (W), dial a long distance telephone number, wait for 8 seconds (,,,) then switch to tone dialing (T) to charge the call to a telephone credit card:

**AT DP9 W 0-408-555-6789,,,,T123-456-7890-1234**

## Using the Auto Answer Feature

The modem automatically answers an incoming call after the number of rings specified by the S0 register, and waits for the remote modem to send a carrier signal. If no carrier signal is detected within the period of time defined by the S7 register, or if any character is sent from your equipment before the modems have established synchronization, the modem sends a NO CARRIER result code to the DTE (computer or terminal). If a carrier is detected, the modem sends a CONNECT XXXX result code indicating the transmission speed of the connection or the DTE interface speed depending on the X command setting. Setting the S0 register to 0 disables auto-answer.

## Changing from Voice to Data Connection

If you are talking on the phone and then want to use your computer to communicate with the other party's computer, use the Dial (D) command and Answer (A) command.

1. Have the other party enter AT D on their system without entering a phone number.
2. Enter AT A on your system within a few seconds.

Both parties can then hang up the telephone. The modem sends a CONNECT result code when the connection is established.

## Using Password/Callback Security

The callback security feature protects the host computer from unauthorized access. Enhanced Command Mode register S46 is used to enable callback security on the answering modem.

When callback security is enabled, the telephone number directory serves as the password and dial-back directory and cannot be displayed. Up to 10 telephone numbers and passwords may be entered in the number directory of the answering modem using the N(n)=(x) command with the password enclosed between backslashes (\) at the end of the dial string (e.g. ATN1=555-1234PASSWORD\).

To change the setting of this register, you will be required to enter a password. The default system password is PEP, which must be entered in uppercase. This password can be changed by entering a U command.

When the S46 register is set to 1, the modem prompts the caller for a password. If the password entered by the caller corresponds with a password listed in the telephone number directory, the answering modem hangs up the phone, waits 10 seconds, and calls back the appropriate number indexed in the number directory, eventually connecting the caller to the local DTE.

When S46 is set to 2, the modem prompts the caller for a password. If the password is correct, the modem hangs up and calls the appropriate number and again prompts the original caller for the password. If the password is verified, the modem connects the caller to the local DTE.

If S46 is set to 3, the modem prompts the caller for a password. If a valid password is entered, the caller is immediately connected to the local DTE. No callback is required.

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# Chapter 4

## Conventional Command Mode

Proceed with this chapter after the modem has been initialized for Conventional Command Mode as described in Chapter 3. If you will be using data communications software that supports Hayes® modems, you do not need to proceed with this manual. Instead, follow the instructions in your communications software manual.

If you intend to use the modem primarily in Enhanced Command Mode to take advantage of the unique advanced features offered by PEP modems, you can skip this chapter. Chapter 5 provides detailed information for configuring and using the modem in Enhanced Command Mode.

You can use the access character (~) to select an enhanced feature such as protocol support without changing modes. For example, entering ~S111=30 enables UUCP protocol support while operating in Conventional Command Mode.

Detailed descriptions of the commands and registers used in Conventional Command Mode along with guidelines for configuring the modem are provided in this chapter. Each command and register description includes explanations of the possible parameters, the range of parameters and the factory default settings.

### Configuration Guidelines

The modem is designed to interface with a wide variety of computer and data communications equipment. Since each device has its own specific requirements, the modem uses a number of registers that can be set to meet the requirements of your system. These register settings can be stored in nonvolatile memory for later use when the modem is powered up or reset.



## Conventional Command Mode

The Set Register (Sn=x) command is used to set a specific register (n) to some value (x). For example, the command AT S0=5 sets the S0 register value to 5.

The Write Configuration Parameters (&W) command stores the current register settings in nonvolatile memory as Profile A (&W0) or Profile B (&W1). The Reset command (Z) is used to load either Profile A (Z0) or Profile B (Z1). If no parameter is entered for the &W or Z commands, Profile A is selected.

### Attended or Unattended Mode

**4A** If the factory default settings for Conventional Command Mode are used, the modem is configured to operate in attended mode with auto-answer disabled (S0=0). When an incoming call is received, the modem sends a RING result code each time the telephone rings, but it will not answer the call until an Answer command (A) is issued.

To set the modem to operate in unattended mode, the following command string will typically suffice:

**AT &F S0=1 &S1 &C1 &D2 &K4 E0 Q1 &W0 &Y0**

This command line recalls the factory default settings (&F); sets the S0 register to answer after the first ring (S0=1); configures the modem to assert DSR and DCD when a valid data carrier is detected (&S1 &C1); hangs up when DTR is dropped (&D2); enables XON/XOFF flow control (&K4); disables command echo (E0); disables displaying result codes (Q1); saves the current configuration to Profile A in nonvolatile memory (&W0); and sets Profile A as the power up default profile (&Y0).

### Transmission Mode Considerations

The modem's transmission speed is negotiated with the remote modem when a connection is made. The N command and S37 register specify the transmission speeds that are acceptable to the modem during negotiation as follows:

**NO** The transmission speed must be the value specified by the S37 register. If the remote modem does not support that speed, a connection is not made.

- N1** The modem is allowed to negotiate the transmission speed up to the maximum specified by S37. The modems arrive at the correct speed by selecting the highest speed that is supported by both modems.
- S37=0** If N=0: Limit transmission to speed of last AT command.  
If N=1: Limit the *highest* transmission speed to the speed of last AT command.
- S37=1-3** Limit the transmission speed to 300 bps operation (Bell 103 or V.21 mode).
- S37=4** Reserved.
- S37=5** Limit the highest transmission speed to 1200 bps maximum (Bell 212A mode if B1 command selected, or CCITT V.22 mode if B0 command selected).
- S37=6** Limit the highest transmission speed to 2400 bps maximum (CCITT V.22bis mode).
- S37=7** Attempt to connect in PEP mode. If unsuccessful, fall back to slower speed .
- S37=8** Reserved.
- S37=9** Attempt to connect in PEP mode. If unsuccessful, fall back to slower speed .

When communicating with another modem in PEP mode, the modem can transmit error-free data with a throughput of up to 18,000 bps. The modem dynamically adjusts its speed based on the quality of the connection.

To select V.32 Mode, issue the command string **AT ~ S50=6**.

If you plan to use the modem in V.22 or V.22bis mode, be aware that some (but not all) of these types of modems use guard tones during synchronization. If you experience problems in establishing a connection try configuring the modem to use one of the following available guard tones:

- &G0** No guard tone
- &G1** Use 550 Hz guard tone
- &G2** Use 1800 Hz guard tone

## Serial Port Interface Speed and Flow Control

Most communication problems occurring over the DTE-DCE interface result from a mismatch in the interface speed and/or flow control method used by the DTE and modem. Both devices must be in complete agreement on the interface speed and flow control method used. Otherwise, information may be lost or garbled.

### Serial Port Interface Speed

The modem examines the AT prefix of the command to automatically determine the interface speed, character length and parity setting of your DTE.

When a connection is made with a remote modem without error control, the modem changes its DTE interface speed to match the speed of the connection. The interface speed at the DTE also must be changed to match the current interface speed, which is indicated by the CONNECT XXXX message sent to the DTE following a connection.

When a connection is made in error control mode, the interface speed is not changed, and flow control is used to compensate for the possible difference between the transmission speed and the interface speed.

### Serial Port Flow Control

The &K command determines the method of data flow control used by the DTE and the modem when transferring data over the serial port. The flow control method specified is only valid when the modem is operating in error control mode.

The modem can be configured to use any of the following flow control methods:

- &K0      Use no flow control.
- &K1      Reserved.
- &K2      Reserved.
- &K3      Use RTS/CTS flow control. This is the factory default setting and is the preferred method of flow control.

- &K4** Use XON/XOFF flow control. The XON and XOFF characters are ASCII DC1 (Control-Q) and ASCII DC3 (Control-S), respectively.
- &K5** Use transparent XON/XOFF flow control. This method provides a way to send XON and XOFF characters as data rather than being interpreted as control characters when used with Hayes' Smartcom III™ communications software.

## RS-232 Control Signal Interpretations

In order to allow the modem to interface with a variety of DTEs, the &C, &D, &R, and &S define the various ways that the modem interprets and uses the RS-232C control signals.

**4A**

### DCD Signal Handling

The &C command determines how the modem handles the DCD (Data Carrier Detected) control signal as follows:

- &C0** The DCD signal is always on.
- &C1** DCD is on when a carrier is detected from the remote modem.

### DTR Signal Interpretation

The &D command and S25 register control how the modem interprets the DTR (Data Terminal Ready) control signal sent from the DTE as follows:

- &D0** The modem assumes that DTR is always true.
- &D1** The modem enters command mode when the DTR signal is switched from on to off.
- &D2** The modem disconnects a call in progress, enters command mode, and disables auto-answer when the DTR signal is switched from on to off. Auto-answer is enabled when the DTR signal is returned to an active state.
- &D3** The modem resets and enters command mode when the DTR signal is switched from on to off. This causes the modem to recall the user profile parameters designated by the &Y command.

## Conventional Command Mode

The modem does not recognize DTR signal level changes with a duration less than the time specified by S25 register.

### RTS/CTS Signal Handling

- &R0 The CTS (Clear to Send) signal tracks the RTS (Ready to Send) signal. CTS is turned on when RTS goes from off to on. Synchronous data received while CTS is off is ignored.
- &R1 The RTS signal is ignored. CTS is turned ON when the modem is ready to receive synchronous data.

**4A**

### DSR Signal Handling

The &S command determines how the modem handles the DSR (Data Set Ready) control signal as follows:

- &S0 The DSR (Data Set Ready) signal is on when the modem is ready to accept commands or data.
- &S1 The DSR signal is turned on when the modem is connected and ready to communicate with a remote modem.

### File Transfer Protocol Support

When file transfer protocol support is enabled, the modem interacts with the protocol to eliminate delays in the file transfer which normally occur with other high-speed modems. This significantly increases the data throughput rate without altering the protocol functionality.

The modem can be configured to provide protocol support for any of the following file transfer protocols when a connection is made in PEP mode only:

- |          |          |
|----------|----------|
| ■ Kermit | ■ UUCP   |
| ■ Xmodem | ■ Ymodem |

The protocol supported is negotiated between the modems at both ends during the connection initialization sequence.

Protocol support is an enhanced feature that is controlled by the S111 register. This register can be accessed in Conventional Command Mode by issuing an `~S111=n` command where `n` specifies the protocol to support.

Setting the S111 register to 255 allows the modem to support the protocol specified by the modem at the other end of the connection. Typically, if the answering modem's S111 register is left at its default setting of 255, the calling modem can then specify the protocol to support via its S111 register setting. If both modems have S111 set to 255, no protocol will be supported. If neither modem has its S111 register set to 255, then both modems must agree on the setting of the S111 register to allow protocol support.

**4A**

Refer to the description of the S111 register in Chapter 5 for specific settings.

## **MNP Support**

The modem can be configured via the `&Q5` command and S36 register to provide MNP support while operating in V.32 and low-speed modes. Classes 1 through 5 are supported. To limit MNP support to classes 1-4 (no data compression), issue an `AT~S96=0` command to the modem. When an MNP connection is made, the modem automatically operates at the highest level supported by both modems.

If an MNP connection cannot be made, the modem either disconnects and returns a NO CARRIER result code (`S36=0`), or falls back to a normal nonerror-controlled connection (`S36=1`).

Refer to the descriptions of the `&Q` command and S36 register for additional information.

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## Command Descriptions

This section describes the commands used when operating in Conventional Command Mode. Refer to Chapter 5 for a description of the commands available in Enhanced Command Mode.

You may enter a command line of up to 80 characters in uppercase or lowercase with the first command in the line preceded by an AT or at and the last command followed by a carriage return. If you make an error while typing a command, simply backspace over the mistake then retype the line. You cannot backspace over the AT prefix because it is interpreted immediately after being typed.

The notation “(n)” in the descriptions represents a decimal numeric option, and “(x)” represents an assigned value. The parentheses should not be typed. If a command is typed without a value when one is expected, the modem assumes a value of 0.

The option should immediately follow the command. For example, to turn off the result codes, type Q1; not Q=1. The use of the equal sign (=) is explained under the S command.

Spaces can be inserted between commands for improved readability. Entering a comma between commands causes the modem to pause for the amount of time specified by the S8 register.

You can repeat the last command line issued by entering A/ or a/. Do not enter the AT prefix or a carriage return when using this command.

### ~      **Enhanced Command Mode Access Character**

A special access character allows you to enter commands that are not normally available in Conventional Command Mode. All commands following a tilde character (~) to the end of the command line are interpreted in Enhanced Command Mode. The modem returns to Conventional Command Mode at the beginning of the next command line unless Enhanced Command Mode is selected by a ~S63=0 or ~S63=1 command.

**4B**



The ASCII code for the access character to be used is stored in the S222 register, which is accessible in Enhanced Command Mode only. If your keyboard does not have a tilde character (~) power up the modem in the Enhanced Command Mode (see *Initializing the Modem* in Chapter 3), and change the value in the S222 register to the ASCII code of the desired character.

**Note:** The modem uses only one set of active operating parameters regardless of the command mode being used. Every Conventional Command Mode function has an equivalent in Enhanced Command Mode. Changing an operating parameter in either command mode alters its equivalent in the other command mode. For example, entering ~S95=2 is identical to entering &Q5 S36=1. Appendix C summarizes the command and register equivalents.

**4B**

## **A Answer**

The A command causes the modem to connect to the phone line and issue a carrier. If you are using the established phone connection for voice communications and then want to switch your system to data mode to communicate with the other party's system, you must use this command in the following way:

1. Have the other party enter AT D on their system without entering a phone number.
2. Enter AT A on your system within a few seconds.

## **B(n) Bell Mode Selection**

n is either 0 or 1

Default is 1

The B command is used to select either CCITT or Bell standards while operating at 300 or 1200 bps transmission mode.

- B Same as B0.
- B0 Use CCITT standard for transmission (V.21 at 300 bps, V.22 at 1200 bps).
- B1 Use Bell standard for transmission (103J at 300 bps, 212A at 1200 bps).

## D(n) Dial

The D command is used to place a call by sending a dialing sequence to the modem. A valid dialing sequence is composed of a D followed by the digits 0-9 and dialing options which specify the number to dial. The characters A, B, C, D, #, and \* also may be used when tone dialing (T) is selected. These characters are ignored while pulse dialing (P). Parentheses, slashes, hyphens, periods and spaces may be used in the dialing sequence to improve readability.

The D command causes the modem to stop interpreting other commands, dial the number indicated, and wait for a connection. If no connection is made within the period of time defined by the S7 register, or if any character is sent from your equipment before the modems have established synchronization, the D command is canceled and the modem returns to command mode.

Since the modem can use either pulse or tone dialing, you must specify which you prefer or the modem uses the last mode selected. Also, the modem defaults to pulse dialing when powered on, unless the parameter in the nonvolatile memory has been set to tone dialing.

The characters listed below are commands that are valid only within a dialing sequence.

- P Use pulse dialing.
- T Use tone dialing.
- W Wait up to the number of seconds in the S7 register for a valid dial tone.
- , Pause for the amount of time specified by the S8 register before continuing the dial sequence.
- @ Wait for five seconds of silence before continuing. If five seconds of silence is not detected within 30 seconds, the modem hangs up and sends a NO ANSWER result code.
- ! Initiate momentary on-hook flash, a function similar to that of rapidly pressing your telephone hook down and up. The telephone handset must be on-hook for this to work.

## Conventional Command Mode

- ;  
Remain in command mode after dialing without waiting for a connection. This option terminates the dial sequence, causing the modem to remain in command mode
- S=n  
References a number string stored in the number directory. This option should be placed at the end of the dialing sequence. All subsequent characters are ignored.
- R  
Switch to answer mode when finished dialing. This option must be entered at the end of the dialing sequence.

The following examples show the correct command format to make the modem dial a number using pulse dialing, wait for an outside line, and then switch to tone dialing:

**AT D P9WT408-555-6789** or  
**AT D P9WT4085556789**

Either way is acceptable since the modem ignores hyphens and spaces in the dialing sequence.

- E(n) Echo ON/OFF**  
n is either 0 or 1  
Default is 1

The E command instructs the modem, while in command mode, to echo characters back to the local DTE.

- E Same as E0.
- E0 Echo OFF.
- E1 Echo ON.

- F(n) Echoplex ON/OFF**  
n is either 0 or 1  
Default is 1

The F command instructs the modem to echo data characters back to the local DTE during data transmission. The Conventional Command Mode does not support online echo.

- F Same as F0.
- F0 Returns ERROR. (Does not alter setting).
- F1 No Echo.

**H(n) Hook ON/OFF**  
n is either 0 or 1

The H command allows the modem to control the telephone switch hook. Both options for n are defined below:

- H Same as H0.
- H0 Hang up.
- H1 Go off-hook.

**I(n) Information**  
n is 0 - 2

The I command requests the modem to return its product identification number, and other information used by Technical Support.

- I Same as I0.
- I0 The modem returns a product identification character string, which defines the model number and revision level.
- I1 The modem returns a three-digit number used by Technical Support.
- I2 The modem responds with an OK result code.

**L(n) Speaker Volume**  
n is 0 - 3  
Default is 2

The L command determines the speaker volume when it is enabled.

- L Same as L0.
- L0 Low volume.
- L1 Low volume.
- L2 Medium volume.
- L3 High volume.

**M(n) Speaker ON/OFF**

n is 0 - 3

Default is 1

The M command determines when the modem's internal speaker is enabled or disabled as follows:

- M Same as M0.
- M0 Speaker Disabled.
- M1 Speaker Enabled only when dialing and connecting.
- M2 Speaker Enabled at all times.
- M3 Speaker Enabled after dialing until carrier detected.

**4B**

**N(n) Transmission Speed Negotiation**

n is either 0 or 1

Default is 1

The N command determines if the modem is allowed to negotiate the modulation standard used when the speeds of the two modems are different. When the factory default setting (N1) is used, the modem determines the correct speed by falling back or rising up to the speed of the remote modem.

- N Same as N0.
- N0 The speed of the connection must be as specified by the S37 register. If S37 is set to 0, the connection speed must match the speed of the last AT command.
- N1 Allows a connection at any transmission speed supported by both modems up to the maximum specified by the S37 register. If S37 is set to 0, the speed of the last AT command is used.

If the selected transmission speed is 300 or 1200 bps, the modem references the present setting of the B command to select either the Bell or CCITT communication standards.

**O(n) On-Line**  
n is either 0 or 1

The O command places the modem in data mode. When the modem has been forced to enter command mode via an escape sequence or because DTR is turned off with &D1 enabled, the O command resumes data communication. If the modem is off-hook but not connected, it attempts to connect in the same mode (originate or answer) as the most recent connection.

- O Same as O0.
- O0 Returns modem to data mode.
- O1 Returns modem to data mode and initiates a retrain sequence.

4B

**Q(n) Quiet Enable**  
n is 0 - 2  
Default is 0

The Q command controls the reporting of result codes to the local modem.

- Q Same as Q0.
- Q0 Modem returns result codes.
- Q1 Modem does not return result codes.
- Q2 Modem returns result codes when originating a call, but does not return result codes when answering a call.

**S(n)=(x) Set Register**

The S(n)=(x) command allows the local DTE to assign register n a value of x. The modem supports a number of definable registers, which are described later.

The S(n) command sets a pointer to the register specified by n. Each new S(n) command reassigns the pointer. Typing the S command without the n parameter points to the S0 register. This means that an S? command returns the value of the S0 register.

The  $=(x)$  is a separate command that assigns a value specified by  $x$  to the register pointed to by the previous  $S(n)$  command. Therefore, any command with an  $=(x)$  used in error changes the last explicitly referenced  $S$  register. Similarly, an  $AT?$  command displays the contents of the previously selected  $S$  register.

### **$S(n)?$ Read Register**

The  $S(n)?$  command allows the local DTE to read the contents of register  $n$ . Remember that an  $S?$  command will set the register pointer to  $S0$  and return the value of the  $S0$  register. An  $AT?$  command will display the contents of the last register selected by an  $S(n)$  command.

**4B**

### **$V(n)$ Verbose ON/OFF**

$n$  is either 0 or 1

Default is 1

The  $V$  command determines the format of the result codes. A 0 directs the modem to return numeric responses. No line feed is sent with numeric responses. A 1 causes the modem to return a more detailed description using English words.

$V$  Same as  $V0$ .

$V0$  Numeric Result Codes Enabled.

$V1$  English Descriptions of Result Codes Enabled.

**W(n) Negotiation Progress Reporting**

n is either 0 or 1

Default is 0

The W(n) command enables an additional set of result codes to report the progress of the negotiation phase in error-control mode. If enabled, these messages report first the carrier speed, then the protocol.

- W Same as W0.
- W0 Error-control call progress not reported.
- W1 Error-control call progress reported, provided the Xn setting is greater than 0.

In error-control mode, the CARRIER speed and CONNECT speed messages may be different. This is because of the modem's ability to communicate with a remote modem at one speed and with the local DTE at another speed.

**4B****X(n) Result Code and Dialing Capabilities**

n is 0 - 4

Default is 4

The X(n) command is used to select result codes and enable dialing capabilities as follows:

- X Same as X0.
- X0 Basic Result Codes (0 - 4) Enabled - The modem blindly dials and sends a CONNECT result code when the connection is made. Dial tone and busy signals are not recognized.
- X1 Result Codes 0 - 5, 10 - 12 and 14 Enabled - The modem blindly dials and sends the appropriate CONNECT XXXX result code when the connection is made. Dial tone and busy signals are not recognized.
- X2 Result Codes 0 - 6, 10 - 12 and 14 Enabled - The modem waits for a dial tone before dialing and sends the appropriate CONNECT XXXX result code when the connection is made. The NO DIALTONE result code is sent if a dial tone is not detected within 5 seconds. The busy signal is not recognized.



- X3 Result Codes 0 - 5, 7,10 - 12 and 14 Enabled - The modem blindly dials and sends the appropriate CONNECT XXXX result code when the connection is made. The BUSY result code is sent if a busy signal is detected. The dial tone is not detected.
- X4 Result Codes 0 - 7,10 - 12 and 14 Enabled - The modem waits for a dial tone before dialing and sends the appropriate CONNECT XXXX result code when the connection is made. The NO DIALTONE result code is sent if a dial tone is not detected within 5 seconds. The BUSY result code is sent if a busy signal is detected.

See Appendix D for result code definitions.

**4B** **Y(n) Disconnect on Break**  
n is either 0 or 1  
Default is 0

The Y command, for non-PEP connections only, determines if the modem will respond to a disconnect signal.

- Y Same as Y0.
- Y0 Modem does not respond to a disconnect signal.
- Y1 If the modem receives a continuous break signal from the remote modem for a period greater than or equal to 1.6 seconds, it disconnects. If the H0 command is issued or DTR is turned off while &D2 is selected, the modem transmits a four second break signal then disconnects (goes on-hook).

**Z(n) Reset**  
n is either 0 or 1

The Z command disconnects the phone line and restores the command and register settings to the appropriate user profile values stored in nonvolatile memory.

- Z Same as Z0.
- Z0 Modem resets and recalls User Profile A.
- Z1 Modem resets and recalls User Profile B.

**&C(n) Data Carrier Detect Control**  
n is either 0 or 1  
Default is 0**4B**

The &C command defines the DCD signal interpretation. It can be set to keep DCD active at all times or to track the state of the data carrier from the remote modem.

- &C Same as &C0.
- &C0 DCD is always on.
- &C1 DCD is on when the carrier from the remote modem is detected.

## **&D(n) Data Terminal Ready Interpretation**

n is 0 - 3

Default is 0

The &D command defines the DTR signal interpretation. The modem responds to changes in the DTR signal as follows:

- &D** Same as &D0.
- &D0** Modem ignores changes in the DTR signal.
- &D1** Modem enters command mode when an on-to-off transition of DTR is detected.
- &D2** Modem hangs up, enters command mode, and disables auto-answer when an on-to-off transition of DTR is detected. Auto-answer is enabled when DTR is turned on.
- &D3** Modem performs a hard reset and enters command mode when an on-to-off transition of DTR is detected. Note that a hard reset recalls the user profile designated as the default by an &Y command.

**4B**

## **&F Recall Factory Configuration Parameters**

This command restores the Conventional Command Mode factory default configuration parameters to the operating registers.

To restore one of the other factory defaults, refer to the list below:

- ~&F0** Enhanced Command Mode Parameters.
- ~&F1** Conventional Command Mode Parameters.
- ~&F2** Enhanced Command Mode, SDLC Parameters.
- ~&F3** V.32 Transparent Synchronous Mode Parameters.

**&G(n) Guard Tone Selection**

n is 0 - 2

Default is 0

In V.22 or V.22bis mode, the answer modem uses this command to determine if a guard tone is required, and what type of guard tone to send.

- &G Same as &G0.
- &G0 No guard tone (typical U.S. operation).
- &G1 Use 550 Hz guard tone.
- &G2 Use 1800 Hz guard tone.

**&J(n) Jack Type Selection**

n is either 0 or 1

Default is 0

**4B**

The &J command designates how the modem utilizes available telco leads.

- &J0 Auxiliary telco leads disabled.
- &J1 A/A1 control selected.

**&K(n) Flow Control**

n is 0 - 5

Default is 3

The &K command determines the method for controlling the flow of data between the local DTE and modem when the modem is configured to operate in error-control mode (&Q5).

- &K Same as &K0.
- &K0 No flow control is used.
- &K1 Reserved.
- &K2 Reserved.

- &K3 Use RTS/CTS flow control. The modem does not send data to the local DTE while RTS is off. When the modem wants to stop the flow of data from the local DTE, it turns off CTS. When the modem is ready to accept data from the local DTE, it turns on CTS.
- &K4 Use XON/XOFF flow control. When the modem receives an XOFF character from the local DTE, it stops sending data to the DTE until it receives an XON. Similarly, if the modem wants to stop the flow of data from the local DTE, it sends an XOFF to the DTE. When it is ready to accept data from the DTE, it sends an XON. This method should not be used if XON or XOFF characters are contained in the data stream. The XON and XOFF characters are ASCII characters DC1 and DC3 respectively.
- &K5 Use transparent XON/XOFF flow control. This method is used by Hayes Smartcom III communication software to provide a way to send XON/XOFF characters as data rather than control characters.

**4B**

**&L(n) Line Type Selection**  
n is either 0 or 1  
Default is 0

The modem can be configured for either two-wire dial-up or leased line operation.

- &L Same as &L0.
- &L0 Dial-up line.
- &L1 Leased line. To make a connection over a leased line, after entering &L1, one modem should originate the call with the D command and the other modem should answer the call with an A command. When connecting the modem to a four-wire private line, a two-wire to four-wire hybrid is required.

**&M(n) Communication Mode Selection**

n is 0-3

Default is 0

The &M command determines the operating mode (asynchronous or synchronous) of the modem.

**&M0** Asynchronous Mode. This mode uses asynchronous communications for commands and data. Dialing options are specified in ECM register S104.

**&M1** Synchronous Mode 1. The modem operates in asynchronous mode until a connection is established, at which time the modem switches to synchronous mode. This transition is signalled by the off to on transition of DCD (if enabled), or by the CONNECT message. All result codes and messages are sent asynchronously. After DCD is true, the modem waits the number of seconds specified in S25 and checks DTR status. If DTR is on, data connection is completed. If DTR is off, the modem hangs up and reverts to asynchronous mode.

Changing the state of the DTR signal causes the action specified in the Enhanced Command Register S52 to occur. This may include going to asynchronous command state or terminating the call. To drop a connection when in the Data Mode, press the Talk/Data switch, disconnect the phone line, or drop DTR (if ECM register S52 is set appropriately). Once the modem hangs-up it reverts to asynchronous mode.

**&M2** Synchronous Mode 2. This mode is similar to &M1, but includes the ability to dial a predesignated number and to disconnect a call via the DTR signal. When DTR is ON, the modem dials the number stored in location 0 of the phone number directory.

Result codes and messages are sent in asynchronous mode. After a connection is established, signalled by DCD true, the serial port changes to synchronous mode. ECM register S52 is set to a value of 4 when this mode is initiated. This value causes a call to be disconnected when the user drops DTR for longer than the time specified in S25. The call can also be dropped by pressing the Talk/Data switch or by losing carrier. When DTR is off, the modem does not auto-answer.

**4B**

**&M3** Synchronous Mode 3. This mode is similar to &M1, but adds the ability to have DTR control modem actions. When DTR is sensed, the modem goes off-hook and attempts to establish a connection. Result codes and messages are in asynchronous mode. After DCD is true, the synchronous mode is used. In establishing a connection, the modem looks at register S1. If S1 is nonzero, the modem attempts to answer the call. If S1=0, the modem attempts to originate the call without dialing a number. ECM register S52 is set to 4 when this mode is initiated. This causes a call to be disconnected when the user drops DTR for longer than the time specified in S25. The call can also be dropped by pressing the Talk/Data switch or by losing carrier. When DTR is off the modem does not auto-answer.

### 4B

#### **&P(n) Pulse Dialing Make/Break Ratio**

n is either 0 or 1  
Default is 0

The &P command is used to select the make/break ratio used when pulse dialing.

- &P** Same as &P0.
- &P0** 39% Make/61% Break ratio. US timing.
- &P1** 33% Make/67% Break ratio. UK timing.

#### **&Q(n) Communication Mode Selection**

n is 0 - 3, 5  
Default is 5

The modem can be configured for asynchronous, synchronous, or error correction mode.

- &Q** Same as &Q0.
- &Q0** Asynchronous Mode. This command is equivalent to &M0.
- &Q1** Synchronous Mode 1. This command is equivalent to &M1.
- &Q2** Synchronous Mode 2. This command is equivalent to &M2.
- &Q3** Synchronous Mode 3. This command is equivalent to &M3.

**&Q5** Asynchronous Error Control Mode. When a carrier is established, the modem attempts to establish an MNP connection. If an MNP connection cannot be made, the modem either drops the connection or falls back to a normal nonerror-controlled connection depending of the setting of the S36 register.

If S36 is set to 0, the modem drops the connection and sends a NO CARRIER result code if an MNP connection cannot be made within 18 seconds of establishing carrier.

If S36 is set to 1, the modem falls back to a normal nonerror-controlled connection if an MNP connection cannot be made within 4 seconds of establishing carrier.

## **&R(n) RTS/CTS Signal Interpretation**

n is either 0 or 1  
Default is 1

**4B**

This command determines how the CTS signal behaves in response to RTS signal changes. In Asynchronous Mode, the CTS signal is always ON.

**&R** Same as &R0.

**&R0** CTS tracks RTS. When the modem is ready to receive synchronous data, CTS is turned on in response to an off-to-on transition of the RTS signal, after the delay specified by register S26.

**&R1** RTS is ignored. CTS is turned on when the modem is ready to receive synchronous data.



## **&S(n) Data Set Ready Interpretation**

n is either 0 or 1  
Default is 0

The &S command defines how the modem interprets the Data Set Ready (DSR) signal.

**&S** Same as &S0.

**&S0** DSR is always ON.

**&S1** DSR is ON when the modem is ready and connected with another modem. DSR is turned ON when the answer tone is detected from the remote modem, while originating a call, or when the modem begins transmitting an answer tone while answering a call.

**4B**

## **&T(n) Test Function**

n is 0 - 8  
Default is 4

The &T command is used to determine if a communications problem is caused by the local modem or DTE, the remote modem or DTE, or the connections between the two sites. When the modem is performing a test function, its MR indicator blinks at a rate of approximately once per second.

To perform tests after establishing a connection, you must return to command mode by issuing the escape sequence (+++).

Issue the appropriate &T command while in command mode.

**&T** Same as &T0.

**&T0** Terminate the test in progress. You may need to issue the escape sequence (+++) to return to command mode prior to issuing an &T0. Entering the H0 (hang-up) or Z (reset) command also terminates the test. The S18 register can be set to automatically terminate a test after a specific amount of time.

**&T1** This test checks the path between the local modem and DTE. Issue an &T1 command and type a few sentences.

If the modem echoes your keyboard input as you type, the local DTE and modem are operating correctly. Terminate the test by issuing an escape sequence and &T0 command.

- &T3** This test checks the communication link and the remote modem. During this test the local modem sends incoming data directly back to the remote modem. Establish a connection with a remote modem, then issue an escape sequence and &T3 command. Ask the person at the remote system to type a few sentences. If the data is sent back to the remote system without errors, the remote modem and communication link are functioning correctly.
- &T4** Allows the local modem to grant a test request from the remote modem.
- &T5** Causes the local modem to deny a test request from the remote modem.
- &T6** This test checks the operation of both modems, the local DTE, and the telephone connection by commanding the remote modem to loop back data received from the local modem. Establish a connection with the remote modem, then issue an escape sequence and &T6 command. After the command has been accepted, the modem goes back on-line. Type a few sentences. They will be sent directly back to your terminal without appearing on the remote terminal's screen. If the modem echoes your keyboard input as you type it, the modem is operating correctly.
- &T7** The local modem sends a self- test pattern to the remote modem, which returns the test pattern to the local modem. The local modem examines the received test pattern and increments a counter each time an error is detected. Establish a connection with the remote modem, then issue an escape sequence and &T7 command. When the test is terminated, a three-digit number is sent to the local DTE indicating the number of errors. If the error count is 000, the modems and telephone network passed the test. An error count of 255 indicates that 255 or more errors were detected.
- &T8** The modem performs a local self test. This test may be performed without establishing a connection with another modem. When the test is terminated, a three-digit number is sent to the local DTE indicating the number of errors.
- If the error count is 000, the modem passed the test. An error count of 255 indicates that 255 or more errors were detected.

## **&V      View Active Configuration and User Profiles**

The &V command displays the active configuration and user profiles A and B. The first four telephone numbers are also displayed. This command should be issued on a line by itself.

A tilde character (~) in the display indicates that a parameter has been set through Enhanced Command Mode that is not normally used in Conventional Command Mode. For example, a ~S58=5 (use ENQ/ACK flow control) causes &K~ to be displayed when an &V command is issued.

## **4B      &W(n) Write Configuration Parameters**

n is either 0 or 1

This command stores the active configuration parameters in non-volatile memory as one of two user-defined profiles.

&W      Same as &W0.

&W0     Writes active configuration parameters to User Profile A.

&W1     Writes active configuration parameters to User Profile B.

The speed at which the &W command is issued determines the speed at which the modem initially attempts to report result codes when the corresponding profile is recalled. Since the modem automatically adjusts its speed to match the speed of the AT command, the stored speed associated with the user profiles is only significant when operating in unattended auto-answer mode.

**&X(n) Synchronous Transmit Clock Source**

n is 0 - 2

Default is 0

**&X** Same as &X0.**&X0** The modem generates the transmit clock signal, and applies it to pin 15 of the RS-232C connector.**&X1** The DTE (Data Terminal Equipment) generates the clock signal, and applies it to pin 24 of the RS-232C connector.**&X2** The modem derives the transmit clock signal from incoming data signals, and applies the clock signal to pin 15 of the RS-232C connector (slave operation).**&Y(n) Default User Profile Selection**

n is either 0 or 1

**4B**

The &Y command designates which user profile to recall when the modem is powered up.

**&Y** Same as &Y0.**&Y0** Recall User Profile A after power up.**&Y1** Recall User Profile B after power up.

*Note: An &F command will not change the setting of this register.*

**&Z(n)=(x) Set Number Directory**

n is 0 - 3

The &Z(n)=(x) command allows you to store phone numbers for later use in the modem's number directory in nonvolatile memory. The string of digits and dialing control characters, x, is limited to 50 characters and is stored at the number location defined by n, where n may equal 0 through 3.

Any commands encountered in the dial string that are not valid dialing options causes an ERROR and the directory entry is not changed.

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## Register Descriptions

You may change any of the modem's registers by using the Set Register Command  $S(n)=(x)$ . For example, the command  $S0=5$  sets register 0's value to 5. The modem is reset to the values stored in the nonvolatile memory if the power is turned off then on, the modem is reset by a Z command, or the DTR signal is turned off when &D is set to 3.

*Note: All unused register numbers and parameters outside of the defined range are reserved for future expansion and may cause undesirable results if used.*

The remainder of this section describes each of the modem's Conventional Command Mode registers. All numeric values are in decimal.

### **S0**      **Answer on Ring Number**

Range: 0 - 255

Default: 0

The S0 register determines the number of rings after which the modem answers a call. Setting S0 to 0 disables auto-answer.

### **S1**      **Count of Rings**

Range: 0 - 255

The S1 register contains the number of incoming rings that have occurred. If the modem does not answer, and more than eight seconds have elapsed since the last ring, the count is reset to 0.

### **S2**      **Escape Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 43 (+)

The S2 register contains the code to be interpreted as the escape character. Setting this register to a value greater than 127 disables the recognition of the escape character by the modem.

*Note: This register is restored to the factory default setting when the modem is powered up or reset.*

**S3 Carriage Return Character**

Range: ASCII Code 0 - 96, 123 - 127

Default: ASCII Code 13

The S3 register contains the code to be interpreted as the carriage return character when in command mode. This register is restored to the factory default setting when the modem is powered up or reset. If the S3 register value is between 97 and 122 or greater than 127, the carriage return is not recognized.

**S4 Line Feed Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 10

The S4 register contains the code to be output as the line feed character when in command mode. This register is restored to the factory default setting when the modem is powered up or reset.

**4C**

**S5 Backspace Character**

Range: ASCII Code 0 - 96, 123 - 127

Default: ASCII Code 8

The S5 register contains the code to be interpreted as the backspace character when in command mode. Setting this register to a value greater than 127 disables the recognition of the backspace character by the modem. The preferred values for this register are ASCII Codes 0 through 32 or 127. This register is restored to the factory default setting when the modem is powered up or reset. If the S5 register value is between 97 and 122 or greater than 127, the backspace is not recognized.

**S6 Wait Time Before Dialing**

Range: 2 - 255

Default: 2 seconds

The S6 register contains the length of time in seconds that the modem will wait after going off-hook before dialing. This allows the central telephone office time to detect the off-hook condition and apply a dial tone. The value of S6 is only relevant when the X0, X1 or X3 commands are in effect.

**S7 Wait For Carrier/Dial Tone Time**

Range: 1 - 255

Default: 30 seconds

The S7 register contains the time in seconds that the modem waits for a valid carrier tone to be sent from the remote modem. This register also sets the duration of the W modifier in the Dial command.

**4C****S8 Pause Time for Comma**

Range: 0 - 255

Default: 2 seconds

The S8 register contains the time in seconds that the modem waits when it encounters a comma in the dialing sequence.

**S9 Carrier Detect Time**

Range: 1 - 255

Default: 6 (600 milliseconds)

The S9 register contains the length of time that the modem waits before connecting to the phone line after a carrier has been detected. Each count represents 100 milliseconds.



**S10 Carrier Loss to Disconnect Time**

Range: 1 - 255

Default: 14 (1.4 seconds)

The S10 register contains the amount of time the modem waits after the carrier has been lost before disconnecting the line. Each count represents 100 milliseconds. This register value should always be set higher than that of S9 in order for carrier detection to operate correctly.

**S11 Touch Tone Timing**

Range: 50 - 255

Default: 95 milliseconds

The S11 register contains the time in milliseconds of the duration and spacing of tones when tone dialing. The S11 register does not affect pulse dialing, which is fixed at 100 milliseconds per pulse.

**4C**

**S12 Escape Sequence Guard Time**

Range: 0 - 255

Default: 50 (1 second)

The escape sequence guard time is the time delay required immediately before and after entering the escape sequence. The guard time is in units of 20 milliseconds (1/50 second).

**S18 Test Termination Timer**

Range: 0 - 255

Default: 0

This register determines the length of time in seconds a diagnostic test runs before being automatically terminated. If the register is left at its factory default setting of 0, the timer expires after one hour.

**S25 DTR Delay Timing**

Range: 0 - 255

Default: 5 (50 milliseconds.)

The modem ignores DTR level changes with a duration of less than the value specified by the S25 register. Each unit represents 10 milliseconds. When the modem is in Synchronous Mode 1, S25 determines the number of milliseconds after a data connection has been synchronized before the modem looks at the DTR line. If DTR is true at that time, the data connection is established. If DTR is false, the call is dropped and the modem returns to Asynchronous Mode.

**S26 RTS to CTS Delay Interval**

Range: 0 - 255

Default: 1 (100 milliseconds)

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*This register affects synchronous operation only.* When the &R0 option (the factory default) is in effect, and the modem detects an off-to-on transition of the RTS signal, the modem delays a period of time specified by this register before turning the CTS signal on. The values in this register represents units of 100 milliseconds.

### **S36 Negotiation Failure Treatment**

Range: 0 - 1

Default: 1

When error control mode is specified (&Q5) and an MNP connection cannot be made, this register determines whether to drop the connection or to fall back to a normal connection without error control.

Possible contents for this register are:

- 0 If an error control connection cannot be made within 18 seconds of establishing carrier, the connection is dropped and NO CARRIER is reported.
- 1 If an error control connection cannot be made within 4 seconds of establishing carrier, the modem falls back to normal connection without error control.

Any characters sent to a non-MNP modem from its DTE during the 4 -second interval in which the modem was unsuccessfully attempting to establish a connection will be lost. In addition, if the answer modem does not support MNP, it receives a burst of characters from the originating modem during the first 4 seconds of the call as the originating modem attempts to make an MNP connection.

### **S37 Transmission Mode**

Range: 0 - 9

Default: 0

This register determines the transmission speed between modems. If the N command is set to N0, the speed specified by this register is the only speed at which the modem connects. If the N command is set to N1, the modem attempts to connect at the highest speed which does not exceed the value specified by this register, and fallback is enabled. Possible contents for this register are:

- 0 Attempt to connect at speed of last AT command.
- 1-3 Limit speed to 300 bps operation (Bell 103 or V.21 Mode).
- 4 Reserved.
- 5 Limit highest speed to 1200 bps maximum (Bell 212A or V.22 Mode).

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- 6 Limit highest speed to 2400 bps maximum (V.22bis Mode).
- 7 Attempt to connect in PEP Mode. Limit highest speed to PEP Mode Maximum. If unsuccessful in connecting, fall back to V.32 and other Low Speed Modes.
- 8 Reserved.
- 9 Attempt to connect in PEP Mode. If unsuccessful in connecting, fall back to V.32 and other Low Speed Modes.

### **S38 Delay Before Disconnecting**

Range: 0 or 255

Default: 20

When the modem receives a command to hang up while in the error control mode, it waits the amount of time in seconds specified by this register before disconnecting. This is required in error control mode to ensure that data in the modem's buffers is sent before the connection is terminated. If the timeout occurs before the buffered data is sent, a NO CARRIER result code is sent to the DTE indicating that data has been lost. If all data is transmitted before the timeout, an OK response is sent.

If S38 is set to 255, the modem does not timeout and continues to send data until the connection is lost or the buffers are empty.



# Chapter 5

## Enhanced Command Mode

Proceed with this chapter after the modem has been initialized, as described in Chapter 3. If you selected Enhanced Command Mode and are using data communications software which supports Telebit modems such as the TrailBlazer Plus, T1000, T1500, T2000, or T2500, you do not need to proceed with this manual. Instead, follow the instructions in your communications software manual.

Detailed descriptions of the commands and registers used in Enhanced Command Mode along with guidelines for configuring the modem are provided in this chapter. Each command and register description includes explanations of the possible parameters, the range of parameters and the factory default settings.

If you have initialized the modem to operate in Conventional Command Mode, you can use the access character (~) to select an enhanced feature such as protocol support without changing modes. For example, entering ~S11=30 enables UUCP protocol support while operating in Conventional Command Mode.

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### Configuration Guidelines

The modem is designed to interface with a wide variety of computer and data communications equipment. Since each device has its own specific requirements, the modem uses a number of registers that can be set to meet the requirements of your system. These register settings can be stored in nonvolatile memory for later use when the modem is powered up or reset.

The Set Register (Sn=x) command is used to set a specific register (n) to some value (x). For example, the command AT S0=5 sets the S0 register value to 5.

The Write Configuration Parameters (&W) command stores the current register settings in nonvolatile memory as Profile A (&W1) or Profile B (&W2). The Recall EEPROM Operating Parameters (&E) command is used to load either Profile A (&E1) or Profile B (&E2) from nonvolatile memory. If no parameter is entered in a &W or &E command, the default profile specified by the S255 register is used.

### Attended or Unattended Mode

The modem can be configured for either attended or unattended operations. Table 5-1 is a listing of typical commands and register settings used to configure the modem to interface with a terminal, personal computer or other attended DTE. Table 5-2 lists those commands typically used to configure the modem to operate in unattended answer mode.

**Table 5-1. Attended Mode Configuration**

~&F	Restore Enhanced Command Mode defaults to ensure that the modem is in a normalized state before changing parameters.
S51=n	<p>Set the interface speed to the highest possible speed supported by the DTE. The speed setting of the DTE must match the speed specified by this register setting where n is equal to:</p> <ul style="list-style-type: none"> <li>0 300 bps</li> <li>1 1200 bps</li> <li>2 2400 bps</li> <li>3 4800 bps</li> <li>4 9600 bps</li> <li>5 19200 bps</li> </ul>
S66=1	Lock the interface speed to the current setting of the S51 register. This allows the host equipment to use the same interface speed between itself and the modem, regardless of the transmission speed between the modem and the remote modem. Flow control is used to handle the difference between the transmission speed and the interface speed.

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**Table 5-2. Unattended Answer Mode Configuration**

~&F	Restore Enhanced Command Mode defaults to ensure that the modem is in a normalized state before changing parameters.
S45=255	Enable remote access to allow convenient reconfiguration after connecting the modem to the host equipment.
S51=n	Set the interface speed to the highest possible speed supported by the DTE. The speed setting of the DTE must match the speed specified by this register setting where n is equal to:  0   300 bps 1   1200 bps 2   2400 bps 3   4800 bps 4   9600 bps 5   19200 bps
S52=1	The modem does not answer an incoming call if DTR is off, and disconnects a call if DTR is dropped.
S54=3	Disable the break signal interpretation so that the modem does not go into command mode when a break is detected. The break signal is passed on to the remote site in sequence with the data stream.
S55=3	Disable the escape character sequence interpretation so that the modem does not go into command mode when it encounters an escape sequence. The escape characters are passed on to the remote site in sequence with the data stream.
S64=1	Ignore data sent by the local DTE while answering a call.
S66=1	Lock the interface speed to the current setting of the S51 register. This allows the host equipment to use the same interface speed between itself and the modem, regardless of the transmission speed between the modem and the remote modem. Flow control is used to handle the difference between the transmission speed and the interface speed.
S67= 1	When a carrier is detected, the modem asserts CTS 200 milliseconds after RTS goes active.
S130=5	When a valid data carrier is detected, DSR is asserted.
S131=1	When a valid data carrier is detected, DCD is asserted.
Q4	Do not send unsolicited result codes to the local DTE.
E0	Do not echo back commands to the local DTE.



## Transmission Mode Considerations

The modem's transmission speed is determined by the current setting of the S50 register. When communicating with another modem in PEP mode, the modem can transmit error-free data with a throughput of up to 19,200 bps. The modem dynamically adjusts its speed based on the quality of the connection.

To accommodate communicating with slower modems, the modem can be configured via the S50 register to operate in any of the following modes:

S50=0	Automatic speed determination
S50=1	300 bps operation (Bell 103 or V.21)
S50=2	1200 bps operation (Bell 212A or V.22)
S50=3	2400 bps operation (V.22bis)
S50=4	Operate in V.21 mode only (300 bps)
S50=6	Operate in V.32 mode only (9600 bps)
S50=254	Match speed of last AT command
S50=255	Operate in PEP mode only

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When a connection is made in Automatic Speed Determination mode (S50=0), the answering modem steps through several different answering tones in sequence to allow the calling modem to synchronize on the appropriate one. In general, the modem starts with the highest transmission speed and works down toward the lowest speed. Therefore, if a slower speed modem is calling, it may need to extend the time that it waits to detect carrier.

If you prefer, you can set the S92 register to 1, which causes the modem to issue the PEP answer tones at the end of the search sequence rather than at the beginning. This allows connections with slower speed modems, which are adversely affected by the PEP answer sequence. Refer to the S92 register description for additional information.

The S90 register determines if the modem issues Bell or CCITT modulations for 300 or 1200 bps operation as follows:

S90=0      Use Bell 103/212A

S90=1      Use CCITT V.21/V.22

If you plan to use the modem in V.22 or V.22bis mode, be aware that some but not all of these types of modems use guard tones during synchronization. If you experience problems in establishing a connection, try configuring the modem to use one of the two available guard tones:

S91=1      Use 1800 Hz guard tone

S91=2      Use 550 Hz guard tone

## **V.42 and MNP Error Control Protocol Support**

The modem supports the CCITT V.42 error control protocol. V.42 provides error-free transmission over a V.32, V.22bis, V.22, or Bell 212A connection.

V.42 includes the Link Access Protocol for Modems (LAP-M), the main protocol used between two V.42 modems. In addition, V.42 includes an alternate protocol, based on the Microcom Networking Protocol (MNP) up to Class 4. The inclusion of MNP provides downward compatibility between V.42 and existing MNP modems.

As shown in the Table 5-3, the V.42 error control mode and fallback is controlled by three Enhanced Command Mode registers: S106, S97 and S95.

Table 5-3. V.42 Error Control

Error Control Mode and Fallback	Originate			Answer		
	S106	S97	S95	S106	S97	S95
NR	0	0	0	0	0	0
MNP Only	0	0	1	0	0	1
MNP → NR	0	0	2	0	0	2
LAP-M Only	0	1	NA	0	1	NA
LAP-M → NR	1	NA	0	1	1	0
LAP-M → MNP	1	NA	1	1	1	1
LAP-M → MNP → NR	1	NA	2	1	1	2

NR - Nonreliable, No Error Control  
 NA - Not Applicable

If S106 and S97 are both set to 0 on either the originating or answering modem, LAP-M error control is disabled. The connecting modems negotiates whether a connection is made in MNP or nonreliable (no error control) mode based on the S95 register setting of each modem.

If S106 is set to 0 and S97 is set to 1 on either the originating or answering modem, only a LAP-M connection is allowed. If LAP-M is disabled or not supported on the opposite modem, no connection is established.

If S106 and S97 are both set to 1 on the answering modem or S106 is set to 1 on the originating modem, the connecting modems negotiates whether a connection is made in LAP-M, MNP or nonreliable (no error control) mode.

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Some typical register settings are shown below.

**For an answering modem:**

S106=1 S97=1 S95=2 Allow LAP-M, MNP or no-error-control calls.

S106=0 S97=1 Allow LAP-M calls only.

S106=0 S97=0 S95=1 Allow MNP calls only.

S106=0 S97=0 S95=0 Do not attempt any error control.

**For an originating modem:**

S106=1 S95=2 Request as first choice LAP-M, then MNP, and finally noerror-control connection.

S106=0 S97=1 Request LAP-M connection. If not possible, drop carrier.

S106=0 S97=0 S95=1 Request MNP connection. If not possible, drop carrier.

S106=1 S95=1 Request as first choice LAP-M, then MNP. Do not connect without error control.

S106=0 S97=0 S95=0 Do not attempt any error control.

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## Data Compression

Data compression for improved data throughput can be enabled while connecting in MNP, LAP-M or PEP mode.

### MNP Data Compression

The S96 register determines if the modem uses data compression while operating in MNP mode:

S96=0 Disable data compression in MNP mode.

S96=1 Enable MNP class 5 data compression provided the modem at the remote end also has data compression enabled.

### **V.42bis LAP-M Data Compression**

The S98 register determines if the modem uses data compression while operating in V.42 LAP-M mode:

- S98=0        Disable data compression in LAP-M mode.
- S98=1        Enable data compression in transmit direction only.
- S98=2        Enable data compression in receive direction only.
- S98=3        Enable data compression in both transmit and receive direction only.

V.42bis data compression is possible only if both connected modems are configured for data compression.

### **PEP Data Compression**

The S110 register determines if the modem uses data compression while operating in PEP Mode.

- S110=0        Disable data compression in PEP mode.
- S110=1        Enable data compression while connecting in PEP mode provided the remote modem also has data compression enabled (S110=1 or 255).
- S110=255      Enable data compression in PEP mode only if the remote modem has S110 set to 1. Only one of the connecting modems can have S110 set to 255. Otherwise, data compression is not supported.

### **Serial Port Interface Speed and Flow Control**

Most communication problems occurring over the DTE-DCE interface result from a mismatch in the interface speed and/or flow control method used by the DTE and modem. Both devices must be in complete agreement on the interface speed and flow control method used. Otherwise, information may be lost or garbled.

## Serial Port Interface Speed

To allow the DTE to communicate with the modem, the interface speed used by both the DTE and the modem must match. For maximum data throughput, the interface speed between the DTE and the modem should be set to the highest possible speed supported by both devices. Registers S51 and S66 govern the serial interface speed of the modem.

The interface speed of the modem can be set either manually or automatically. To manually set the modem's interface speed, the S51 register should be set to one of the following values:

S51=0	300 bps
S51=1	1200 bps
S51=2	2400 bps
S51=3	4800 bps
S51=4	9600 bps
S51=5	19200 bps

For automatic speed selection, the S51 can be set to one of the following three values:

S51=252	for automatic speed selection with type-ahead not permitted.
S51=254	for automatic speed selection with type-ahead permitted and a default speed of 19200 bps.
S51=255	for automatic speed selection with type-ahead permitted and a default speed of 9600 bps.

All three methods require the AT prefix when entering commands. The modem uses the A in the prefix to determine the serial interface speed.

When S51 is set to 252, the current interface speed is determined after each command line, and a new command line cannot be entered until the result code from the previous command is displayed. If no command lines have been entered after a power-up, the speed at which the default profile was saved will be the speed used to send RING and CONNECT messages when an incoming call is received.

When S51 is set to 254 or 255, the modem only checks the interface speed on the first AT prefix after one of the following events occur:

- The modem is powered up or reset.
- The S51 register is set to 254 or 255.
- A break signal is detected from the DTE when not connected to another modem.
- A data call is disconnected, and the modem is placed on-hook.
- A NO CARRIER condition is detected due to connect time expiration, dial command being aborted, or the loss of carrier.

Since the interface speed is not determined after every command line, multiple command lines can be entered without waiting for the results of previous command lines. Some communications programs may not wait for result codes when setting up the modem and require this type-ahead capability.

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If no command lines have been entered after a power-up, the modem uses 19200 bps (S51=254) or 9600 bps (S51= 255) to send RING and CONNECT messages when an incoming call is received.

When the modem is connected to a remote modem in PEP mode, the interface speed between the modem and the DTE remains at the same speed used in command mode and flow control is used to compensate for the difference between the line transmission speed and the DTE interface speed.

When the modem is connected to a remote modem in Low Speed (non-PEP) Mode, the S66 register determines whether or not the modem changes interface speed and use flow control as described below:

- S66=0      The modem changes its interface speed to match the line transmission speed following a connection in Low Speed Mode. No flow control is used.

- S66=1 The interface speed remains at the same speed used in command mode. Flow control is used.
- S66=2 If a non-MNP connection is established, the modem changes its interface speed to match the line transmission speed. When an MNP connection is established, the interface speed remains at the same speed used in command mode and flow control is used.

### Serial Port Flow Control

To avoid loss of data, the flow control method used by the DTE and the modem must be established. The S58 and S68 registers determine the method of data flow control used by the DTE and the modem when transferring data over the serial interface.

There are times when the flow control used for data entering the modem from the serial interface must differ from the flow control method used for data leaving the modem over the interface. The S58 register governs the method of flow control used by the DTE to control the flow of data coming from the modem:

- S58=0 No flow control is used.
- S58=1 RTS/CTS flow control in half duplex mode is used.
- S58=2 RTS/CTS flow control in full duplex mode is used.
- S58=3 XON/XOFF flow control is used.
- S58=4 Both RTS/CTS and XON/XOFF flow control is used.
- S58=5 ENQ/ACK flow control is used.
- S58=6 Both ENQ/ACK and XON/XOFF flow control is used.
- S58=7 Transparent XON/XOFF flow control is used.

The S68 register controls the flow of data from the DTE to the modem:

- S68=0 No flow control is used.
- S68=2 RTS/CTS flow control in full duplex mode is used.
- S68=3 XON/XOFF flow control is used.



- S68=4 Both RTS/CTS and XON/XOFF flow control is used.
- S68=5 ENQ/ACK flow control is used.
- S68=6 Both ENQ/ACK and XON/XOFF flow control is used.
- S68=255 Same flow control as specified by S58 is used.

For more information about flow control schemes, refer to the *Register Descriptions* sections of Chapters 4 and 5 of this manual.

The flow control methods specified by the S58 and S68 registers are only valid when the modem is operating in command or PEP mode, or when the S66 register is set to use flow control as described earlier.

When XON/XOFF flow control is used, recognition of the XON and XOFF characters is controlled by the S56, S57 and S48 registers.

The S56 and S57 registers specify the ASCII code to be used for the XON and XOFF characters, respectively. The S48 register determines how an incoming character should be treated when compared with the contents of S56 and S57.

If S48 is set to 0, the modem only examines the lower 7 data bits to detect an XON or XOFF character. This means that if the DTE is using an 8-bit data format, characters with a decimal value greater than 127 could be misinterpreted as an XON or XOFF character. To avoid this condition, the S48 register should be set to 1 when the DTE is using 8-bit characters.

The primary reason for selecting RTS/CTS flow control is to allow non-ASCII text data to be transferred without unintentionally detecting an XON or XOFF. It may be necessary to also disable recognition of the ESC character by setting the S55 register to 3.

## RS-232 Control Signal Interpretations

In order to allow the modem to interface with a variety of DTEs, registers S25, S26, S47, S52, S67, S104, S130, and S131 define the various ways that the modem interprets and uses the RS-232C control signals.

## DTR Signal Interpretation

The S25, S52, and S104 registers control how the modem interprets the DTR (Data Terminal Ready) control signal sent from the DTE as follows:

- S25=n      The modem ignores DTR level changes with a duration of less than the value specified by the S25 register. Each unit n represents 10 milliseconds.
- S52=0      The modem assumes that DTR is always true.
- S52=1      The modem does not answer an incoming call if DTR is off, and disconnects a call if DTR is dropped.
- S52=2      Same as S52=1 and the modem recalls the default profile parameters when DTR is dropped.
- S52=3      The modem enters command mode when the DTR signal is switched from on to off.
- S52=4      The modem disconnects a call in progress, and disables auto-answer before entering command mode. Auto-answer is enabled when the DTR is returned to an active state.
- S104=0     Automatic dialing via the DTR signal is disabled.
- S104=1     The modem automatically dials the first number (NO) in the number directory when an off-to-on transition of the DTR signal is detected.
- S104=4     When the DTR signal is asserted, the modem assumes the originate mode if the setting of register S1 is less than that of register S0. If the setting of register S1 is greater than or equal to that of register S0, the modem assumes the answer mode.

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## DSR Signal Handling

The S47 and S130 registers determine how the modem handles the RS-232 DSR (Data Set Ready) control signals as follows:

- S130=0     DSR is always on.
- S130=1     DSR is turned on when an answer tone is detected while originating a call or transmitted when answering a call.
- S130=2     DSR is turned on when the modem is ready to accept commands or data.

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- S130=3 DSR is turned on when the modem is ready to accept commands or data. When the carrier is lost DSR is turned back off for the amount of time specified by the S47 register, then on.
- S130=4 DSR is turned on when the modem is off-hook.
- S130=5 DSR is turned on when a valid carrier is detected from the remote modem.
- S130=6 The DSR signal is raised if the DTR signal is raised while the modem is not online, or if a connection is made to another modem and the DTR signal was already asserted before the modem was reset.

### DCD Signal Handling

The S47 and S131 registers determine how the modem handles the DCD (Data Carrier Detected) control signal as follows:

- S131=0 DCD is always on.
- S131=1 DCD is turned on when a valid carrier is detected from the remote modem.
- S131=2 DCD is turned on when the modem is ready to accept commands or data.
- S131=3 DCD is turned on when the modem is ready to accept commands or data. When the carrier is lost, DCD is turned back off for the amount of time specified by S47, then on.
- S131=4 DCD is the inverse of CTS in command and online modes. Recommended for use in transparent synchronous mode only.

### CTS Signal Handling

The S26 and S67 registers determine how the modem interprets the CTS (Clear to Send) control signal as follows:

- S67=0 If RTS/CTS flow control is not used, CTS is always on. If RTS/CTS flow control is used, the modem turns CTS on and off to control the flow of data from the DTE. When CTS is on, the modem accepts data from the DTE.

- S67=1 CTS is held off until a valid carrier is detected. When a carrier is detected, CTS is turned on 200 milliseconds after RTS goes active. If RTS/CTS flow control is used, CTS is used to control the flow of data from the DTE.
- S67=2 CTS is turned ON in response to an OFF-to-ON transition of RTS after a delay specified by register S26.

## Break Signal and Escape Sequence Handling

The modem's default action upon receiving a break signal or escape sequence is to enter command mode. The modem can be configured to pass the break signal on to the remote end by changing the setting of the S54 register. Similarly, the S55 register setting controls the modem's response to an escape sequence.

The S54 register determines how the modem handles a break signal as follows:

- S54=0 The modem switches to command mode when a break signal is received.
- S54=1 Reserved.
- S54=2 The modem immediately sends a break to the remote end.
- S54=3 The modem sends a break in sequence with the data stream.
- S54=4 The modem discards the break signal.

The S55 register determines how the modem processes escape characters as follows:

- S55=0 The modem switches to command mode when an escape sequence is received. An escape sequence consists of three consecutive escape characters (defined by register S2) bordered by the proper guard time (specified by register S12).
- S55=1 The modem discards its buffered data and passes the escape character to the remote end.
- S55=2 The modem immediately passes the escape character to the remote end.
- S55=3 The modem sends the escape character in sequence with the data stream.

*Note: If both the S54 and S55 registers are set to some value other than 0, there is no way to enter command mode during a connection. Since the main use of command mode is to establish a connection, this may not be an important consideration.*

If an escape sequence is received from the remote site and the DTE is echoing data transmissions, the modem could inadvertently be placed in command mode when the DTE echoes the escape sequence. Since the escape sequence could conceivably appear in the data stream, use of the break signal is the preferred method for switching to command mode during a connection.

## File Transfer Protocol Support

When file transfer protocol support is enabled, the modem interacts with the protocol to eliminate delays in the file transfer, which normally occur with other high-speed modems. This significantly increases the data throughput rate without altering the protocol functionality.

The modem can be configured via the S111 register to provide support for any of the following file transfer protocols when a connection is made in PEP mode:

- Kermit
- X/Ymodem
- UUCP

The protocol supported is negotiated between the modems at both ends during the connection initialization sequence.

The S111 register's default setting of 255 allows the modem to support the protocol specified by the modem at the other end of the connection. Typically, if the answering modem's S111 register is left at its default setting of 255, the calling modem can then specify the protocol to support via its S111 register setting. If both modems have the S111 set to 255, no protocol is supported. If neither modem has its S111 register set to 255, then both modems must agree on the setting of the S111 register to allow protocol support.

## SDLC Support

When SDLC Mode is selected, both modems must be operating in PEP Mode and set to provide SLDC support. Note that only point-to-point SDLC configurations are supported; multipoint support is not provided.

The contents of the S150 register determine if the modem operates in Asynchronous or SDLC Mode when it is powered up or reset via a Z command, an &T command, or a change in the A/B switch setting.

If the S150 register is set to 0, the modem operates in the Asynchronous Mode, and the contents of registers S151 through S169 are ignored. However, if S150 is set to 1, SDLC Mode is selected, only PEP connections are allowed, and the contents of registers S151 through S169 define the operating characteristics of the modem. The following registers are ignored while operating in SDLC Mode: S12, S47, S50, S51, S54, S55, S58, S62, S65, S67, S68, S111, S130, and S131.

## Transparent Synchronous Support

If S150 is set to 2, the modem operates in the Transparent Synchronous Mode, and the contents of registers S151 through S153, and S155 through S164 are ignored. The modem can use this mode when communicating in Bell 212A, V.22, V.22bis, and V.32 modulations.

The contents of the S150 register determines if the modem operates in Asynchronous, Transparent Synchronous, or SDLC Mode when it is powered up or reset via a Z command, an &T command, or a change in the A/B switch setting.

## **Bit Synchronous Dialing in Transparent Synchronous or SDLC Mode**

To use bit synchronous dialing, you must first preconfigure the modem to operate in SDLC or Transparent Synchronous mode. Set the S169 register to 1 to enable IBM 4941 dialing support, or 2 to enable V.25bis dialing support. Save the current configuration in nonvolatile memory with an AT&W command.

When the modem is powered up or reset with the current profile selected, it is configured to accept IBM 4941 or V.25bis dialing commands in synchronous mode.

**5A**

## Command Descriptions

This section describes the commands used when operating in Enhanced Command Mode. Refer to Chapter 4 for a description of the commands available in Conventional Command Mode.

You may enter a command line of up to 80 characters in uppercase or lowercase with the first command in the line preceded by an AT (or at) and the last command followed by a carriage return. If the S63 register is set to 0, you should not enter the AT at the beginning of the command line.

If you make an error while typing a command, simply backspace over the mistake then retype the line. You cannot backspace over the AT prefix because it is interpreted immediately after being typed.

The notation (n) in the descriptions represents a decimal numeric option, and (x) represents an assigned value. The parentheses should not be typed. If a command is typed without a value when one is expected, the modem assumes a value of 0.

The option should immediately follow the command. For example, to turn off the result codes, type Q1; not Q=1. The use of the equal sign (=) is explained in the S command description.

You can repeat the last command line issued by entering A/ (or a/). Do not enter the AT prefix or a carriage return when using this command.

### **A      Answer**

The A command causes the modem to connect to the phone line and issue a carrier. If you are using the established phone connection for voice communications and then want to switch your system to data mode to communicate with the other party's system, you must use this command in the following way:



1. Have the other party enter AT D on their system without entering a phone number.
2. Enter AT A on your system within a few seconds. Both parties can hang-up the phone. The modem sends a CONNECT result code when the connection is made.

**C(n) Turn Carrier ON/OFF**  
n is either 0 or 1

The C command is used to turn the carrier ON or OFF while operating in the following modulations: 103J, 212A, V.21, V.22, and V.22bis. A 0 selects OFF, while a 1 selects ON.

- |    |              |
|----|--------------|
| C  | Same as C0.  |
| C0 | Carrier OFF. |
| C1 | Carrier ON.  |

**D(n) Dial**

The D command is used to place a call by sending a dialing sequence to the modem. A valid dialing sequence is composed of a D followed by the digits 0-9 and dialing options which specify the number to dial. The characters A, B, C, D, #, and \* may also be used when tone dialing (T) is selected. These characters are ignored while pulse dialing (P). Parentheses, slashes, hyphens, periods and spaces may be used in the dialing sequence to improve readability, but are not required.

To use the D command, dial the number indicated and wait for a connection. If no connection is made within the period of time defined by the S7 register, or if any character is sent from your equipment before the modems have established synchronization, the D command is canceled and the modem returns to command mode.

**5B**

Since the modem can use either pulse or tone dialing, you must state which you prefer or the modem uses the last mode selected. Also, the modem defaults to pulse dialing when powered on, unless the parameter in the nonvolatile memory has been set to tone dialing.

The following characters listed are commands that are valid only within a dialing sequence.

All but the last character can appear multiple times in the dialing sequence.

- P Use pulse dialing.
- T Use tone dialing.
- W Wait up to the number of seconds in the S6 register for a valid dial tone.
- N(n) Reference a number string stored in the number directory.
- , Pause for the amount of time specified by the S8 register before continuing the dial sequence.
- @ Wait for five seconds of silence before continuing. If five seconds of silence is not detected within 30 seconds, the modem hangs up and sends a NO ANSWER result code.
- ! Initiate momentary on-hook flash, a function similar to that of rapidly pressing your telephone hook down and up. The telephone handset must be on-hook for this to work.
- ; Remain in command mode after dialing without waiting for a connection. This character terminates the dial sequence, causing the modem to remain in command mode.

The backslash symbol (\) indicates to the modem that a number defined by a name in the number directory is to be dialed. That name is defined at the time the number is placed in the number directory. For example,

**AT DT 408 N1 or AT DT 408\Test Call\**

will dial the telephone number previously stored in the number directory.

**5B**

The following character can only be used at the end of a dialing sequence:

- R Switch to answer mode when finished dialing. This option should be used only in Low Speed Mode.

The following examples show the correct command format to make the modem dial a number using pulse dialing, wait for an outside line, and then switch to tone dialing:

**AT D P9W T408-555-6789 or**  
**AT D P9WT4085556789**

Either way is acceptable since the modem ignores hyphens in the dialing sequence.

- E(n) Echo ON/OFF**  
n is either 0 or 1  
Default is 1

The E command instructs the modem, while in command mode, to echo characters back to the local DTE.

- E Same as E0.
- E0 Echo OFF.
- E1 Echo ON.

**5B**

- F(n) Echoplex ON/OFF**  
n is either 0 - 2  
Default is 1

The F command instructs the modem to echo data characters back to the local DTE during data transmission.

- F Same as F0.
- F0 Echo.
- F1 No Echo.
- F2 Send a linefeed after a carriage return is echoed.

## **G        Go To Voice**

The G command informs the modem that you want to use the telephone for voice communication and that the modem should cease use of the connection until further notice. The telephone handset must be lifted off-hook before this command is entered.

### **H(n)     Hook ON/OFF** n is either 0 or 1

The H command allows the modem to control the telephone switch hook.

Both options for n are defined below:

- H        Same as H0.
- H0      Hang up.
- H1      Go off-hook.

### **I(n)     Information** n is 0 - 6

The I command requests the modem to return its product identification number, internal diagnostic status, current transmission mode, current revision level, or the values of those registers that are negotiated at the beginning of a connection.

- I0       Causes the modem to return a product identification character string which defines the model number. See the S49 register description for model number options.
- I1       Causes the modem to return any error code status generated by summing the numbers associated with failed tests.

- 12 Causes the modem to respond with the current transmission mode as follows:

Response    Meaning

0	Not Connected
300	Connected in Bell 103 or V.21 Mode
1200	Connected in Bell 212A or V.22 Mode
2400	Connected in V.22bis Mode
9600	Connected in V.32 Mode
FAST	Connected in PEP Mode

If the X command is set to 2 or higher, and the modem is connected in MNP mode, then /REL is also be reported.

If the X command is set to 3 or higher, and the modem is connected in PEP mode with file transfer protocol support and/or data compression enabled, then /KERM, /XMDM, /UUCP and/or /COMP is also reported.

- 13 Causes the modem to respond with the version level of the installed firmware.

- 14 Causes the modem to return the negotiated (currently active) values, which remain after a connection is dropped, for the following registers:

S95	MNP Operating Mode
S96	MNP Data Compression Enable
S97	LAP-M Enable
S98	V.42bis Data Compression
S110	Data Compression Enable
S111	File Transfer Protocol Support
S121	Echo Suppressor Compensation
S150	Asynchronous/ Synchronous Mode Selection

- 15 Causes the modem to display in ASCII, the last number dialed by the modem.

- 16 Causes the modem to respond with the hardware platform determination.

*Note: The values returned may not be the same as the register settings.*

**5B**

**M(n) Speaker ON/OFF**

n is 0 - 3

Default is 1

The M command controls the modem's internal speaker as follows:

- M Same as M0.
- M0 Speaker Disabled.
- M1 Speaker Enabled only when dialing and connecting.
- M2 Speaker Enabled at all times.
- M3 Speaker Enabled after dialing until carrier detected.

**N(n)=(x) Set Number Directory**

n is 0-9

The N(n)=(x) command allows you to store phone numbers for later use in the modem's number directory in nonvolatile memory. The string of digits and dialing control characters, x, are stored at the number location defined by n where n may equal 0 through 9.

In addition to the numbers stored in the number directory, you may define alpha character names to be used for later reference in initiating calls.

**5B**

To define a name for a particular telephone number, you must precede and follow the name by a backslash symbol (\). Each directory number may contain up to 50 alphanumeric characters. For example,

**AT N1=555-6789\Test Call**

If the N command is to be followed by other commands on the same line, then the N command must be terminated with a name (which can be empty). For example:

**AT N1=555-6789\\S7=10**

When callback security is enabled, the telephone number directory serves as the password and dial-back directory and cannot be displayed. Up to 10 telephone numbers and passwords may be entered in the number directory of the answering modem using the  $N(n)=(x)$  command with the password enclosed between backslashes (\) at the end of the dial string (e.g. `ATN1=555-1234\PASSWORD\`).

### **N(n)?    Display Number** n is 0-9

The  $N(n)?$  command instructs the modem to display the contents of the directory address defined by n.

### **N?        Display Number Directory** **and S Registers**

The  $N?$  command allows the entire contents of the number directory, the current settings of the S registers and the firmware version number to be displayed. Colons (:) mark those registers that are not at the factory default settings for Enhanced Command Mode.

## **5B**    **O        On-Line**

The O command places the modem in data mode. When the modem has been forced to enter command mode via the break signal or the escape character, the O command resumes data communication. If the modem is off-hook but not connected, it attempts to connect in the same mode (originate or answer) as the most recent connection.

**Q(n) Quiet Enable**

n is 0 - 9

Default is 0

The Q command controls the reporting of result codes to the local modem, and to the remote modem in response to commands received from the remote modem via the % command. A summary of the modem's result codes is provided in Appendix D.

Possible parameter values and the modem's response are listed below:

<u>Parameter</u>	<u>Remote Quiet</u>	<u>Local Quiet</u>
0	No	No
1	No	Yes
2	Yes	No
3	Yes	Yes
4	No	Partial 1
5	Yes	Partial 1
6	No	Partial 2
7	Yes	Partial 2
8	No	Partial 3
9	Yes	Partial 3

**5B**

The partial quiet modes are defined as follows:

- Partial 1** The local modem does not report the RING result codes and it does not report NO CARRIER, CONNECT, BUSY or RRING unless the connection was initiated with an ATD or ATA command.
- Partial 2** The local modem does not report RING result codes and it does not report NO CARRIER, CONNECT, BUSY or RRING during a connection in which the local modem is in answer mode.
- Partial 3** The local modem returns result codes when originating a call, but does not return result codes when answering a call.



## **S(n)=(x)            Set Register**

The S(n)=(x) command allows the local DTE to assign register n a value of x. The modem supports a number of definable registers, which are described later.

The S(n) command sets a pointer to the register specified by n. Each new S(n) command reassigns the pointer. Typing the S command without the n parameter points to the S0 register. This means that an S? command returns the value of the S0 register. The =(x) is a separate command, which assigns a value specified by x to the register pointed to by the previous S(n) command.

Therefore, any command with an =(x) used in error changes the last explicitly referenced S register. Similarly, an AT? command displays the contents of the previously selected S register.

## **S(n)?    Read Register**

The S(n)? command allows the local DTE to read the contents of register n. Remember that an S? command sets the register pointer to S0 and returns the value of the S0 register. An AT? command displays the contents of the last register selected by an S(n) command.

# **5B**

## **U            Update System Password**

The U command is used to change the system callback security password, which must be given when attempting to change the value of the S46 register. This password is also required when attempting to change an entry in the telephone number directory when callback security is enabled (S46 not equal to zero).

When the U command is entered, you are prompted for the old password (PEP is the factory default, which must be entered in uppercase), the new password (which can be entered in any combination of uppercase and lowercase), and a confirmation of the new password.

After changing the password, you are prompted for a new prompt string (up to 20 characters), which is to be displayed at the caller's terminal. The default value of this prompt string is Enter Password. This prompt string can be retained by entering a carriage return.

### **V(n) Verbose ON/OFF**

n is either 0 or 1

Default is 1

The V command determines the format of the result codes. A 0 directs the modem to return numeric responses. No linefeed is sent with numeric responses. A 1 causes the modem to return a more detailed description using English words.

- V Same as V0.
- V0 Numeric Result Codes Enabled.
- V1 English Descriptions of Result Codes Enabled.

### **W(n) Negotiation Progress Reporting**

n is either 0 or 1

Default is 0

The W(n) command enables an additional set of result codes to report progress of the negotiation phase in error-control mode. If enabled, these messages report first the carrier speed, then the protocol.

- W Same as W0.
- W0 Error-control call progress not reported.
- W1 Error-control call progress reported provided X11 - X14 is selected.

In error-control mode, the CARRIER speed and CONNECT speed messages may be different. This is because of the modem's ability to communicate with a remote modem at one speed and with the local DTE at another speed.

**5B**

**X(n) Result Code Basic/Extended**

n is 0 - 3, 10 - 14

Default is 1- Enhanced 14 - Conventional

The X(n) command is used to select either basic or extended result codes as follows:

- X0 Basic Result Codes (0 - 4) Enabled.
- X1 Extended Result Codes (0 - 52) Enabled.
- X2 MNP Extended Result Codes Enabled.
- X3 MNP and PEP Extended Result Codes Enabled.
- X10 Basic Result Codes (0 - 4) Enabled.
- X11 Result Codes 0 - 5, 10 -12 and 14 Enabled.
- X12 Result Codes 0 - 6, 10 -12 and 14 Enabled.
- X13 Result Codes 0 - 5, 7, 10 -12 and 14 Enabled.
- X14 Result Codes 0 - 7, 10 -12 and 14 Enabled.

Refer to Appendix D for an explanation of the result code sets listed above.

**Y(n) Disconnect on Break**

n is either 0 or 1

Default is 0

The Y command determines if the modem responds to a disconnect signal, for non -PEP connections only.

- Y Same as Y0.
- Y0 Modem does not respond to a disconnect signal.
- Y1 If the modem receives a continuous break signal from the remote modem for a period greater than or equal to 1.6 seconds, it disconnects. When commanded to hang up, the modem transmits a four second break signal then disconnects (goes on-hook).

**Note:** Y(0) only works in Emulation Mode.

**5B**

**Z(n) Reset**  
n is 0 - 2  
Default is 0

The Z command disconnects the phone line and restores the active configuration to the appropriate user profile values stored in nonvolatile memory.

- Z Same as Z0.
- Z0 Modem resets and recalls default user profile specified by the S255 register.
- Z1 Modem resets and recalls User Profile A.
- Z2 Modem resets and recalls User Profile B.

**&B Blind Command**

The &B command disables the command processor within the modem, causing the modem to ignore any local commands. The modem still returns result codes if it isn't in quiet mode (Q0), and continues to echo commands if the echo command is enabled (E1). If remote access is enabled (register S45 set to 255), the modem processes remote commands.

*Note: Since the modem no longer accepts local commands when in blind mode, the only way to exit blind mode is to turn the modem off and then on again. The blind option setting is not saved in the nonvolatile memory.*

**5B**

## **&E(n) Recall EEPROM Operating Parameters**

n is 0 - 2

This command loads the operating parameters stored in non-volatile memory into the operating registers. If the EEPROM checksum is incorrect, the modem notes the error and leaves the operating parameters at the current settings.

The modem accepts any of the following &E commands:

- &E Same as &E0.
- &E0 Retrieve default user profile specified by the S255 register.
- &E1 Retrieve User Profile A.
- &E2 Retrieve User Profile B.

## **&F(n) Recall Factory Configuration Parameters**

This command restores the factory default configuration parameters to the operating registers, according to the n value as follows:

- &F Same as &F0.
- &F0 Enhanced Command Mode parameters.
- &F1 Conventional Command Mode parameters.
- &F2 Enhanced Command Mode, SDLC parameters.
- &F3 V.32 Synchronous Mode with full duplex operation on switched (dial) lines.

**5B**

**&N(n) Display EEPROM Operating Parameters**

n is 0 - 2

This command displays the operating parameters that are stored in nonvolatile memory. The actual operating parameters are not changed. If the EEPROM checksum is incorrect, the modem notes the error.

The modem accepts any of the following &N commands:

- &N Same as &N0.
- &N0 Display default user profile specified by the S255 register.
- &N1 Display User Profile A.
- &N2 Display User Profile B.

**&P(n) Pulse Dialing Make/Break Ratio**

n is either 0 or 1

Default is 0

The &P command is used to select the make/break ratio used when pulse dialing.

- &P Same as &P0.
- &P0 39% Make/61% Break ratio. US timing.
- &P1 33% Make/67% Break ratio. UK timing.

**5B****&R(n) Force Retrain or Renegotiate**

n is either 0 or 1

This command either forces the modem to re-evaluate the condition of the connection and adjust its data rate accordingly, or causes the modem to renegotiate data compression and/or protocol support based on the current settings of the S110 and S111 registers at each end of the connection.

The modem accepts any of the following &R commands:

- &R Same as &R0.
- &R0 Force Retrain.
- &R1 Renegotiate data compression and protocol support in PEP Mode only.

Any retrain that occurs within a minute of a previous retrain may cause the modem to reduce its data rate or to drop the carrier.

When an &R command is issued in V.22bis mode, the modem attempts to retrain its equalizer.

When an &R command is issued in V.32 mode, the modem attempts to retrain.

When an &R1 command is issued while connected in PEP Mode, the modem immediately returns an OK response and begins renegotiating data compression and/or the protocol supported as described in the S110 and S111 register descriptions. Once the renegotiation is completed, the modem returns a CONNECT FAST message. When X3 is selected, the CONNECT message indicates if data compression is enabled and which protocol (if any) is currently being supported.

The &R1 command should only be performed when the serial buffers are empty and there is no data transfer operation in process. Any data stored in the serial buffers while the renegotiation is in progress will be discarded.

The modem returns an ERROR in response to an &R1 if the remote modem's firmware does not provide data compression or protocol support; or a renegotiation is already in progress.

**5B**

*Note: During a PEP retraining sequence, initiated by an &R command or by an internal retrain, the PEP indicator flashes on and off at 1/2 second intervals until the retraining operation is completed.*

### **&T(n) Test Function**

n is 0 - 8

Default is 4

The &T command is used to determine if a communications problem is caused by the local modem or DTE, the remote modem or DTE, or the connections between the two sites. When the modem is performing a test function, its MR indicator blinks at a rate of approximately once per second.

To perform tests after establishing a connection, return to command mode by issuing the escape sequence (+++).

Issue the appropriate &T command while in command mode.

**&T** Same as &T0.

**&T0** This command disconnects the phone line and initiates the same internal diagnostic routines that are executed when the modem is turned ON. The results of the tests are displayed at the end of the tests, and can also be displayed by entering the I1 command. At the end of the tests, all parameters are restored to the values saved in the default user profile of nonvolatile memory.

If the EEPROM checksum is incorrect, the factory default settings are used.

**&T1** This test checks the path between the local modem and DTE. Issue an &T1 command and type a few sentences. If the modem echoes your keyboard input as you type, the local DTE and modem are operating correctly. Terminate the test by issuing an escape sequence and &T2 command.

**&T2** This command terminates the test in progress. You may need to issue the escape sequence (+++) to return to command mode prior to issuing an &T2. Entering the H0 (hang-up) or Z (reset) command also terminates the test. The S18 register can be set to automatically terminate a test after a specific amount of time.

**&T3** This test checks the communication link and the remote modem. During this test the local modem sends incoming data directly back to the remote modem. Establish a connection with a remote modem, then issue an escape sequence and &T3 command. Ask the person at the remote system to type a few sentences. If the data is sent back to the remote system without errors, the remote modem and communication link are functioning correctly.

**&T4** This command grants a test request from the remote modem.

**&T5** This command denies a test request from the remote modem.

**&T6** This test checks the operation of both modems, the local DTE, and the telephone connection by commanding the remote modem to loop back data received from the local modem. The remote must be set to grant a test request (&T4).



Establish a connection with the remote modem, then issue an escape sequence and &T6 command. After the command has been accepted, the modem goes back on-line. Type a few sentences.

The sentences are sent directly back to your terminal without appearing on the remote terminal's screen. If the modem echoes your keyboard input as you type it, the modem is operating correctly.

**&T7** The local modem sends a self-test pattern to the remote modem, which returns the test pattern to the local modem. The local modem examines the received test pattern and increments a counter each time an error is detected. The remote must be set to grant a test request (&T4). Establish a connection with the remote modem, then issue an escape sequence and &T7 command. When the test is terminated, a three-digit number is sent to the local DTE indicating the number of errors. If the error count is 000, the modems and telephone network passed the test. An error count of 255 indicates that 255 or more errors were detected.

**&T8** The modem performs a local self-test. This test may be performed without establishing a connection to another modem. When the test is terminated, a three-digit number is sent to the local DTE indicating the number of errors. If the error count is 000, the modem passed the test. An error count of 255 indicates that 255 or more errors were detected.

*Note: After an AT&T command is issued, the modem will reset.*

## **&W(n) Write Configuration Parameters**

n is 0 - 2

This command stores the current operating parameters in the nonvolatile memory for use when the modem is subsequently reset or powered off and on.

The modem accepts any of the following &W commands:

- &W** Same as &W0.
- &W0** Writes current settings to profile specified by the value of the S255 register.
- &W1** Writes current settings to Profile A.
- &W2** Writes current settings to Profile B.

## **% Remote Modem Access**

This command allows you to send commands to a remote modem as if the commands had been entered by the remote DTE. Remote access is only allowed if enabled. Refer to the S45 Register Description.

All commands following a percent sign (%) to the end of the command line are directed to the remote modem. For example, the command

**AT%N?**

reads the remote modem's number directory and S Registers.

Responses from the remote modem are preceded by a percent sign (%) character and are controlled by the setting of the remote modem's Q, V and X commands. If remote access is disabled on the remote modem (S45=0), the remote modem ignores the commands and no response is received from the remote modem. Note that the local modem responds with an OK to acknowledge that it has sent the remote command.

Local and remote commands can be entered on the same line. For example, to get the line noise data and frequency offset of the local modem, followed by the same information for the remote modem, enter:

**ATS76?S77?%S76?S77?**

Remember that all commands following the % remote command prefix to the end of the command line are directed to the remote modem.

The local modem first processes the local commands and displays the local data. It then sends the remote commands to the remote modem, and displays an OK indicating that the command line has been processed. The remote modem processes the command and sends back the requested data. Completion of the remote command is signaled by a %OK response from the remote modem.

Once a remote command is issued, another remote command cannot be sent until the remote modem has finished processing the previous command.

**5B**



## Register Descriptions

You may change any of the modem's registers by using the Set Register Command S(n)=(x). For example, the command S0=5 sets register 0's value to 5. The modem is reset to the values stored in the nonvolatile memory if the power is turned off then on, the modem is reset by a Z or &T command, or the DTR signal is turned off when the S52 register is set to 2.

Certain registers are applicable only to the PEP transmission mode. These consist of registers S45, S51 (unless S66 is set to 1), S54 (value 1 or 2), S70 through S76, and S121. See the S50 register description for an explanation of when the modem is in PEP mode.

*All unused register numbers and parameters outside of the defined range are reserved for future expansion and may cause undesirable results if used.*

The remainder of this section describes each of the Enhanced Command Mode registers. All numeric values are in decimal.

### **S0 Answer on Ring Number**

Range: 0 - 255

Default: 1 - Enhanced, 0 - Conventional

The S0 register determines the number of rings after which the modem answers a call. The modem counts the number of rings and answers the call on the count contained in this register. S0=0 is used to disable auto-answer.

**5C**

### **S1 Count of Rings**

Range: 0 - 255

The S1 register contains the number of incoming rings that have occurred. If the modem does not answer, and if more than 8-seconds have elapsed since the last ring, the count is reset to 0.

**S2      Escape Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 43 (+)

The S2 register contains the code to be interpreted as the escape character. See registers S12 and S55. If S48=0, setting this register to a value greater than 127 disables the recognition of the escape character by the modem.

**S3      Carriage Return Character**

Range: ASCII Code 0 - 96, 123 - 127

Default: ASCII Code 13

The S3 register contains the code to be interpreted as the carriage return character when in command mode. If the value stored in S3 is between 97 and 122 or greater than 127, the character is not recognized by the modem.

**S4      Line Feed Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 10

The S4 register contains the code to be output as the line feed character when in command mode.

**5C**

**S5      Backspace Character**

Range: ASCII Code 0 - 96, 123 - 127

Default: ASCII Code 8

The S5 register contains the code to be interpreted as the backspace character when in command mode. If the value stored in S3 is between 97 and 122 or greater than 127, the character is not recognized by the modem. The preferred values for this register are ASCII Codes 0 through 31 or 127.

**S6 Dial Tone Wait Time**

Range: 2 - 255

Default: 2 seconds

The S6 register contains the length of time in seconds that the modem waits for a dial tone when the W character is used in a D (Dial) command or before dialing the first digit in a dialing sequence.

**S7 Wait For Carrier Time**

Range: 1 - 255

Default: 40 - Enhanced, 30 - Conventional

The S7 register contains the time in seconds that the modem waits for a valid carrier tone to be sent from the remote modem.

**S8 Pause Time for Comma**

Range: 0 - 255

Default: 2 seconds

The S8 register contains the time in seconds that the modem waits when it encounters a comma in the command line.

**S9 Carrier Detect Time**

Range: 1 - 255

Default: 6 (600 milliseconds)

**5C**

The S9 register contains the length of time that the modem waits before connecting to the phone line after a carrier has been detected in Low Speed Mode. Each count represents 100 milliseconds.

**S10 Carrier Loss to Disconnect Time**

Range: 1 - 255

Default: 7 - Enhanced, 14 - Conventional

The S10 register contains the amount of time the modem waits after the carrier has been lost before disconnecting the line when in Low Speed Mode. Each count represents 100 milliseconds.

- S11 Touch Tone Timing**  
Range: 50 - 255  
Default: 70 - Enhanced, 95 - Conventional

The S11 register contains the time in milliseconds of the duration and spacing of tones when tone dialing. The S11 register does not affect pulse dialing, which is fixed at 100 milliseconds per pulse.

- S12 Escape Sequence Guard Time**  
Range: 0 - 255  
Default: 50 (1 second)

The escape sequence guard time is the time delay required immediately before and after entering the escape sequence. The guard time is in units of 20 milliseconds (1/50 second).

- S18 Test Termination Timer**  
Range: 0 - 255  
Default: 0

This register determines the length of time in seconds a diagnostic test runs before being automatically terminated. If the register is left at its factory default setting of 0, the timer expires after one hour.

- S25 DTR Delay Timing**  
Range: 0 - 255  
Default: 5 (50 milliseconds)

The modem ignores DTR level changes with a duration of less than the value specified by the S25 register. Each unit represents 10 milliseconds. When the modem is in Synchronous Mode 1, S25 determines the number of milliseconds after a data connection has been synchronized before the modem looks at the DTR line.

**5C**

If DTR is true at that time, the data connection established. If DTR is false, the call is dropped and the modem returns to Asynchronous Mode.

**S26      RTS to CTS Delay Interval**

Range: 0 - 255

Default: 0

This register affects synchronous operation only. When the S67=2 option is in effect, and the modem detects an off-to-on transition of the RTS signal, the modem delays a period of time specified by this register before turning the CTS signal on. The values in this register represents units of 100 milliseconds.

**S38      Delay Before Disconnecting**

Range: 0 - 255

Default: 0 - Enhanced, 20 - Conventional

When the modem receives a command to hang up in error control mode, it waits the amount of time in seconds specified by this register before disconnecting. This is required in error control mode to ensure that data in the modem's buffers is sent before the connection is terminated. If the timeout occurs before the buffered data is sent, a NO CARRIER result code is sent to the DTE indicating that data has been lost. If all data is transmitted before the timeout, an OK response is sent.

If S38 is set to 255, the modem does not timeout and continues to send data until the connection is lost or the buffers are empty.

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## **S41 Inactivity Timer**

Range: 0 - 255

Default: 0

The S41 register specifies the amount of time in tenths of hours (six minutes per count) that the modem allows the connection to be idle. If no data is received by either modem within the time specified by this register, the modem disconnects the call. This prevents hung connections from running up an expensive connection cost. The register default setting of 0 disables the inactivity timer.

## **S45 Remote Access Enable**

Range: 0, 254, 255

Default: 0

The S45 register enables or disables access to the control functions of the modem from a remote modem. The remote access capability is allowed when operating in PEP or a MNP mode.

Possible contents of the S45 register are:

- |     |                                   |
|-----|-----------------------------------|
| 0   | Remote access disabled.           |
| 254 | Request remote access (MNP only). |
| 255 | Remote access enabled.            |

To allow remote command access during a non-PEP connection, the following conditions must be met:

1. Originating modem - set register S45 to 254 (requests remote access during the MNP negotiation sequence), and set S97=0, S106=0 (disable LAP-M).
2. Answering modem - set register S45 to 255 (Allows remote access).

*Note: Remote access in non-PEP connections, is only supported in releases since firmware version 6.01. Both modems must run at least this level of firmware. Command ATI set to 3 causes the modem to respond with the version level of the firmware installed in your modem.*

See % Remote Modem Access on page 5-37 for details on how to use remote access.

## **S46 Modem Security**

Range: 0 - 3

Default: 0

This register is used to enable the callback security feature on the modem when answering an incoming call. To change the setting of this register, you are required to enter a password. The default system password is PEP, which must be entered in uppercase. This password can be changed by entering a U command. Possible contents of this register are the following:

- 0 Callback security disabled.
- 1 Callback security enabled.
- 2 Callback security enabled with password reverification.
- 3 Pass through security enabled, no callback initiated.

When the S46 register is set to 1, the modem prompts the caller for a password. If the password entered by the caller corresponds with a password listed in the telephone number directory, the answering modem hangs up the phone, waits 10 seconds, and calls back the appropriate number indexed in the number directory, eventually connecting the caller to the local DTE.

When S46 is set to 2, the modem prompts the caller for a password. If the password is correct, the modem hangs up and calls the appropriate number and again prompts the original caller for the password. If the password is verified, the modem connects the caller to the local DTE.

If S46 is set to 3, the modem prompts the caller for a password. If a valid password is entered, the caller is immediately connected to the local DTE. No callback is required.

*Note: The command ATN? or AT%N does not display the S46 value. Type ATS46? to display the value.*

### **S47 DSR/DCD Delay Time**

Range: 0 - 255

Default: 4 (200 milliseconds)

The S47 register specifies the amount of time that DSR or DCD is held off when carrier is lost and S130 or S131 is set to 3. Each count represents 50 milliseconds. Refer to option 3 of the S130 and S131 register descriptions for additional information.

### **S48 8-Bit Comparison**

Range: 0 or 1

Default: 0

The S48 register controls how the modem determines if a character sent by the local DTE is an XON, XOFF, or escape character.

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Possible contents for this register are:

- 0 The most significant bit of the 8-bit character received is set to 0 before comparing it with the value in the S2, S56, and S57 registers to determine if the character is an escape, XON or XOFF character, respectively.  
As a result, if S2, S56 or S57 is set to a decimal value greater than 127, recognition of the character specified by the register is disabled.
- 1 All 8- bits are compared with the value in the S2, S56 or S57 registers to determine if the character is an escape, XON or XOFF character. This register setting should only be used when the local DTE is using 8 data bits with or without parity.

*Note: If the local DTE is using a data format of 7 data bits plus parity, the S48 register should be set to 0 to mask the eighth bit when testing for escape, XON or XOFF. This permits end-to-end parity checking between DTEs, as well as allowing the modem to recognize Escape, XON and XOFF.*

## **S49 Product Identification String**

Range: 0 - 2

Default: 0

The S49 register defines the product identification number reported by the I0 command.

Possible contents for this register are:

- 0 The I0 command may report one of the following ID numbers:
  - 961 Model RA12C
  - 962 Model RA12E
  - 963 Model RM12C
  - 964 Model T18PC
  - 965 Model T18SA , T2SAA or T2SAS
  - 966 Model T18RMM
  - 967 Model T2MC
  - 968 Model T1SA
  - 971 Model T25SA
  - 972 Model T25RM
- 1 I0 command reports 123 as Product ID number.
- 2 I0 command returns 965 ID code to make the modem appear as a TrailBlazer Plus to current software application programs.

**S50 Transmission Mode**

Range: 0 - 4, 6, 254 - 255

Default: 0 - Enhanced, 254 - Conventional

The S50 register determines the data transfer method between modems. Possible contents for this register are:

- 0 Automatic speed determination
- 1 300 bps operation (Bell 103 or V.21 Mode)
- 2 1200 bps operation (Bell 212A or V.22 Mode)
- 3 2400 bps operation (V.22bis Mode)
- 4 300 bps operation (V.21 Mode)
- 6 9600 bps operation (V.32 Mode)
- 254 Attempt to connect at speed of last AT command
- 255 FAST operation (PEP Mode)

If S94 is set to 0, the modem connects only at the speed specified by the S50 register, whereas if the S94 register is set to 1, it attempts to connect at any speed up to the maximum specified by the S50 register. The S94 register is ignored if the S50 register is set to 0 or 255.

If the S50 register is set to 0, the modem automatically determines the appropriate data transmission method.

Depending on the contents of the S90 and S92 registers, the modem goes through one of the following search sequences to arrive at the correct data transmission method:

S90=1 (CCITT Mode) S92=0

- PEP
- V.25 answer tone
- V.32
- V.22bis\*
- V.22\*
- V.21

S90=0 (Bell Mode) S92=0

- PEP
- V.25 answer tone
- V.32
- V.22bis\*
- Bell 212
- Bell 103

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\*Use of guard tones with V.22 mode depends on the contents register S91. If S91=0, no guard tone is used. If S91=1, an 1800 Hz guard tone is used. If S91=2, a 550 Hz guard tone is used.

*Note: If the answering modem's S92 register is set to 1, the PEP answer tones are presented at the end of the search sequence rather than the beginning. This allows the modem to connect with slower speed modems, which are adversely affected by the PEP answer sequence. If S92=2, an additional V.25 answer tone precedes the sequence shown above. Refer to the S92 register description for additional information.*

If the S50 register is set to 1, the modem checks the contents of the S90 register to determine whether Bell 103 or V.21 mode is used, and starts any search sequence at 300 bps.

If the S50 register is set to 2, the modem checks the contents of the S90 register to determine whether Bell 212A or V.22 mode is used, and starts any search sequence at 1200 bps.

If the S50 register is set to 3, the modem operates in V.22bis mode, and starts any search sequence at 2400 bps.

If the S50 register is set to 4, the modem operates in V.21 mode only, at 300 bps.

If the S50 register is set to 6, the modem operates in V.32 mode, and starts any search sequence at 9600 bps.

When the S50 register is set to either 2 or 3, the modem checks the S91 register to determine what type of guard tone (if any) should be transmitted with the data in answer mode. The V.25 answer sequence is used while in V.22 or V.22bis mode. Refer to the descriptions of the S90 and S91 registers for more information.

If the S50 register is set to 254, the modem automatically searches for the correct transmission speed starting with the speed of the last AT command. For example, if the last AT command was entered at 2400 bps, the modem would attempt to connect at 2400 bps followed by 1200 bps and finally 300 bps. A PEP connection would only be attempted if the last AT command was issued at 9600 or 19200 bps.

If the S50 register is set to 255, the modem uses the Packetized Ensemble Protocol (PEP) to establish a connection in PEP mode.

### **S51      Interface Speed**

Range: 0 - 5, 252, 254 or 255

Default: 255 - Enhanced, 252 - Conventional

The S51 register determines the data rate between the modem and the local DTE.

When the connection is made in V.32 or Low Speed Mode and flow control is not enabled (S66=0 or S66=2 and a non-MNP connection is established), the local DTE must be set to match the modem's transmission speed indicated by the CONNECT XXXX result code.

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Failure to do so results in erroneous data. When the connection is terminated, the speed reverts to that specified by S51, unless S51 is set to 252, 254 or 255 (auto speed select).

Possible contents for this register are:

- |   |          |
|---|----------|
| 0 | 300 bps  |
| 1 | 1200 bps |
| 2 | 2400 bps |
| 3 | 4800 bps |

- 4 9600 bps
- 5 19200 bps
- 252 Automatic speed select; type-ahead not permitted
- 254 Automatic speed select; type-ahead permitted; default to 19200 bps
- 255 Automatic speed select; type-ahead permitted; default to 9600 bps

**Note:** *One of the following data formats should be used:*

- 8-bit data, no parity
- 7-bit data, even/odd parity
- 7-bit data, mark/space parity

When S51 is set to 252, the modem examines each AT prefix to derive the current interface speed, and a new command line may not be entered until the result code from the previous command is displayed. If no command lines have been entered after powering on, the speed at which the default profile was saved is the speed used to send RING and CONNECT messages when an incoming call is received.

When S51 is set to 254 or 255, the modem only checks the interface speed on the first AT prefix after one of the following events occur:

- The modem is powered on or reset.
- S51 is set to 254 or 255 while in command mode.
- A break is sent to the modem from the local DTE while the modem is not connected to another modem.
- A data call is disconnected and the modem is placed on-hook.
- A NO CARRIER condition is detected when the connect time has expired, dial command is aborted, or the carrier is lost.

Since the interface speed is not checked after each command line, multiple command lines can be entered without waiting for the results from the previous command. This may be useful for communications software scripting.



If no command lines have been entered after powering on, the modem uses 19200 bps (S51=254) or 9600 bps (S51=255) to send RING and CONNECT messages when a call is received.

## **S52 DTR Interpretation**

Range: 0 - 4

Default: 0

The S52 register defines the interpretation of the Data Terminal Ready (DTR) signal.

Possible contents for this register are:

- 0 Modem assumes that DTR is always true.
- 1 Modem hangs up if DTR is turned off. Modem does not auto-answer if DTR is off.
- 2 Modem performs a hard reset and enters command mode when an on-to-off transition of DTR is detected. Note that a hard reset recalls the user profile designated as the default by the S255 register. Modem does not auto-answer if DTR is off.
- 3 Modem enters command mode when an on-to-off transition of DTR is detected.
- 4 Modem hangs up, enters command mode, and disables auto-answer when an on-to-off transition of DTR is detected. Auto-answer is enabled when DTR is turned on.

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If S52 is set to 3 or 4, the modem ignores DTR level changes with a duration of less than the time specified by the S25 register.

**S54 Break Signal Interpretation**

Range: 0 - 4

Default: 0 - Enhanced, 3 - Conventional

The S54 register defines the modem's response when a break signal is transmitted by the local DTE. When the modem is operating in PEP mode, its response to a break signal is as follows:

- 0 If the modem is in data mode, it switches to command mode. If it is already in command mode, it remains in command mode.
- 1 Reserved.
- 2 The modem immediately sends a break signal to the remote DTE.
- 3 If the modem is in data mode, it sends a break signal to the remote DTE in sequence with the data stream. If it is in command mode, it immediately sends the break signal.
- 4 The modem discards the break signal.

If the modem is operating in V.32 or Low Speed Mode, and S54 is set to either 0 or 4, the modem responds the same as in PEP mode. Otherwise, when the local DTE sends a break signal, the modem sends a break to the remote DTE.

Regardless of the setting of the S54 register, when the remote modem receives a break over the phone lines in PEP mode, it discards the data buffered to send to the local modem.

The length of the break signal sent to the remote DTE is controlled by the remote S62 register.

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## **S55      Escape Character/Sequence - Interpretation**

Range: 0 - 3

Default: 0

The S55 register defines the modem's response when you enter an escape sequence or the escape character (example: +) defined in the S2 register. An escape sequence is a series of three consecutive escape characters (example: +++ ) and is used only while in data mode to enter command mode. The following cases describe the action taken by the modem when the local DTE sends the escape character.

- 0      The modem enters command mode only after the escape sequence with the proper guard time (defined by the S12 register) has been entered. It also sends each of the escape characters to the remote DTE. If the Modem is already in command mode, it remains in command mode.
- 1      The modem discards data in its data buffers and sends the escape character to the remote DTE.
- 2      The modem immediately sends the escape character to the remote DTE.
- 3      The modem sends the escape character to the remote DTE in sequence with the data stream. If the modem is in command mode, it immediately sends the escape character to the remote DTE.

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## **S56      XON Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 17 (CTRL-Q)

The S56 register defines the character to be used for resuming data flow when S58 or S68 is set to 3, 4, or 6. If S48=0, setting this register to a value greater than 127 disables the recognition of the XON character by the modem.

**S57 XOFF Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 19 (CTRL-S)

The S57 register defines the character to be used for suspending data flow when S58 or S68 is set to 3, 4, or 6. If S48=0, setting this register to a value greater than 127 disables the recognition of the XOFF character by the modem.

**S58 Flow Control Used by DTE**

(Data Terminal Equipment)

Range: 0 - 7

Default: 3 - Enhanced, 2 - Conventional

The S58 register determines the method of flow control used by the local DTE to control the flow of data coming from the modem when operating in PEP mode, or when S66=1 or S66=2 and an error-control connection (PEP or MNP) is established.

Possible contents of this register are:

- 0 No flow control is used. (Not recommended.)
- 1 Use RTS/CTS flow control in half duplex mode. When the local DTE turns on RTS, the modem responds by turning on CTS. The modem receives data from the local DTE. When the local DTE turns off RTS, the modem turns off CTS and sends buffered data to the local DTE.
- 2 Use full duplex RTS/CTS flow control. When RTS is off, the modem does not send data to the local DTE. When RTS is on, the modem sends data to the local DTE.
- 3 Use XON/XOFF flow control. If an XOFF is received by the modem, it stops sending data to the local DTE until an XON is received.

The XON and XOFF characters used for flow control are defined by the S56 and S57 registers, respectively. The S48 register defines how the modem determines if an XON or XOFF is received when an 8-bit data format is used.

- 4 Use both XON/XOFF flow control and full duplex RTS/CTS flow control. If an XOFF is received or if RTS is off, the modem stops sending data to the local DTE. Sending is resumed when RTS is turned on or an XON is received.
- 5 Use ENQ/ACK flow control. To operate correctly, the remote modem's S68 register must also be configured to use ENQ/ACK flow control. When an ENQ is received from the remote modem and sent to the local DTE, the modem stops sending data to the local DTE until an ACK is received from the local DTE. The ACK from the local DTE is not passed to the remote modem.

In V.32 and Low Speed Modes, no flow control is used and ENQ/ACKs are passed to the remote modem.

*Note: This option is intended for use with some Hewlett Packard computers in PEP mode only.*

- 6 Use ENQ/ACK and XON/XOFF. The modem stops sending data to the local DTE if an ENQ is received from the remote modem and passed on to the local DTE, or if an XOFF is received from the local DTE. The modem does not resume sending data to the local DTE until an ACK has been received for any outstanding ENQ and an XON has been received for any previously received XOFF.

When connected in V.32 and Low Speed Modes, only XON/XOFF flow control is used. ENQ/ACKs are passed to the remote modem.

- 7 Use transparent XON/XOFF flow control. This method provides a way to send XON/XOFF characters as data rather than being interpreted as control characters when Hayes' Smartcom III software is used. Register S68 should be set to 255 when this option is selected.

A similar register, S68, controls the flow of data in the opposite direction, that is, from the local DTE to the modem.

**S59 Prompt Character**  
Range: ASCII Code 0 - 255  
Default: 0

The S59 register contains the character that is used as a prompt character when in command mode. If no prompt is desired, a 0 should be entered.

**S61 Speaker Volume**  
Range: 0 - 255  
Default: 150

The index specified in this register determines the speaker volume when it is enabled. When S61 is set to 0, the speaker is turned off.

The speaker volume is low at 1-99, medium at 100-199, and high at 200-255.

**S62 Break Length Time**  
Range: 2 - 255  
Default: 3 (150 milliseconds.)

The contents of the S62 register determines the length of time a break signal is placed on the Receive Data (RD) line when received from the remote modem. Each count represents 50 milliseconds.

**S63 Command Mode Selection**  
Range: 0 - 2  
Default: 1 - Enhanced, 2 - Conventional

The S63 register is used to select either Conventional or Enhanced Command Mode, or to disable the requirement for the AT attention code.

This register can only be accessed in Enhanced Command Mode or by entering an ~S63=n command in Conventional Command Mode.

Changes to this register take effect immediately. This means that an ~S63=0 or 1 command causes the modem to process any subsequent commands contained in the same line in Enhanced Command Mode. Similarly, any commands contained in the same line following an S63=2 is processed in Conventional Command Mode.

Possible contents for this register are:

- 0 AT prefix not allowed and Enhanced Command Mode selected.
- 1 AT prefix required and Enhanced Command Mode selected.
- 2 AT prefix required and Conventional Command Mode selected.

If the content of the S63 register is a 0, the modem treats all characters as commands and operates on the AT as two separate commands. If the content of the register is a 1 or 2, the modem requires the AT (or at) to be entered at the beginning of each command line.

When selecting a command mode for compatibility with your computer's data communications software, there are several other associated parameters that must also be changed. The best way to accomplish this is by following the procedure described under *Initializing the Modem* in Chapter 3. You can, however, initialize the modem using commands as described below.

To initialize the modem for Conventional Command Mode, enter the following command line:

**AT ~&F &F1&W0 &W1 &Y0**

To initialize the modem for Enhanced Command Mode, enter:

**AT ~ &F &W1 &W2**

**S64 Dial/Answer Sequence Abort**

Range: 0 or 1

Default 0

The S64 register controls whether or not the modem aborts a dialing or answering sequence if characters are transmitted by the local DTE before a connection is established.

Possible contents for this register are:

- 0 Abort the dialing or answering sequence if characters transmitted by the local DTE before a connection is established.
- 1 Ignore any characters sent by the local DTE while dialing or answering a call.

**S65 XON/XOFF Failsafe**

Range: 0 or 1

Default 0

The S65 register allows the modem to reissue one or more XOFF control characters over the serial interface if the local DTE continues to transmit data after an XOFF has been issued.

Possible contents for this register are:

- 0 Use normal XON/XOFF flow control.
- 1 Use failsafe XON/XOFF flow control. The modem issues an XOFF when the flow control threshold is reached, and once again for every five characters subsequently sent by the local DTE.

*Note: This register is only valid when the modem is using XON/XOFF flow control. The S68 register must be set to 3, 4, 6, or 255 (when S58 is set to 3, 4, or 6).*

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## **S66 Lock Interface Speed**

Range: 0 - 2

Default: 0 - Enhanced, 2 - Conventional

The S66 register controls whether or not the DTE interface speed is maintained and flow control is performed in V.32 and Low Speed Mode (103J, 212A, V.21, V.22 or V.22bis). This register should be configured before attempting to connect in any of these modes.

Possible contents for this register are:

- 0 Change interface speed to match connection and do not use flow control when a connection is made in a V.32 or Low Speed Modes.
- 1 Lock interface speed and use flow control in V.32 or Low Speed Modes.
- 2 Lock interface speed and use flow control in V.32 or Low Speed Modes if MNP connection is established. Do not use flow control in command mode. For non-MNP connections, the interface speed changes to match the speed of the connection and no flow control is used.

If S66 is set to 0 and a connection is made in V.32 or Low Speed Mode, the modem forces the serial interface speed to match the speed of the connection and performs no flow control. The local DTE interface must also be changed to match the speed of the connection or data is garbled. If S66 is set to 1 or 2, the local DTE must support the flow control method specified by the S58 and S68 registers, otherwise data is lost.

**S67 Clear to Send (CTS)  
Signal Interpretation**

Range: 0 or 2

Default: 0

The S67 register defines how the modem uses Clear To Send (CTS) in relationship to Request To Send (RTS) and carrier detected. This register allows you to make the RTS-CTS signals behave like that of a conventional, nonintelligent modem. This register's effect on the CTS signaling depends on the setting of the S58 and S68 registers.

If S58 is set to 1, the content of the S67 register is ignored, and the modem operates in half duplex mode. Refer to the S58 register description for information on half duplex operation.

If S58 is set to some value other than 1, then the content of the S67 register determines how the modem generates the CTS control signal:

- 0 If full duplex RTS/CTS flow control is used, CTS is used to control the data flow as described for the S68 register. If full duplex RTS/CTS flow control is not used, CTS is always on.
- 1 CTS is held OFF until a valid carrier is detected. When a carrier is detected, CTS is turned on 200 milliseconds after RTS goes active. If RTS/CTS flow control is used, CTS is used to control the flow of data from the DTE.
- 2 CTS is turned on in response to an off-to-on transition of RTS after a delay specified by register S26. Recommended for use in transparent synchronous mode only.

**S68      Flow Control Used by DCE**  
(Data Communications Equipment)  
Range: 0, 2 - 6, or 255  
Default: 255

The S68 register determines the method of flow control used by the modem. This register, in conjunction with the S58 register, controls the flow of data from the local DTE to the modem when operating in PEP mode, or when S66=1 or S66=2 and an error-control connection (PEP or MNP) is established.

If S58 is set to 1, the content of the S68 register is ignored, and the modem operates in half duplex mode. Refer to the S58 register description for information on half duplex operation. If S58 is set to 7 (transparent ON/XOFF flow control), this register should be set to 255.

Possible contents of the S68 register are:

- 0      No flow control is used (not recommended).
- 2      Use RTS/CTS flow control. CTS is turned OFF by the modem when it wants to stop the flow of data to it. CTS is turned ON when the modem will accept data
- 3      Use XON/XOFF flow control. An XOFF is issued by the modem when it wants to stop the flow of data to it. An XON is issued to resume the flow of data.

The XON and XOFF characters used for flow control are defined by the S56 and S57 registers, respectively. The format of the XON and XOFF characters is defined by the S60 register.

- 4      Use both XON/XOFF and RTS/CTS flow control.
- 5      Use ENQ/ACK flow control. Note that this option is intended for use with some Hewlett Packard computers in PEP mode only. To operate correctly, the remote modem's S58 register must also be configured to use ENQ/ACK flow control. When an ENQ is issued by the local DTE, the modem returns an ACK to the local DTE when the modem can accept at least 2000 bytes of data. The ENQ is passed on to the remote modem.

In V.32 and Low Speed Modes, no flow control is used and ENQ/ACKs are passed to the remote modem.

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- 6 Use ENQ/ACK and XON/XOFF flow control. The modem always sends an ACK in response to an ENQ from the local DTE, and uses XON/XOFF to control the flow of data from the local DTE to the modem. The ENQ is passed on to the remote modem.

When connected in V.32 and Low Speed Modes, only XON/XOFF flow control is used. ENQ/ACKs are passed to the remote modem.

- 255 Use the flow control specified by S58.

## **S69 XON Signal Handling**

Range: 0 - 2

Default: 0

The S69 register determines how the XON character is treated when XON/XOFF flow control is used by the local DTE.

Possible contents for this register are:

- 0 XON character is processed and consumed by the modem and is not passed to the remote modem.
- 1 XON character is processed and consumed by the modem and is not passed to the remote modem.
- 2 If the modem has been previously XOFFed, the XON character is processed by the modem and is not passed on to the remote modem. If the modem has not been XOFFed, the XON character is not processed, but is passed on to the remote modem.

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Registers S70 through S78 provide statistics information and cannot be set by the user. Registers S70 through S76 pertain only to Packetized Ensemble Protocol™ (PEP).

## **S70 Instantaneous Transmit Rate**

The S70 register indicates the instantaneous rate at which data is being transmitted to the remote modem in bits per second. It represents the present data transmission capacity of the dial-up lines. This register does not contain the actual data throughput.

S70 is a read only register and contains either the current data if communication is currently active or the last sample made if the connection is broken. Any new connection attempt reinitializes this register.

### **S71      Transmit Bits Per Channel**

The S71 register contains the number of transmit bits assigned to each channel at 511 frequency points in the current telephone connection. All 511 values are displayed at the time this read only register is accessed.

### **S72      Instantaneous Receive Rate**

The S72 register indicates the instantaneous rate at which data is being received from the remote modem in bits per second. It represents the present data transmission capacity of the dial-up lines.

This register does not contain actual data throughput. S72 is a read only register and contains either the current data rate if communication is currently active or the last sample made if the connection is broken. Any new connection attempt reinitializes this register.

### **S73      Receive Bits Per Channel**

The S73 register contains the number of receive bits assigned to each channel at 511 frequency points in the current telephone connection. All 511 values are displayed at the time this read-only register is accessed.

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## **S74 Received Packets Retransmitted**

The S74 register contains a count of the number of received packets requiring retransmission since the current connection was made. When the connection is broken, the register retains the count until the next connection is attempted. S74 is a read-only register.

## **S75 Packets Accepted**

The S75 register contains a count of the number of acceptable packets received since the current connection was made. When the connection is broken, the register retains the count until the next connection is attempted. S75 is a read-only register.

## **S76 Equivalent Line Noise Profile**

The S76 register contains the noise level in dBm to the nearest tenth observed at 511 frequency points in the current telephone connection. All 511 values are displayed at the time this read-only register is accessed.

## **S77 Frequency Offset**

The S77 register contains the observed frequency offset of the communication channel in Hertz to the nearest sixteenth for the current connection. Frequency offset is also reported in the 1200 bps and 2400 bps modes.

**5C**

## **S78 Line Quality**

The S78 register reports the modem's estimate of the quality of the current connection. This register is valid only when in 212A, V.22, V.22bis, or V.32 mode. The quality is represented in a scale from 0 to 100. The higher the number the better the quality of the line. Errors are less likely to occur on a higher quality line.

A line quality greater than 50 can be considered acceptable for good communications. You may want to redial to establish another connection if the line quality is less than 30, as the line error rate may increase transmission cost and reduce reliability.

*Note: Register S78 does not return line quality information when PEP mode is being used.*

## **S90 CCITT/Bell Mode Select**

Range: 0 or 1

Default: 0

The S90 register selects Bell 103 or V.21 mode when operating in 300 bps transmission mode, and Bell 212 or V.22 mode when operating in 1200 bps transmission mode.

Possible contents for this register are:

- 0 Bell Mode (103J at 300 bps, 212A at 1200 bps)
- 1 CCITT Mode (V.21 at 300 bps, V.22 at 1200 bps)

Refer to the descriptions of registers S50 and S91 for additional information.

**S91 Guard Tone Selection**

Range: 0 - 2

Default: 0

In V.22 or V.22bis mode, the answer modem checks this register to determine if a guard tone is required, and what type of guard tone to transmit with the data.

Possible contents of this register are:

- 0 No guard tone (typical U.S. operation)
- 1 1800 Hz guard tone
- 2 550 Hz guard tone

Refer to the descriptions of the S50 and S90 registers for more information.

**S92 Answering Sequence Selection**

Range: 0 - 2

Default: 0

The S92 register is used to change the sequence of answering tones issued by the modem when answering a call in automatic speed determination mode (S50=0). This is required to accommodate slower speed modems, which are adversely affected by PEP answer tones.

The following possible contents of the S92 register are only valid when the modem is answering a call in automatic speed determination mode:

- 0 Use the normal search sequence specified in the S50 register description.
- 1 Issue the PEP answer tones at the end of the search sequence rather than at the beginning to accommodate connecting with slower speed (non-PEP) modems. In order to establish a connection in PEP mode when the answering modem's S92 register is set to 1, the calling (originating) modem must have its S50 register set to 255.



In addition, the calling modem's S7 register should be set to 60 seconds or greater to allow enough time to detect a valid PEP answer sequence.

- 2 Use the normal search sequence specified in the S50 register description but preceded by a three second V.25 answer tone.

### **S93 V.32 AC Transmit Duration**

Range: 0 - 255 (n = 100 milliseconds)

Default: 8

This register sets the amount of time the modem waits for a V.32 answer sequence before abandoning this mode, assuming that the modem is in answer mode, and register S50 is set to any value other than 255. The default of 800 milliseconds works well with most V.32 modems.

If you have some trouble connecting with some V.22bis modems, try a shorter duration. For manual or late answer V.32 modems, a longer duration may be necessary.

### **S94 Transmission Speed Negotiation**

Range: 0 - 3

Default: 1

The S94 register determines whether the modem connects at any speed up to the maximum specified by the S50 register, or only at the speed specified by the S50 register. This register is ignored when the S50 register is set to 0 to 255.

- 0 Fallback disabled. The speed of the connection must be as specified by the S50 register. If S50 is set to 254, the connection speed must match the speed of the last AT command.
- 1 Allows a connection at any transmission speed supported by both modems up to the maximum specified by the S50 register. The modems arrive at the correct speed by selecting the highest speed that is supported by both modems.

Fallback can occur within a given modulation scheme, or, if necessary, can go to another scheme.

- 2 Fallback within a specified modulation scheme only. The modem cannot use another scheme if the connection fails. Note that the modem uses the DTE/DSR signal in this setting only (see Appendix B).
- 3 Use appropriate fallback exclusively.

If the selected transmission speed is 300 or 1200 bps, the modem references the present setting of the S90 register (CCITT/Bell Mode Select) to determine whether Bell 103 or V.21 is used for 300 bps, or whether Bell 212A or V.22 is used for 1200 bps. If forced fallback is specified, and the specified modulation has no fallback, the primary speed is used.

## **S95 MNP Operating Mode**

Range: 0 - 2

Default: 0 - Enhanced, 2 - Conventional

This register determines how the modem establishes an MNP connection while operating in V.32 and Low Speed Modes. MNP is a nearly-transparent, packetizing protocol, which provides an error-free link to a remote asynchronous modem.

There are several classes of MNP that provide various levels of performance. This modem supports Classes 1 through 5. When an MNP connection is established, the modem automatically operates at the highest MNP level supported by both modems. The negotiated setting of this register can be displayed by issuing an I4 command.

Possible contents for this register are:

- 0 Normal Mode - MNP is disabled. The modem does not attempt to establish an MNP connection.
- 1 Reliable Mode - When a carrier is established, the modem attempts to establish an MNP connection. If a connection cannot be made within 18 seconds of establishing carrier, the connection is dropped and NO CARRIER is reported. If an MNP connection is established, a CONNECT XXXX/REL message is reported.

- 2 Auto-reliable Mode - When a carrier is established, the modem attempts to establish an MNP connection. If a connection cannot be made within 4 seconds of establishing carrier, the modem falls back to a normal, nonreliable connection and a CONNECT XXXX message is reported.

Any characters sent to a non-MNP modem from its DTE during the 4 second interval in which the modem was unsuccessfully attempting to establish a connection is lost. In addition, if the answer modem does not support MNP, it receives a burst of characters from the originating modem during the first 4 seconds of the call as the originating modem attempts to make an MNP connection.

*Note: The Microcom modems use the \N command to set MNP capabilities. The corresponding Microcom and Telebit settings are:*

Mode	Microcom	Telebit
Normal	\N0	S95=0 S66=1
Direct	\N1	S95=0 S66=0
Reliable	\N2	S95=1 S66=1 on 2*
Auto-Reliable	\N3	S95=2 S66=1 or 2

*\* Note: When register S95 is set to 1 or 2, you must also set the S66 register to 1 or 2 to enable flow control.*

**5C**

**S96 MNP Data Compression Enable**

Range: 0 or 1

Default: 0

This register determines if the modem uses data compression while operating in MNP Mode. Possible contents for this register are:

- 0 Data Compression is disable.
- 1 Data Compression is enabled, provided the connection is made in MNP Mode and the modem at the remote end also has Data Compression enabled (S96=1).

Data compression is negotiated between the two connecting modems during the MNP negotiation in V.32 and Low Speed Modes. If either modem does not support data compression, then it is not used during the communications session. Changing this register after a connection is established does not change the data compression setting for the session in progress. The data compression negotiated by the connecting modems can be displayed by issuing an I4 command.

### **S97 V.42 LAP-M Enable**

Range: 0 - 1

Default: 0

The S97 register enables or disables LAP-M, while the modem is operating in V.42 mode (S106=1). Possible contents for this register are:

- 0 Disable LAP-M in V.42 answer sequence.
- 1 Enable LAP-M in V.42 answer sequence.

### **S98 V.42bis Data Compression**

Range: 0, 1, 2, or 3

Default 3

The S98 register determines if the modem uses data compression while operating in LAP-M mode. Possible contents for this register are:

- 0 No data compression.
- 1 Data compression in transmit direction only.
- 2 Data compression in receive direction only.
- 3 Data compression in both transmit and receive directions.

V.42bis data compression is possible only if a connection is established in LAP-M, and both connected modems are configured for data compression.

## **S100 Answer in Originate Mode**

Range: 0 or 1

Default: 0

The S100 register controls whether the modem answers as an originate modem or in a normal answer mode used to establish a connection. Possible contents for this register are:

- 0 Normal Mode. The modem answer or originates a call in normal answer or originate mode.
- 1 Reverse mode. The modem answers the ringing signal and attempts to connect as if it had originated the call.

## **S101 Continuous Answer/Organize**

Range: 0 - 4

Default: 0

This register can be set to have the modem continuously attempt to establish a connection in either answer or originate mode. Values 1 - 4 are intended for leased lines.

Possible contents for the register are:

- 0 Connect normally. That is, as if the modem was called on the Public Switched Telephone Network (PSTN) with S0 not equal to 0, or in response to a D or A command.
- 1 Attempt to connect as an answer modem every 20 seconds whenever a carrier is not present.
- 2 Attempt to connect as an originate modem every 20 seconds whenever a carrier is not present.
- 3 Immediately attempt to connect as an answer modem whenever a carrier is not present. The modem pauses for 20 seconds after carrier is lost before attempting a new connection.
- 4 Immediately attempt to connect as an originate modem whenever a carrier is not present. The modem pauses for 20 seconds after carrier is lost before attempting a new connection.

## **S102 Auxiliary Telco Lead Setting**

Range: 0 - 2

Default: 0

This register must be set to match the A/A1 or MI/MIC jumper connection on the modem board. These jumper connections are used to either signal the line switching equipment that the modem is using the telephone line or to cause the modem to initiate a call. Since the modem uses only four wires in the cable, only one of the functions may be used. The hardware jumpers must be properly connected before the modem is installed. The S102 register must then be set to inform the firmware how the auxiliary leads should be used. Possible contents of the S102 register are:

- 0 Ignore the auxiliary leads regardless of how the hardware jumpers are set.
- 1 The modem uses the A/A1 leads to inform the switching equipment that it is using the line. The A/A1 hardware jumpers must be installed on the modem to use this feature.
- 2 The modem detects contact closure on the MI/MIC leads to initiate a connection. The MI/MIC jumpers must be installed to use this feature.

## **S104 Automatic Dialing Options**

Range: 0 - 4

Default: 0

**5C**

The S104 register is used to enable automatic dialing via the DTR signal from the local DTE or from the front panel T/D switch.

Possible contents for this register are:

- 0 Disable automatic dialing.
- 1 Enable automatic dialing via an off to on transition on the DTR control signal line. When DTR is on, the modem goes off-hook and dials the first or second number in the Number Directory (the actual number is determined by the position of the A/B switch).

The modem attempts to connect in either originate or answer mode depending on the setting of the S100 register.

- 2 Reserved. An ERROR response code is sent if this register setting is attempted.
- 3 Enable automatic dialing from the front panel T/D switch. When the modem is idle (OH indicator is off), pressing the T/D switch causes the modem to go off-hook and automatically dial the first or second number in the Number Directory (the actual number is determined by the position of the A/B switch).
- 4 When the DTR signal is asserted, the modem assumes the originate mode if the setting of register S1 is less than that of register S0. If the setting of register S1 is greater than or equal to that of register S0, the modem assumes the answer mode.

When the modem is used with some types of Automatic Calling Units (ACU), set S104 = 4, switch DTR to off, lift the receiver and listen for a dial tone, dial the number designated, wait for the remote modem to make a connection, then switch DTR to off.

For values 0 - 3, the modem attempts to connect in either originate or answer mode depending on the setting of the S100 register.

In originate mode, the number dialed is dependent on the setting of the A/B switch when the dialing function initiated. If the A/B switch is in the A position, the first number (N0) in the Number Directory is dialed; if the switch is in the B position, the second number (N1) is dialed.

**5C**

**S105 T/D Switch Enable**

Range: 0 - 2

Default: 1

The S105 register enables or disables the T/D switch on the front panel. Possible contents for this register are:

- 0      Disable the T/D switch.
- 1      Enable the T/D switch.
- 2      Enable the T/D switch only when the modem is on-hook (OH indicator is off).

This register does not prohibit the use of the T/D switch when initializing the modem to its factory default settings.

**S106 V.42 Detection Enable**

Range: 0 or 1

Default: 0

This S106 register determines if the answering modem detects a data pattern, indicating an attempt to connect in V.42 mode. Possible contents for this register are the following:

- 0      Modem does not perform V.42 detection.
- 1      The modem performs detection of V.42 mode. LAP-M, MNP or no error control, depending on the settings of the S95 and S97 registers.

As shown in Table 5-4, the V.42 error control mode and fallback is controlled by the following three registers: S106, S97 and S95.

If S106 and S97 are both set to 0 on either the originating or answering modem, LAP-M error control is disabled. The connecting modems negotiates whether a connection is made in MNP or nonreliable (no error control) mode based on the S95 register setting of each modem.



If S106 is set to 0 and S97 is set to 1 on either the originating or answering modem, only a LAP-M connection is allowed. If LAP-M is disabled or not supported on the opposite modem, no connection is established.

Table 5-4. V.42 Error Control

Error Control Mode and Fallback	Originate			Answer		
	S106	S97	S95	S106	S97	S95
NR	0	0	0	0	0	0
MNP Only	0	0	1	0	0	1
MNP → NR	0	0	2	0	0	2
LAP-M Only	0	1	NA	0	1	NA
LAP-M → NR	1	NA	0	1	1	0
LAP-M → MNP	1	NA	1	1	1	1
LAP-M → MNP → NR	1	NA	2	1	1	2

NR - Nonreliable, No Error Control

NA - Not Applicable

**5C** If S106 and S97 are both set to 1 on the answering modem or S106 is set to 1 on the originating modem, the connecting modems negotiates whether a connection is made in LAP-M, MNP or nonreliable (no error control) mode.

V.42 detection is negotiated between the two connecting modems. In originate mode, the modem sends a special data pattern for a predetermined period of time set by the S107 register. During this time, the modem attempts to detect a data pattern from the answering modem indicating if it should proceed to connect in LAP-M mode.

If the answering modem fails to respond with the correct data pattern, the originating modem either falls back to nonreliable (no error control) mode or attempts to make an MNP connection, depending on the setting of S95 register.

In answer mode, the modem tries to detect the data pattern indicating the start of LAP-M or MNP mode. If the start of LAP-M mode is detected, then the modem responds with a data pattern indicating that it wants to connect in LAP-M mode provided the S97 register is set to 1.

If the start of MNP is detected from the originating modem, the setting of S95 register determines whether the answering modem responds in MNP mode or nonreliable mode.

If the answering modem does not detect a special data pattern for either LAP-M or MNP mode within a predetermined amount of time, then the modem drops back to nonreliable (no error control) mode.

### **S107      Detection Timer**

Range: 0 - 255

Default: 20 (2.8 seconds)

The S107 register determines the amount of time the modem sets for the LAP-M mode or MNP mode start pattern.

The length of time for the start pattern is determined by the following formula:

$$\text{Time} = 800n + 100 \text{ ms}$$

where n is the value in milliseconds stored in the S107 register.

**5C**

### **S108      V.42 Match Count**

Range: 0 - 1

Default : 0

The S108 register determines the match count for V.42 detection. Possible contents for the register are:

- 0      Match count is 4 (V.42 standard, Current Microcom V.42).
- 1      Match count is 1 (Current Hayes V.42 Implementation).

## **S110 PEP Mode Data Compression Enable**

Range: 0, 1 or 255

Default: 255

This register determines if the modem uses data compression while operating in PEP mode. Possible contents for this register are:

- 0 Data compression is disabled.
- 1 Data compression is enabled provided the connection is made in PEP Mode, and the modem at the remote end also has data compression enabled (S110=1 or 255).
- 255 Data compression is enabled only if the connection is made in PEP Mode and the remote modem has (S110 set to 1).

Data compression is negotiated between the two connecting modems during the PEP initialization sequence. If either modem does not support data compression, then it is not used during the communications session. Changing this register after a connection is established does not change the data compression setting for the session in progress unless an &R1 command is issued to the modem. The data compression negotiated by the two connecting modems can be displayed by issuing an I4 command.

**5C**

## **S111 File Transfer Protocol Support**

Range: 0, 10 - 14, 20, 30, 255

Default: 255

When file transfer protocol support is enabled, the modem interacts with the protocol to eliminate delays in the file transfer which normally occur with other high-speed modems. This significantly increases the data throughput rate without altering the protocol functionality.

The S111 register determines which file transfer protocol, if any, should be supported during a communications session. The content of this register is valid when a connection is made in PEP mode or when a MNP connection is established in V.32 mode.

Possible contents for this register are:

- 0 No protocol is supported.
- 10 Kermit protocol with no parity supported.
- 11 Kermit protocol with odd parity supported.
- 12 Kermit protocol with even parity supported.
- 13 Kermit protocol with mark parity supported.
- 14 Kermit protocol with space parity supported.
- 20 XMODEM/YMODEM protocol supported.
- 30 UUCP g protocol supported.
- 255 Use protocol specified by remote modem.

Protocol support is negotiated between the two connecting modems during the PEP initialization sequence. Both modems must agree on the protocol supported, otherwise no protocol is supported. If one modem has its S111 register set to 255, it supports the protocol specified by the other modem. If both modems have the S111 register set to 255, no protocol is supported. Changing this register after a connection is established does not change the protocol supported for the session in progress unless an &R1 command is issued to the modem.

The protocol support negotiated by the two connecting modems can be displayed by issuing an I4 command.

*Note: All transfer protocols defined by the S111 register are supported when a MNP connection is established in V.32 mode.*

**Note to UUCP users:**

For additional information when configuring the modem for UUCP protocol support, send an electronic mail request, which includes the type of system in which the modem will be used, to:

{ames,sun,uunet}!telebit!modems

or call your Telebit Technical Support representative. Also refer to the Nutshell handbook, entitled *Managing UUCP and Usenet*, by O'Reilly and Associates, Inc.

**Note to Kermit users:**

Kermit protocols that use sliding windows or large blocks may be used with protocol support. However, the modem modifies the S packet exchange forcing regular Kermit (no window, 94 byte maximum packet size) to be negotiated between both computers.

**S112 Kermit Mark Character**

Range: ASCII Code 0 - 255

Default: ASCII Code 1 (SOH)

The S112 register specifies the code used by Kermit as mark character to begin a packet. The default of 1 (ASCII SOH) is the standard mark character used by Kermit. This register is only used while operating in Kermit protocol support mode.

**S121 Echo Suppressor Compensation**  
(PEP Mode only)  
Range: 0 or 1  
Default: 0

The S121 register is used to compensate for the effects of echo suppressors that may be interfering with data transmissions between modems.

This compensation reduces throughput by approximately five percent, and should only be used when data transmission problems occur over a connection involving echo suppressors.

The possible contents of this register are:

- 0 Do not compensate for echo suppression.
- 1 Enable echo suppressor compensation.

*Note: If either modem has S121 set to 1, echo suppressor compensation is enabled. This is negotiated during the PEP initialization sequence. Changing this register setting after the connection is established does not change the echo suppressor compensation for that session unless an &R1 command is issued to the modem. The negotiated setting of this register can be displayed by issuing an I4 command.*

**S130 Data Set Ready Interpretation**  
Range: 0 - 6  
Default: 2 - Enhanced, 0 - Conventional

The S130 register defines the Data Set Ready (DSR) signal interpretation.

Possible contents for this register are:

- 0 DSR is always on.
- 1 DSR is turned on when an answer tone is detected from the remote modem while originating a call, or when the modem begins transmitting an answer tone while answering a call.

- 2 DSR is on when the modem is ready to accept commands or data.
- 3 DSR is on when the modem is ready to accept commands or data. When carrier is lost, DSR is turned off for the amount of time specified by the S47 register, then is turned on.
- 4 DSR is on when the modem is off-hook.
- 5 DSR is on only when a carrier is detected from the remote modem.
- 6 The DSR signal is raised if the DTR signal is raised while the modem is not online, or if a connection is made to another modem and the DTR signal was already asserted before the modem was reset.  
  
The DSR signal is lowered if the DTR signal drops or if the remote modem's carrier is dropped. Recommended for use in transparent synchronous mode only.

### **S131 Data Carrier Detected Interpretation**

Range: 0 - 4

Default: 2 - Enhanced, 0 - Conventional

The S131 register defines the Data Carrier Detected (DCD) signal interpretation. Possible contents for this register are:

- 0 DCD is always on.
- 1 DCD is on only when a carrier is detected from the remote modem.
- 2 DCD is on when the modem is ready to accept commands or data.
- 3 DCD is on when the modem is ready to accept commands or data. When carrier is lost, DCD is turned off for the amount of time specified by the S47 register, then is turned on.
- 4 DCD is the inverse of CTS in command and online modes. Recommended for use in transparent synchronous mode only.

**5C**

**S150 Asynchronous/Synchronous Mode Selection**

Range: 0 - 3

Default: 0

This register determines if the modem operates in Asynchronous, SDLC, or Transparent Synchronous Mode when the modem is powered up or reset via a Z command, an &T command, or a change in the A/B switch position and S150 is in the nonvolatile memory as 1 or 2.

Possible contents for this register are:

- 0 Asynchronous Mode
- 1 PEP SDLC Mode
- 2 Transparent Synchronous Mode
- 3 Asynchronous/Synchronous Mode

When the S150 register is set to 0, the modem ignores the contents of the registers S151-S153, S154, S155, S164, and operates in Asynchronous Mode.

When the S150 register is set to 1, only PEP connections are allowed, and registers S151-S164 are used to configure the modem for SDLC operations. The following registers are ignored while operating in SDLC Mode: S12, S47, S50, S51, S54, S55, S58, S62, S65, S67, S111, S130, and S131.

*Note: Changing the setting to or from 1 has no effect until the next reset operation. To switch from SDLC Mode you must set the S150 register to the appropriate value, save the setting in nonvolatile memory, and reset the modem.*

While operating in SDLC Mode, and communicating using PEP modulation, the modem automatically determines if it is acting as an SDLC primary or secondary link station during the initial SDLC protocol sequence. If the modem is connected to a primary link station through the serial interface, it acts as a secondary link station. On the other hand, if the modem is connected to a secondary link station, it acts as a primary link station.



When the S150 register is set to 2, the modem ignores the contents of registers S151-S153, S154, S155-S164, and operates in the Transparent Synchronous Mode. While in this mode, the modem is capable of using V.22, V.22bis Bell212A, and V.32 modulations. When the modem is not online, the primary data and clock lines are disabled.

The modem sends the asynchronous CONNECT, RING, RRING, BUSY, and NO CARRIER messages through the secondary data line. The primary data and clock lines of the modem are enabled in synchronous mode when a connection to another modem is initiated.

*Note: The S150=2 mode can only be set or reset by pushing the A/B switch, by issuing an ATZ command from the command port, or by reloading the factory default. To enter or exit Transparent Synchronous Mode you must set the S150 to 2, save the setting in nonvolatile memory, and reset the modem. Refer to Table 5-5 Transparent Synchronous Cross Reference.*

When the S150 register is set to 3, the modem operates in the Asynchronous/Synchronous Mode. When the modem is not online, the primary data and clock lines operate in asynchronous mode, but the modem switches to synchronous mode when a connection to another modem is established.

## 5C

### **S151 SDLC Interface Speed**

Range: 1 - 5

Default: 4

The S151 register specifies the data rate between the modem and local DTE while operating in SDLC Mode.

Possible contents for this register are:

- |   |           |
|---|-----------|
| 1 | 1200 bps  |
| 2 | 2400 bps  |
| 3 | 4800 bps  |
| 4 | 9600 bps  |
| 5 | 19200 bps |

Table 5-5. Transparent Synchronous Cross Reference

ACF/NCP/VSMacro	T2500 Register Setting
<b>GROUP</b> or ,DIAL=YES ,DIAL=NO ,LNCTL=BSC or SDLC	<b>S130=6</b> S130=0 <b>S150=2</b>
<b>LINE</b> or ,ANSTONE=NO ,AUTO=address <b>(AUTO omitted)</b> or ,CALL=IN or INOUT or ,CALL=OUT or ,CLOCKNG=EXT or ,CLOCKNG=INT or ,DUPLEX=HALF or ,DUPLEX=FULL ,LPDATS=NO ,NEWSYNC=NO ,RING=YES ,SPEED=9600 or ,SPEED=4800	S102=2 <b>S102=0</b> <b>S0=1</b> S0=0 <b>S154=0</b> S154=1 S67=2 S131=4 <b>S67=0 S131=1</b>  <b>S52=4</b> <b>S50=6</b> S50=6 S94=3

( Boldface values represent &amp;F3 settings)

## **S152 SDLC Switched/Nonswitched**

Range: 0 - 2

Default: 1

The S152 register defines how the modem interprets the Data Set Ready (DSR) signal. *The S52 register defines how the modem interprets the DTR signal.*

Possible contents for this register are:

- 0 Modem operates in Nonswitched Mode. DSR is active when the modem is ready to communicate with the local DTE. If the DTR signal is off, the modem does not communicate with the local DTE.
- 1 Modem operates in Switched Mode. DSR is held off until DTR is turned on and a communications link is established with the remote modem in PEP mode.
- 2 Modem operates in a Special Switched Mode. DSR is active when the modem is ready to communicate with the local DTE.

## **S153 SDLC Full/Half Duplex Mode Selection**

Range: 0 or 1

Default: 1

**5C** The S153 register determines the data transfer mode used between the modem and the local DTE.

Possible contents of this register are:

- 0 Modem operates in Full Duplex Mode. In this mode DCD and CTS are active when the modem is ready to communicate with the local DTE.
- 1 Modem operates in Half Duplex Mode. When the modem is transferring received data to the local DTE, DCD is on and CTS is off. When the local DTE turns on RTS, the modem responds by turning CTS on. The local DTE cannot transmit until the modem turns on CTS, indicating that the modem is ready to accept data from the local DTE for transmission to the remote site. The SDLC protocol ensures that a conflict does not occur between the modem and the DTE.

**S154 Synchronous Clock Mode**

Range: 0 - 2

Default: 0

The S154 register specifies which RS-232C timing signals are used for synchronization while operating in SDLC or Transparent Synchronous Mode.

Possible contents for this register are:

- 0 The DCE Transmitter Signal Element Timing (pin 15) and the Receiver Signal Element Timing (pin 17) signals from the modem are used to control the timing of the transmitted and received data stream.
- 1 The DTE Transmitter Signal Element Timing (pin 24) signal from the local DTE is used to control the timing of the transmitted and received data stream.
- 2 The DCE Transmitter Signal Element Timing (pin15) is derived from the incoming data carrier signal (slave operation). This setting is valid only in Transparent Synchronous Mode.

**S155 NRZ/NRZI Data Encoding**

Range: 0 or 1

Default : 0

The S155 register specifies which data encoding method is used while operating in the SDLC Mode. Possible contents of this register are:

- 0 NRZ encoding is used. A 1 is represented by a high level and a "0" is represented by a low level.
- 1 NRZI encoding is used. A 1 is represented by no change in the level and a 0 is represented by a change in the level. This encoding method facilitates deriving the clock from the data itself.

**S157 SDLC Disconnection Delay Time**

Range: 0 - 255

Default: 0

The S157 register specifies the amount of time in tenths of seconds that the modem will wait before disconnecting (dropping carrier and DSR) after one of the following events occur:

- DTR is dropped by the local DTE when S52 is set to 1.
- a SDLC DISC command is received from the local or remote DTE.
- the carrier from the remote DTE is lost.

The modem will wait until its transmit and receive buffers are empty, or until the time specified by this register expires, whichever occurs first.

**S158 SDLC DSR Delay Time**

Range: 0 - 255

Default 0

The S158 register specifies the amount of time in seconds that the modem will wait before asserting DSR after detecting a contact closure on the MI/MIC auxiliary telco leads when S102 is set to 2. The other RS-232C signals are asserted after the connection is established.

**5C**

*Registers S160 through S164 are designed for fine tuning SDLC protocol support. It is recommended that you use the defaults for these registers.*

**S160 SDLC Frame Retransmit Limit**

Range: 0 - 255

Default: 10 (frames)

The S160 register specifies the maximum number of times any one frame can be retransmitted without receiving an SDLC acknowledgment from the DTE. It also limits the number of SDLC polls that can go unanswered by the DTE. If the limit is exceeded, the modem terminates the connection.

**S161 SDLC Device Timeout**

Range: 0 - 255

Default: 20 (seconds)

The S161 register specifies the number of seconds the modem allows the SDLC link to be idle. If the limit is exceeded, the modem terminates the connection. If this register is set to 0, no device timeout is enforced.

**S162 SDLC Nonproductive Timeout**

Range: 0 - 255

Default: 2 (seconds)

The S162 register specifies the maximum number of seconds the modem waits before generating an SDLC frame to keep the link alive.

When the modem is acting as an SDLC primary link station, it regenerates the poll/final bit if the DTE allows more than 1-1/2 times this length of time to elapse.

The modem automatically determines if it is a primary or secondary link station as described in the S150 register description. If this register is set to 0, the nonproductive timeout function is not used.

**S163 SDLC Retransmit Timeout**

Range: 0 - 255

Default: 3 (seconds)

The S163 register specifies the number of seconds the modem waits for the DTE to acknowledge an SDLC frame. If the timeout is exceeded, the modem retransmits the I-frames. If this register is set to 0, no retransmit timeout is in effect.

**5C**

**S164 SDLC Primary Poll Rate**

Range: 1 - 32

Default: 7 (polls)

The S164 register specifies the number of SDLC polls per second, which are generated by the modem while operating as primary link station in Normal Response Mode when an idle condition exists.

The modem automatically determines if it is a primary or secondary link station as described in the S150 register description.

**S169 Synchronous Dialing Command Set Enable**

Range: 0 - 2

Default: 0

This register determines if the IBM 4941 or V.25bis dialing command set is enabled while operating in SDLC or Transparent Synchronous Mode. Possible contents for the S169 register are:

- 0 Disable synchronous dialing.
- 1 Enable IBM 4941 synchronous dialing to operate with IBM mainframes in bit synchronous mode.
- 2 Enable V.24bis synchronous dialing to operate in bit synchronous mode as defined in the 108/2 option of the CCITT V.25bis recommendation.

To use bit synchronous dialing, the modem must be preconfigured to operate in SDLC or Transparent Synchronous Mode as described:

1. Configure the modem for synchronous mode by entering: AT&F2 to select PEP SLDC Mode, AT&3 to select V.32 Transparent Synchronous Mode, or AT&F3S50=n where n specifies the desired speed of the connect to select Slow Synchronous Mode.
2. Set the S169 register to 1 to enable IBM 4941 dialing support, or set S169 to 2 to enable V.25bis dialing support.
3. Save the current configuration in nonvolatile memory with an AT&W command.

When the modem is powered up or reset with the current profile selected, it will be configured to accept IBM 4941 or V.25bis dialing commands in synchronous mode.



**S222 Enhanced Command Mode  
Access Character**  
Range: ASCII Code 0 - 255  
Default: ASCII Code 126

This register contains the ASCII code for the character that is interpreted as the Enhanced Mode Access character used in Conventional Command Mode.

The default character is a tilde character (~). If your keyboard does not have a tilde character (~) character, the modem should be powered up in the Enhanced Command Mode (refer to Chapter 3, *Initializing the Modem*) and the S222 register changed to the ASCII code of the character to be used as the access character.

The T2500 modem uses only one set of active operating parameters regardless of the command mode being used. Every Conventional Command Mode function has an equivalent in Enhanced Command Mode. Changing an operating parameter in either command mode alters its equivalent in the other command mode. For example, entering ~S95-2 is identical to entering &Q5 S36=1. Appendix C summarizes the command and register equivalents.

Setting the S222 register to a value other than 127 disables the recognition of the escape character by the modem.

**S255 Default User Profile Selection**

Range: 0 - 2

The S255 register designates which user profile to recall when the modem is powered up or reset. The possible contents of this register are:

- 0 Recall user profile specified by A/B switch after power up or reset.
- 1 Recall User Profile A after power up or reset. Disable A/B switch.
- 2 Recall User Profile B after power up or reset. Disable A/B switch.

This register also determines the profile used when none is specified for any of the following commands:

Reset (Z)

Recall EEPROM Operating Parameters (&amp;E)

Display EEPROM Operating Parameters (&amp;N)

Write Configuration Parameters (&amp;W)

*Note: An &F command does not change the setting of this register.*



# Chapter 6

## Diagnostics and Service

This chapter describes the diagnostic tests performed by the modem when it is powered up, and provides user assurance test procedures along with troubleshooting guidelines if you encounter a problem while setting up or using the modem.

### Diagnostic Tests

When power is turned on, the modem automatically runs a series of self-diagnostic tests. The results of these tests can be obtained by using the ~!1 command. This command returns a decimal number that represents the sum of the failure codes triggered during testing. If no errors are detected during the diagnostic tests, 000 (zero) is returned.

You can run the diagnostic tests at any time by using the ~&T command. However, you should not run the diagnostic tests during a current communications session as this disconnects the line and resets the modem. The ~&T command displays the results of the tests as a short message on the screen. If no errors are detected, the ~&T command returns a Diagnostics Complete message.

The diagnostic tests performed by the modem upon power up or when the ~&T command is issued are listed below:

- ROM Test
- RAM Addressing Test
- RAM Read/Write Test
- EEPROM Test
- Loopback Test
- 32010 Signal Processor Test

Successful completion of the first three tests means that the modem's firmware is intact and that the memory is functioning correctly.

During the EEPROM test, a checksum is read, which tests the integrity of the nonvolatile memory. If the checksum is correct, Profile A or B register settings stored in the EEPROM are loaded into memory. If the checksum is incorrect, the factory default settings are loaded. The configuration loaded is dependent on the current setting of the S255 register.

The final two tests check the loopback capability of the Digital/Analog Interface chip and verify that the 32010 Signal Processor chip is operating correctly.

## User Assurance Tests

The following tests are intended to check those components not tested at power-up. You should be familiar with the contents of this manual and understand how to operate the modem. It is assumed that you can communicate with the modem through the RS-232C serial interface port using a terminal or personal computer. If you are not able to communicate with the modem through the serial interface, read the *Troubleshooting* section at the end of this chapter.

### Nonvolatile Memory Test

To verify that the modem's nonvolatile memory is working correctly:

1. Enter one or two telephone numbers in the Number Directory.
2. Turn the modem off then back on, and verify that the new numbers are still present.

### Telephone Dialer Test

To check the integrity of the analog/digital circuitry and telephone line interface:

1. Enter the following tone dialing command:  
**AT DT 12345**
2. Listen to the tones from the speaker to verify that the modem is tone dialing.

3. Press any key to hang up the line.
4. Enter the following pulse dialing command:  
**AT DP 12345**
5. Listen for the relay clicking sounds to verify that the modem is pulse dialing.

## Telephone Line Relay Test

To check the operation of the line relay control signals:

1. Plug a telephone into the TO PHONE connector on the modem's rear panel, and verify that the modem is connected to the telephone line via the TO LINE connector.
2. Lift the receiver and listen for a dial tone.
3. Press the T/D switch on the modem's front panel. The dial tone from the receiver should go away when the modem goes off-hook (OH indicator lit).
4. Press the T/D switch again to put the modem back on-hook (OH indicator is off). The dial tone from the telephone receiver should return.

## Ring Detect Test

The easiest way to check the modem's ring detection circuit is to disable the auto-answer feature by setting the S0 register to 0, and call the number to which the modem is connected. When the modem detects a ring signal, the word RING is displayed on the screen. The word should appear every four to six seconds to indicate the end of each ring signal.

Remember to set the S0 register back to 1 if you plan on using the auto-answer feature.

## Troubleshooting

If you encounter problems while setting up and using your modem, you can simplify the troubleshooting process by progressing in stages. This approach makes it easier to isolate and resolve any problems which you might encounter as you progress through the various stages.

This section covers the following three stages of establishing a communications link:

- **Pre-Call Initialization** - focuses on ensuring that the modem and your equipment are properly configured for communications over the DTE-DCE interface.

To confirm that the modem can in fact communicate with your equipment, refer to Table 6-1.

- **Call Establishment** - deals with problems that may occur while attempting to place or answer a call up to the point at which data can be exchanged across the communications link.

If you have problems placing or answering a call, refer to Table 6-2 or 6-3, respectively.

- **Call In Progress** - addresses problems that may occur while actually transmitting information between two locations.

Some of the problems that can occur while a call is in progress are lost or garbled data, the modems unexpectedly stop communicating, or the connection is prematurely dropped. If you experience problems in any of these areas refer to Table 6-4 for recommended solutions.

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**Table 6-1. Modem Preconfiguration****Is the modem configured to operate in Asynchronous Mode and connected to an asynchronous DTE?**

The modem and DTE must be operating in Asynchronous Mode while preconfiguring the modem.

The modem is shipped from the factory configured to operate in Enhanced Command Mode. If you are using communications software which supports Hayes V-series modems, initialize the modem to operate in Conventional Command Mode as described in Chapter 3, *Using the Modem*.

**Is the MR (Modem Ready) indicator on the front panel lit?**

The MR light indicates that the modem is operational. If the indicator is off, try issuing an AT ~I1 command to obtain the results of the diagnostic tests. If you get no response or the test result code returned is not 000, try running the self-diagnostics test again by turning the modem's power off and back on. If the MR indicator still does not light, contact your technical support representative for further assistance.

**Issue an AT ~N? command to display the modem's current register settings.****Are double characters appearing on the screen?**

Both the DTE and the modem are echoing characters to the screen. Disable local echo on your DTE. If this is not possible then disable echo from the modem by issuing an AT ~E0 command to the modem.

**Are you getting garbled data or no response from the modem?**

Verify that the modem is connected to a functioning RS-232C port on your DTE, and that the RS-232 cable is configured correctly.

Make sure that the modem and DTE are both operating in Asynchronous Mode and are using the same interface speed and data format.



**Table 6-1. Modem Preconfiguration (continued)**

<p>If your modem has been used before, you may need to reinitialize it for either Enhanced or Conventional Command Mode as described in Chapter 3, <i>Using the Modem</i>.</p>
<p><b>Configure the modem to meet the specific requirements of your system and save the configuration parameters in non-volatile memory.</b></p> <p>Refer to Chapter 4, <i>Conventional Command Mode</i>, or Chapter 5, <i>Enhanced Command Mode</i>, for configuration guidelines.</p>

**Table 6-2. Placing a Call**

<p><b>Is the telephone line connected to the TO LINE connector on the modem's backpanel?</b></p> <p>A common mistake is to connect the telephone line to the TO PHONE connector, which is used for connecting a telephone to the modem for voice communications. Connect the telephone line to the TO LINE connector on the modem's backpanel. Optionally, connect a telephone set to the TO PHONE connector.</p>
<p><b>Is the modem ready to accept commands or data from the DTE? The MR (Modem Ready), DTR (Data Terminal Ready) and CTS (Clear to Send) indicators should be lit.</b></p> <p>The modem must be operational and able to communicate with the DTE before placing a call. See Table 6-1 for information on verifying that the modem is able to communicate with your equipment.</p>
<p><b>Send a dialing command sequence to the modem from your terminal or computer.</b></p> <p>Be sure to include any required access codes and wait for dial tone characters (W) in the dialing sequence. If your call requires operator assistance you can place a call manually using your telephone set, then press the T/D switch to cause the modem to go off-hook and listen for the called modem's answer tones.</p>

Table 6-2. Placing a Call (continued)

**Did the modem go off-hook and begin the dialing sequence? You should hear a brief dial tone followed by dialing sounds as the modem places the call. The OH (Off-Hook) indicator should be lit.**

If the OH indicator did not light, the modem probably did not recognize the dial command. Try entering the command again. Be sure to precede the command with an AT prefix (unless register S63 is set to 0) and follow the command with a carriage return. Verify that the modem is properly configured to communicate with your equipment.

If you did not hear a dial tone before the modem started dialing, connect a telephone to the telephone line and listen for a dial tone. If you do not hear the dial tone, the telephone line is dead. Contact your telephone company service representative for assistance.

**Did the telephone ring at the remote site? You should hear a ringing signal over the speaker.**

Depending on how quickly the remote site answers the call, you may not hear a ringing signal. If you hear the answering modem's answer tones, you can assume that the remote site answered the call.

Make certain that you entered the correct dialing sequence. If you are going through a PBX (Private Branch Exchange), you may need to enter 9W to access an outside line and wait for a second dial tone. The S6 register determines how long the modem waits for a dial tone when a W is entered in a dialing sequence.

If your call is routed through key systems, security devices or similar equipment, additional access digits might be required, and it may take longer to set up the call. One or more commas can be used in the dialing sequence to cause the modem to pause when necessary. The length of the pause is determined by the S8 register.

You may need to extend the time that the modem waits for a carrier by increasing the value of the S7 register.

**Table 6-2. Placing a Call (continued)**

It is possible that the touch tone speed is too fast for the phone switching equipment, which occasionally happens with older phone equipment. Try lengthening the touch tone timing specified by the S11 register.

**Did the remote modem answer the call? You should hear answer tones from the remote site over the speaker.**

If the phone continues to ring with no answer, verify that you are dialing the correct number. Ask the operator at the remote site to confirm that their equipment will answer the phone.

If the ringing signal stops but you do not hear the answer tones from the answering modem, ask the operator at the remote site to check their equipment and connections.

**Did the modems at both ends synchronize? The CD (Carrier Detect) indicator should be lit .**

Verify that the modems at both ends agree on the transmission mode used. The S50 register determines the transmission mode used by the modem. If this register is not set for Automatic Speed Determination (S50=0), it must match the transmission speed of the remote modem.

If the modem goes on-hook (the OH indicator turns off) during synchronization, you may need to extend the time that it waits for a carrier by increasing the value of the S7 register.

If you are calling a V.22 or V.22bis type modem, you should also check the setting of the S90 and S91 registers. The S90 register is used to select either 212A (S90=0) or V.22 (S90=1) emulation when operating at 1200 bps. Some V.22 or V.22bis modems use guard tones during synchronization. Try changing the setting of the S91 register to use either a 1800 Hz guard tone (S91=1) or a 550 Hz guard tone (S91=2).

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**Table 6-2. Placing a Call (continued)****If expected, did you receive a valid (ungarbled) sign-on message from the remote site?**

Sign-on procedures vary from one system to another. You may need to press the space bar or take some other action to get the sign-on message. Refer to the system's operating instructions for the appropriate procedure.

If after taking the appropriate action you still do not receive a sign-on message, or the message is garbled, there may be some problem with the interface speed between the DTE and modem at either end, or a mismatch in the data format (usually parity) used between the DTEs at each site. Refer to Table 6-4 for information on resolving either of these two conditions.

**Table 6-3. Answering a Call****Is the telephone line connected to the TO LINE connector on the modem's backpanel?**

A common mistake is to connect the telephone line to the TO PHONE connect, which is used for connecting a telephone to the modem for voice communications. Connect the telephone line to the TO LINE connector on the modem's backpanel. Optionally, connect a telephone set to the TO PHONE connector.

**Is the MR (Modem Ready) indicator on the modem's front panel lit?**

The MR light indicates that the modem is operational. If the indicator is off, the modem failed the power up diagnostic test. Contact your technical support representative for further assistance.

**Did the modem answer an incoming call by going off-hook when a ringing signal was received? The OH (Off-Hook) indicator should be lit.**

If register S0 is set to 0, the modem does not automatically answer an incoming call. To enable auto-answer mode, set this register to the ring number on which the modem should answer a call.

**Table 6-3. Answering a Call (continued)**

If S52 is non-zero, the modem does not answer an incoming call while DTR (Data Terminal Ready) is off. Your equipment should provide this signal when it is ready to transmit or receive data, or in response to a ringing signal on the RI (Ring Indicator) signal line of the RS-232 interface. If the DTR indicator on the front panel is not lit, verify that the RS-232 cable is configured correctly. If your equipment asserts DTR in response to a ringing signal, verify that it is receiving a signal on the RI line, and turning on DTR at the appropriate time.

Try placing the same call with a telephone set on each end of the connection. If the call cannot be placed with telephone sets, it will not work with modems.

**Did the modem answer the call and then hang-up before a connection was established? This can occur very rapidly so that the OH (Off-Hook) indicator is barely noticeable. The caller may hear a pair of clicks after the last ring.**

Make certain that your equipment is not sending a sign-on message before DCD (Data Carrier Detected) is turned on. This could cause the modem to hang-up. Note that setting S64 to 1 causes the modem to ignore any characters sent by the local DTE while dialing or answering a call.

If the modem is configured to show status messages, your equipment may be echoing the status message back to the modem causing it to hang-up. To solve this problem, turn off echo and place the modem in quiet mode by issuing the E0 and Q1 commands.

When S52 is nonzero, the modem disconnects a call if DTR is dropped. Make certain that your equipment is not turning off DTR during a call. Your equipment may be periodically switching DTR on and off while searching for an active device (looking for an active DSR or DCD signal from a modem). Try changing the S130 and S131 register settings to enable these signals. If you cannot configure your equipment to provide DTR, set the S52 register to 0 so that the modem does not hang up when DTR is not present.

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**Table 6-3. Answering a Call (continued)****Did the modems at both ends synchronize? The CD (Carrier Detect Indicator) should be lit.**

Verify that the modems at both ends agree on the transmission mode used. The S50 register determines the transmission mode used by the modem. If this register is not set for Automatic Speed Determination (S50=0), it must match the transmission speed of the calling modem.

When the modem answers a call in Automatic Speed Determination mode, it steps through several different answer tones to allow the calling modem to synchronize on the appropriate tone. If the calling modem is not a PEP-compatible modem, it may be adversely affected by PEP answer tones. Try setting the S92 register to 1 to move the PEP answer tones to the end of the answering sequence.

The calling modem may need to extend the time that it waits for a carrier before disconnecting to allow time for the modem to arrive at the correct answer tone.

If the calling modem is a V.22 or V.22bis type modem, you should also check the setting of the S90 and S91 registers. The S90 register is used to select either 212A (S90=0) or V.22 (S90=1) emulation when operating at 1200 bps. Some V.22 or V.22bis modems use guard tones during synchronization. Try changing the setting of the S91 register to use either a 1800 Hz guard tone (S91=1) or a 550 Hz guard tone (S91=2).

**If expected, did the calling modem receive a valid (ungarbled) sign-on message from the remote site?**

Sign-on procedures vary from one system to another. The caller may need to press the space bar or take some other action to get the sign-on message. Ask the operator at the calling site to confirm that they are following the correct sign-on procedure.

**Table 6-3. Answering a Call (continued)**

If after taking the appropriate action the caller still does not receive a sign-on message, or the message is garbled, there may be some problem with the interface speed between the DTE and modem at either end, or a mismatch in the data format (usually parity) used between the DTEs at each site. Refer to Table 6-4 for information on resolving either of these two conditions.

**At this point, the modem should be capable of communicating with the calling modem.**

See Table 6-4 for information on solving problems that may occur during a communications session.

**Table 6-4. Call in Progress**

**Is data (or the sign-on message) being garbled during transmission?**

If a connection has been made in nonpacketized mode (PEP indicator is not lit), the line quality of the connection may be inadequate for error-free transmission. The modem only detects transmission errors when operating in packetized mode. Hang up and try placing the call again. The probability of getting the same connection is unlikely.

There may be some problem with the interface speed between the DTE and modem at either end, or a mismatch in the data format (usually parity) used between the DTEs at each site.

If the other modem is not a PEP-compatible modem, verify that your S66 register is set to 1. This prevents the modem from changing the interface speed when a connection is made. If S66 is set to 0 and a connection is made in nonpacketized mode, the modem changes the interface speed to match the speed of the connection.

Ask the operator at the remote site to confirm that they do not have an interface speed mismatch at their end.

**Table 6-4. Call in Progress (continued)**

<p>Check the setting of the S60 register. Except for a few rare cases, this register should be set to 0, which permits end-to-end parity checking between DTEs as well as providing a transparent data path for binary file transmissions.</p> <p>Verify that the data format (data length, parity, and stop bits) used by your DTE matches the data format used by the DTE at the remote site. Refer to your equipment's manual for instructions on setting the data format.</p>
<p><b>Is data being lost during transmission?</b></p> <p>Most problems with loss of data during transmission result from a mismatch in the flow control method used between the modem and the DTE at either end. Data in the DTE or modem's buffer is being overwritten.</p> <p>The modem uses two registers to control the flow of data between the DTE and the modem. The S58 register controls data flow over the Received Data (RD) line to the DTE. A similar register, S68, controls data flow over the Transmitted Data (TD) line to the modem. The two most common flow control methods supported by the modem are XON/XOFF or RTS/CTS. Check your equipment's manual to determine which type of flow control method it supports, and set the S58 and S68 registers to match that flow control method.</p> <p>The DTE may not be responding to the flow control signal soon enough to avoid a buffer overflow condition.</p>
<p><b>Did either modem unexpectedly stop transmitting or receiving data?</b></p> <p>The calling modem, answering modem or both modems may have been inadvertently placed in Command Mode by a break signal or escape sequence. Registers S54 and S55 determine how the modem responds to a break signal or escape sequence. You may need to change the setting of either or both of these registers to prevent the modem from entering Command Mode at an inappropriate time. Note that if the modem is installed in an unattended answer environment, these two registers should usually be set to not enter Command Mode under any condition.</p>



**Table 6-4. Call in Progress (continued)**

If the answering site's modem is configured to ignore the DTR signal (S52=0), it maintains the connection even if its DTE drops DTR due to inactivity or some other condition. If this happens, the calling site must terminate the connection, and if desired reinitiate the call.

**Was the connection dropped prematurely?**

If a connection has been made in nonpacketized mode (SLW indicator is lit), the carrier signal may have been dropped due to a degradation in the line quality of the connection. Try placing the call again. The probability of getting the same connection is unlikely.

If the modem's S52 register is nonzero and its associated DTE drops DTR due to inactivity or some other condition, the modem disconnects the call.

# Chapter 7

## Technical Support Procedures

Telebit Corporation has made every effort to ensure that the product you have purchased is of excellent quality in all respects. Telebit products are rigorously tested and subjected to strict quality control procedures. However, if you experience difficulty in the use of this product, or it does not appear to operate correctly, we suggest doing the following:

- Read this manual. It has been provided to help you configure and use your modem.
- Contact your dealer. Telebit authorized dealers are familiar with Telebit's products and should be able to help you resolve any problems that you may encounter while setting up and using the modem.
- Finally, call Telebit's Technical Support at 408-734-5200. Before calling, please have all the following information about your unit available:

Product Name \_\_\_\_\_

Serial Number \_\_\_\_\_

Date of Purchase \_\_\_\_\_

Place of Purchase \_\_\_\_\_

If your product should require service, we will repair or replace it under the terms of our Two Year Limited Warranty. Please read the warranty statement included in this chapter, and return the Warranty Registration Card at the back of this manual.

When the Two Year Limited Warranty period expires, Telebit will continue to service your product for the current applicable service fee. If you wish, you may extend your warranty protection for an additional two years by purchasing our Extended Warranty any time before the first year warranty expires. However, there is a cost savings if you purchase this option within 10 days of the original equipment purchase date.

## Return for Repair Procedure

The following procedure describes how to return the unit to Telebit for repair. This procedure is applicable to both in or out of warranty repairs.

1. Call Telebit's Technical Support Department at 408-734-5200 and describe the problem. Tell the technical support representative if your unit is or is not covered by warranty. They will issue you an RMA number.

*If the unit is covered by a warranty but not registered, you must submit **proof of purchase**.*

*If you do not have proof of purchase or your unit is not covered by the warranty, you must send the **current repair fee** with your unit.*

The technical support representative will provide you with that information and any further instructions if necessary.

2. Pack the unit in its original container or in a sturdy corrugated box using *nonstatic* material such as newspaper as a cushion. *Do not* use highly static prone material such as plastic wrap or styrofoam packing material (beads or peanuts) as they may further damage the unit in transit.
3. Ship the unit only. Do not ship manuals, power supply or phone cord unless your technical support representative instructs you to do so.
4. Include the following information with your unit:

Name  
Address  
City, State, Zip Code  
Telephone Number  
RMA Number  
Description of the problem  
Current Repair Fee (if applicable)

5. Ship the unit (for repair) freight prepaid to:

Telebit Corporation  
1315 Chesapeake Terrace  
Sunnyvale, CA 94089

Attention: Technical Support RMA #

We recommend that you insure the unit when shipped.  
***Telebit will not accept units shipped C.O.D.***

6. Telebit will ship the repaired or replacement product at no cost to you to any destination in the U.S.A. Telebit will choose the carrier and method of shipment. If you desire some other specific form of conveyance or you are located outside the U.S.A., you must bear the cost of return shipment and other incidental costs.

## **Two Year Limited Warranty**

Telebit Corporation (Telebit) warrants the hardware products and all components thereof against defects in materials and/or workmanship for two (2) year from the date of your original retail purchase.

If you discover a malfunction or defect in materials or workmanship, Telebit, at its option, will repair or replace the product or component at no charge to you, provided you return it, as set forth above, during the warranty period. Telebit will furnish repair parts and replacement products on an exchange basis; all returned parts and products become Telebit's property. Repairs and replacements may be either reconditioned or new. Telebit will make the final determination as to the existence and cause of any alleged defect. If a returned product shows *no trouble found*, Telebit may assess a repair charge.

Telebit does not warrant that any product will operate uninterrupted or without error. The warranty is contingent upon proper use of the product in the application for which it is intended. The warranty will be void on products which have been subjected to abuse, misuse, accident, alteration, neglect, unauthorized repair or installation; modified without Telebit's approval; subjected to unusual physical or electrical stress; or used with a power supply other than the one provided with the product. Expendable items (such as lamps and fuses) are not warranted. This limited warranty is extended only to the original purchaser and is not assignable.

**THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHERS, ORAL OR WRITTEN, EXPRESS OR IMPLIED. TELEBIT MAKES NO EXPRESS OR IMPLIED WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, EXCEPT AS EXPRESSLY SET FORTH IN THIS LIMITED WARRANTY. SOFTWARE AND DOCUMENTATION IS PROVIDED ON AN AS IS BASIS. IN NO EVENT SHALL TELEBIT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, COSTS OR EXPENSES ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF ANY PRODUCT DELIVERED HEREUNDER.**

*Note: Some states do not allow the exclusion or limitation of implied warranties or liability for incidental or consequential damages for consumer products, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.*

Please see *Return for Repair Procedure* in this chapter for specific instructions on returning products for service.

You may extend the limited warranty period for an additional two (2) years by purchasing the Two Year Limited Warranty Extension. The limited warranty will then be for a total of four (4) years from the purchase date.

## **Two Year Limited Warranty Extension**

You can extend your two year limited warranty for an additional two years by paying a reasonable one time fee. This fee guarantees repair or replacement of a faulty unit as often as required while it is under warranty subject to the same terms and conditions as the Telebit Two Year Limited Warranty. The warranty period will then be for a total of four (4) years from the date of purchase. You may purchase this warranty extension at any time before the two year limited warranty expires.

If you purchase this warranty extension within 10 days of the date you purchase the modem, the price of the extended warranty is reduced. Contact your sales representative or Telebit's Technical Support Department for the current pricing options for your product. Be prepared to provide them with the product name, serial number, date and place of purchase.

You may also purchase this warranty extension by completing Part 2 of the Warranty Registration Card and returning it to Telebit.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

# Appendix A

## ASCII Code Chart

Code	Mnem	Dec	Hex	Code	Dec	Hex	Code	Dec	Hex	Code	Dec	Hex
	NUL	00	00	SP	32	20	@	64	40	`	96	60
CTRL A	SOH	01	01	!	33	21	A	65	41	a	97	61
CTRL B	STX	02	02	"	34	22	B	66	42	b	98	62
CTRL C	ETX	03	03	#	35	23	C	67	43	c	99	63
CTRL D	EOT	04	04	\$	36	24	D	68	44	d	100	64
CTRL E	ENQ	05	05	%	37	25	E	69	45	e	101	65
CTRL F	ACK	06	06	&	38	26	F	70	46	f	102	66
CTRL G	BEL	07	07	'	39	27	G	71	47	g	103	67
CTRL H	BS	08	08	(	40	28	H	72	48	h	104	68
CTRL I	HT	09	09	)	41	29	I	73	49	i	105	69
CTRL J	LF	10	0A	*	42	2A	J	74	4A	j	106	6A
CTRL K	VT	11	0B	+	43	2B	K	75	4B	k	107	6B
CTRL L	FF	12	0C	,	44	2C	L	76	4C	l	108	6C
CTRL M	CR	13	0D	-	45	2D	M	77	4D	m	109	6D
CTRL N	S0	14	0E	.	46	2E	N	78	4E	n	110	6E
CTRL O	SI	15	0F	/	47	2F	O	79	4F	o	111	6F
CTRL P	DLE	16	10	0	48	30	P	80	50	p	112	70
CTRL Q	DC1	17	11	1	49	31	Q	81	51	q	113	71
CTRL R	DC2	18	12	2	50	32	R	82	52	r	114	72
CTRL S	DC3	19	13	3	51	33	S	83	53	s	115	73
CTRL T	DC4	20	14	4	52	34	T	84	54	t	116	74
CTRL U	NAK	21	15	5	53	35	U	85	55	u	117	75
CTRL V	SYN	22	16	6	54	36	V	86	56	v	118	76
CTRL W	ETB	23	17	7	55	37	W	87	57	w	119	77
CTRL X	CAN	24	18	8	56	38	X	88	58	x	120	78
CTRL Y	EM	25	19	9	57	39	Y	89	59	y	121	79
CTRL Z	SUB	26	1A	:	58	3A	Z	90	5A	z	122	7A
	ESC	27	1B	;	59	3B	[	91	5B	{	123	7B
	FS	28	1C	<	60	3C	\	92	5C		124	7C
	GS	29	1D	=	61	3D	]	93	5D	}	125	7D
	RS	30	1E	>	62	3E	^	94	5E	~	126	7E
	US	31	1F	?	63	3F	_	95	5F	DEL	127	7F





# Appendix B

## Interface Description

### Telephone Network Interface

The modem is connected to the telephone network through an RJ11 modular connector. Table B-1 presents a definition of the pins in the line connector.

**Table B-1. Phone Line Connector Pin Definitions**

PIN	LINE	PHONE
1	Not Used	Not Used
2	A or MI	A1 or MIC
3	Ring	Tip
4	Tip	Ring
5	A1 or MIC	A or MI
6	Not Used	Not Used

### RS-232C Interface

Communication between the modem and the local DTE is accomplished through a 25-pin RS-232C connector.

The RS-232C standard is a set of specifications developed by the Electronic Industries Association (EIA) that applies to the transfer of data between Data Terminal Equipment (DTE) and Data Communications Equipment (DCE). It is the most common DTE-DCE interface in use in the United States, and is compatible with the International Telegraph and Telephone Consultative Committee Recommendation V.24.

## Interface Description

The RS-232C standard covers three specific areas:

1. The electrical and mechanical characteristics of the interface.
2. The function of each interchange circuit.
3. Standard subsets of interchange circuits for specific communication system applications.

A specific connector is not defined. However, the DB-25 connector is almost universally associated with the RS-232C interface. Table B-2 lists the RS-232C interchange signals and their associated pins.

**Table B-2. RS-232 Connector Pin Assignments**

Pin	EIA Circuit	CCITT Circuit	Signal Description	From DCE	To DCE
1	AA	101	Protective Ground	X	X
2	BA	103	Transmitted Data (TD)		X
3	BB	104	Received Data (RD)	X	
4	CA	105	Request to Send (RTS)		X
5	CB	106	Clear to Send (CTS)	X	
6	CC	107	Data Set Ready (DSR)	X	
7	AB	102	Signal Ground	X	X
8	CF	109	Data Carrier Detected (DCD)	X	
9	-	-	Reserved for Test		
10	-	-	Reserved for Test		
11	-	-	Unassigned		
12	CI	122	DCE Signal Rate Select	X	
13	SCB	121	Reserved for Test		
14	SBA	118	Reserved for Test		
15	DB	114	DCE Transmitter Signal Element Timing	X	
16	SBB	119	Reserved for Test	X	
17	DD	115	Receiver Signal Element Timing	X	
18	-	141	Local Loopback		X
19	SCA	120	Reserved for Test		
20	CD	108.2	Data Terminal Ready (DTR)		X
21	-	-	Remote Digital Loopback		X
22	CE	125	Ring Indicator (RI)	X	
23	CH	111	DTE Signal Rate Selector		X
24	DA	113	DTE Transmitter Signal Element Timing		X
25	-	142	Test Mode	X	

## Test Signals

### Remote Digital Loopback

Pin 21 (Remote Digital Loopback) is used by the local DTE to place the modem into remote digital loopback. The modem must have a connection established with a remote modem, and must be in the data mode. When Pin 21 is turned on, the modem loops back all data received from the remote modem. When Pin 21 is turned off, the modem returns to the data mode.

### Local Digital Loopback

Pin 18 (Local Digital Loopback) is used by the local DTE to put the modem into local digital loopback. The modem should be off-line and in the command mode. When Pin 18 is turned ON, the modem enters local digital loopback. All data received on the primary transmit data pin (Pin 2) is looped back on the primary receive data pin (Pin 3). When Pin 18 is turned off the modem returns to the off-line condition.

### Test Mode

Pin 25 (Test Mode) is a signal from the modem to the local DTE signifying that the modem is in a test mode. The test mode may be initiated either through the &T commands, or the Remote Digital or Local Digital Loopback RS-232 pins.

## Rate Select Signals

### DTE Signal Rate Select

Pin 23 (DTE Signal Rate Select) is used by the local DTE to select between a primary signaling rate and the fallback rate. The only modulation modes where Pin 23 may be used are V.32 (9600 bps and 4800 bps fallback) and V.22bis (2400 bps and 1200 bps fallback). Use of Pin 23 is enabled by setting S94=2 (if in V.22bis, register S90 must be set to 1). In this setting the only connection speeds available are the selected modulation mode's primary and fallback rates. If Pin 23 is on prior to the completion of a connection, the T2500 attempts to connect only at the primary rate.

If Pin 23 is off, then only the fallback rate is attempted. If this pin is not driven by the local DTE, it assumes the on condition.

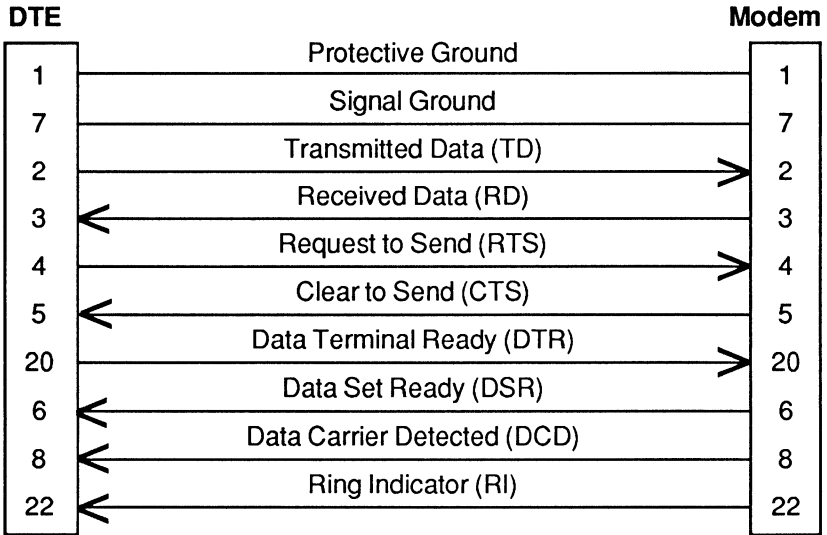
### **DCE Signal Rate Select**

Pin 12 (DCE Signal Rate Select) is generated by the modem to inform the local DTE of the current connection rate. The only modulation modes where Pin 12 is valid are V.32 (9600 bps and 4800 bps fallback) and V.22bis (2400 bps and 1200 bps fallback). When Pin 12 is on, the connection was made at the primary rate. When Pin 12 is off, the connection was made at the fallback rate.

### **RS-232C Primary Interchange Signals**

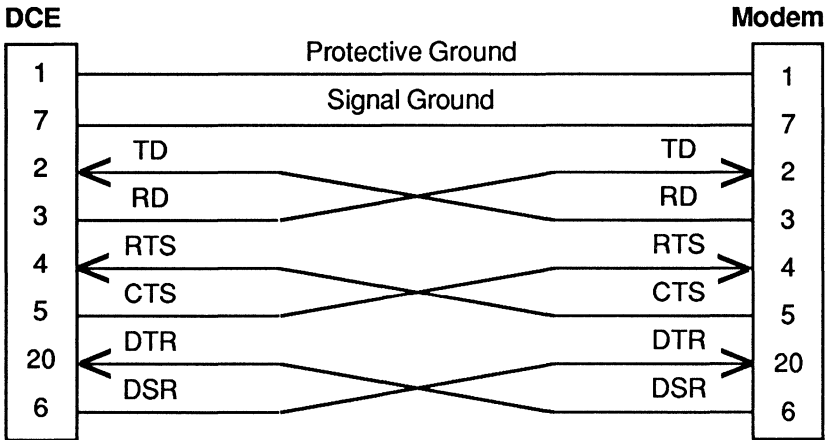
The modem hardware supports all data, control and timing signals defined by the RS-232C standard. However, when operating in Asynchronous Mode, the modem only uses the primary interchange circuits defined in Figure B-1. This figure shows the cable configuration for connecting the modem to a standard DTE device.

For systems that require the modem to act as a DTE connected to a DCE device, a specially modified RS-232C cable must be used. Figure B-2 shows a recommended cable arrangement for this case. Your system may require a different cable configuration. Consult your equipment manual for specific cabling requirements.



**Figure B-1. Asynchronous RS-232C Cable Diagram**

**A**



**Figure B-2. Special Asynchronous RS-232C Cable Diagram**

The primary interchange signals used by the modem in Asynchronous Mode are described in the following sections.

**Protective and Signal Ground**

Pin 1 (Protective Ground) should be electrically connected to the frame or chassis of the equipment. The equipment may be further connected to an external earth ground as required by local electrical codes. Pin 7 (Signal Ground) is the common reference signal ground for all of the other pins. This line should be connected at both ends to complete the signal circuits.

**Transmitted Data (TD) and Received Data (RD)**

These two signal lines are used for transferring data between the DTE (computer or terminal) and the DCE (modem). All signal names are as viewed from the DTE. Therefore, the DTE transmits data on the Transmitted Data line (pin 2) and receives data on the Received Data line (pin 3). On the other hand, the DCE receives data from the DTE on the Transmitted Data line (pin 2) and sends data to the DTE on the Received Data line (pin 3).

**A**

### **Request to Send (RTS) and Clear to Send (CTS)**

According to the RS-232C standard, the DTE asserts Request to Send (RTS) on pin 4 when it has data to transmit. It then waits for the DCE to respond by asserting Clear to Send (CTS) on pin 5 before sending data to the DTE via the Transmitted Data (TD) line.

Depending on its register settings while operating in Asynchronous Mode, the modem uses RTS and CTS to implement hardware flow control between the DTE and the modem.

### **Data Terminal Ready (DTR) and Data Set Ready (DSR)**

Pin 20 (Data Terminal Ready) is used by the DTE to indicate its readiness to transmit or receive data. In automatic answer mode, DTR is activated in response to the ring indicator to tell the modem to answer the call. The DTR signal may be turned on whenever the DTE is ready to transfer data over the interface, or simply used to indicate that the DTE has been turned on.

The modem can be configured to interpret the DTR signal in a couple of different ways thus allowing it to interface with a variety of DTE devices which may use DTR differently.

Pin 6 (Data Set Ready) is used by the modem to indicate its readiness to transmit or receive data. Data Set is another term for modem typically used by the Bell Operating Companies.

Like the DTR signal, the modem can be configured to use the DSR signal in a variety of ways to meet the expectations of the DTE device.

### **Data Carrier Detected (DCD)**

Although this signal line is actually named *Received Line Signal Detector* in the RS-232C standard, the term Data Carrier Detected is more commonly used. An active level on pin 8 (Data Carrier Detected) indicates to the DTE that the modem has received a signal over the telephone network which meets its criteria for an acceptable carrier signal.



Depending on the requirements of the DTE device, the modem can be configured to hold DCD active whether or not a carrier is detected, or to activate DCD only when an acceptable carrier signal is detected.

### **Ring Indicator (RI)**

Pin 22 (Ring Indicator) is used by the modem to inform the DTE that the telephone is ringing. The Ring Indicator (RI) signal is asserted in cadence with the ringing signal on the telephone line. When the ringing voltage is present, RI is active. Between rings, RI is off.

The modem can be configured to automatically answer an incoming call, or to answer the call only when the DTE indicates that it is ready to accept the call by asserting the DTR signal.

### **RS-232C Timing Interchange Signals**

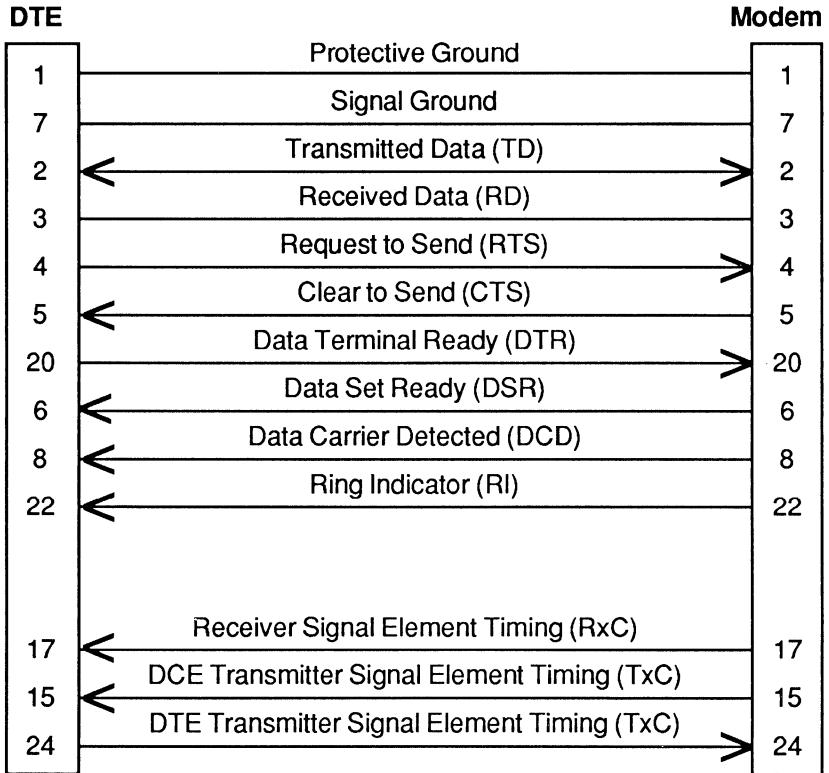
When operating in SDLC or Transparent Synchronous Mode, the modem uses the RS-232C timing signals in addition to the primary interchange signals described above. Figure B-3 shows the recommended cable configuration for connecting the modem to a synchronous device.

The timing interchange signals used by the modem in SDLC or Transparent Synchronous Mode are described below:

#### **Receiver Signal Element Timing (RxC)**

Pin 17 (Receiver Signal Element Timing) is used by the modem to provide the local DTE with received signal element timing information. The transition from an on to off condition indicates the center of each signal element on the Received Data (RD) signal line.

**A**



**Figure B-3. SDLC & Transparent Synchronous RS-232C Cable Diagram**

### Transmitter Signal Element Timing (TxC)

The modem can be configured to either provide the Transmitter Signal Element Timing signal to the DTE via pin 15, or accept the Transmitter Signal Element Timing signal from the DTE via pin 24. The S154 register determines which Transmit Clock is used. The default setting for this register is to use the DCE Transmit Clock (pin 15) to control the timing of the DTE's transmissions.

## Interface Description

An on to off transition on pin 15 (DCE Transmitter Signal Element Timing) indicates that a transition between signal elements on the Transmitted Data (TD) signal line should occur.

An on to off transition on pin 24 (DTE Transmitter Signal Element Timing) indicates the center of each signal element that is sent over the Transmitted Data (TD) signal line.

**A**

# Appendix C

## Command Cross-Reference

(Boldface commands are default values)

Command Mode		Description
Conventional	Enhanced	
A	A	Answer
B	S90=1	Use V.21 for 300 bps operation
B0	S90=1	Same as B
<b>B1</b>	S90=0	Use Bell 103 for 300 bps operation
Dn	Dn	Dial
En	En	Echo On/Off
Fn	Fn	Echoplex On/Off
Hn	Hn	Hook On/Off
In	In	Information (each command mode provides different information)
L0	S61=50	Low speaker volume
L1	S61=15	Low speaker volume
<b>L2</b>	S61=150	Medium speaker volume
L3	S61=250	High speaker volume
Mn	Mn	Speaker On/Off
N0	S94=0	Limit transmission speed
N1	S94=1	Allow speed negotiation
O0	O	Go on-line
O1	&RO	Retrain and go on-line
<b>Q0</b>	Q0	Return result codes
Q1	Q3	Do not return result codes
Q2	Q9	Return result code when originating a call, but not when answering a call
Sn=x	Sn=x	Set Register
Sn?	Sn?	Read Register
Vn	Vn	Verbose
Wn	Wn	Negotiation Progress Reporting
X0	X10	Result codes 0-4
X1	X11	Result codes 0-5, 10-12 and 14
X2	X12	Result codes 0-6, 10-12 and 14
X3	X13	Result codes 0-5, 7, 10-12 and 14
<b>X4</b>	X14	Result codes 0-7, 10-12 and 14
Yn	Yn	Disconnect on Break
Z0	Z1	Reset and recall Profile A
Z1	Z2	Reset and recall Profile B

A

# Command Cross- Reference

Command Mode		Description
Conventional	Enhanced	
<b>&amp;C0</b>	S131=0	DCD is always on
<b>&amp;C1</b>	S131=1	DCD on when carrier detected
<b>&amp;D0</b>	S52=0	DTR is ignored
<b>&amp;D1</b>	S52=3	Enter command mode when DTR is turned off for S25 time
<b>&amp;D2</b>	S52=4	Disconnect, enter command mode when DTR is turned off for S25 time
<b>&amp;D3</b>	S52=2	Reset and enter command mode when DTR is turned off
<b>&amp;F</b>	&F	Recall factory defaults (see Note 1)
<b>&amp;G0</b>	S91=0	No V.22 or V.22bis guard tone
<b>&amp;G1</b>	S91=2	Use 550 Hz guard tone
<b>&amp;G2</b>	S91=1	Use 1800 Hz guard tone
<b>&amp;J</b> and <b>&amp;J0</b>	S102=0	No A/A1 lead control
<b>&amp;J1</b>	S102=1	Same as &f
<b>&amp;K0</b>	S58=0 S68=255	No flow control
<b>&amp;K3</b>	S58=2 S68=255	RTS/CTS flow control
<b>&amp;K4</b>	S58=3 S68=255	XON/XOFF flow control
<b>&amp;K5</b>	S58=7 S68=255 S56=17 S57=19	Transparent XON/XOFF flow control
<b>&amp;L0</b>	S101=0	Dial up line operation
<b>&amp;L1A</b>	S101=3	Leased Line Answer Mode
<b>&amp;L1D</b>	S101=4	Leased Line Originate Mode
<b>&amp;M0</b>	S95=0 S150=0	Asynchronous Mode (factory default)
<b>&amp;M1</b>	S95=0 S150=2	Synchronous Mode 1
<b>&amp;M2</b>	S95=0 S150=2	Synchronous Mode 2
<b>&amp;M3</b>	S95=0 S150=2 S52=4 S104=4	Synchronous Mode 3
<b>&amp;Pn</b>	&Pn	Pulse Dialing Make/Break Ratio
<b>&amp;Q0</b>	S95=0	Same as &M0
<b>&amp;Q1</b>	S95=0 S150=3	Same as &M1
<b>&amp;Q2</b>	S95=0 S150=3 S52=4 S104=1	Same as &M2
<b>&amp;Q3</b>	S95=0 S150=3 S52=4 S104=4	Same as &M3
<b>&amp;Q5 S36=0</b>	S95=1 S150=0	Select MNP Reliable Mode
<b>&amp;Q5 S36=1</b>	S95=2 S150=0	Select MNP Autoreliable Mode

Command Mode		Description
Conventional	Enhanced	
<b>&amp;R0</b>	S67=2	CTS is always on exceptot when used for flow control
<b>&amp;R1</b>	S67=0	CTS always on, RTS ignored
<b>&amp;S0</b>	S130=0	DSR is always on
<b>&amp;S1</b>	S130	DSR is on when answer tone is detected or transmitted
<b>&amp;Tn</b>	&Tn	Test Functions
<b>&amp;T0</b>	&T2	Terminate test
<b>&amp;V</b>	N? and &Nn	View active and stored profiles
<b>&amp;W0</b>	&W1	Write to Profile A
<b>&amp;W1</b>	&W2	Write to Profile B
<b>&amp;X0</b>	S154=0	DCE Transmitter Timing
<b>&amp;X1</b>	S154=1	DTE Transmitter Timing
<b>&amp;X2</b>	S154=2	RX Source Timing
<b>&amp;Y0</b>	S255=1	Recall Profile A on power-up
<b>&amp;Y1</b>	S255=2	Recall Profile B on power-up
<b>&amp;Zn=x</b>	Nn=x	Store telephone number

# Command Cross- Reference

Command Mode		Description
Conventional	Enhanced	
S0	S0	Answer on Ring Number
S1	S1	Count of Rings
S2	S2	Escape Character
S3	S3	Carriage Return Character
S4	S4	Line Feed Character
S5	S5	Backspace Character
S6	S6	Wait Time Before Dialing (see Note 2)
S7	S7	Wait For XCarrier Time (see Note 2)
S8	S8	Pause Time for Comma
S9	S9	Carrier Detect Time
S10	S109	Carrier Loss to Disconnect Time
S11	S11	Touch Tone Timing
S12	S12	Escape Sequence Guard Time
S25	S25	DTR Delay Timing
S26	S26	RTS/CTS Delay Timing
S36=0 & Q5	S95=1	Select MNP Reliable Mode
S36=1 & Q5	S95=2	Select MNP Autoreliable Mode
S37=0	S50=25	Connect at last AT speed
S37=1 - 3	S50=1	Connect at 300 bps maximum
S37=5	S50=2	Connect at 1200 bps maximum
S37=6	S50=3	Connect at 2400 bps maximum
S37=7 or 9	S50=0	Automatic speed determination
S38	S38	Delay Before Disconnecting

## Notes:

1 - When &F is entered in Conventional Command Mode (S63=2) or the modem is initialized to operate in Conventional Command Mode, the only Enhanced Command Mode parameters reset are those listed in this appendix and the following registers: S51, S54, S63, and S66.

When &F is entered in Enhanced Command Mode (S63=0 or 1) or the modem is initialized to operate in Enhanced Command Mode, all of the modem operating parameters are reset to the Enhanced Command Mode defaults. See the Enhanced Command Mode Quick Reference Card for a summary of all default values.

2 - In Conventional Command Mode, the dial tone wait time is specified by S7. In Enhanced Command Mode, the dial tone wait time is specified by S6.

# Appendix D

## Result Codes

The modem provides you with the current status of a call by issuing result codes. Depending on the current setting of the Vn command, the modem's responses are displayed in either numeric (V0) or text (V1) mode.

The current setting of the Xn command and Wn command determines which set of result codes are used as described below.

### Conventional Command Mode

- X0 Only use the first five basic result codes (0 - 4) listed in Table D-1. The modem blindly dials and sends a CONNECT result code when the connection is made at any speed. Dial tone and busy signal are not recognized.
- X1 Use result codes 0 - 5, 10 - 12 and 14 listed in Table D-1. The modem blindly dials and sends the appropriate CONNECT XXXX result code when the connection is made. Dial tone and busy signal are not recognized.
- X2 Use result codes 0 - 6, 10 - 12 and 14 listed in Table D-1. The modem waits for a dial tone before dialing and sends the appropriate CONNECT XXXX result code when the connection is made. The NO DIALTONE result code is sent if a dial tone is not detected within 5 seconds. The busy signal is not recognized.
- X3 Use result codes 0 - 5, 7, 10 -12, and 14 listed in Table D-1. The modem blindly dials and sends the appropriate CONNECT XXXX result code when the connection is made. The BUSY result code is sent if a busy signal is detected. The dial tone is not detected.



## Result Codes

- X4 Use result codes 0 - 7, 10 -12, and 14 listed in Table D-1. The modem waits for a dial tone before dialing and sends the appropriate CONNECT XXXX result code when the connection is made. The NO DIALTONE result code is sent if a dial tone is not detected within 5 seconds. The BUSY result code is sent if a busy signal is detected.
- W0 Do not report error control call progress result codes listed in Table D-2.
- W1 Send the carrier speed and protocol messages listed in Table D-2 while establishing a connection in error control mode. If the X0 command setting is used, this option is ignored.

**Table D-1. Conventional Command Mode Result Codes**

Number	Message and Description
0	OK – The command was successfully completed.
1	CONNECT – Connection at 0 to 300 bps interface speed.
2	RING – An incoming ring has been detected.
3	NO CARRIER – Time to connect has expired, dial command aborted or carrier lost.
4	ERROR – A command error has been encountered.
5	CONNECT 1200 – Connection at 1200 bps interface speed.
6	NO DIALTONE – No dial tone was detected.
7	BUSY – Remote connection is busy.
8	NO ANSWER – Five seconds of silence was not detected within 30 seconds when an @ modifier was encountered in the dial string.
10	CONNECT 2400 – Connection at 2400 bps interface speed.
11	CONNECT 4800 – Connection at 4800 bps interface speed.
12	CONNECT 9600 – Connection at 9600 bps interface speed.
14	CONNECT 19200 – Connection at 19200 bps interface speed.

**Table D-2. Error Control Call Progress Result Codes**

<b>Number</b>	<b>Message and Description</b>
40	CARRIER 300 – Carrier detected at 300 bps (Bell 103 compatible).
46	CARRIER 1200 – Carrier detected at 1200 bps (Bell 212A or V.22 compatible).
47	CARRIER 2400 – Carrier detected at 2400 bps (V.22 bis compatible).
50	CARRIER 9600 – Modem is operating in PEP or 9600bps (V.32 compatible).
70	PROTOCOL: NONE – Error control is not being used.
71	PROTOCOL: ERROR-CONTROL/LAP-B – Either PEP, LAP-M, or MNP error control is enforced

## Enhanced Command Mode

- X0 Only use the first five basic result codes (0-4) listed in Table D-3. No speed is reported in the CONNECT message. BUSY, NO ANSWER and NO DIAL TONE are mapped to NO CARRIER. The RRING message is not reported.
- X1 Use all of the extended result codes listed in Table D-3. This is the factory default setting of the Xn command.
- X2 When an MNP connection is made, use the MNP extended result codes listed in Table D-4 in place of the CONNECT XXXX message.
- X3 When an MNP connection is made, use the MNP extended result codes listed in Table D-4. When a connection is made in PEP Mode in which an asynchronous protocol is supported or data compression is enabled, use the PEP extended result codes listed in Table D-5.
- X10 Same as the X0 command listed in Conventional Command Mode.
- X11 Same as the X1 command listed in Conventional Command Mode.

## Result Codes

- X12 Same as the X2 command listed in Conventional Command Mode.
- X13 Same as the X3 command listed in Conventional Command Mode.
- X14 Same as the X4 command listed in Conventional Command Mode.
- W0 Same as the W0 command listed in Conventional Command Mode.
- W1 Same as the W1 command listed in Conventional Command Mode. This option is only applicable for X11 through X14 command settings.

**Table D-3. Enhanced Command Mode Result Codes**

Number	Message and Description
0	OK – The command was successfully completed.
1	CONNECT 300 – Connected at 300 bps (Bell 103 and V.21 compatible).
2	RING – An incoming ring has been detected.
3	NO CARRIER – Time to connect has expired, dial command aborted or carrier lost.
4	ERROR – A command error has been encountered.
5	CONNECT 1200 – Connected at 1200 bps (Bell 212A or V.22 Compatible).
6	NO DIAL TONE – No dial tone was detected.
7	BUSY – Remote connection is busy.
8	NO ANSWER – Five seconds of silence was not detected within 30 seconds when an @ modifier was encountered in the dial string.
10	CONNECT 2400 - Connected at 2400 bps (V.22bis Compatible).
11	CONNECT 4800 - Connected at 4800 bps (V.32 fallback).
12	CONNECT 9600 - (V.32 mode).
50	CONNECT FAST- Connected to a modem using the Packetized Ensemble Protocol (PEP).
52	RRING – Remote connection is ringing.

**Table D-4. MNP Extended Result Codes**

<b>Number</b>	<b>Message and Description</b>
20	CONNECT 300/REL – MNP connection at 300 bps.
22	CONNECT 1200/REL – MNP connection at 1200 bps.
23	CONNECT 2400/REL – MNP connection at 2400 bps.
24	CONNECT 4800/REL- MNP connection at 4800 bps.
25	CONNECT 9600/REL - MNP connection at 9600 bps.

**Table D-5. PEP Extended Result Codes**

<b>Number</b>	<b>Message and Description</b>
61	CONNECT FAST/KERM – PEP connection with Kermit protocol supported.
62	CONNECT FAST/XMDM – PEP connection with Xmodem protocol supported.
63	CONNECT FAST/UUCP – PEP connection with UUCP protocol supported.
70	CONNECT FAST/COMP – PEP connection with data compression enabled.
71	CONNECT FAST/KERM/COMP – PEP connection with Kermit protocol supported and data compression enabled.
72	CONNECT FAST/XMDM/COMP – PEP connection with Xmodem protocol supported and data compression enabled.
73	CONNECT FAST/UUCP/COMP – PEP connection with UUCP protocol supported and data compression enabled.



# Appendix E

## T2500 to T2500 Interconnection

The following chart illustrates how two T2500 modems would interact given S90=0 or 2, for a normal answer sequence, and S90=1, CCITT Mode selected. Other registers are assumed to be set to factory default settings.

		Originate Modem																	
		S94=0								S94=1									
		S50=	0	1	2	3	4	5	6	255	0	1	2	3	4	5	6	255	
Answer Modem	S94=0	0	F	A	B	D	A	C	E	F	F	A	B	D	A	C	E	F	
		1	A	A	-	-	-	-	-	-	A	A	A	A	A	-	A	-	
		2	B	-	B	-	-	-	-	-	B	-	B	B	-	-	B	-	
		3	D	-	-	D	-	-	-	-	D	-	-	D	-	-	D	-	
		4	A	-	-	-	A	-	-	-	A	A	A	A	A	-	A	-	
		5	C	-	-	-	-	C	-	-	C	C	C	C	C	C	C	C	-
		6	E	-	-	-	-	-	E	-	E	-	-	-	-	-	E	-	
		255	F	-	-	-	-	-	-	F	F	-	-	-	-	-	-	-	F
	S94=1	0	F	A	B	D	A	C	E	F	F	A	B	D	A	C	E	F	
		1	A	A	-	-	A	C	-	-	A	A	A	A	A	C	A	-	
		2	B	A	B	-	A	C	-	-	B	A	B	B	A	C	B	-	
		3	D	A	B	D	A	C	-	-	D	A	B	D	A	C	D	-	
		4	A	A	-	-	A	C	-	-	A	A	A	A	A	C	A	-	
		5	C	-	-	-	-	C	-	-	C	C	C	C	C	C	C	C	-
6		E	A	B	D	A	C	E	-	E	A	B	D	A	C	E	-		
255		F	-	-	-	-	-	-	F	F	-	-	-	-	-	-	-	F	

- KEY:
- A = 300 bps
  - B = 1200 bps
  - C = 1200/75 bps
  - D = 2400 bps
  - E = V.32
  - F = PEP
  - = No Connection Made





# Appendix F

## Leased Line Considerations

When connecting the modem to private or leased lines, the output power level can be adjusted by changing a plug-in resistor on the modem board shown in Figure F-1. The following table lists the resistor values which correspond to various output power levels:

<u>Power Limit (dBm)</u>	<u>Resistor (1%)</u>
0.0	18.7K
-1.5	22.6K
-3.0	27.4K
-4.5	33.2K
-6.0	39.2K
-7.5	47.5K
-9.0	56.2K
-10.5	66.5K
-12.0	80.6K
-13.5	95.3K
-15.0	113K

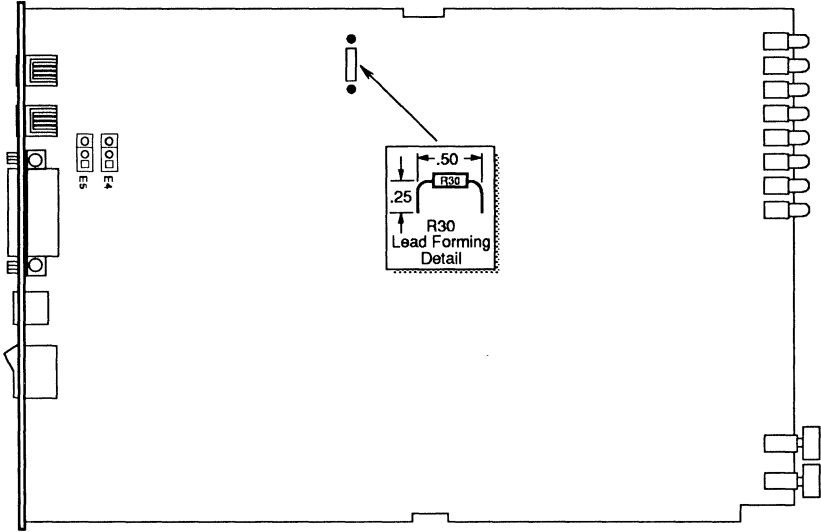
Note that the modem is shipped with a 56.2K resistor installed for a dBm level of -9.0. In order to conform to FCC requirements, this resistor must not be changed when connecting the modem to a switched telephone network in the U.S.

The modem is designed to connect to a two-wire circuit. If you need to connect to a four-wire leased line, you will need to obtain a four-wire to two-wire hybrid from your leased line representative.

**A**



# Leased Line Considerations



**Figure F-1. Gain Control Resistor Location**

For leased line applications, the modems should be configured as follows:

<u>Originate Modem</u>	<u>Answer Modem</u>
S7=255	S7=255
S50=255	S50=255
S101=2	S101=1

This configuration allows the modems to attempt to establish a connection in PEP Mode every 20 seconds whenever carrier is not present. For additional information read the descriptions for the above registers.

**A** In Conventional Command Mode, the &L command sets the S101 register to an appropriate value when a subsequent Answer (A) or Dial (D) command is stored. See *Command Cross Reference* in Appendix C.

# Appendix G

## Technical Specifications

### Environmental Limits

Operating Temperature	50 to 120° Fahrenheit 10 to 50° Celsius
Storage Temperature	-40 to 149° Fahrenheit -40 to 65° Celsius
Relative Humidity	5 to 95% noncondensing
Altitude (maximum)	20,000 feet (6,096 meters)

### Power Requirements

60 Hz Operation	115 VAC (+10%/-15%) @ 0.55 Amps maximum
50 Hz Operation	230 VAC (+10%/-15%) @ 0.28 Amps maximum

### Physical Dimensions

Height	2.4 inches (6.1 cm)
Width	8.5 inches (21.6 cm)
Depth	13.0 inches (33.0 cm)
Weight	2.8 pounds (1.27 Kg)

### Interface

Serial Port	25 pin RS-232C
Phone	8 pin RJ11C

### Operation

Asynchronous binary, SDLC, or  
Transparent synchronous  
transmissions

**A**

# Technical Specifications

## Transmission Modes

Bell 103 or V.21 (300 bps)  
Bell 212A or V.22 (1200 bps)  
V.22bis (2400 bps)  
V.32 (9600, 4800 bps)  
PEP (up to 18,000 bps)

## Standard Character Format

1 start bit, 7 or 8 data bits,  
plus 1 parity bit, and 1 stop bit

## Modulation

FSK (Bell 103, V.21)  
DPSK (Bell 212A, V.22)  
QAM (V.22bis, V.32)  
DAMQAM (PEP)

## Receiver Sensitivity

-45 dBm

## Frequencies

### Bell 103

Originate Mode

<u>Tx Frequency</u>	<u>Rx Frequency</u>
1070 Hz = space	2025 Hz = space
1270 Hz = mark	2225 Hz = mark
2025 Hz = space	1070 Hz = space
2225 Hz = mark	1270 Hz = mark

Answer Mode

### V.21

Originate Mode

<u>Tx Frequency</u>	<u>Rx Frequency</u>
1180Hz = space	1850Hz = space
980Hz = mark	1650Hz = mark
1850Hz = space	1180Hz = space
1650Hz = mark	980Hz = mark

Answer Mode

### Bell 212A/V.22/V.22bis

Originate Mode

<u>Tx Frequency</u>	<u>Rx Frequency</u>
1200 Hz (carrier)	2400 Hz (carrier)
2400 Hz (carrier)	1200 Hz (carrier)

Answer Mode

### V.32

Originate Mode

<u>Tx Frequency</u>	<u>Rx Frequency</u>
1800Hz (carrier)	1800Hz (carrier)
1800Hz (carrier)	1800Hz (carrier)

Answer Mode

**A**

**Packetized Ensemble Protocol**      Up to 512 carriers spaced 7.8 Hz  
apart in the 0 to 4000 Hz band

**Frequency Offset**                      Can tolerate up to  $\pm 7$  Hz  
**Certifications**                        FCC Part 15J Class A, part 68  
15-ER95W5T1SA  
  
FCC Part 68  
ER95W5-17716-MD-E T25SA  
  
DOC CS-03, Issue 05  
CSA #LR66104-7  
UL #E104318 (S)



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# GLOSSARY

## A

**ACK** — Control character transmitted by a receiving device as an affirmation to a sending device.

**alphanumeric** — Letters (alphabetic) and numbers (numeric).

**ANSI** — American National Standards Institute. Primary standards development body in the U.S.A.

**ASCII** — American Standard Code for Information Interchange, a 7-bit code established by ANSI for representing alphanumeric and control characters.

**asynchronous transmission** — Digital transmission technique characterized by start and stop bits at the beginning and end of each character and not synchronized by a clock signal.

**autobaud** — Determines the speed and parity of any properly entered command line prefix, AT. The modem uses the A in the prefix to determine the serial interface speed and the T to determine the parity.

## B

**baud rate** — Number of discrete signaling events per second; not necessarily the same as bits per second.

**bit** — An acronym for binary digit. A bit is the smallest unit of digital information represented by the choice of one of two possible states – one (mark) or zero (space).

**block** — Group of characters treated as a unit for the purpose of data transmission.

G

**bps (bits per second)** — The most common unit of measure for specifying the data transfer rate in a communication network.

**break** — Signal used by computer equipment to interrupt some process, usually represented by 12 or more consecutive bits.

**buffer** — Temporary storage area used to compensate for a difference in the rate of data flow into and out of a device.

**byte** — A grouping of bits to specify a single character usually consisting of eight consecutive bits.

## C

**carrier** — An analog signal that is modulated by another signal containing information to be transmitted.

**Carrier Detected (CD)** — RS-232C control signal used by the DCE to inform the DTE that it has detected a valid carrier signal.

**CCITT** — Consultive Committee for International Telephone and Telegraph. A standard organization that sets standards for worldwide voice and data communications.

**CCITT V.XX** — International standards in communications concerned with modem interfaces, speeds, and transmission modes.

**channel** — An electronic communications path. A voice grade channel generally ranges from 300 to 4000 Hz.

**character** — A letter, number, or other symbol contained in a message or used in a control function.

**character set** — The characters that can be coded or used by a particular machine.

**Clear to Send (CTS)** — An RS-232C control signal sent by the DCE to indicate that the DTE may begin a transmission.

**clock** — Source of timing signals used in synchronous transmission.

**code** — A predefined set of rules that specifies the way data is to be represented by the transmitting and receiving device.

**common carrier** — Telephone company that furnishes communications services to the general public.

**conditioning** — The addition of equipment to a leased voice grade line to improve the transmission characteristics of the line.

**console** — Part of a computer system, usually a video display terminal, used by the operator to communicate with the computer.

**contention** — Condition arising when two or more devices try to transmit at the same time using the same channel.

**control character** — Character that initiates some control function on the receiving device.

**CPU** — Central Processing Unit. The computer hardware that processes software instructions to control the computer system and its peripherals.

**CRT** — Cathode Ray Tube. This term is commonly used to stand for the video display terminal.

**Cyclic Redundancy Check (CRC)** — An error detection technique in which a data validation value is mathematically derived from a block of data and transmitted at the end of the block. The receiving end recomputes the value and if it matches the value sent, the data is assumed to be valid (error-free). If not, the receiver notifies the transmitter that an error has occurred and the block is retransmitted.



# D

**Data Carrier Detected (CD)** — RS-232C control signal used by the DCE to inform the DTE that it has detected a valid carrier signal.

**Data Communications Equipment (DCE)** — The equipment that provides all the functions required to establish, maintain and terminate a connection, and provides the signal conversion required for communications between the Data Terminal Equipment and the Telephone Network.

**data compression** — An encoding technique that provides for the transmission of fewer data bits without the loss of information. The receiving end expands the data received to its original form.

**data set** — *See modem.*

**Data Set Ready (DSR)** — An RS-232C control signal used to indicate the readiness of the DCE to accept data from the DTE.

**Data Terminal Equipment (DTE)** — The equipment that provides the data source and/or receiving end of a data transmission link. The DTE may be a CRT or teletype terminal, a personal computer, a printer, a front-end processor to a large mainframe computer, or any other device that can transmit or receive data.

**Data Terminal Ready (DTR)** — An RS-232C control signal used to indicate the readiness of the DTE for data transmission.

**decibel (dB)** — Unit of measure indicating the logarithmic ratio of output signal power to input signal power.

**dedicated line** — A communications line that is not dialed. Also known as leased line or private line.

**demodulation** — The process of recovering digital information from a modulated analog carrier waveform.

**dial-up line** — A communication circuit that is established by a switched circuit connection using the telephone dial network.

**dibit** — A grouping of two bits.

**digital signal** — A signal composed of discrete signal levels as opposed to the continuous signal levels of an analog signal.

**distortion** — Undesired change in a signal's original waveform resulting from the characteristics of the transmission circuits or other external influences.

**dumb terminal** — Terminals that do not contain an intelligent microprocessor and usually send data one character at a time.

## E

**EBCDIC** — Extended Binary Coded Decimal Interchange Code. An 8-bit code used primarily by IBM equipment.

**echoplex** — Method of verification of transmitted data by echoing the characters transmitted back to the source device for verification.

**EEPROM** — Electrically Erasable Programmable Read Only Memory.

**EIA** — Electronic Industries Association. Standards organization in the U.S. that sets standards for the functional characteristics of electronic interfaces.

**ENQ** — Control character used to enquire as to the identification or status of a remote device.

**ETX** — Control character that indicates the end of text in a transmitted message.

## G

## F

**FCC** — Federal Communications Commission.

**firmware** — Computer program stored permanently in Read Only Memory.

**Forward Error Correction (FEC)** — Technique of transmitting additional information with the original data such that if small errors are detected, the correct information can be re-created by the receiving end without requiring a retransmission.

**frame** — *see block.*

**front-end processor** — Computer equipment designed primarily for communications control associated with a large mainframe.

**full duplex** — Method of transmission in which transmissions can occur in both directions at the same time.

## G

**guard band** — Narrow frequency bands left unused between adjacent channels to minimize interference.

**guard tone** — A tone used to signal the presence of a carrier.

## H

**half duplex** — Method of transmission in which communications can occur in both directions but not at the same time.

**hardware** — The electronic or electromechanical devices in a computer system as opposed to the programs or software.

**HDLC** — High Level Data Link Control. Communications protocol developed by the International Standards Organization.

**header** — In communications protocols, this is the control information that precedes the message or text portion of a block of data.

**Hertz (Hz)** — Unit of frequency; one cycle per second.

**Horizontal Redundancy Checking (HRC)** — Technique in which redundant information is included with a block of data for validating the transmitted data at the receiving end.

**host computer** — The main computer system in a data communications system.

**I**

**interface** — A shared boundary defined by common physical interconnection characteristics, signal characteristics, and meaning of interchanged signals.

**interference** — Undesirable disturbances or distortions in a data transmission signal.

**ISO** — International Standards Organization.

**J**

**K**

**Kermit** — A data communications protocol. *Also see protocol.*

**G**

## L

**leased line** — Telephone line reserved for the exclusive use of a single customer.

**link** — A circuit or transmission path, including all equipment, between a sender and a receiver.

**Longitudinal Redundancy Check (LRC)** — Error detection technique that consists of a byte where each bit is calculated on the basis of the parity of all bits in the block in the same position.

**loopback** — Directing signals sent back toward the source at some point in the communications path.

## M

**mainframe** — Large scale computer system composed of large number of peripherals and comprehensive software.

**mark** — One of the two possible states of a binary data element. The closed circuit and idle condition in a teleprinter circuit. *Also see space.*

**MNP** — Microcom Networking Protocol. *Also see protocol.*

**modem** — MOdulator/DEModulator. A type of DCE that converts digital data to an analog signal for transmission on telephone circuits. A modem at the receiving end converts the analog signal to digital form.

**modulation** — The process of varying some characteristic of the carrier wave in accordance with the data to be transmitted.

**multidrop Line** — Single communications circuit interconnecting many stations (nodes) each containing terminal devices.

## N

**NAK** — Negative Acknowledgement. This control character indicates that the last block transmitted was in error and that the receiver is expecting a retransmission.

**node** — A point of interconnection on a circuit.

**noise** — Random electrical signals introduced by components of the circuit or natural disturbances that can produce errors in transmission.

**nonvolatile memory** — Memory that retains its contents even when no power is applied.

## O

## P

**parity** — A bit that is derived from a character's data bits and transmitted along with the character. The receiving end recalculates the parity and if it matches the transmitted parity that character is assumed to have been transmitted correctly. If the parity does not match, the character is deemed invalid.

**PBX** — Private Branch Exchange. Telephone switching equipment dedicated to one customer and connected to the public switched network.

**point-to-point** — A connection between two points as opposed to a multipoint or multidrop line.

**private line** — *See leased line.*

**PROM** — Programmable Read Only Memory.

**propagation delay** — The time required for a signal to travel from one end of a circuit to another.

**protocol** — The rules governing the orderly exchange of information between devices on a data link.

**protocol converter** — Device that converts from one protocol to another.

**public switched network** — Telephone system providing circuit switching to many customers.

## Q

## R

**RAM** — Random Access Memory.

**Received Line Signal Detector** — *See Carrier Detected.*

**redundancy check** — Technique of error detection involving the transmission of additional data related to the message so that the receiving device can determine if the data transmitted is valid (error-free).

**Request to Send (RTS)** — RS-232C control signal used by the DTE to inform the DCE that it is ready to transmit data. When used for flow control between the DTE and modem, this signal indicates to the modem that the DTE is ready to accept data.

**Ring Indicator (RI)** — RS-232C control signal used by the DCE to inform the DTE that it is receiving a ringing signal.

## G

**ROM** — Read Only Memory.

**RS-232C** — Recommended standard of the Electronics Industries Association for the interface between data terminal equipment and data communications equipment.

## S

**serial transmission** — Method of transmission in which each data bit is transmitted sequentially.

**software** — Computer program or set of computer programs held in storage, and loaded into RAM for execution.

**SOH** — Start Of Header. Control character used in synchronous transmissions indicating the start of a header block.

**space** — One of the two possible states of a binary data element. The open circuit condition in a teleprinter circuit. *Also see mark.*

**start bit** — The first bit or element transmitted in asynchronous transmission of a character to synchronize the receiver.

**stop bit** — The last bit or element transmitted in asynchronous transmission of a character to return the circuit to an idle state.

**STX** — Start Of Text. Control character used in synchronous transmission that precedes the text portion of the data block.

**SYN** — Synchronous Idle. Control character transmitted when the line is idle in synchronous transmissions.

**synchronous transmission** — Transmission method in which the transmitter and receiver are continuously operating at a fixed rate with a clock signal, either derived from the data stream, or provided by the transmitter or receiver.

## T

**terminal** — Any device capable of sending and/or receiving data over a communications channel.

**text** — The message portion of a data block in synchronous data transmissions.



**Trellis Code Modulation** — A method of modulating a carrier to reduce errors.

**turnaround time** — The time required to reverse the direction of transmission when operating in half- duplex mode.

## U

**UART** — Universal Asynchronous Receiver Transmitter. An integrated circuit that performs the functions required for asynchronous communications.

**USART** — Universal Synchronous/Asynchronous Receiver Transmitter. An integrated circuit that performs the functions required for both synchronous and asynchronous communications.

## V

**Vertical Redundancy Check (VRC)** — A method of character parity checking.

**voice grade line** — Channel with a frequency range of 300 to 3400 Hz suitable for the transmission of speech or data in analog form.

## W

# G

**X**

**XMODEM** — A file transfer protocol. *Also see protocol.*

**XOFF/ XON** — The control characters used to stop or resume transmissions.

**Y**

**Z**



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