

2400-BPS Half Card Modem Operation Manual

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If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- Plug the computer into a different outlet so that computer and receiver are on different branch circuits.

Warning

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2400-BPS Half Card Modem Operation Manual:
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Introduction

The Tandy® 2400-bps Half Card Modem has all the features needed to enhance your data communications applications — including a data output rate eight times faster than that of a 300-bps modem.

This direct-connect, Bell 103/212A/V.22 bis-type modem is designed with standard automatic dial, answer, and disconnect features and also has a wide range of system configuration enhancements. Its central processing unit (CPU) provides operation in Hayes® protocol mode. Your modem is AT-compatible and capable of running with Hayes software.

After dialing a phone number, the modem monitors the call and reports its progress to your computer. You can even control the dialing method — pulse or tone.

These functions and others are controlled by ASCII (American Standard Code for Information Interchange) encoded commands that you program from your computer keyboard.

The basic operation of your modem is, in some ways, like that of a telephone operator making a call. Your modem:

- Waits as the phone rings until the dialed number is answered
- Hangs up if the number is busy or if the call is not answered after a specified period of time
- Disconnects the line at the end of a completed call.

Incorporating a high degree of intelligence, the modem allows your computer to function virtually unattended when connected to a telephone, making possible a wide range of telecommunications applications. Used with the proper applications software package, the modem is capable of performing operations such as electronic mail and shopping, central database access, home banking, and remote-peripheral sharing.

Another feature of the modem is a built-in monitor speaker that enables you to audibly monitor the dialing and data communication progress. The situation is reported visually on your computer display with messages called result codes.

The next few pages will give you a quick start for using your modem. For many users this will be enough information to put you well on your way to full modem communication. The remainder of the manual provides technical details of programming and operation of the modem.

A Quick Start with Your Modem

Why did you buy a modem? So you can communicate between two computers using standard telephone lines.

In order to operate the modem you must use some type of communications software. DeskMate's Telecom or Tandy's PC-Link program are two examples of easy-to-use communications programs.

You'll use the software communications program to set some technical conditions (such as baud rate, word length, etc.). Telecom and PC-Link are set for the most common conditions (and these are easy to change). Just follow the instructions provided with those programs.

Install and connect your modem following the information in "Appendix A: Setting Up." Type:

AT

(This is an attention code—it tells the modem and computer to come to attention—to wake up.)

The modem should respond OK. (This tells you everything is connected OK.)

If you will be using a *smart* communications software package (one that controls the modem for you), you will not need to learn the modem commands. (Telecom is such a package; PC-Link is a specialized package that is even easier to use, but connects you to a specific computer and database.) Refer to the instructions for that package.

If you will be using a *dumb* terminal emulation program (one that does not control the modem for you), you will only need to learn a few of the basic commands.

A. Preparing to Initiate a Call:

1. Set up your communications software for the correct baud rate, word length, parity, etc. (That is explained on Page 5 and in the manual for the communications software.)
2. Type the command **AT D 555-1212 <ENTER>**

AT is the attention code that tells the modem to be ready for a command.

D is the command to dial.

555-1212 would be the number you want the modem to dial. (There is no need to use the hyphen (-); the modem ignores it.)

Note: For an explanation of all the commands, refer to Tables 1 and 2.

D causes the modem to go *off hook* and wait for a dial tone. If for some reason there is no dial tone, a message NO DIAL TONE shows on the screen. After the dial tone has been detected, the modem dials the number. It waits for a preset amount of time for the number to be answered and a carrier sent out. (This is a buzz or squeal that you would hear on the phone.) If the number is busy, you get a BUSY message on the screen. If a carrier is not detected, you get a NO CARRIER message.

If a connection is made, you get one of the following messages:

CONNECT if it is a 300 baud connection

CONNECT 1200 if it is a 1200 baud connection

CONNECT 2400 if it is a 2400 baud connection

Proceed with your normal communication process (copying a file, loading a file, or whatever).

Tone Dialing

If you wanted to dial the same number, but use tone dialing instead of the default standard of pulse dialing, type the following:

AT DT 555-1212

To Connect to an Outside Line Using 9

If you were using a PBX line (typical business line) and needed to dial 9 for an outside line, then pause for a second dial tone, before dialing the outside number, type the following:

AT D 9,555-1212

To Repeat the Last Modem Command

To resend the last command you gave to the modem (for example, to redial if the number was busy), type:

A/ (no need to press <ENTER>)

B. Preparing to Receive a Call:

To Set Up Your Modem for Automatic Answer after Three Rings

If you wanted to have your modem automatically answer the phone after three rings and then send out a carrier signal, type the following:

AT SO = 3

To Go Off-Hook

If you wanted to have the modem go off-hook and send out a carrier immediately, type:

AT A

C. Overview of Modem Function

As illustrated by the previous examples, your modem is always in one of these two modes of operation:

Command Mode (sometimes called Local Command State)—in this mode anything you type on the keyboard controls the modem; information is not sent to the other modem/computer.

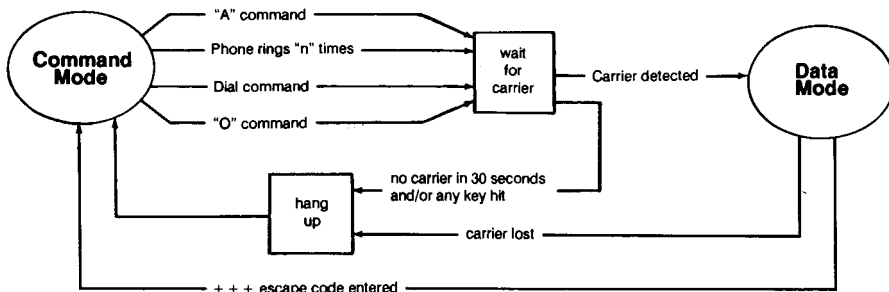
Data Mode (sometimes called On-line state)—in this mode anything you type on the computer is sent to the other modem/computer.

Command Mode is the mode you normally start with at powerup. In this mode the modem accepts commands directly from the keyboard and each command must be terminated with a carriage return (ENTER).

Data Mode is the mode the modem goes into when answering an incoming call or connecting with a distant modem. In this mode you can make direct communication with the distant modem.

When in the Data mode, the modem will not execute commands. To get back to the Command mode, you must use an escape code—for example +++. (Also, the modem automatically returns to the Command mode if the carrier is lost —i.e. the distant modem hangs up.)

The following illustration will help you understand the relationship between these two modes.



Description of the Modem 1

Before you connect the 2400-bps Half Card Modem, read the instructions in Appendix A, "Setting Up." Be sure to turn off your computer before connecting the modem.

Communications Protocol

Certain criteria must be met before computer-to-computer communication can occur. The modem operates on 10 or 11-bit data words. The following combinations are allowed:

START BIT COUNT	DATA BIT COUNT	PARITY BIT	STOP BIT COUNT
1	8	NO	1
1	8	NO	2
1	7	YES	1
1	7	YES	2
1	7	NO	2

The condition of one start bit, seven data bits, no parity bit, and only one stop bit is auto recognized as having a marking or spacing eighth data bit. A communication error could result if you do not use at least 10 bits as shown above.

When opened for programming by the attention code sequence, the modem automatically synchronizes the baud rate, word length, parity, and stop-bit numbers (communications protocol) of your computer system.

High and Low Speed Operations

The 2400-bps Half Card Modem automatically synchronizes with standard speed rates of 300, 1200, and 2400 bits per second (bps).

Switching from high-speed (2400 bps) to lower-speed (1200 or 300 bps) operation occurs when the modem receives the attention code in Hayes protocol mode. When the modem detects 2400 bps after receiving the code sequence, it communicates in high speed. If the modem is awakened at 300 bps, it uses low-speed operation. If it is awakened at 1200 bps, it operates at this medium speed.

The originating station always determines the speed of operation. If you wake up the modem in low-speed mode, the modem will select the low-speed 300-bps operation. If you intend to call a high-speed modem, you must set your modem to high speed before calling a remote modem unless the remote modem has low-speed detection circuitry.

Automatic Operation

When you want the modem to dial a phone number or answer the phone for you, set it to automatic operation mode. In this mode, the modem dials the phone number you stored in its memory or answers the phone when someone calls you. Automatic mode, for instance, lets you dial the information service number without picking up the phone. Simply type the number, along with the proper modem programming commands, on the computer keyboard.

Originate vs. Answer Mode

To place a call to an information service or another modem using communications software, set your modem to originate mode. In this mode, the call originates from your computer. When you want to receive a call (answer the phone), set the modem to answer mode. Note that originate and answer modes can be used either manually or automatically.

For further operation information, refer to the operation manual that accompanies your communications software package.

Command Reference 2

Direct communication with the modem is performed using the AT command. The modem accepts commands from your computer when it is in the command mode. To enter commands while the modem is in the data mode, it must be placed in the command mode by entering an escape code sequence.

Command Execution

Your modem accepts only ASCII characters as commands. The commands you enter in the command mode are stored in a memory buffer that is 40 characters long. When you input a carriage return (**ENTER**), the command is compared to a list of possible commands. If a match is found, the command is executed.

You must start a command line with the attention code AT, and you can place more than one command in the command line. You can separate each command by a space for readability. After each command is executed, result codes are sent back to the terminal, unless you disable the echo back.

Command Guidelines

Operation and configuration of the modem can be simple and efficient if you follow the guidelines for entering commands to the modem.

The modem determines the data transmission format of the computer when it sees the attention code AT at the beginning of each command line. If you make an error while entering the command, it can be edited before pressing the **ENTER** key. Pressing the **BACKSPACE** key deletes that last character entered. By pressing the **BACKSPACE** key repeatedly, you can delete the entire command line, except the AT command. If you inadvertently or intentionally leave out a parameter when entering a command, the modem assumes a value of 0.

Since the command buffer is 40 characters long, exceeding that number causes the modem to abort execution of the command line and send an error message to the computer.

The Basic Commands

The basic commands for programming the modem are provided in Table 1. Table 2 lists the dialing command and its modifiers. For a detailed explanation of each command, refer to the section “Command Definitions” that follows command tables.

Table 1. Basic Command Codes

Command	Description	Function
AT	Attention Code	Command line prefix; precedes command lines except +++ (Escape Code) and A/ (Repeat Command).
A/	Repeat Command	Repeats the command line. Neither AT nor ENTER is necessary for this command.
A	Answer Mode	Sets the modem to answer mode immediately without waiting for a ringing signal.
ENTER	Carriage Return	Closes the command line and executes commands. S3 defines the carriage return character.
BACKSPACE	Backspace	Edits the command line by deleting characters one by one. S5 defines the backspace character.
+++	Escape Code	Returns the modem to command mode from data (on-line) mode. S2 defines the escape code character. S12 defines the escape code guard time.
Z	Reset	Resets the modem.

Table 2. Dialing Commands and Modifiers

Command		Description	Function
D		Dialing Command	Sets the modem to originate a call by dialing numbers and executing modifiers that follow D in the command line.
Modifiers	P	Pulse Dialing	Sets the modem to pulse dialing mode.
	T	Tone Dialing	Sets the modem to tone dialing mode.
	R	Reverse Mode	Changes the modem to answer mode automatically after a call is originated.
	W		Wait for dial tone before dialing.
	,	Pause	Causes the modem to pause when dialing. Place it after the access code. Length of pause time is set by S8.
	@		Wait until no sound is heard.
	!		Flash the switchhook for 0.5 seconds.
	;		Returns the modem to command mode after dialing.

The Commands with Parameters

Some of the commands have parameters (Table 3). The parameter value, usually 0, 1, or 2, follows the command. When you do not select a command parameter, the modem assumes a value of 0. For example, command echo is disabled when you use the *E* command to select a parameter value of 0. Command echo is enabled when you designate a parameter value of 1. *E* used alone is the same as E0.

Table 3. Commands with Parameters

Command	Parameters	Function
B	0	Selects CCITT V.22 operation when communicating at 1200 bps.
	1 (Default)	Selects BELL 212A operation when communicating at 1200 bps.
E	0	Commands are not echoed.
	1 (Default)	Echos commands.
H	0 (Default)	On-hook (hang-up).
	1	Go off-hook.
I	0	Requests product identification code.
	1	Performs checksum on firmware ROM; returns checksum.
	2	Performs checksum on firmware ROM; returns OK or ERROR.
M	0	Speaker off.
	1 (Default)	Speaker on until carrier detected.
	2	Speaker always on.
	3	Speaker on until carrier detected, except during dialing.
O	0	Return to on-line state.
	1	Return to on-line state and initiate retrain.*
Q	0 (Default)	Modem returns result codes.
	1	Modem does not return result codes.
V	0	Numeric result codes.
	1 (Default)	Word result codes.

Command	Parameters	Function
X	0	Result code set 0
	1	Result code set 1
	2	Result code set 2
	3	Result code set 3
	4 (Default)	Result code set 4

* Retrain allows two 2400-bps modems to resynchronize to each other.

The Advanced Commands

Table 4. Advanced Commands

Command	Parameters	Function
&C	0	DCD (Data Carrier Detect) always on.
	1 (Default)	DCD on indicates presence of data carrier.
&D	0 (Default)	Modem ignores DTR (Data Terminal Ready).
	1	Modem assumes command mode when on-to-off transition is detected on DTR.
	2	When on-line with a host system, modem goes on-hook and assumes command mode upon detecting an on-to-off transition on DTR.
	3	Modem assumes initialization state upon detecting an on-to-off transition on DTR.
&F	None	Resets the modem.
&P	0 (Default)	Pulse dial make/break ratio=39/61 (USA).
	1	Pulse dial make/break ratio=33/67 (UK/HK).
&S	0 (Default)	DSR (Data Set Ready) always on.
	1	DSR operates in accordance with EIA RS-232C specifications.
&T	0 (Default)	Terminate test in progress.
	1	Initiate local analog loopback test.
	2-7	Not supported.
	8	Initiate local analog loopback with self-test.

Command Definitions

A Go off hook and answer phone immediately

The modem immediately goes off hook, transmits the answer tone and waits for a carrier from the remote modem. Commands entered after the A command are ignored.

A/ Repeat previous command

The last command executed by the modem will execute again. This command does not require the attention code AT or carriage return

ENTER .

The repeat command is cancelled under the following conditions:

- You enter a new command line beginning with AT.
- You enter the reset command Z or &F.
- You turn off the computer.

Bn BELL/CCITT mode select

B0 — Selects CCITT V.22 operation at 1200 bps

B1 — Selects BELL 212A operation at 1200 bps (Default)

Most 1200 bps modems in the United States operate using the BELL 212A specification. To communicate with a modem conforming to the international CCITT V.22 standard, enter the B0 command before dialing.

Dn Dial the number immediately following this command

where *n* = digits 0 to 9 together with the dial modifiers listed below.

The modem dials the number specified in the manner determined by the dial modifiers. The dial modifiers may appear anywhere within the dial string with the exception of the ; modifier which must appear at the end of the string.

Dial Modifiers: P Pulse dial.

 T Tone dial.

 R Set the modem to answer mode automatically after a call is originated.

- W Wait for dial tone before dialing.
- , Pause before dialing next digit.
- ; Return to command mode after dialing.
- @ Wait for quiet answer before dialing.
- ! Flash-hook.

Example:

```
AT DP9WT713,5552759;
```

In this example, the modem pulse dials 9, waits for a dial tone, then tone dials 713. Next, the modem pauses the length of time specified in register S8. It then dials the number 5552759. Finally, the modem returns to the command mode after the final digit has been dialed.

You can use (), -, and space to make the telephone number readable, but it doesn't take up the memory space in the modem.

The P modifier causes the modem to pulse or rotary dial at a fixed rate of 10 pulses per second. (The make/break ratio for pulse dialing is determined by the &P command.)

The T modifier causes the modem to dial using DTMF (dual-tone multi-frequency) signals, the same as those used by touch-tone telephones.

The R modifier is used to call modems which can communicate only using the originate mode carrier frequencies. This is a limitation generally found only in older modems. When you enter R, the modem dials the telephone number (originate mode) and then activates the answer mode automatically.

The W modifier causes the modem to wait for a dial tone signal for the number of seconds specified in register S7. This is generally used when trying to dial through a PBX or when using a long distance service such as US SPRINT® or MCI®.

The @ modifier causes the modem to wait for the time specified by register S7 for one or more rings followed by 5 seconds of silence before processing the next symbol in the dial string. It is used to access a system that does not provide a dial tone.

The **!** modifier causes the modem to go on hook for ½ second. This is equivalent to holding down the switch-hook button on your telephone for ½ second. The flash is generally used for transferring calls.

En Echo back characters in command mode

E0 — no characters echoed back to the computer in command mode

E1 — echoes back characters to the computer typed in command mode (default)

This command controls the echoing back of commands to your computer. In most personal computer applications, the default E1 is used so that you can see what you just typed in. When running in half-duplex mode, the E0 command should be used to avoid having 2 copies of each character displayed on the screen.

Hn Activate switch-hook

H0 — go on hook (hang-up) (default)

H1 — go off hook (pick up the phone)

This command forces the modem to pick up or hang up the phone in the same way as a telephone handset is picked up to answer a call or placed back on the switch-hook to terminate a call.

H0 may be used to terminate a call after entering + + + to return to the command mode.

Use of the H1 command is generally not required as the modem automatically answers an incoming call if the S0 register is not set to 0.

In Request product code and ROM checksum

I0 — display product code

I1 — display ROM checksum

I2 — display ROM checksum as OK or ERROR

This command is used as a diagnostic tool when troubleshooting the modem.

Mn Speaker on/off commands

M0 — speaker always off

M1 — speaker on until carrier detected (default)

M2 — speaker always on

M3 — disables speaker while dialing and when receiving carrier from remote modem

The M commands are used to control a monitor speaker. M0 turns the speaker off at all times. M1 is the default condition which allows the user to hear dial, ring, and connection. The M2 command causes the speaker to stay on at all times, which may be useful in debugging transmission problems. M3 allows you to monitor just the ring and connection process.

On Place modem in the on-line data mode

O0 — Modem returns to on-line state

O1 — Modem returns to on-line state and initiates an equalizer retrain sequence.

When connected to another modem, it may be necessary to go back into command mode (using + + +) to enter some command to the modem. After you complete the commands, an ATO or ATO1 command returns the modem to the on-line condition.

Note: Retraining is the ability of two 2400-bps modems to resynchronize themselves automatically or manually. The modems accomplish this by outputting an S1 signal sequence which consists of an unscrambled 0011 pattern. Depending on the parity/data bit configuration you are using at the time, the retrain patterns are displayed as question marks or up arrows.

Qn Enable/disable result codes

Q0 — Result codes sent (default)

Q1 — No result codes sent

The Q commands are used to enable or disable the sending of result codes (such as OK, CONNECT 2400, ERROR, etc.) to the computer. In the Q0 default mode, result codes are returned to the computer. In Q1 mode, no result codes are sent.

Vn Sets result code format

V0 — selects numeric result codes

V1 — selects verbal result codes (default)

Word Result Codes	Numeric Result Codes
OK	0
CONNECT	1
RING	2
NO CARRIER	3
ERROR	4
CONNECT 1200	5
NO DIAL TONE	6
BUSY	7
NO ANSWER	8
CONNECT 2400	10

Xn Select extended result code set

By using the X commands, you can enable and disable the following modem functions: NO DIAL TONE detect, BUSY detect, BLIND DIAL capability, and send only the CONNECT message after connecting. The table below specifies which functions are enabled, depending on which command is entered.

Function	X0	X1	X2	X3	X4
BUSY detected	No	No	No	Yes	Yes
DIAL TONE detected	No	No	Yes	No	Yes
CONNECT message only	Yes	No	No	No	No
BLIND DIAL enabled	Yes	Yes	No	Yes	No

Sending only the CONNECT message complies with Hayes SMART-MODEM 300 compatibility. When X1 through X4 are selected, the full range of CONNECT messages is displayed (CONNECT 2400 = 2400 bps connection, CONNECT 1200 = 1200 bps connection, and CONNECT = 300 bps connection). All CONNECT messages are sent at the data terminal's autobaud rate, while all subsequent data is sent at the connect data rate.

When blind dialing, the modem dials regardless of the presence or absence of a dial tone. The modem waits the number of seconds determined by register S6, which has a default of 2 seconds.

When X2 or X4 is enabled, the line is monitored for a dial tone instead of doing a blind dial. The dial tone must be present for at least 2 seconds. If there is not a dial tone (or not enough dial tone time) within 5 seconds, the call is cancelled, and the result code **NO DIAL TONE** is issued.

The **BUSY** message, when enabled, informs you that a busy signal was encountered during the dial process.

Z Reset the Modem

This command resets the modem to its default values and resets the user-changed registers to their original default setting.

Default Settings

Speed=2400 bps	Speaker enabled but off when receiving carrier
BELL 212A operation at 1200 bps	Ring count=0
Auto answer disabled	Escape code char=43
Command echo on	Carriage return char=13
All result codes enabled	Line feed char=10
Wait for dial tone before dialing	Back space char=8
Detects busy signal	Duration of wait time for dial tone =2 seconds
Full word result codes	Duration of wait time for carrier after dialing=30 seconds
Pulse dial make/break ratio=39/61	Duration of dial pause (comma) =2 seconds
Test timer set to 0 seconds	Escape code guard time=1 second
DCD follows carrier signal	
Modem ignores DTR	
CTS (Clear to Send) always on, RTS (Request to Send) ignored	
DSR always on	

&Cn Data-Carrier-Detect (DCD) control

&C0 — DCD always on

&C1 — DCD follows state of data carrier (default)

When $n=0$, the DCD line remains in the ON condition regardless of the state of the data carrier coming from the remote modem.

When $n=1$, DCD follows the state of the data carrier coming from the remote modem. When a data carrier is detected, DCD is on; otherwise DCD is off.

&Dn Data-Terminal-Ready (DTR) control

&D0 — The modem ignores DTR. (Default)

&D1 — The modem goes into command mode if an on-to-off transition is detected on DTR.

&D2 — When on-line with a host system, the modem goes on-hook and assumes command mode upon detecting an on-to-off transition on DTR. Auto answer does not function when DTR is off (low).

&D3 — An on-to-off transition on DTR causes the modem to go through an initialization sequence. Default values for all commands and S registers are re-instated.

The modem ignores any DTR transition that lasts for less than the value contained in register S25. The factory setting is 5/100 of a second.

&F Restore default configuration

The &F command restores the factory default values to all S registers. In the modem, the Z command and &F command are equivalent because there is no non-volatile memory storage.

&P Pulse dial make/break ratio select

&P0 — U.S. setting, 39% make/61% break (default)

&P1 — UK/Hong Kong setting, 33% make/67% break

This command determines the ratio of off-hook (make) to on-hook (break) intervals when pulse dialing.

&Sn Data-Set-Ready (DSR) control

&S0 — DSR always on (default)

&S1 — DSR operates in accordance with EIA RS-232C specifications

As soon as your modem detects carrier signal from the other modem, DSR is asserted. Later, as soon as the carrier is confirmed as valid, DCD (Carrier Detect) is asserted. Both are disasserted at the same time when the connection is broken.

Note: It is possible to get DSR asserted, but never establish DCD, resulting in a failed connection.

&Tn Test and Diagnostic commands

&T0 — Terminate any test in progress

&T1 — Initiate manual local analog loopback test

&T2-T7 — Not supported

&T8 — Initiate automatic local analog loopback test

When $n=0$, any test in progress is terminated. This may only be the last command in a command line.

When $n=1$, a manual local analog loopback test is initiated.

When $n=8$, an automatic local analog loopback test is initiated.

Registers

Registers are used to store the parameters that control communications. Each register has variables that determine how the modem operates or supplies information on the modem's current condition. The modem's registers and the default values are shown in the table below.

With the exception of the reserved and bit-mapped registers, you can read the current value of registers or assign a new value to match the registers to your particular environment by using the register command.

Table 5. Register Summary

Register	Range	Units	Default	Function
S0	0-255	Rings	0*	Defines the rings in answer mode
S1	0-255	Rings	00	Ring counter
S2	0-127	ASCII	43	Defines escape code character
S3	0-127	ASCII	13	Defines CR code character
S4	0-127	ASCII	10	Defines LF code character
S5	0-32, 127	ASCII	08	Defines BS code character
S6	2-255	Sec.	02	Defines dial tone wait time
S7	1-255	Sec.	30	Defines carrier wait time
S8	0-54	Sec.	02	Defines pause duration for comma
S9	1-255	1/10 sec.	06	Defines carrier detect response time
S10	1-255	1/10 sec.	14	Defines carrier loss time to hang up
S11	50-255	msec.	95	Defines tone dialing speed
S12	20-255	1/50 sec.	50	Escape code guard time
S13-S15	Reserved			
S16	None	Flags	00	Self-test options
S17	Reserved			

Register	Range	Units	Default	Function
S18	0-255	Sec.	00	Test timer
S19-S24	Reserved			
S25	0-255	1/100 sec.	05	Detect DTR change
S26	Reserved			
S27	None	Flags	64	Bit-mapped register

* When the modem is configured to power up in auto answer mode, S0 has the value of 1.

Note: Reserved registers and bit-mapped register are read only registers that should never be written. Do not use these registers to control the modem.

Writing to these registers may produce unpredictable results.

Command Syntax

S_n Read value stored in register S_n

where $n=0 \dots 27$ and specifies the register to be read.

This command causes the modem to read the value stored in one of the S registers and display it on the screen as a decimal number. For example, to check the value of register S0, type:

AT S0? **ENTER**

On the screen, you will see —

000
OK

You can also check the values of more than one register in the same command line. To check the values of register S0 and register S7, type:

AT S0? S7? **ENTER**

The screen might show:

000
030
OK

$S_n=r$ Store the value r in register S_n

where $n=0 \dots 27$ and specifies the register to which the value r is assigned, and $r=0 \dots 255$ and is the value to be stored in register S_n .

This command stores the value r in register S_n

Use this syntax to assign or change register values. To assign the value 3 to register S0, type:

AT S0=3 **ENTER**

After changing the value, the modem signals OK. Another syntax for changing a register value is:

AT S0 **ENTER**

Set the pointer to register S0.

AT ? **ENTER**

Read the value of S0.

AT=3 **ENTER**

Assign the new value 3 to S0.

Register Definitions

S0 Ring to Answer On

The value stored in register S0 determines how many incoming rings are required before the modem answers the phone. A value of 1 to 255 enables auto answer mode, and a value of 0 disables auto answer mode. The modem determines whether to power up with auto answer enabled or disabled by the jumper setting as described under auto answer operation in Appendix A. When the modem is set to power up with auto answer enabled, S0 has the value of 1. If it is powered up with auto answer disabled, S0 has the value of 0.

S1 Ring Count

The value of S1 is increased each time the modem detects an incoming ring signal. This register is cleared if no rings occur within about 8 seconds of the last ring.

S2 Escape Code Character

The value stored in this register determines the ASCII character which causes the modem to escape from on-line data mode back to command mode. A string of 3 escape characters followed by a carriage return is required to cause an escape.

The default value stored in this register is 43, which corresponds to an ASCII +. Enter a decimal number in the range 0 to 127. If you enter a value out of this range, the escape will not work. When the escape code is disabled, hangup can be achieved if the remote modem drops carrier or if an on-to-off transition is detected on DTR by the modem when &D1, &D2, or &D3 are in effect.

S3 Carriage Return Character

S3 holds the ASCII value of the carriage return character. The default value is 13.

S4 Line Feed Character

S4 holds the ASCII value of the line feed character. The character is output after the carriage return only when the word result code (V1) is supported. The default value is 10. You can redefine the value by entering a decimal number in the range 0 to 127.

S5 Backspace Character

S5 holds the ASCII value of the back space character. The default value is 8. The backspace character must not be set to a value corresponding to a printable ASCII character (between 33 and 126). If it is, the modem will ignore it. Select a value from 0-32 or 127.

S6 Wait for Dial Tone

The value in S6 determines how many seconds the modem waits after going off-hook before dialing the first digit. The delay is used to allow the central office time to detect the off-hook condition and send a dial tone. The default value is set at the minimum wait time of 2 seconds, which is regulated by the FCC. X0, X1, or X3 must be set before the new value in S6 is recognized.

S7 Wait-time for Carrier before Abort

The value stored in S7 determines how many seconds the modem waits for carrier signal from the remote modem after it has gone off-hook. The default value is 30 seconds. If the modem does not receive a carrier tone within the specified time, it hangs up and displays the result code **NO CARRIER**. The modem then returns to the command mode. To change the wait time, input the number of seconds in the range 1 to 255.

S8 Pause Time for Comma

Register S8 determines the duration of the dialing pause caused by detecting a , (comma) dial modifier in the dial string. The comma is usually used to wait for a second dial tone when dialing through a PBX or using a special telephone service. The default is 2 seconds, but you can change the value by entering the desired number of seconds in the range 0 to 54. Although you can input a value up to 255, the actual maximum value is 54.

S9 Carrier Detect Response Time

The value stored in this register determines the length of time it takes the modem to recognize an incoming carrier tone and sends the **CONNECT** result code. As the value increases, the possibility of detecting a false carrier from noise decreases. The default value of S9 is fixed at 6 with the unit of 1/10 second (0.6 seconds). To change this value, input the desired duration in the range 1 to 255.

Note: 2400-bps operation analyzes the incoming carrier and does not use the value stored in S9.

S10 Carrier Loss to Hang Up

Register S10 establishes the delay time between the detection of a loss of data carrier from the remote modem and the time when the modem disconnects. The default value is 14 with the unit of 1/10 second. Setting S10 to 255 causes the modem to ignore the carrier detect status and function as though a carrier were always present.

If S10 is set to a value smaller than the S9 carrier detect response time, any loss of carrier results in a disconnect, because the modem times out before the carrier detect response delay expires. The actual length of a momentary loss that can be tolerated is the difference between S10 and S9.

S11 Tone (DTMF) Dialing Speed

Register S11 holds the value which determines the length of duration for each DTMF digit in milliseconds and the silence interval between adjacent digits. The default is 95 milliseconds and can be changed in the range 50 to 255 milliseconds.

S12 Escape Code Guard Time

In the modem, the escape code guard time is defined as the time delay between the last character of the escape code (+ + +) and the next data character transmitted by your computer. The default value is 50 in the unit of 1/50 second (1 second).

Note: Be careful when you assign a small guard time. The guard time should be greater than the time required to transmit one of the three escape characters.

S13-S15 Reserved**S16 Modem Test Options**

Bit 0	Local Analog Loopback (See &T1)	0 — Disabled (default) 1 — Enabled
Bit 1-5	Reserved	
Bit 6	Local Analog Loopback L3 with self test. (See &T8)	0 — Disabled (default) 1 — Enabled
Bit 7	Reserved	

S17 Reserved

S18 Test Timer

Establishes the duration of the modem diagnostic routines. When a test has been active for a period of time equal to the value stored in register S18, the modem automatically cancels the test. Setting S18 to 0 disables the test timer (default). A test can be terminated from command mode at any time by issuing the &T0 command.

S19-S24 Reserved

S25 Detect DTR Change

A change in the state (on-to-off) of the Data Terminal Ready line which persists for less than the value contained in register S25 is ignored by the modem. Values for S25 range from 0 to 255 in the unit of 1/100 second, with the default being 5/100 of a second.

S26 Reserved

S27 Bit-Mapped Register

Bits 0-5,7 Reserved

Bit 6 Bell vs. CCITT 0 — CCITT V.22 at 1200 bps

(See B command) 1 — Bell 212A at 1200 bps (default)

The 2400-bps Half Card Modem originates a call by dialing a remote modem, using either pulse or tone dialing depending on the dial modifier (P or T) issued by the user. You can switch between pulse and tone in the middle of a dial sequence.

Dialing can be performed in one of two possible modes:

1. Call progress mode where the modem monitors the progress of the call.
2. Blind mode where the modem does not monitor the call progress signal after dialing is completed.

When you enter a dial command D, the modem places itself in originate mode unless reverse mode modifier R is specified. If reverse mode dialing is specified, the modem reconfigures itself in the answer mode when dialing is completed.

If call progress mode is enabled, the modem detects the presence of a dial tone before proceeding with the dialing of numbers. When call progress mode is disabled, the modem uses blind dialing in which the numbers are dialed without waiting for the presence of a dial tone. The modem is also capable of overriding its dialer, thus allowing manual dialing using an external telephone handset. After dialing, the modem waits for an answer tone from the remote modem.

Call Progress Dialing

Once the dialing command is entered, the modem places itself offhook and looks for the dial tone signal. It assumes pulse dialing (unless tone dialing is requested) and dials the entered number.

If a W is encountered while dialing numbers, the modem searches for another dial tone before proceeding with the remainder of the dialing sequence. When the dialing sequence is complete, the modem searches for a remote ring signal. If this signal is detected, it then searches for an answer carrier tone. The modem waits for an originate carrier tone if the reverse modem is selected. (See R command.)

When the carrier tone is detected, the modem is placed in the originate mode and completes the modem handshake sequence. The modem is then automatically placed in the data mode.

Blind Dialing

Blind dialing is similar to call progress dialing except that the call progress signals are disabled and ignored by the modem. Once offhook, the modem delays the dialing sequence by the time specified in status register S6 (wait for dial tone). If a + + + is encountered in the dialing sequence, it is ignored. To wait for a second dial tone (for PBX systems), insert a pause subcommand (,) between the numbers to be dialed. After the dialing sequence is completed, the modem searches for an answer tone. The remainder of the sequence is identical to the call progress dialing, described in the preceding section.

Auto-Answer Mode

When the auto-answer configuration is selected, the modem automatically answers the phone after n rings. The parameter n is set using the register syntax $Sr=n$. The value in status register S0 controls the number of rings that must occur before answering. After the telephone is answered, the modem waits two seconds (billing delay) during which the modem sends only an answer carrier tone to the originating modem and then proceeds with the call establishment handshake as specified by the respective protocol. After the handshake is completed, the modem sends a result code to your computer (unless disabled) and enters the data mode.

If the A command is used and status register S0 is set to 0, the modem answers the phone without waiting for a ring.

Data Call Termination

Connection may be terminated by either your computer or the remote modem in the following ways:

Data Terminal Ready	If &D2 is selected and the Data-Terminal-Ready (DTR) signal goes low for more than the time specified by register S25, the modem begins a disconnect sequence (except for certain test modes). The modem then returns to the command mode.
----------------------------	--

Carrier Loss	If the carrier signal is lost for more than the time specified by the register S10, the modem returns to the command mode. The telephone line is automatically disconnected and the modem goes onhook if the command mode is re-entered as a result of a carrier loss.
Abort	If the carrier signal is not detected within a specified time interval after dialing, the modem goes onhook and then returns to the command mode.

Handshake Protocol

Modem handshake protocols for Bell 103J, Bell 212A, V.22, and V.22 bis are specified by the respective Bell and CCITT recommendations. After the handshake sequence is complete, the modem automatically enters the data mode. An exception occurs if the modem has been given the command to return to the command mode after dialing.

Appendices

Information About the Telephone Line

To operate, your modem must be connected to a telephone line. Your modem is FCC registered for direct connection to the telephone line. Give your local telephone company the following information if they request it:

Registration:	AAO9YN-10077-MD-E
Ringer Equivalence:	0.8B

Please note that each product connected to the telephone line places a certain load on the line. We designate this as the unit's "Ringer Equivalence Number."

When using more than one product on the line, total all the ringer equivalence numbers. If they total more than five, your phone might not ring. In rural areas, a total of three might impair ringer operation. To be sure, check with your local telephone company.

Warning: This modem board must not be connected to coin-operated or party-line phones. Also, do not connect your modem to multiple-line telephones without an optional multiple-line controller.

Before Installing Your Modem

Before you start installing the modem into your computer, change the configuration of the modem if necessary.

Note: Whenever you are installing or removing circuit boards in your computer, make sure that the power is switched off. Never insert or remove the modem when the power is on.

Selecting a Com Port

Most computers allow two Com ports, Com 1 and 2, to identify the I/O address map for each serial device. The shorting connector CN4 is factory set to select Com 2. If you want to select Com 1, change the connector position as shown in Figure 1.

If your communications software allows you to select a Com port, be sure to select the same port as you set with CN4.

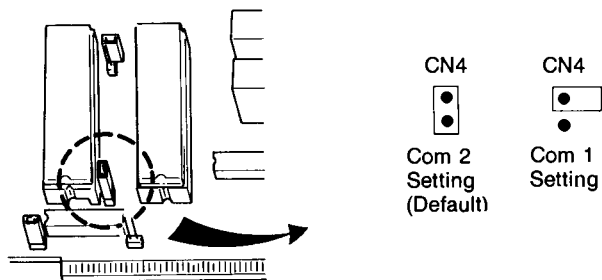


Figure 1. Com Port Setting

Selecting the Interrupt Signal

The interrupt signals IRQ3 and IRQ4 are used to inform the I/O condition of the modem to your computer. The modem is set to output IRQ3 through shorting connector CN6.

Note: The interrupt signal should match with the I/O port you have assigned for the modem. If you assigned Com 1, you must select IRQ4. If you assigned Com 2, select IRQ3.

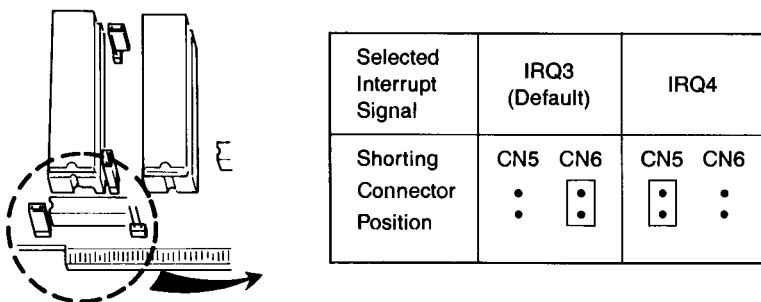


Figure 2. Interrupt Signal Setting

Multi-line Business Phone Connection

If you are planning to connect the modem to a 1A2 or similar type multi-line business phone, you have to change the position of shorting connector CN3. Insert the edge of pointed object into the base of the connector and lift up the socket to remove it. Then re-insert the socket to change the position as shown in Figure 3. This is necessary on some key systems to signal the local network that the line is in use (A-A1 signaling).

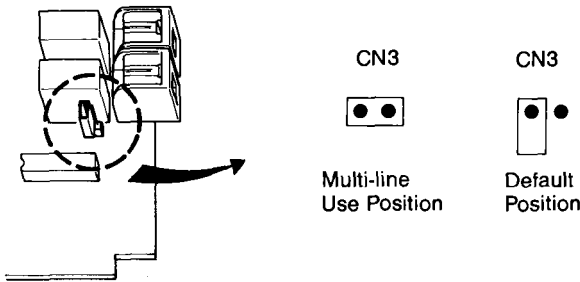


Figure 3. Multi-line Setting

Auto-Answer Operation

The shorting connector CN7 controls the auto-answer operation. It is set to auto-answer disable position since when the modem needs to share the phone line with people, it is better not to seize the line automatically when it rings. If the line is used only for data, you might want to set the modem for auto-answer by changing the position of the CN7 as shown in Figure 4.

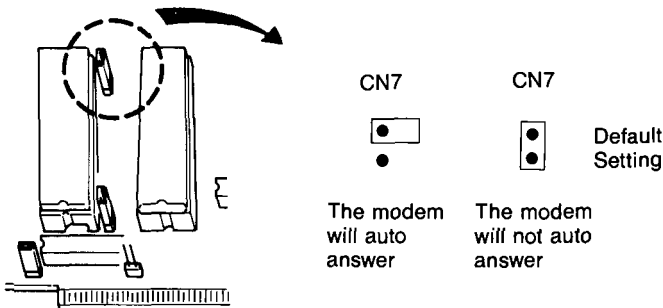


Figure 4. Auto-answer Selector

Installation in Your Computer

The modem is designed for easy installation in any compatible computer. Because of its small size, the modem will fit in both short and standard-length expansion slots.

1. Power to the computer must be turned off before proceeding with the rest of the installation. Refer to the computer owner's manual for information on turning off the computer.

Warning: To avoid static electricity buildup, which can destroy certain integrated circuits, touch a grounded metal object (such as the computer chassis) while handling any circuit board. Do not stand on a carpeted floor while installing this board.

2. After the computer is turned off, remove the screws securing the computer's cover, and slide the cover to open the computer. Save these screws so that you can replace the computer's cover at the end of installation. Refer to the computer owner's manual for more information on removing the computer's cover.
3. The modem board fits in a half-card expansion slot, but it may be installed into a full-card slot if desired. Decide which expansion slot you want to install your modem in. To remove the expansion slot's rear panel blank card bracket, remove its fastening screw and lift the bracket straight up. Save the screw for attaching the modem board later.

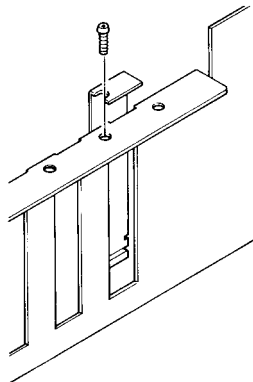


Figure 5. Blank Card Removal

4. Plug the modem board into the empty expansion slot. Then, fasten the board to the computer using the screw that was removed from the blank card bracket.

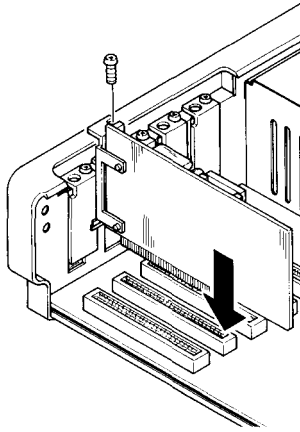


Figure 6. Modem Board Installation

5. Replace the computer's cover, securing it with the screws previously removed.
6. There are two modular phone connectors on the modem. Connect one end of the modular phone cable supplied with the modem to either of these two jacks. These jacks are identical; it does not matter which one you use.

Connect the other end of this modular cable to the phone jack on your wall.

Note: You can connect your standard telephone to the second jack on the back of the modem. This jack is provided for your convenience so that you can continue to use your telephone normally. As long as you leave your modem and phone connected, you can continue to use your telephone even when your computer is turned off.

Now turn on the computer.

Communications Software Execution

Communication software is required for communication to the modem. The AT command set requires that the computer functions as a dumb terminal to communicate with the modem. Although the computer acts like a CRT data terminal, it must be specifically programmed by basic data communications software to operate like a dumb terminal. This involves sending data entered from the keyboard to Com (communications port) 1 or Com 2 of the modem and displaying the data received from that communications port on the screen. Most communications software packages available go well beyond this point. These packages are usually capable of sending data to the communications port from a file and accepting data into a file. They may also be able to reconfigure the data speed and format.

Some of the communications software packages available today are CROSSTALK XVI, SMARTCOM II, and QMODEM.

For execution of the communications software, perform the following:

1. Verify that the system is started up and running properly.
2. Execute the communications software (CROSSTALK XVI, SMARTCOM II, QMODEM, or equivalent).
3. Verify that the communications software is configured to talk to the port you selected. Refer to the communications software manual for more information.

Installation Testing

After the modem is installed in the computer and power is turned on, the computer is automatically reset.

Type ATZ. The modem responds with OK.

Type AT&T1 to enable the analog loopback test of the modem. Type any desired pattern at the keyboard. The modem echoes the pattern back to the monitor. This test lets you know that the modem is correctly connected and that the computer and the modem can communicate with one another.

To end the test, follow the escape sequence by typing + + + and then wait one second. The modem responds with OK. Type AT&T0. The modem responds with OK again. Now you are ready for normal modem operation.

Common Communications Errors

If the data entered at the keyboard during the test is not displayed on the monitor without errors, re-enter ATZ. Two common causes for the errors are:

1. More than one piece of hardware is assigned to the same communications port address or the communications software is not configured to the same port set on the modem. This can be corrected by making certain that no other board installed in the computer has the same port address as the modem board.
2. Some communications software may have automatic echo enabled. In this case, the display to the monitor is duplicated. (If A is entered at the keyboard, the monitor displays AA .) This can be corrected by turning off the automatic echo of the communications software.

Communication Modes

Your modem communicates with your computer in either the command mode or the data mode (on-line mode). The modem controls the switching between the two modes. The status of the modem is displayed in result codes.

Command Mode

At power up, the modem enters the command mode and configures itself in the default configuration. The modem then enters the autobaud routine and waits for the attention code AT from your computer.

In the command mode, you can communicate with the modem via the computer. The command mode is used for modem configuration or dialing. The modem executes local commands from your computer and returns the result codes. After the autodialing and modem handshake sequences are completed, the modem enters the data mode, unless otherwise specified by the dial modifier.

Data Mode (On-line Mode)

In the data mode, the modem receives data from the computer and processes the data before transmitting it to the telephone line. The modem also checks the data from the computer for an escape code sequence. It does not execute any local commands in the data mode. The modem returns to the command mode only when it receives an escape code sequence from the computer, or one of the data call termination procedures described in Chapter 3.

Mode Control

At power up, the modem is in the command mode. The modem can enter the data mode while connected to another modem or when using diagnostics. The escape code is used to return to the command mode. To return to the data mode again, the ATO (on-line) command is used.

The escape code character is defined by the value set in register S2, and escape code guard time is defined by register S12. The escape code guard time is the time delay between the last character of the escape code transmitted and the next data character. The default guard time is one second and the default escape code character is +. The escape code character must be entered three consecutive times. To execute the escape code:

1. Type + + +.
2. Wait one second before transmitting another command character.

The modem returns to the command mode and sends the result code OK. The telephone line connection is retained. The connection is aborted automatically if the carrier signal from the remote modem is lost.

If the modem is forced into the command mode from the data mode using the escape sequence, the ATO (on-line) command can be used to return to the data mode. The modem can be reconfigured to the default state by executing the reset command ATZ.

Result Codes

Result codes are the responses to commands that have been executed. Result codes may be selected as English words or numeric digits. Word result codes are followed by a carriage return/line feed sequence; numeric result codes are followed by a carriage return only. Table 6 lists the result codes.

Table 6. Result Codes

Numeric Code	Word Code	Result
0	OK	Command executed without error.
1	CONNECT	Carrier detected (300 bps or 1200 bps if X0 is set).
2	RING	Phone is ringing.
3	NO CARRIER	Carrier lost or never detected.

Numeric Code	Word Code	Result
4	ERROR	Error in command line, line too long, or invalid character format.
5	CONNECT 1200	Carrier detected at 1200 bps if X1 set.
6	NO DIAL TONE	No dial tone is detected within 5 seconds and X2 or X4 is set.
7	BUSY	Busy signal is detected and X3 or X4 is set.
8	NO ANSWER	Displayed when "@" dial modifier used and phone continues to ring.
10	CONNECT 2400	Carrier detected at 2400 bps. X1 or X4 must be set.

Notes

- V0 and V1 are the modem commands that determine whether the modem is to render numeric or word result codes, respectively.
- The Q command determines whether or not results are sent.
- Another command related to the result code is the X command. Depending on the selected value of this command, the result code that appears will vary.
- RING only indicates that the phone is ringing. The modem does not answer it unless commanded to or unless auto-answer is enabled.
- NO CARRIER is displayed if the carrier signal from the other modem is not detected for a sufficient length of time. NO CARRIER means that a data call was not successfully completed.

Data Transmission Rate

Your modem transmits and receives data at the rate specified by the Table 7. The transmission rate is determined at the time of connection by four factors: The data rate of the data terminal connected to the modem, the speed and standard of the remote modem, the quality of the connection, and whether or not your modem is answering or originating the call.

The originating modem normally determines the baud rate that you use. But, if the line quality is such that the modem sees errors at 2400 bps, it falls back to 1200 bps operation. The fallback stops here. The modem does not try to fall back to 300 bps.

Be careful when communicating over telephone lines that are very noisy (pops and clicks are present when you talk on the line). Your computer might not realize that a baud rate change has taken place. Using the original baud rate that was used to wake it up, the modem informs you that it changed the baud rate.

For example, assume you tell the modem to make a call at 2400 bps to a local service. Upon answering, the modems determine that the line is too noisy to communicate at 2400 bps, so they connect up at 1200 bps. Your modem tells you "CONNECT 1200" if you have selected the X1 to X4 (default) command. However if you have changed the command to X0, the modem simply says "CONNECT." This message does not inform you of the baud rate change.

Table 7. Data Transmission Rate

Originating 2400-bps Half Card Modem	Answering Modem			
	BELL 103 300	BELL 212 1200	V.22 1200	V.22 bis 2400
BELL 300	300	300	300	300
BELL 1200	1200*	1200	1200	1200
CCITT 1200	1200*	1200	1200	1200
CCITT 2400	2400*	1200	1200	2400
Answering 2400-bps Half Card Modem	Originating Modem			
	BELL 103 300	BELL 212 1200	V.22 1200	V.22 bis 2400
BELL 300	300	1200	1200	2400
BELL 1200	300	1200	1200	2400
CCITT 1200	300*	1200	1200	2400
CCITT 2400	300*	1200	1200	2400

* The connect rate shown results when a 2400-bps Half Card Modem calls another 2400-bps Half Card Modem. The connect rate may differ when a 2400-bps Half Card Modem is connecting with a different type of modem.

Troubleshooting C

When you have problems transmitting data (garbled data, intermittent errors, etc.), there are a few checks you can make;

- Phone connection is clean and noise-free.
- No one is talking on the telephone line.
- Phone and all extensions are on the hook
- Operation speed is correct for the modem you are using and the modem with which you are communicating.

If you still cannot transmit data, disconnect your modem to see if the phone line is operating correctly. If it is, the trouble is probably in your modem. Take it to a Radio Shack serviced technician for further testing and/or repair.

Note: It is very unlikely . . . but if your modem causes problems on the phone line, the telephone company has the right to temporarily discontinue your service. If this happens, the telephone company will notify you and give you a chance to have the problem corrected. Also, the telephone company has the right to make changes in their lines and/or equipment. If these changes affect your modem or require changes in its connection, the phone company will notify you in writing so that you can take the necessary steps to ensure uninterrupted service.

Lightning. Your modem has built-in protection circuits that meet or exceed FCC requirements to reduce risk of damage from surges in telephone line current. However, an incident such as a lightning strike near, or directly to, the telephone line might cause an excessive surge of voltage that can damage the phone device.

Lightning damage is uncommon, but it can occur to phones and other electronic devices. If you are concerned about it or live in an area with frequent and/or severe electrical storms, we suggest that you unplug electronic products during storms.

Diagnostics

The modem incorporates diagnostic capabilities. Test patterns for the analog loopback may be generated by either the modem itself or the computer. Conditions for the diagnostic tests are set by changing the contents of status register S16. The modem does not respond to an incoming call while in the diagnostic mode.

In the analog loopback mode, the analog transmitter of the local modem is routed to its receiver. The test pattern sent by the computer or modem is modulated and transmitted back to its own receiver where it is demodulated before sending to the computer. Since the modem never goes off-hook during this operation, no data is transmitted over the phone lines.

Specifications **D**

Modem Compatibility:	Bell 212A at 1200, 300 bps. Bell 103, 113 at 300 bps. V.22 bis at 2400 bps.
Dialer Compatibility:	Industry standard "AT" command set.
Modem Data Rates:	2400, 1200, and 300 bps.
Speed Selection:	
Originate Mode:	Automatic on attention character.
Answer Mode:	Automatically set to speed of incoming call.
Operating Modes:	Automatic operation.
Test Modes:	Analog (local) loopback (both initiate and respond). Software command controlled.
Receiver Sensitivity:	-45 dBm
Transmit Level:	-16 dBm
Tone Dial Level:	0 dBm
Line Impedance:	600 ohms
Ringer Equivalence:	0.8B
Modulation:	
300 bps:	Frequency shift keyed (FSK).
1200 bps:	Differential phase shift keyed (DPSK).
2400 bps:	16 point quadrature amplitude modulation/Phase shift keyed (QAM/PSK).

Specifications

Data Formats:	8 bit, no parity; 7 bit even, odd, mark or space parity.
Dialing:	
Pulse:	Rotary (10 pps)
Tone:	Including * and #, duration 70 ms (adjustable)
Command Buffer:	40 characters.
Speaker:	Normally on during dialing; can be turned off by command.
Technology:	Low power CMOS circuitry utilizes proprietary LSI modem circuits, 70A2400 microprocessor. Control program: 4K bytes.

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Notes

SERVICE POLICY

Radio Shack's nationwide network of service facilities provides quick, convenient, and reliable repair services for all of its computer products, in most instances. Warranty service will be performed in accordance with Radio Shack's Limited Warranty. Non-warranty service will be provided at reasonable parts and labor costs.

