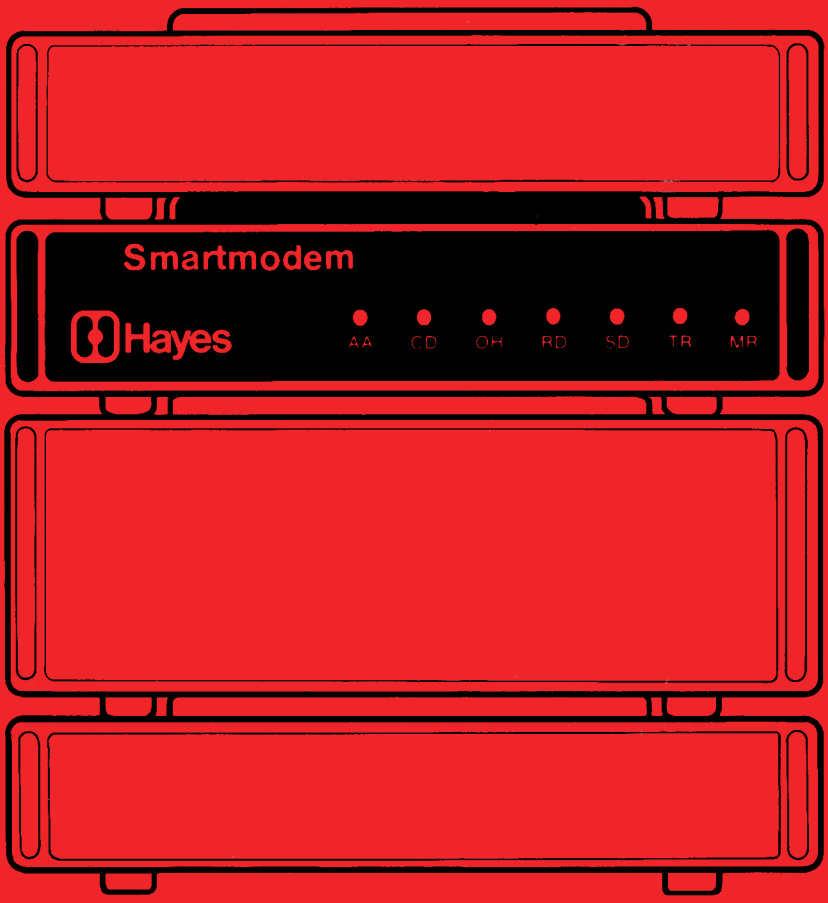
Hayes
Stack

Smartmodem



Owner's Manual

HAYES STACK SMARTMODEM
OWNER'S MANUAL

Hayes Microcomputer Products, Inc.

NOTICE

Hayes Microcomputer Products, Inc. reserves the right to make improvements in the product described in this manual at any time and without notice.

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Chapter 1
INTRODUCTION

DESCRIPTION

The Hayes Stack Smartmodem is a complete high-performance communications system for small computers. It is designed for use with RS-232C compatible computers and terminals to permit communication over the telephone lines with other computers or time-sharing systems.

A unique feature is that the Smartmodem can be program controlled in any language by ASCII character strings.

This intelligent datacomm system analyzes and executes commands and in response sends result codes which, at the user's option, can be English words or decimal digits. Commands may be user-entered via a terminal keyboard or issued under program control.

There are unique "Set" commands that allow the user to select (and change) various operational parameters such as dialing speed, how long to wait for a dial tone before beginning to dial a number, and number of rings to answer on.

The Smartmodem can be used to automatically call and communicate with time-sharing systems and other computers or to automatically answer incoming calls from distant systems. A special design feature is that all circuitry required for auto-answering and auto-dialing is built into the unit. This eliminates the need for any auxiliary equipment and makes the Smartmodem a stand-alone system.

The Smartmodem is approved by the FCC for direct connection to the telephone lines. Since it is a direct-connect device, the losses and distortions associated with acoustic couplers are eliminated.

Unlike most modems, the Hayes Stack Smartmodem can be connected to any telephone system in the United States since either Touch-Tone* or pulse dialing can be used. Furthermore, Touch-Tone and pulse dialing can be combined within a command, with pulse being used, for example, to access a PBX board and Touch-Tone for dialing an outside number after the second dial tone is received.

An audio monitor within the Smartmodem permits the user to follow the progress of the call and be alerted to wrong numbers and busy signals. If a busy signal is encountered, the user can enter a repeat command and the Smartmodem automatically redials the last phone number entered.

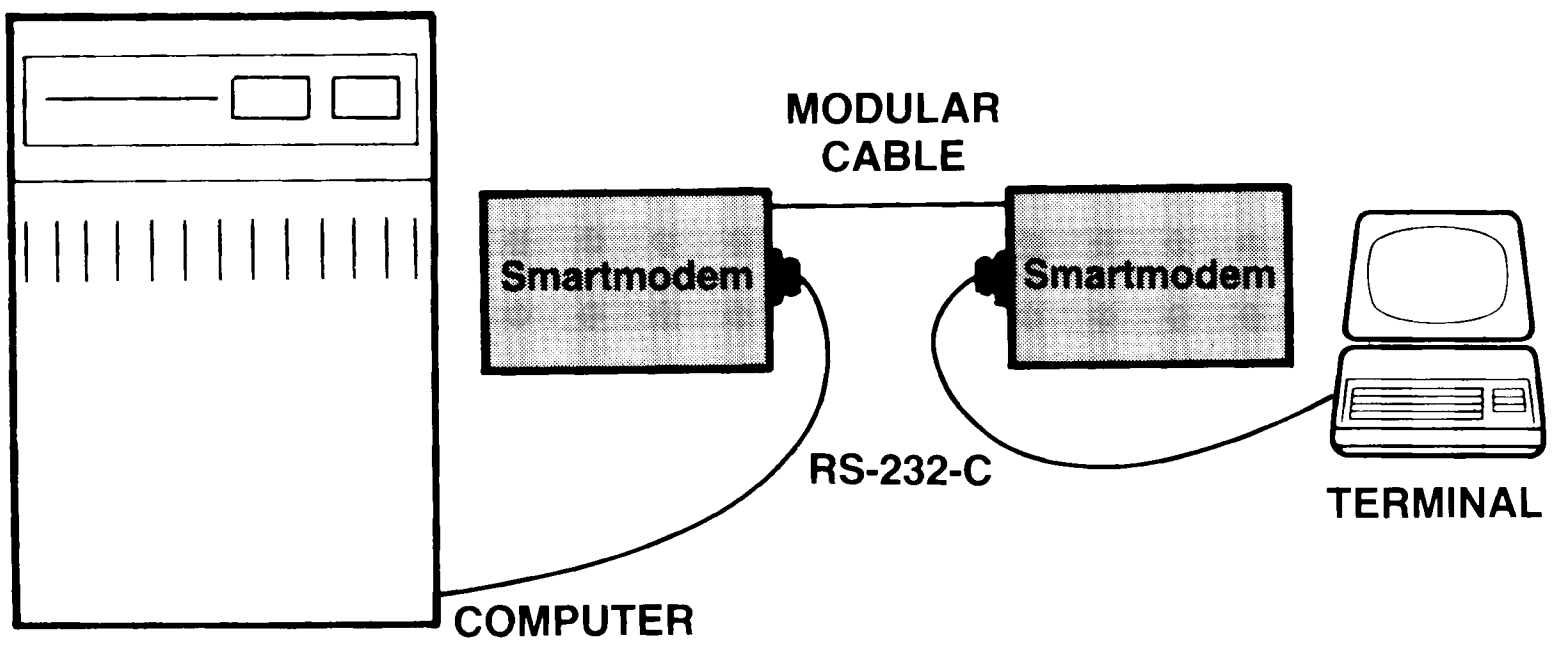
The Smartmodem is completely compatible with Bell 1Ø3-type modems. Operation can be in full- or half-duplex with a data rate of Ø-3ØØ baud. Power-on default options are controlled by the positioning of seven configuration switches. Four of these configurations can be overridden by software commands that are user-entered or issued under program control. LED status indicators on the front panel of the unit provide a visual check of the Smartmodem's operational status.

The Smartmodem datacomm system consists of the Smartmodem unit, a modular telephone cable and a power pack. Installation is a simple three-step process that involves plugging in the telephone cable and power pack and connecting your system's RS-232C interface cable to the RS-232C connector installed on the back panel of the Smartmodem.

The Smartmodem can be used in three operational modes, i.e., connection to a terminal, computer, or receive-only device.

Although the Smartmodem is an intelligent system, there are just some things it was not designed to do:

1) The Smartmodem will not and cannot be modified to operate at speeds higher than 3ØØ baud.
2) The Smartmodem cannot detect dial tones and distant busy or ringing signals, therefore, it cannot tell if the call it made was answered unless it connects with another modem.
3) Commands given to the Smartmodem must be ASCII coded at baud rates between 11Ø baud and 12ØØ baud. Once "on-line" any code at any speed from Ø to 3ØØ baud may be used.
4) Two Smartmodems cannot be connected back to back (RS-232C to RS-232C) even with a cross-over cable. They can be directly connected with a modular cable as shown below.



5) The monitor speaker only allows you to monitor the progress of a call. You cannot talk back if a person answers. It is not a speaker phone.

HOW TO USE THIS MANUAL

This manual provides complete installation and operation procedures for Smartmodem owners. It does not include technical information about the construction or design of the equipment. The material in this manual is organized so that you only have to do a minimum amount of reading before you begin using your Smartmodem. You certainly do not have to (nor is it expected that you will) read this manual from cover to cover before starting operation. In fact, as is explained here, there are some chapters that many users may never reference — except out of curiosity.

Chapter 2, Installation, should be read by everyone. In addition, it is recommended that all users read Chapters 3 and 4. Then depending upon whether you want to initially use your Smartmodem for dialing or answering proceed to Chapter 5 or 6.

Chapter 2 contains all pertinent FCC-related information, including the notification procedures that must be followed before connecting your Smartmodem to the phone lines. The remainder of this chapter gives you step-by-step installation instructions and a general introduction to the functions of the various design features of the Smartmodem.

Chapter 3 introduces you to the two major functional states – i.e., local command and on-line — in which the Smartmodem operates. This background information explains what your Smartmodem does in each functional state and how you can force it to move from one state to the other.

Chapter 4 provides you with guidelines to follow in sending commands to the Smartmodem. Also introduced are the result codes which the Smartmodem sends in response to your commands.

Now with your Smartmodem installed and with the background information gained from Chapters 3 and 4 you are ready to put your Smartmodem to work.

Chapter 5 is a stand-alone chapter that gives complete instructions for executing dialing commands/operations. If you are only interested in auto-answering, skip Chapter 5 and go to Chapter 6.

Chapter 6 is also a stand-alone chapter, but information contained here provides you with complete instructions for utilizing the auto-answering capability of the Smartmodem.

Chapter 7 lists and defines all commands that can be used with the Smartmodem. Of course, by the time you have finished Chapters 2-6 you will already be familiar with the most frequently used commands. Don't let the size of this chapter fool you; some of the commands listed you will rarely, if ever, use. In fact, most users will probably, at least initially, only use this chapter

as a reference in changing values assigned to the Set registers or operational parameters, e.g., full-duplex to half-duplex. As you become more adventuresome, however, you may want to experiment with some of these other commands just to see what other capabilities your Smartmodem has.

Chapter 8 gives more detailed information on the configuration switches and various settings for these switches. In Chapter 2 you are introduced to the configuration switches and the factory setting for these switches. With the switches in the factory setting the Smartmodem will function effectively whether it is connected to a computer, terminal or printer. So, you may want to skip Chapter 8. However, if you are interested in learning more about these switches and possible alternate settings, then you will find the facts in Chapter 8.

Chapter 9 is specifically for users who plan to utilize the Smartmodem under program control. Since the Smartmodem can be program controlled in any language, specific programs are not included in this manual because requirements differ with each type of computer. This chapter does, however, provide you with specific programming considerations that will assist you in program development.

Chapter 10, Background Information, is included to give you a brief history of the development of modems.

The appendices to this manual contain supplementary information and notes on some special applications. The applications included are:

- Local Network with Two Smartmodems, Appendix F;
- Monitoring a Low Speed Data Line, Appendix G;
- Amateur Radio, Appendix H.

*Trademark of American Telephone and Telegraph.

Chapter 2
INSTALLATION

This chapter contains the information necessary to get your Smartmodem ready for use. Instructions for notifying the telephone company and pertinent FCC-related information are presented.

Step-by-step installation instructions are provided with illustrations to assist you in this three-step process. Combined with the installation instructions are brief descriptions of the various design features of the Smartmodem. The intent is that when you have completed this chapter, you will not only have your Smartmodem installed, but will also be generally familiar with the function of each component.

FCC REGISTRATION

The Hayes Stack Smartmodem system is registered with the Federal Communications Commission (FCC) which places three restrictions on its use:

- The Smartmodem cannot be connected to a party line or pay telephone.
- The telephone company must be notified that an FCC registered device is being installed.
- Hayes Microcomputer Products must make any necessary repairs to the Smartmodem in order to maintain valid FCC registration.
- If you experience trouble with your telephone during or after installation, disconnect the Smartmodem to determine if it is causing the difficulty. For further details on what to do if the Smartmodem appears to be the cause see the Precautions section in this chapter.

NOTIFYING THE TELEPHONE COMPANY

The telephone company will need the following information before the Smartmodem is installed:

- The telephone number to which it is to be connected.
- The FCC registration number which is:

BFJ9D9-68737-DME

- The ringer equivalence: Ø.4B.
- The Smartmodem needs to be connected to one of the following standard modular jacks:

USOC-RJ11W	USOC-RJ11C
USOC-RJ12W	USOC-RJ12C
USOC-RJ13W	USOC-RJ13C

If you plan to connect the Smartmodem to several different telephone lines, give the telephone company a list of the numbers. This avoids having to notify them each time the Smartmodem is moved. The telephone company must also be notified when the Smartmodem is permanently removed from a

telephone line. If the local telephone company has questions, refer them to Hayes Microcomputer Products, Inc., Norcross, Georgia.

PARTS

In addition to this manual, the Hayes Stack Smartmodem data communications system consists of three parts (see Figure 1):

1. Smartmodem unit
2. Power Pack
3. One modular telephone cable to connect the Smartmodem to the telephone line.

Remove each part from the molded container and check to make certain the Smartmodem system is complete and undamaged.

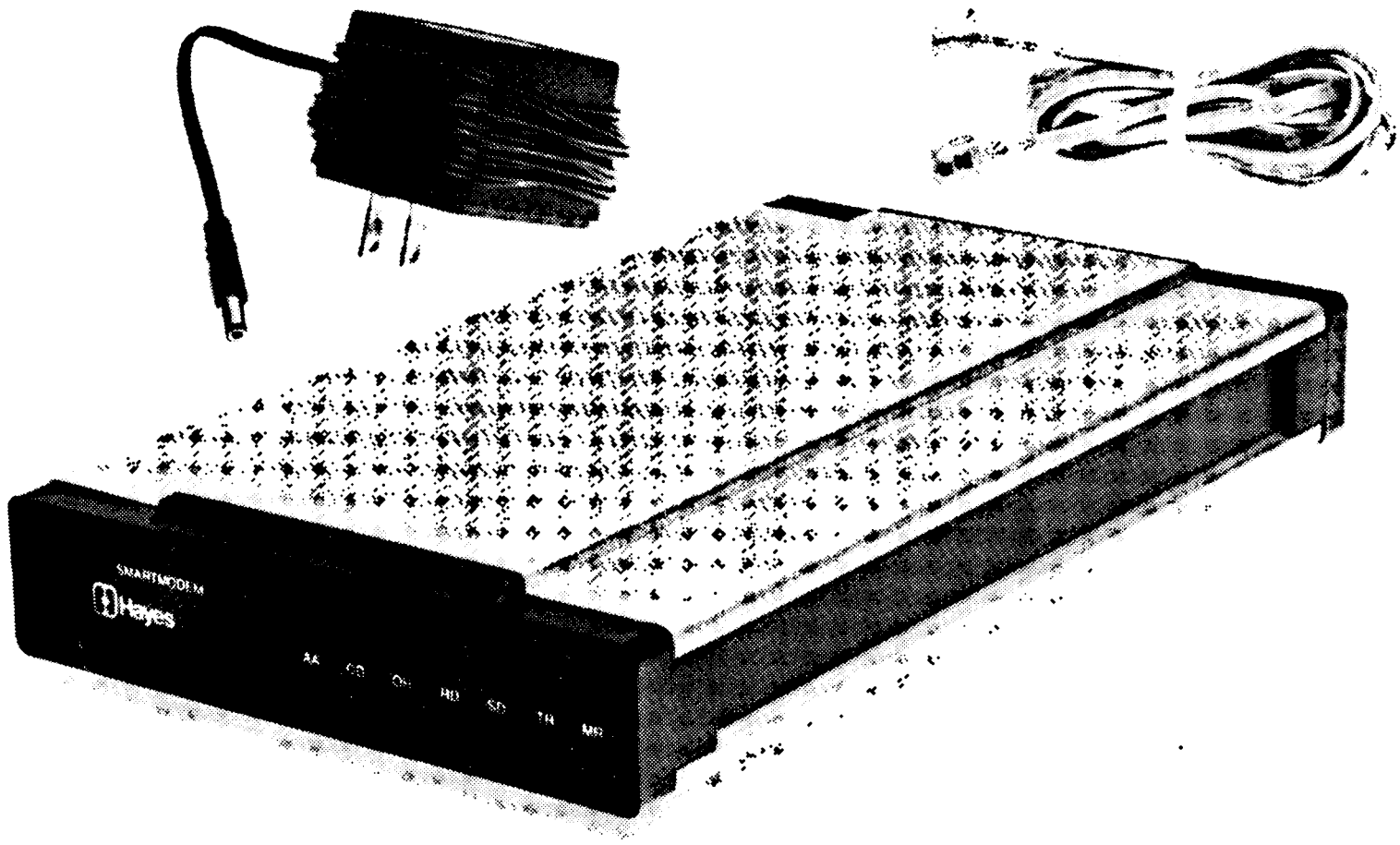


Figure 1
Smartmodem System Parts

NOTE: If you are connecting the Smartmodem to a computer, you will need an RS-232C serial port, an RS-232C cable with a DB-25 connector and software that will permit an interface between the computer and the Smartmodem. If your computer does not have this equipment, consult your computer reference manual or your computer dealer and obtain the appropriate RS-232C equipment and software. Install the RS-232C equipment and software according to the instructions provided in your computer reference manual or provided by your dealer.

NOTE: If the device (computer, terminal or printer) to which the Smartmodem is to be connected does not have a DB-25 connector, it will be necessary to obtain an adapter that will permit connection with the DB-25 female connector installed on the back panel of the Smartmodem. This is required to set up the RS-232C connection.

CHECK POWER SWITCH

Examine the back panel of the Smartmodem unit and consult Figure 2 for identification of the connectors, power switch and volume control.

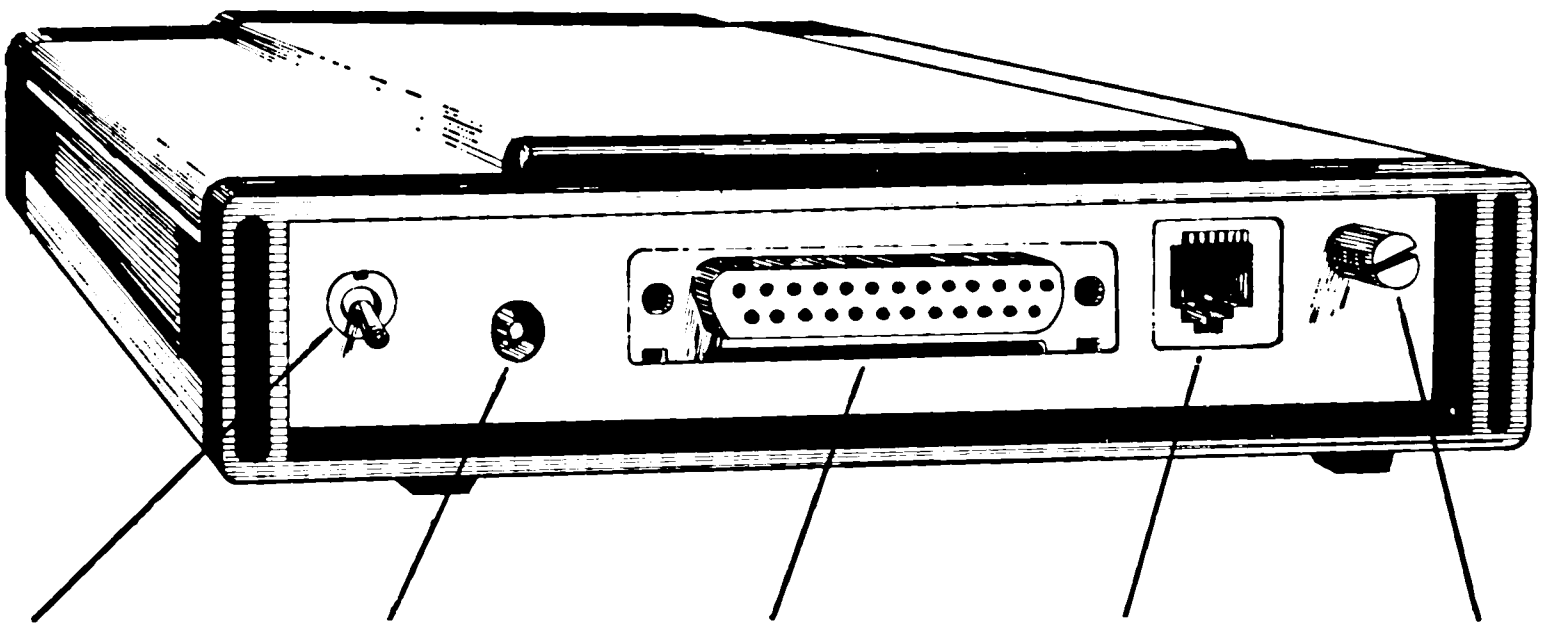


Figure 2
Smartmodem Back Panel

There is only one toggle power switch located on the back panel of the Smartmodem. BEFORE PROCEEDING WITH THIS INSTALLATION, BE CERTAIN THE SMARTMODEM POWER SWITCH IS TURNED OFF (i.e., DOWN POSITION) AND POWER TO YOUR COMPUTER, TERMINAL OR PRINTER IS OFF.

VOLUME CONTROL KNOB

The Volume Control knob allows you to control the volume from the audio monitor or speaker installed in the Smartmodem. For example, when the Smartmodem is used for automatic dialing, the audio monitor allows you to listen to the progress of the call. You will hear the number being dialed; the phone ring; and a busy signal, if one is given.

When the Volume Control knob is turned completely counterclockwise, volume is off. For initial setting it is suggested that this control knob be turned slightly clockwise. Then during actual operation, adjust the volume to the desired level or turn it off.

CONNECTING TO THE PHONE LINE

After the telephone company has been notified according to the instructions previously specified, follow this procedure to connect the Smartmodem to the phone line.

With the gold contacts up, plug one end of the modular telephone cable into the phone connection on the back panel of the Smartmodem. The cable will slide in easily and snap in place when the connection is made.

Next, plug the remaining end of the telephone cable into a telephone wall jack just as you would a modular telephone.

If you are making a single line connection, the cable must be inserted in an RJ11C or RJ11W wall jack; any other connection for single line phone installations could cause trouble with the phone lines or damage the Smartmodem.

If the installation is for multiple key line installations the cable must be connected to an RJ12W, RJ12C, RJ13W or RJ13C phone jack. Detailed explanations of this procedure are usually found in the information pages in the front of the telephone book. Appendix B of this manual contains diagrams of the modular phone jack connections.

RS-232C CONNECTION

NOTE: No wiring changes are required if you are connecting your Smartmodem to a terminal or to a computer that is wired as DTE (Data Terminal Equipment). (If you are not certain how your equipment is wired, check the manual supplied by the manufacturer of the equipment or contact your computer dealer.) If your computer is wired as DCE (Data Communications Equipment), you must first make the following adjustments:

1. *Use only pins 2, 3 and 7 for the RS-232C interface.*
2. *Reverse pins 2 and 3 in the RS-232C connector.*

Now to make the RS-232C connection from your computer, terminal or printer to the Smartmodem, insert the male DB-25-P connector in the DB-25-S female connector located on the back panel of the Smartmodem. This connection can only be made one way: if the connector does not fit, turn it upside down and insert in the female DB-25-S connector. Connect the other end of the RS-232C cable to your terminal, computer or printer.

Consult Appendix A in this manual for interface connector pin assignments.

CONFIGURATION SWITCHES

The setting of the configuration switches establishes the operating parameters for the Smartmodem *whenever* power is turned on, i.e., how the Smartmodem will operate from a "cold start."

Once power is turned on, many of these operating parameters, or default values, can be overridden by commands to the Smartmodem. Note, however, if power is turned off and then on, or if the Smartmodem is sent a reset command, the Smartmodem will revert to the operating parameters established by the switch settings. You will find out more about this as it relates to dialing, Chapter 5; auto-answer, Chapter 6; and all commands, Chapter 7.

The configuration switches are located behind the front panel of the Smartmodem. To reach the configuration switches, you must remove the end cap from the front panel. (Note that the end cap fits snugly into the front panel.) Firmly hold or support the unit and carefully remove the end cap according to the following procedures.

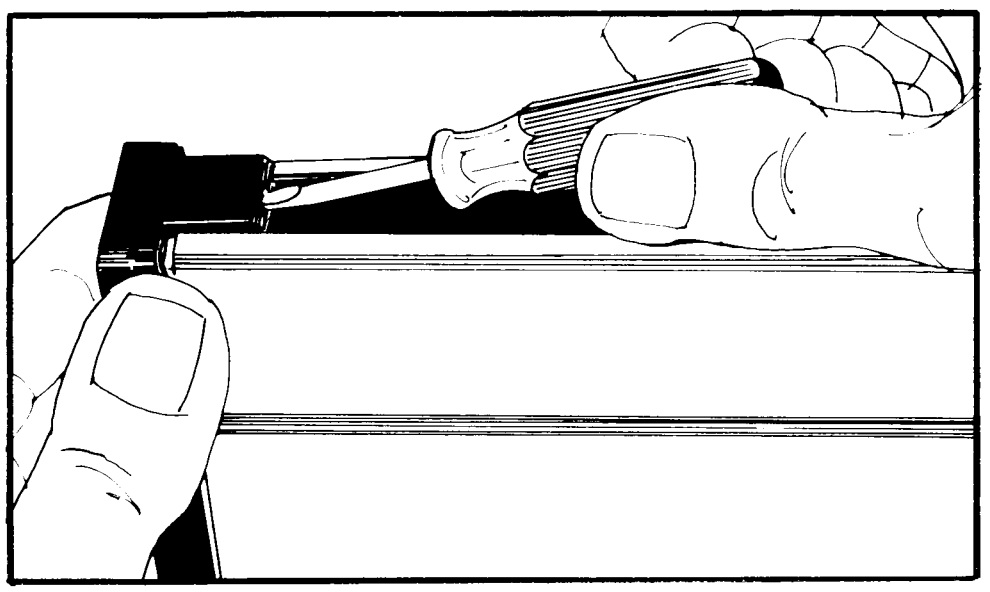


Figure 3a

Insert the tip of a small tool in the notch as shown above. Twist slightly to release the end cap.

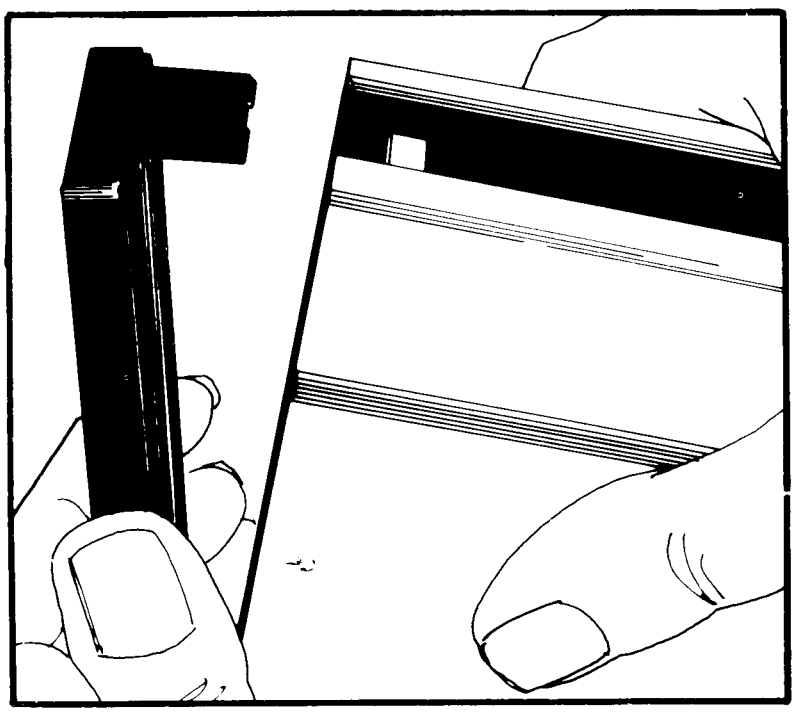


Figure 3b

Carefully remove the end cap from the Smartmodem.

The configuration switches are numbered 1 through 8 (switch 8 is not used and its setting does not matter).

The factory setting for the configuration switches and the functions established by these settings are defined in Table 1. (Note that the position of the switches is defined as being either UP or DOWN.) Check the position of the configuration switches on your Smartmodem and make any adjustments necessary to have the settings correspond to the factory setting in Table 1 and illustrated in Figure 4.

TABLE 1
CONFIGURATION SWITCHES

SWITCH NO.	FACTORY SETTING	FUNCTION
1	DOWN	Enables Smartmodem to execute commands by providing signal that the data terminal is ready to receive or send data.
2	UP	Smartmodem responds to commands with verbose (English words) result codes.
3	DOWN	Result codes are sent by Smartmodem to your terminal or computer.
4	UP	Smartmodem will echo characters while in the command state. That is, commands you send to the Smartmodem will be sent back (echoed) to your terminal screen.
5	DOWN	Smartmodem will *not* automatically answer the phone when it rings.
6	DOWN	Forces computer to accept locally echoed characters and result codes from Smartmodem.
7	UP	Setting used for connection to an RJ11 modular telephone jack (single line connection).
8	DOES NOT MATTER	Switch not used.

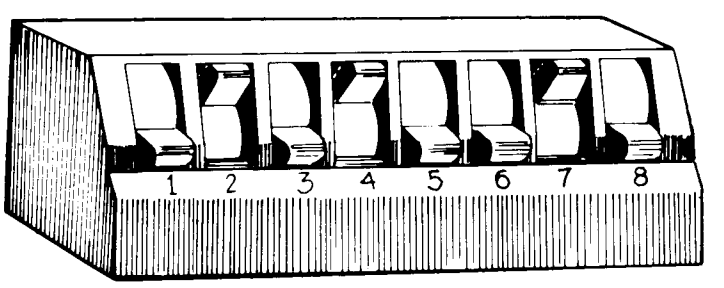


Figure 4
Configuration Switches

The Smartmodem will function effectively in any of the operational modes (i.e., with a terminal, computer or printer) when the configuration switches are positioned according to the factory setting shown in Table 1. (For more information on the configuration switches and typical settings for various modes of operation, see Chapter 8.)

When the positions of the configuration switches have been checked and are in the factory setting, carefully replace the end cap on the front panel of the Smartmodem.

LED INDICATOR LIGHTS

The front panel of the Smartmodem contains seven indicator lights that visually identify the status of the Smartmodem (see Figure 5).

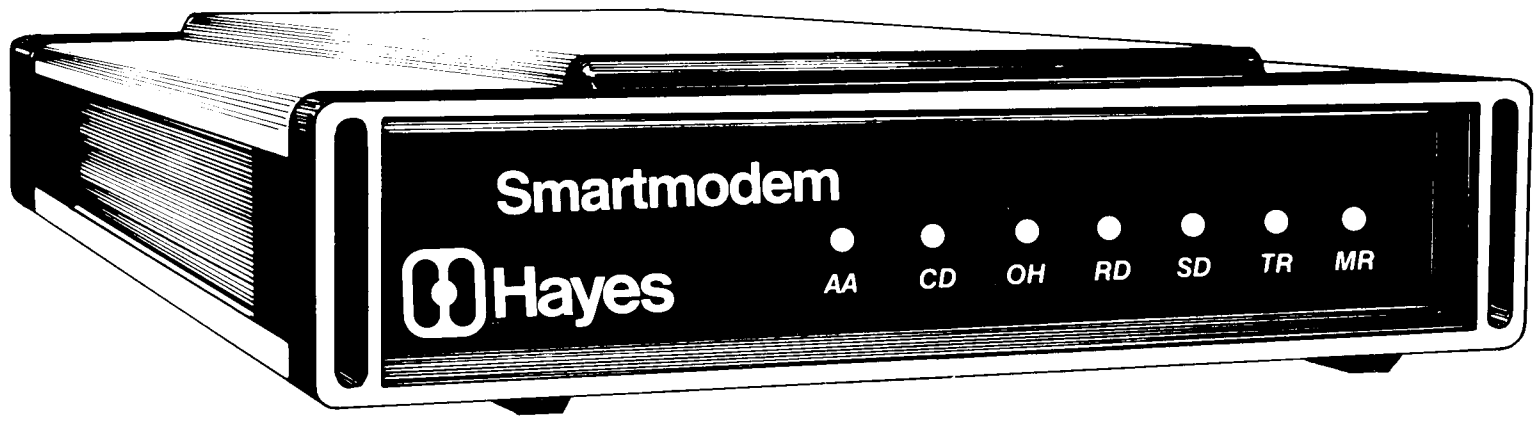


Figure 5
Smartmodem Front Panel

From right to left, the indicator lights are:

MR = Modem Ready
TR = Terminal Ready
SD = Send Data
RD = Receive Data
OH = Off Hook
CD = Carrier Detect
AA = Auto Answer Mode

MR (Modem Ready) indicator light is illuminated at all times when the Smartmodem is powered up.

TR (Terminal Ready) indicator lights to show a signal has been given to the Smartmodem that the data terminal is ready to receive or send data; this signal enables the Smartmodem to execute commands.

The position of configuration switch 1 determines when the TR indicator will light. When configuration switch 1 is in the DOWN position, the TR indicator light will illuminate and remain lit at all times while the Smartmodem is powered up.

When configuration switch 1 is set in the UP position, the TR light will illuminate and remain lit only when the Smartmodem is powered up *and* power to your computer or terminal is on. This setting can only be used if your data terminal supports the RS-232C Data Terminal Ready lead (pin 20). See Chapter 8 for more on this.

SD (Send Data) indicator flashes when data is sent from the RS-232C port to the Smartmodem (i.e., when commands are sent to the Smartmodem or data is transmitted to a distant computer).

RD (Receive Data) light flashes when data received from a distant computer or terminal is sent from the Smartmodem to the RS-232C port. In full-duplex (with echo), this light will pulsate when commands are sent to the Smartmodem since the information sent is also returned or echoed. It will also flash when the Smartmodem sends result codes.

OH (Off Hook) indicates if the Smartmodem has "picked up" the telephone. The OH indicator light is illuminated when the Smartmodem is using the telephone line; otherwise this light is off.

CD (Carrier Detect) shows if the Smartmodem has detected a carrier signal from a distant modem. When the Smartmodem recognizes a carrier signal, the CD indicator will light. When no detectable carrier is present, or if the distant modem hangs up, this light will be off.

AA (Auto-Answer) identifies the state of the auto-answer mode if the Smartmodem is set (via the position of configuration switch 5 or by command) to automatically answer, the AA light will be illuminated. Then, when the phone rings, the light will go off during each ring and the Smartmodem will automatically answer the phone after the number of rings specified.

If the Smartmodem is set to *not* answer the phone (i.e., configuration switch 5 is in the DOWN position and no command override has been given), the AA light will be off. Then when the telephone rings, the AA indicator will light during each ring. In this state the Smartmodem requires a command to answer the phone.

POWER CONNECTION

Insert the power cable connector in the power inlet on the back panel of the Smartmodem. Next, connect the power pack plug to the electrical outlet. Flip the toggle power switch ON (i.e., UP position).

In response the MR and TR indicator lights will illuminate indicating the Smartmodem is ready. (If configuration switch 1 is not in the

factory setting — i.e., is in the UP position — the TR indicator will not light until power to the computer or terminal is turned on.)

Turn power to the terminal or computer ON.

The Smartmodem data communications system is now completely installed.

INITIAL CHECK OUT

If the Smartmodem is attached to a computer that is being used as a terminal, before entering data you must enter the appropriate command listed in your computer reference manual to access the RS-232C port that the Smartmodem is connected to.

To determine if the Smartmodem is listening:

Depress: **RETURN KEY** (while entering data, the RD and SD indicator lights will flash)

Enter: **AT**

Depress: **RETURN KEY**

If everything is functioning properly, the Smartmodem will respond with "OK" and await your command.

If something is wrong, there will be no message and the RD and SD indicator lights will not flash when data is entered. Consult your dealer to see if the unit should be returned for repair. If so, follow the Return for Repair Procedure specified in Appendix I of this manual.

PRECAUTIONS

Disconnect the Smartmodem if you experience trouble with the telephone line after installation. If the Smartmodem is responsible for the trouble on the line, do not use it until it has been repaired by Hayes Microcomputer Products. The telephone company is not responsible for disturbances caused by non-telephone company equipment.

The telephone company may change their equipment and is under no obligation to ensure that the new equipment will be compatible with the Hayes Smartmodem. However, it is unlikely that any changes in telephone equipment will make the Smartmodem unusable. This is because the interface between the Smartmodem and the telephone line is functionally identical to the interface between millions of standard telephones in use and the telephone line.

FCC-SUPPLIED INFORMATION FOR USERS

(Source of information: The Federal Communications Commission has established technical standards regarding radiation or radio frequency energy by computing devices. The Smartmodem falls under rules of Class B computing device and the following information must be supplied to the user in accordance with paragraph 15.838 of the FCC standard Part 15, Subpart J.)

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential 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 equipment 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.

Relocate the computer with respect to the receiver.

Move the computer away from the receiver.

Plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems."

The booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 004-000-00345-4.

Chapter 3
FUNCTIONAL STATES

FUNCTIONAL STATES

The Smartmodem is always in one of two major functional states: local command state or on-line state. In the on-line state, the Smartmodem performs the classic modem function; i.e., it serves as a communication link to transmit or receive data from a distant modem over the phone lines.

A special feature of the Smartmodem is that it also communicates data to your computer or terminal when it is not on-line. In what is called the "local command state," the Smartmodem analyzes and executes commands that are user-entered via a terminal keyboard or under program control. The Smartmodem then echoes back the commands and sends result codes to your data terminal.

This chapter gives you background information on what the Smartmodem actually does when it is in the local command and on-line states and what causes the Smartmodem to change from one state to the other. Examples are presented to show how, in response to simple dial/answer commands, the Smartmodem automatically goes from the command to the on-line state. Also explained are ways in which the user — via such operations as the escape code — can force the Smartmodem from on-line back to the command state.

In this chapter commands are presented merely to demonstrate how the Smartmodem functions in response to your instructions. More specific information on command usage is given in subsequent chapters (Dialing, Chapter 5; Answering, Chapter 6; and Commands, Chapter 7).

LOCAL COMMAND STATE

In the local command state, commands are issued direct to the Smartmodem. The Smartmodem "listens" while the command is entered and will not act on the command until there is a carriage return.

To signal completion of the command, the Smartmodem answers with a result code and awaits the next command.

EXAMPLE:

Enter: **AT S0=10** (Auto-answer on 10th ring)

Result: **OK**

In this example, the Smartmodem is instructed to answer the phone automatically on the tenth ring. To signal that this instruction will be followed, the Smartmodem responds "OK" and remains in the command state ready for the next command.

ON-LINE STATE

The Smartmodem automatically goes to the on-line state after:

- answering an incoming call
- or dialing a call and connecting with the distant modem.

The on-line state permits direct communication between your computer, terminal or printer and the distant modem.

For example, when you send the Smartmodem a dial command:

EXAMPLE:

Enter: **AT D555-1212** (Dial number)

the Smartmodem dials the number, leaves the command state and "waits" for a signal from the distant modem. While the Smartmodem is waiting for the modem's return signal, it is actually in an interim stage between the command state and on-line state. In this waiting stage, you can force the Smartmodem back to the command state by simply depressing any key.

If the distant modem does not answer within the specified length of time, the Smartmodem stops waiting for the carrier signal, sends a NO CARRIER result code and automatically returns to the local command state. *(Note: The Smartmodem can only determine a return signal from a distant modem; it cannot determine voice communication, busy signals, or ringing at the other end of the telephone line. Busy signals, wrong numbers and no answers are handled the same way – i.e., NO CARRIER result code.)*

If the distant modem answers within the specified length of time, the Smartmodem sends a CONNECT result code and automatically goes to the on-line state, thereby allowing direct communication with the distant modem.

GOING FROM ON-LINE TO COMMAND STATE

In the on-line state the Smartmodem will not execute any commands. Once on-line, there are only two ways to get the Smartmodem back to the command state: loss of carrier (the distant modem hangs up) or a user-entered escape code. Figure 6 illustrates how the Smartmodem goes from on-line state to command state.

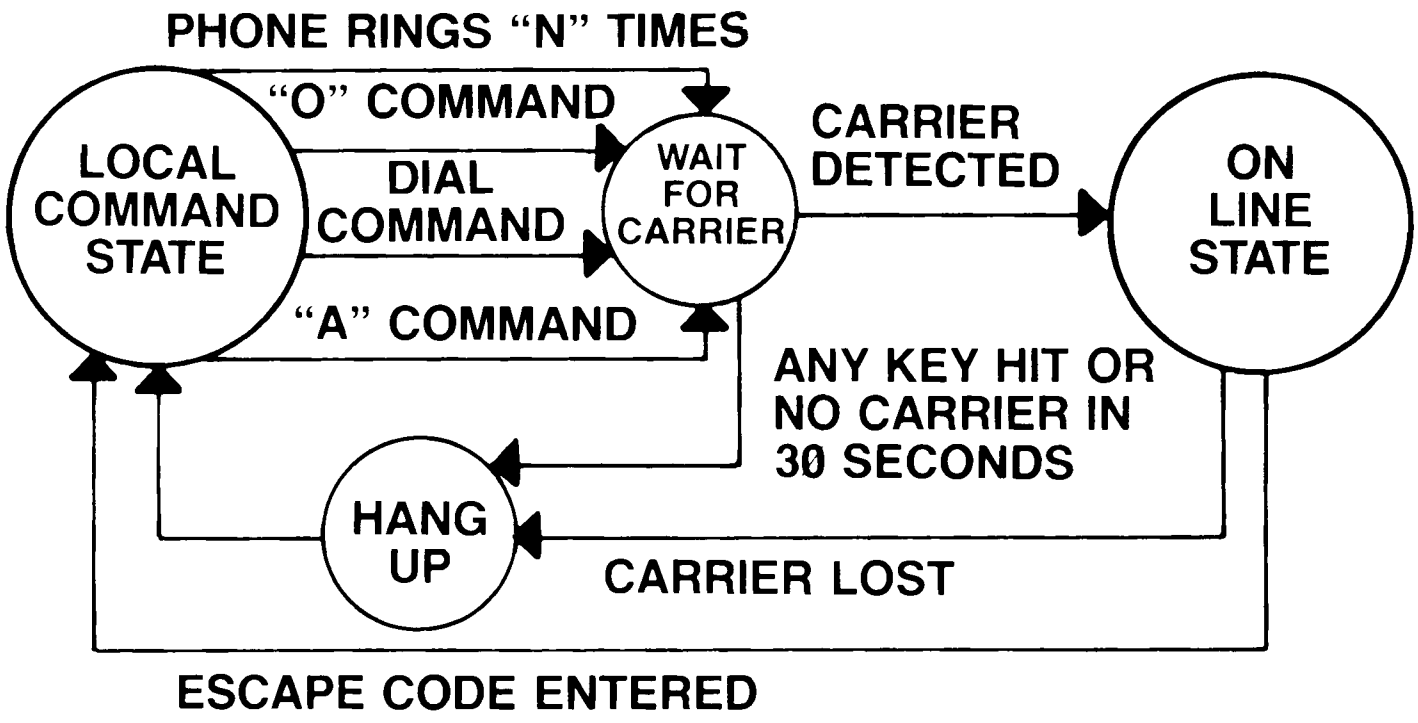


Figure 6
Command State To On-Line State

Escape Code

The escape code causes the Smartmodem to return to the local command state; the Smartmodem will indicate this change in status by giving the result code OK.

Once in the local command state, any valid command line can be sent to the Smartmodem.

***EXAMPLE:* To hang up:**

Enter: **AT H0** (Hang up)

***Result:* OK**

To have the Smartmodem execute a specific command and then return to on-line *without* hanging up, enter the desired command followed by the **O** command.

To illustrate this use, assume you entered a dial command, were connected to a distant modem, and then realized that the Smartmodem was set to operate in half-duplex when you actually want full-duplex. In this case, you would enter the escape code and when the Smartmodem responds OK,

Enter: **AT F1 O** (Full-duplex, return to on-line)

In response the Smartmodem will change operation to full-duplex and return to the on-line state without hanging up the telephone.

After the escape code has been entered, the Smartmodem can also be forced to hang up and return to the command state by entering the **Z** command:

Enter: **ATZ** (Hang up and perform software reset)

Result: **OK**

When the **Z** command is used, however, the effect is the same as if you had just turned power to the Smartmodem on. That is, the settings of the configuration switches will be read and all values will be returned to the values set by the positioning of the switches. Any command override you had previously entered must be re-entered.

Escape Code Operation

The escape code is used to force the Smartmodem back to the local command state from the on-line state. The escape code consists of an escape guard time and an escape character. The escape guard time is defined as the required delay between the last character transmitted and the entering of the escape code. The default guard time is 1 second and the default escape character is "+." The escape character must be entered three consecutive times. To enter the escape code* using the default values, you would:

EXAMPLE:

WAIT 1 SECOND (After the last character transmitted)

Enter: ***+++***

WAIT 1 MORE SECOND (Before transmitting another character)

In response, the Smartmodem will return to the local command state and will send the result code OK. The Smartmodem will not hang up unless it receives an ATH command.

If you do not want to use the default values for the escape code, you can change the guard time and the escape code by using the **S** command. This is fully explained in Chapter 7. The important thing to note here is that whatever the escape code character is, it must be entered three consecutive times and must be preceded and followed by a specific guard time.

The guard time is necessary to "guard" or protect the escape characters. It is possible, for example, that the escape character -- whether it be a "+" or a user-defined character – could actually be part of a message that must be sent to the distant modem. If this were the case and the escape characters were not protected by the guard time, you could not send the escape characters to a distant modem as part of a message. Surrounding the escape characters with the guard time sets the

*Note: To enter the escape code immediately after receipt of a CONNECT result code, the escape code must be preceded by sending or entering any character, i.e., Enter: Any Character. Wait 1 second. Enter: + + +. Wait 1 second.

escape code off as a message for the Smartmodem; this message enables you to force the Smartmodem back to the command state.

For specific guidelines to follow in establishing user-defined guard times see the discussion of register S12 in Chapter 7.

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The Smartmodem can be forced back to the local command state after dialing *and* without hanging up by ending the dial command with a semicolon.

Use of the semicolon with the Smartmodem as an autodialer is discussed in Chapter 5.

Another application is in calling a bank service or phone order service when Touch-Tones will have to be used to enter data requested by the service (e.g., ID number, password, transaction information). An example of how to use the Smartmodem for this application is also presented in Chapter 5.

Chapter 4
COMMAND GUIDELINES

COMMAND GUIDELINES

When the Smartmodem is in the local command state, you can not only send dialing and answering instructions you can also issue commands to change the various operating parameters (e.g., change from full-duplex to half-duplex). This feature gives you complete flexibility to customize operations to meet any special requirements of the system you are contacting.

The following chapters provide you with complete instructions for executing dialing and answering commands. This chapter gives you some basic guidelines that must be followed in sending any commands to the Smartmodem. Also defined in this chapter are the result codes which the Smartmodem sends in response to your commands.

AT ATTENTION CODE

All command lines must begin with **AT** which is the attention code. The terminal's baud rate is determined from the **A** and the word length and parity are determined from the **T**. The remainder of the command line contains commands for the Smartmodem.

A/ COMMAND

The **A/** command instructs the Smartmodem to repeat the last command line. The most common use for this is to redial the last telephone number entered if a busy signal was encountered. **A/** is used in place of **"AT"** and no carriage return is required.

The Smartmodem will execute the **A/** command as long as power to the unit is left on and until **AT** is entered. Once **AT** is entered, it immediately clears the command line buffer of previous data. (This effect is caused by **AT** alone, i.e., no carriage return.)

BACKSPACE KEY

When in verbose mode (English words) if the carriage has not been returned, simple editing can be done with the backspace key. A backspace will delete the last character entered. Note, however, that the backspace key cannot be used to delete the **AT** at the beginning of the command line.

CARRIAGE RETURN

The command line is ended with a carriage return. The Smartmodem's Z8 microprocessor will not begin to execute the command until there is a carriage return.

MISSING PARAMETER

A missing parameter will evaluate to zero. For example, the **H** (switch hook) command can have a parameter of zero to hang up or a parameter of one to pick up **HØ** or **H1**. **H** alone is the same as **HØ** or hang up.

COMMAND BUFFER

The command buffer capacity is 4Ø characters. If the command line exceeds 4Ø characters, the Smartmodem will refuse to execute any portion of that command line and will send the following result code:

***Result:* ERROR**

The command must then be adjusted to the 4Ø character maximum and re-entered.

AT entered at the beginning of the command line and control characters do not take up space in the command buffer.

Blanks and spaces are ignored (not counted) but may be entered for user readability.

Telephone numbers may be entered with or without punctuation, i.e.,:

(4Ø4) 393-1234 or 4Ø43931234

If punctuation is used in the telephone number, it will take up space in the command buffer.

RESULT CODES

The result codes are actually responses by the Smartmodem to user-entered commands. When a command line is followed by a carriage return, the Smartmodem will begin to execute the command. When the command has been completed, the Smartmodem will send a result code.

Result codes may be verbose (English words) or non-verbose (single digits Ø. . .4). It is recommended that verbose codes be used when the Smartmodem is connected to a terminal and non-verbose codes be utilized when the Smartmodem is operated under program control.

Verbose results are preceded and followed by a carriage return-line feed sequence. Non-verbose results are followed by only a single carriage return.

The result codes and their meanings are summarized on the following page.

RESULT CODES

NON-VERBOSE	VERBOSE	MEANING
Ø	OK	Command line executed with no errors.
1	CONNECT	Carrier has been detected.
2	RING	Phone is ringing* (See Note below).
3	NO CARRIER	Carrier lost or never heard.
4	ERROR	Error in command line.
		Invalid command (command unrecognizable to Smartmodem).
		Command line exceeds command buffer, i.e., greater than the maximum 4Ø characters.

Note: When the phone rings, the Smartmodem will send a RING result code. However, the Smartmodem will answer the phone only if it is in auto-answer status or is given an* **A *command.*

Chapter 5
DIALING

DIALING

Dialing is one of the most frequently used operations with the Smartmodem. This chapter provides you with complete instructions for executing dialing commands/operations. You will only have to reference Chapter 7 if you want to change any of the timing parameters involved in the dialing sequence.

DIAL COMMANDS

In response to simple dial commands the Smartmodem will automatically originate telephone calls. No auxiliary device is required for automatic dialing.

This capability enables you to call any time-sharing system or distant modem without using a telephone or automatic calling unit.

The commands used in dialing are:

Command	Description
D	Dial: forces Smartmodem to originate mode to dial a number.
,	Pause: causes Smartmodem to wait for a second dial tone before dialing the outside number; used, for example, in placing a call through a PBX board to get an outside line.
T	Touch-Tone dialing.
P	Pulse dialing.
R	Reverse mode: forces Smartmodem to answer mode to dial a number; used in calling an "originate only" modem.
A/	Repeat last command; used to redial the last number entered.
;	Forces Smartmodem back to command state after dialing.

The following discussion defines each command and, by example, shows how you can combine these commands and easily adjust the timing sequence to meet your special dialing requirements.

Dial A Number — "D"

The Dial Command takes the form **Ds** with **s** being a string of characters. In the simplest form **s** will be only the digits of the phone number to be dialed.

SIMPLE DIAL EXAMPLE:

***Enter:* AT D5551212** (Dial number)

In response to this command, the Smartmodem will dial the phone number "555-1212" and then wait for a carrier tone from a distant modem. If no carrier is heard within a given time (the default time is 3Ø seconds), the Smartmodem will automatically hang up and give a NO CARRIER result code. If a carrier signal is detected, the Smartmodem will give a CONNECT result code and go to the on-line state, thereby permitting direct communication with the distant modem.

As with any command, spaces may be entered in the dial command line for user readability, but any spaces will be ignored, i.e.,

EXAMPLE:

AT D 555 1212 is equal to ATD5551212

In the simple dial command above, **s** was the phone number only. For special dialing requirements the following commands may be combined with the phone number.

PAUSE ","

When placing a call from an office with a phone that is connected to a PBX, it is necessary to dial an access code (usually 9) to get an outside line. You can cause the dialing operation to pause long enough to get the second dial tone by inserting a comma in the phone number. The default pause time is 2 seconds.

PAUSE EXAMPLE:

***Enter:* AT D9,5551212** (Dial 9 pause dial number)

Note that multiple commas may be used for a greater delay time if desired.

TONE AND PULSE DIALING — "T" "P"

The Smartmodem is capable of using DTMF (Touch-Tones) or dial pulses when dialing a phone number. If the dial command does not specify which type of dialing to use, the Smartmodem will dial using the dialing mode specified in the last command.

The **T** and **P** commands set the dialing mode. They can be inserted into the phone number at any point, thus allowing the dialing mode to be changed during the dialing operation. The following example shows how to dial 9 using dial pulses to get

an outside line from a rotary dial PBX and then swtich to Touch-Tone dialing for the remaining digits.

TONE AND PULSE DIAL SELECTION EXAMPLE:

Enter: **AT DP9, T5551212** (Pulse dial 9 pause Touch-Tone dial number)

ORIGINATING A CALL IN ANSWER MODE — "R"

The **D** dial command forces the Smartmodem into originate mode. If you need to call someone with an originate-only modem, you must set your Smartmodem to answer mode even though you are originating the call. This can be done with the **R** command. The **R** (reverse) command should be entered at the end of the telephone number.

ORIGINATING A CALL IN ANSWER MODE, EXAMPLE:

Enter: **AT D 555 1212 R** (Dial number in answer mode)

REDIAL LAST NUMBER "A/"

The repeat last command **A/**, can be used to redial the last number entered when a busy signal has been encountered. **A/** is used in place of **AT** and no carriage return is required.

EXAMPLE:

Enter: **A/** (Redial last number)

Specific guidelines for using the **A/** command are discussed in Chapter 4.

RETURN TO COMMAND STATE ";"

Ending the dial command with a carriage return causes the Smartmodem to enter a "wait for carrier loop" which can be exited by depressing any key. Or, the Smartmodem will automatically return to command state after a pre-determined delay (usually 3Ø seconds).

The Smartmodem can be forced to re-enter the command state after dialing (without hanging up) by ending the dial command with a semicolon. This is useful, for example, in calling a phone order service or bank service. In these applications after a connection is made, you are required to use Touch-Tones to enter additional information (e.g., customer ID, password).

EXAMPLE:

Enter: **AT D 876-5432;** (Dial number and return for command)

Result: **OK**

Enter: **AT D T 22498#;** (ID number and return for command)

Result: **OK**

Enter: **AT D 1234#;** (Password and return for command)

Result: **OK**

Enter: **AT D 312 * 90#;** (Transaction and return for command)

Result: **OK**

Enter: **AT H** (Hang up)

Result: **OK**

Autodialer

Ending the dial command with a semicolon is also utilized when you want to use the Smartmodem as an autodialer.

AUTODIALER EXAMPLE:

Enter: **AT DT9, 5551212;** (Touch-Tone dial 9 pause dial number return for command)

Result: **OK**

The user then listens to the built-in monitor speaker for a ringing signal. When the ring is heard, the user picks up the telephone handset and issues the hang up command to the Smartmodem.

EXAMPLE:

Enter: **ATH** (Hang up)

Result: **OK**

The user can then talk to a person on the telephone.

Another approach to using the Smartmodem as an autodialer is to dial normally without the semicolon, wait for the ringing signal, pick up the telephone and depress any key on the terminal to cause the Smartmodem to hang up. This method will allow use of the **A/** command to redial the last number if it is busy.

In the previous autodialer example, the redial command **A/** cannot be used, because the last command entered was **ATH**. When the attention code **AT** is entered, this immediately clears the command line buffer, thereby making it impossible for the Smartmodem to redial the last number.

TIMING PARAMETERS — "S"

The various timing parameters in the dialing sequence are controlled by the values assigned to Set Registers S6 through S11. The function of each of these registers and the default values are listed on the next page.

Register	Function	Default Value
S6	Length of time Smartmodem will wait for a dial tone before dialing the first digit of a phone number.	2 seconds
S7	After dialing a number, length of time Smartmodem will wait for a carrier signal before hanging up.	3Ø seconds
S8	Length of pause time resulting from the "," command.	2 seconds
S9	Length of time a return carrier signal must be present before the Smartmodem will recognize it.	6ØØ milliseconds
S1Ø	Time between loss of carrier (distant modem hangs up) and Smartmodem disconnect.	7ØØ milliseconds
S11	Speed of the Touch-Tone dialer; sets the duration and spacing of the tones.	7Ø milliseconds

You can change the values assigned to these registers by using the **S** command. For example, if you normally have difficulty in getting a dial tone and the Smartmodem begins to dial before you get a dial tone, you may want to increase the value of the S6 register from 2 seconds to 3 seconds. To do this:

EXAMPLE:

Enter: **AT S6 = 3** (Wait 3 seconds for dial tone)

Result: **OK**

The Smartmodem will now wait 3 seconds to receive a dial tone from central office equipment before it dials the first digit in the phone number.

Consult Chapter 7 for a detailed description of the **S** registers and for the range of values that can be assigned to each register.

COMMAND SEQUENCE

Any command except **D** can be used from within the dial command. However, the only useful ones are **T**, **P** and **R**. Other commands should be placed before the dial command or after it if the dial command is terminated with a semicolon.

EXAMPLE:

Enter: **AT M2 FØ V1 DT 555-1212; S2=1 O**

The aforementioned example instructs the Smartmodem to.

M2	keep the monitor speaker on always
FØ	operate in half-duplex
V1	send verbose result codes
DT	dial touch tone 555-1212
;	end dial command
S2 = 1	set register 2 to 1 (set escape code to control A)
O	go on-line and wait for carrier

Any character not in the command set will be ignored while in the dial command. No error message will be generated. This is to allow punctuation in the telephone number.

EXAMPLE:

ENTER: **ATDT 9,(404)555-1212**

Chapter 6
AUTOMATIC ANSWERING

AUTOMATIC ANSWERING

Automatic answering is one of the most widely used features of the Smartmodem. This chapter provides complete information necessary for you to use your Smartmodem for auto-answer. With these instructions you can, even in your absence, have data transmitted over the phone lines to the RS-232C port of your computer or terminal. In fact, when you are at your office, you can call home, your Smartmodem will answer and you can access your home computer.

AUTO-ANSWER STATUS

The key to placing your Smartmodem in auto-answer status is the SØ register. This register controls the number of rings that must occur before the Smartmodem will answer the phone. The range of values that can be assigned to this register is Ø-255.

SØ = Ø DO NOT ANSWER PHONE
SØ = 1 ANSWER ON RING 1 — DEFAULT VALUE
SØ = 2 ANSWER ON RING 2
SØ = 3 ANSWER ON RING 3
•
•
•
SØ = 255 ANSWER ON RING 255

"Switch Set" For Auto-Answer

Configuration switch 5 (located behind the Smartmodem's front panel) controls the automatic answer status of the Smartmodem when power is turned on.

If the Smartmodem is "switch set" to auto-answer (i.e., configuration switch 5 is in the UP position), the Smartmodem will automatically answer the phone on the *first* ring when power to the unit is turned on. No command is required.

The Smartmodem will continue to automatically answer on the first ring *until* you assign another value to the SØ register.

If, for example, you want the phone to be answered on the fifth ring, you would, simply:

Enter: **AT SØ = 5** (Answer on 5th ring)

Result: **OK**

In response the Smartmodem will now answer the telephone on the fifth ring.

If you later decide to change the "answer on" ring, you can do this by simply using the procedure described above.

As long as power to the unit remains on, the Smartmodem will answer the telephone on the current value (ring number) you have assigned to the SØ register.

When power to the Smartmodem is turned off and then on again, or a **Z** (reset) command is given, the Smartmodem will return to the default value of the SØ register. That is, it will automatically answer the telephone on the *first* ring and only the first ring.

Command Setting

If configuration switch 5 is placed in the non-auto-answer setting (i.e., DOWN position), the Smartmodem will *not* answer the telephone when power is turned ON.

However, when the unit is powered up, you can, by program command, override this switch setting and place the Smartmodem in auto-answer status. To do this, you would simply use the procedure just described and assign a value to the SØ register that is greater than zero.

When power to the Smartmodem is turned off and on again or a **Z** command is entered, the Smartmodem will read configuration switch 5 and return to its setting. That is, since the switch is set for non-auto-answer, the Smartmodem will not automatically answer the telephone.

If you want to place the Smartmodem in auto-answer status, you must reassign a value to the SØ register that is greater than zero.

DIFFERENCE BETWEEN SWITCH SETTINGS

The difference between the two switch settings is *what will automatically occur whenever power to the Smartmodem is turned on*, i.e., auto-answer on first ring versus do not answer on any ring.

Clearly the Smartmodem will function in auto-answer status regardless of the setting of configuration switch 5. The determining factor is the value you assign to the SØ register.

AUTO-ANSWER PROCESS

When the Smartmodem is in auto-answer status, the AA (automatic answer) LED on the front panel will illuminate and will remain lit.

When the phone rings, the AA light will go off during each ring. The Smartmodem will count the rings and answer on the *nth* ring (i.e., the ring to answer on assigned in the SØ register). The Smartmodem then goes from command state to a "wait for carrier" state. At this time, the Smartmodem sends its carrier signal to the originating (calling) modem and then waits for a carrier tone from the originating modem.

If no carrier signal is received from the originating modem within a specified time (usually 3Ø seconds), the Smartmodem will hang up, send a NO CARRIER result code and return to the command state.

If the carrier tone is received, then:

- the CD indicator light on the front panel of the Smartmodem will illuminate to show a carrier detect.
- the Smartmodem will send a CONNECT result code and go to the on-line state.
- data transmitted from the originating modem will then be transmitted directly to the RS-232C port of the computer or terminal and the RD indicator light on the Smartmodem's front panel will illuminate to show that data is being received.

This entire auto-answer process is illustrated below.

AUTO ANSWER PROCESS

Command State	AA light on RING. RING . . . *NTH RING* (AA light OFF)			
Wait for Carrier State	ANSWER Smartmodem sends its carrier tone ORIG. modem sends its carrier tone	**or**		NO signal received in specified time
On-line State	CD light turns on CONNECT result sent Smartmodem goes on-line Transmitted data goes to RS-232C port RD light turns on	**or**	**Command State**	Smartmodem hangs up NO CARRIER result sent Smartmodem returns to command state

DISABLING AUTO ANSWER

The automatic answer capability can be disabled by setting the SØ register to zero:

EXAMPLE:

Enter: **AT SØ =Ø** (Do not answer)

Result: **OK**

In response to this command, the Smartmodem will *not* answer incoming calls. To indicate this the AA indicator light will be OFF and will remain off until the telephone rings.

"A" COMMAND

The **A** command is an answer command that forces the Smartmodem to answer the telephone without waiting for any rings.

EXAMPLE:

***Enter:* ATA** (Answer immediately)

In response the Smartmodem will immediately answer the telephone and go to a "wait for carrier" state.

The **A** command is used to transfer a call already in progress between two individuals (who have modems) to a communication between their computers. In this application, the Smartmodem can be utilized as either the originating or answering modem.

Since the **A** command forces the Smartmodem to go to the "wait for carrier" state, the Smartmodem will not execute any command entered in the command line *after* **A**. Additional commands must be placed before the **A** command.

EXAMPLE OF COMMAND SEQUENCE:

***Enter:* AT F1 A** (Change to full-duplex and answer telephone immediately)

In response to this, the Smartmodem will first execute the **F1** command (i.e., change from half-duplex to full-duplex) and then go to answer mode and wait for a carrier.

TIMING PARAMETERS

In addition to the SØ register, the user has the option of adjusting the values set in the S7, S9 and S1Ø registers. These registers control the various timing parameters involved in answering the telephone. The function of each register and the default values are summarized below. For the range of values that can be assigned to each register, consult the "Set" Command section in Chapter 7.

Register	Function	Default Value
S7	Total time after answering that Smartmodem will wait for carrier signal from originating modem.	3Ø seconds.
S9	Length of time a carrier signal must be present before the Smartmodem recognizes it.	6ØØ milliseconds
S1Ø	Time between loss of carrier (originating modem hangs up) and disconnect by Smartmodem.	7ØØ milliseconds

Chapter 7
COMMANDS

COMMANDS

This chapter defines all the commands that are used with the Smartmodem. For your ease in referencing, the commands are listed alphabetically. A separate section is then devoted to a discussion of the Set commands that are used to read or change the values assigned to the set registers.

The default value for each command is specified. These values determine how the Smartmodem will function whenever power to the unit is turned on or a reset command is given. Of course, once power to the Smartmodem is on, you can modify any of these operational parameters via command. To assist you in making any modifications, the parameters or range of values possible for each command are defined.

COMMAND/FUNCTION	DESCRIPTION
A	Parameters: None
Forces Smartmodem to answer telephone without waiting for any rings	Since the **A** command forces the Smartmodem to go immediately to the "wait for carrier" state, the Smartmodem will not execute any command entered in the command line after **A**. Additional commands must be placed before the **A**. The **A** command is used to transfer a call already in progress between two individuals to a communication between their computers.
A/	Parameters: None
Causes automatic repeat of last command	Used for automatic redial of last telephone number when a busy signal was encountered. **A/** takes the place of **AT** and no carriage return is required.
C*n*	Default: C1 Parameters: n = Ø . . 1 n = Ø Transmitter off n = 1 Transmitter on
Controls Smartmodem's transmitter carrier; i.e., signal sent when calling, answering or connected to a distant modem	Smartmodem defaults to C1 state where its carrier signal is automatically switched on or off as required. The signal is on when the Smartmodem is calling, answering or connected to a distant modem otherwise the signal is off. The CØ command is for applications where the user needs to receive only without the transmitter carrier on. The C command has both immediate and delayed effects: • When C1 is entered, the carrier transmitter is turned on and a carrier status flag is set.

- When CØ is entered the carrier transmitter is turned off and a carrier status flag is cleared. The carrier transmitter will not turn on again (even after a dial or answer command) until a C1 or Z command is executed.

, (Comma)

Causes a pause to wait for a second dial tone

Default: 2 seconds
Parameters: None

The comma is used, for example in placing a call through a PBX board. The comma causes the Smartmodem to pause for a second dial tone before it begins to dial the telephone number. The length of the pause is determined by the value assigned to the S8 register. Multiple commas may be inserted to increase the pause time.

D*s*

Forces Smartmodem to originate mode to dial a number

In a simple dial command "s" is only the digits of the telephone number to be dialed; for special dialing requirements the telephone number can be combined with any of the other dialing commands, i.e., T, P, R and;

E*n*

Controls whether or not the Smartmodem will, when in command state, echo back to the terminal screen data sent to the Smartmodem via the RS-232C port

Default: E1
Parameters: n = Ø. .1

n = 1 Echo back all characters when in command mode. This permits you to see what you are sending to the Smartmodem when using a full-duplex terminal.

n = Ø Do not echo characters when in command mode.

The default setting is E1. This should be changed to EØ (no echo) when the Smartmodem is connected to a terminal that is in half-duplex and you are calling a computer that is in half-duplex.

F*n*

Determine if full- or half-duplex mode is used

Default: F1
Parameters: n = Ø. .1

The default setting is full-duplex (F1). This should be changed to half-duplex, when the Smartmodem is connected to a full-duplex terminal and you are calling a half-duplex system.

If you are not certain whether the system you are calling is full- or half-duplex, assume half-duplex to begin with. Then if the system is in full-duplex, each character you send to it will appear twice on your screen. You can then correct this by changing the Smartmodem to full-duplex. Of course, you must first enter the escape code to place the Smartmodem in command state; i.e.,

Enter: + + +
AT F1 O

H*n*

Controls the telephone switch hook

Parameters: n = Ø. .2
n = 1 Off hook
n = Ø On hook (hang up)
n = 2 Special off hook

To illustrate what is meant by the Smartmodem being off-hook, consider a regular telephone receiver. When the receiver is resting on its hook, the telephone is not in use. When the receiver is picked up, you are using the telephone lines. That is, when the telephone goes off hook, a switch in the receiver activates a switch hook relay; this, in turn, causes a dial tone to be sent from the central equipment office. This process is similar when the Smartmodem is using the telephone.

The **H** command takes effect immediately with no delayed effects.

In normal operation on the telephone line only the HØ form will be used. The switch hook will be turned on automatically when originating calls with the dial command or in answering calls.

For special applications, the H1 command will operate both the telephone line relay and the auxiliary relay.

The H2 command will only operate the line relay. The auxiliary relay will remain open and the "OH" LED light on the Smartmodem's front panel will not light. The H2 command can be used in applications where the Smartmodem is connected to amateur radio equipment. For information on this application, see Appendix H.

In all cases (i.e., with HØ, H1 and H2) there is a 2 second delay between the time the switch hook relay is activated and any other operation. This is in compliance with FCC billing protection regulations.

M*n*

Controls monitor speaker

Default: M1
Parameters: n = Ø . .2
n = Ø Speaker off always
n = 1 Speaker on until carrier detect
n = 2 Speaker on always.

The monitor speaker allows you to listen to the progress of a call in process (i.e., dial tone, carrier tone, busy signals). The default setting is n = 1; the monitor speaker is on until the Smartmodem recognizes a return carrier tone from the distant modem, indicates a carrier detect, and sends a CONNECT result code.

M2 enables you to have the speaker remain on after a connect is made. If you are encountering difficulties (e.g., the Smartmodem keeps hanging up after a CONNECT), you can use this feature to "listen in" and try to troubleshoot the problem. In doing this, you may first want to use the Volume Control knob to turn down the volume.

MØ is used when you do not want to monitor the call and want completely soundless operation.

O

Parameters: None

Forces Smartmodem back to the on-line state

When the Smartmodem is in the on-line state, you can force it back to the command state by entering the escape code (see Chapter 3). After the Smartmodem has executed the desired command, the **O** command is used to force the Smartmodem back to the on-line state.

P

Parameters: None

Instructs the Smartmodem to dial subsequent digits in pulse dialing

The **P** command can be used between digits of a telephone number to cause the digits following it to be pulse dialed. Pulse dialing speed is fixed at 1Ø pulses per second.

Entering **AT P** alone followed by a carriage return will cause all subsequent telephone numbers to be pulse dialed.

Q*n*

Controls quiet mode; i.e., determines if Smartmodem will send result codes

Default: QØ
Parameters: n = Ø. .1
n = 1 Quiet, no result codes sent
n = Ø Result codes sent

When the Smartmodem is being used with a receive only printer, you may want to use the quiet mode and eliminate the result codes from the print out of the transmitted data.

R

Forces Smartmodem to answer mode to dial a number

Parameters: None

Used to call an "originate only" modem. The **R** (reverse) command must be entered at the end of the telephone number.

S*r*?

Used to "read" the current value assigned to any of the seventeen S registers

Range: r = Ø. .16

Reads the content of register "r" and sends it to the computer or terminal as a decimal number with a range of Ø. .255. For the procedure to follow in reading a register, see the section on the **S** commands at the end of this chapter.

S*r* = *n*

Used to assign a value to any of the seventeen S registers

Range: r = Ø. .16
n = Ø. .255

For the procedures to follow in assigning a value to a set register, see the discussion at the end of this chapter.

; (Semicolon)

Forces Smartmodem back to command state after dialing a number

Parameters: None

When the semicolon is used, it must be placed at the end of the dial command. This command is useful in calling a bank service or phone order service and in utilizing the Smartmodem as an autodialer.

T

Parameters: None

Instructs the Smartmodem to use Touch-Tone dialing

This command is used between the digits of a telephone number to cause all the following digits in the dial command to be dialed in Touch-Tones. The speed of the Touch-Tone dialer is set by the S11 register.

Entering **AT T** alone followed by a carriage return will cause all subsequent telephone numbers to be dialed in Touch-Tones until a command is issued to change the dial mode.

V*n*

Default: V1
Parameters: n = Ø . . 1

Determines if the result codes will be verbose (English words) or non-verbose (single digits)

n = 1 Result codes are verbose (transmitted as words)
n = Ø Result codes are non-verbose (transmitted as single digits).

The V1 (verbose) mode is generally used when the Smartmodem is connected to a terminal; the VØ (non-verbose) mode is utilized when using a computer program to operate the Smartmodem.

Z

Parameters: None

Performs a software reset and applies all default values

The settings on the cold-start configuration switches are applied. This command will produce an OK result code BEFORE it does the initialization, therefore, the user should wait at least one-half second before sending any additional commands. Also, any commands remaining on the original command line after the **Z** will not be executed since part of the initialization clears the command line buffer.

"S" Set Commands

There are seventeen set registers (Registers SØ-S16) which control certain operational parameters for the Smartmodem and establish the time allowed for various steps involved in dialing or answering the phone.

To give you an overview of the Set Commands, each register is briefly described in Table 2.

TABLE 2
"S" REGISTERS — FUNCTIONS

REGISTER	RANGE	UNITS	DEFAULT	DESCRIPTION
SØ	Ø..255	rings	1	Ring to answer on
S1	Ø..255	rings	Ø	Rings which have occurred
S2	Ø..127	ASCII	43	Escape code character
S3	Ø..127	ASCII	13	Character used as carriage return
S4	Ø..127	ASCII	1Ø	Character used as line feed
S5	Ø..127	ASCII	8	Character used as back space
S6	1..255	seconds	2	Wait for dial tone time
S7	1..255	seconds	3Ø	Wait for carrier after dialing or answering time
S8	Ø..255	seconds	2	Sets pause time for comma
S9	1..255	1/1Ø second	6	Carrier detector response time
S1Ø	1..255	1/1Ø second	7	Delay between loss of carrier and hangup
S11	5Ø..255	milliseconds	7Ø	Touch-Tone duration and spacing
S12	2Ø..255	1/5Ø second	5Ø	Escape code guard time
S13		bit mapped		UART status register
S14		bit mapped		Option register
S15		bit mapped		Flag register
S16	Ø..1	none		Loop back control; 1 = loop back

You will use the **S** commands to either "read" the current value in a register or to change the value assigned to a register. Both procedures are explained below.

Reading A Register

To read the current value in any of the Smartmodem parameter registers, use the form **S*r*?**. The decimal value of the register contents will then be sent to the RS-232C port in ASCII. Multiple registers can be read.

To illustrate this, assume you wanted to read the current value in registers SØ (ring to answer on) and S7 (how long after dialing or answering the Smartmodem will wait for a carrier signal before hanging up).

EXAMPLE:

Enter: **AT SØ? S7?** (Value in register SØ? Value in register S7?)

A typical response to this in verbose mode might be:

Result: **ØØ1** (Smartmodem will answer on first ring)

Result: **Ø3Ø** (Smartmodem will wait 3Ø seconds for a carrier)

Result: **OK** (Register read command completed; Smartmodem is ready for a new command line)

Changing A Parameter

To set or change a parameter, the form "S*r*=*n*" is used; "r" is a value between zero and sixteen (i.e., the number of the register, Ø-16) and "n" is a value between zero and 255 (i.e., the range of values that can be assigned to registers SØ-S16).

In the previous register read example the value in the SØ register was set so the Smartmodem would answer the telephone on the first ring. If you want to change this to have the telephone answered on the fifth ring, for example:

Enter: **AT SØ=5** (Auto-answer on ring 5)

Result: **OK**

To signal that the command has been executed, the Smartmodem sends the result code OK. All incoming calls will now be answered by the Smartmodem on the fifth ring.

The **S** command can be used alone, i.e., without the **?** or **=**. The **S** command actually sets a pointer register to the address specified following the **S**.

The **?** and **=** are completely separate commands which either read or put data at the address specified by the pointer register. To illustrate this, if you

Enter: **AT S7** (Register S7)

Depress: **RETURN**

as long as no other ***S*** *command is entered*, you can at any time

Enter: **AT ?** (Value in register S7?)

and in response the Smartmodem will give you the current value in the S7 register.

Similarly, if you

Enter: **AT = 8** (Change value in S7 register to 8)

the Smartmodem will change the value in the S7 register to 8.

DETAILED DESCRIPTION OF REGISTERS AND S COMMANDS

COMMAND/FUNCTION	DESCRIPTION
SØ? **SØ =** **Controls auto-answer: sets ring to answer on**	Default: 1 ring (This default applies only when configuration switch 5 is in the UP position.) Range: Ø. .255 Units: Rings Assigning a value from 1 to 255 will place the Smartmodem in auto-answer mode. *(Note: placing configuration switch 5 in the UP position automatically sets the Smartmodem to answer on the first ring.)* To indicate this status, the "AA" LED light on the front panel will illuminate. Setting SØ to zero will disable the auto-answer capability. *(Note: placing configuration switch 5 in the DOWN position, sets the value in the SØ register to zero.)* The "AA" indicator light will be turned off to indicate this status.
S1? **S1 =** **Records rings that have occurred**	Default: Ø Range: Ø. .255 Units: Rings S1 is incremented each time the phone rings and cleared if no rings occur within approximately 8 seconds of the last ring. For most applications, you will not have to do anything with S1; but it can be read or set. If you set S1, it will be cleared to zero 8 seconds later if the phone does not ring.
S2? **S2 =** **Holds ASCII value of escape code**	Default: 43 Range: Ø. .127 Units: ASCII The default is 43 which is an ASCII "+". S2 can be set to any value from zero to 255. Values greater than 127 will completely disable escape code detection and ensure complete transparancy to transmitted data, but will prevent the user from giving a hang up command.

There are only two ways to disconnect when the escape code is disabled: 1) lose carrier (the distant modem hangs up) or 2) turn off the DTR lead (pin 20) on the RS-232C connector.

For a discussion of the escape code, see Chapter 3.

S3?
S3=

Default: 13
Range: Ø..127
Units: ASCII

Holds ASCII value of the carriage return or end-of-line character

Normally, the official ASCII carriage return value of 13 will be used; however, if you have non-standard equipment, you may wish to change this value. Keep in mind that this defines both the command line termination character and the result code terminator.

S4?
S4=

Default: 1Ø
Range: Ø..127
Units: ASCII

Holds ASCII value of the line feed character

The line feed character is output only in verbose mode after carriage returns. If you do not want or need a line feed character, you may change it to a null; but, it cannot be totally disabled.

S5?
S5=

Default: 8
Range: Ø..127
Units: ASCII

Holds ASCII value of the back space character

This is both the back space key and the character that is echoed to move the cursor back one position. It will not work if set to values between 33 and 126 or above 127. Since this is the range of printable ASCII characters, this should cause no problems.

A back space is processed as follows: The user's key stroke is echoed back to his terminal and moves the cursor back over the last character entered. The last character in the command buffer is deleted. The Smartmodem sends an ASCII space or blank to erase that character on the user's terminal. The space moves the cursor to the next position, so the Smartmodem must send another back space character to backup the cursor again. Since two extra characters are sent after the backspace, response will be slowed somewhat. Use of a repeat key may not work properly on back spaces.

S6?
S6=

Default: 2 seconds
Range: 1. .255
Units: Seconds

Controls wait for dial tone time before dialing

Register S6 determines how long the Smartmodem will wait after "picking up" the phone before it actually begins to dial the first digit of a phone number. This delay allows time for the central office equipment to give a dial tone. The minimum time is 2 seconds. If S6 is set for less than 2 seconds, the Smartmodem will still wait for 2 seconds before dialing. Values greater than 2 seconds may be set if you have trouble getting a dial tone within the normal 2 second period.

S7?
S7=

Default: 3Ø seconds
Range: 1. .225
Units: Seconds

Time Smartmodem will wait for a carrier signal from a distant modem after dialing or answering before hanging up

A time delay of 3Ø seconds is usually enough, but S7 can be set to any value from 1 to 255 seconds. If the Smartmodem hears no carrier tone within the specified time period, it will hang up and return a NO CARRIER result code. If a carrier tone is detected, the Smartmodem will return a CONNECT result code and go on-line.

S8?
S8=

Default: 2 seconds
Range: Ø. .255
Units: Seconds

Sets pause time for comma in dial commands

The comma is used in telephone numbers to pause for a second dial tone when calling from a PBX or using special telephone services. Two seconds is usually enough time for these applications, but this can be changed to anything from Ø to 255 seconds. Note that multiple commas can be used for greater delays as desired.

S9?
S9=

Default: 6ØØ milliseconds
Range: 1. .255
Units: 1/1Ø seconds

Sets carrier detect response time, i.e., how long carrier tone must be present for Smartmodem to recognize it and signal a carrier detect

Carrier detector response time should not be confused with register S7 (total time Smartmodem will wait for a carrier before it hangs up).

Carrier detector response time is the length of time a carrier must be *present* before the Smartmodem will recognize it. (See Chapter 5.)

The default setting for carrier detector response time is 6ØØ milliseconds. In general, as this time is made longer there will be less chance of a false carrier detect from noises

such as busy signals, voices, etc. The value in S9 is in tenths of seconds; for example, 1.2 seconds of response time would be obtained from a value of 12.

S9 only affects the time required to recognize the presence of a carrier. The absence of a carrier is detected in a fixed time of 1Ø milliseconds.

S1Ø
S1Ø =

Default: 7ØØ milliseconds
Range: 1. .255
Units: 1/1Ø Seconds

Sets time between loss of carrier (distant modem hangs up) and disconnect by Smartmodem

This delay time between carrier loss and disconnect allows short carrier dropouts to occur without initiating a hang up.

The value assigned to S1Ø is adjustable in tenths of seconds. The default value is 7 for a delay time of 7ØØ milliseconds.

Note: If this time is set to a smaller value than the S9 carrier detector response time, any dropout will cause a disconnect because the disconnect timer loaded from S1Ø will time out before the carrier detector response delay expires. The actual length of a dropout which can be tolerated is the difference between S1Ø and S9, i.e., dropout = S1Ø-S9.

Setting S1Ø to 255 will cause the Smartmodem to ignore carrier detect status. The Smartmodem will always act as if a carrier is present. However, the CD indicator light and the RS-232C CD line will follow the true carrier status.

S11?
S11 =

Default: 7Ø milliseconds
Range: 5Ø. .255
Units: Milliseconds

Controls the speed of the Touch-Tone dialer

The default setting, 7Ø milliseconds, sets a dialing rate of 7.14 digits per second. This register sets the duration and spacing of the tones. The minimum length for reliable dialing is 5Ø milliseconds (1Ø digits per second). The rate can be slowed down to 1.9 digits per second by increasing the value assigned in S11 to the maximum value of 255. Note that this has no effect on pulse dialing which is fixed at 1Ø pulses per second.

S12?
S12 =

Default: 1 second
Range: 2Ø. .255
Units: 1/5Ø seconds

Controls the escape guard time

The escape guard time is the specific wait time required prior to and immediately after entering the escape code. The guard time is in units of 2Ø milliseconds (1/5Ø second)

and, as is the case with all **S** registers, has a maximum value of 255 (5.1 seconds).

If you define the guard time to be zero, timing will not be a factor at all. The three escape characters can occur with any timing relationship, but they *must* be consecutive.

Be cautious when assigning small guard times. You may not be able to enter three characters fast enough, especially if the guard time is less than one character time at your baud rate.

The Smartmodem must know what your baud rate is before it can recognize the escape code. If you originate the call, this is no problem since the **AT** attention code causes the Smartmodem to lock on to the proper baud rate. However, if the Smartmodem were turned on and then answered an incoming call before receiving any commands, it will be set to the default speed of 3ØØ baud. If the receiving terminal or device is running at any other speed, it will not be able to give an escape code to the Smartmodem.

See Chapter 3 for instructions on using the escape code.

S13?

Bit mapped

UART Status Register

This register is bit mapped. Only the experienced programmer will require more information on this register for specialized programming. Consult Chapter 9 for this data.

S14?

Bit mapped

Option Register

This register is bit mapped. Only experienced programmers will require more information on this register for specialized programming. Consult Chapter 9 for this data.

S15?

Bit mapped

Flag Register

This register is bit mapped. Only experienced programmers will require more information on this register for specialized programs. Consult Chapter 9 for this data.

S16?
S16=

Default: Ø
Range: Ø. .1

Flag register used to put Smartmodem into self-test or loopback mode

The only valid values that can be assigned to S16 are 1 and Ø. When S16 contains a 1, the Smartmodem will be in loopback mode. This means that the transmitter will be tuned to the same frequency as the receiver allowing transmitted data to read back through the Smartmodem.

The modular telephone plug should be disconnected from the back panel of the Smartmodem or from the wall jack before doing a loopback test. This is necessary because the Smartmodem will go off-hook during the test. Therefore, if you fail to disconnect the phone plug, the normal phone line noises (busy signal, etc.) will distort the loopback test.

The following command lines are used to put the Smartmodem into the loopback mode.

EXAMPLE: TO TEST ORIGINATE MODE,

***Enter:* AT S16=1 C1 D**

EXAMPLE: TO TEST ANSWER MODE,

***Enter:* AT S16=1 A**

The Smartmodem will respond with a CONNECT result code and echo back all data that is transmitted. Note that the C1 in the first example is required to force the carrier transmitter to turn on before carrier detect when in originate mode.

Chapter 8
CONFIGURATION SWITCHES

As mentioned in Chapter 2, with the configuration switches positioned according to the factory setting, the Smartmodem will function effectively in any of the operational modes, i.e., with a terminal, printer or computer equipment configuration. However, for optimum results some adjustments may be desired to "fine tune" the Smartmodem for a particular operational mode.

SWITCHES 2, 3, 4 AND 5

It is important to note that the configuration switches are read only when power to the Smartmodem is turned on or when a **Z** (reset) command is given. After power to the Smartmodem is turned on, you can override the switch settings for switches 2, 3, 4 and 5 by simply sending a command to the Smartmodem.

To illustrate this, the conditions that are established by setting configuration switches 2, 3, 4, and 5 as follows:

EXAMPLE:

SWITCH 2 = UP
SWITCH 3 = UP
SWITCH 4 = DOWN
SWITCH 5 = UP

are the same as the conditions, achieved by:

EXAMPLE:

TURN POWER ON

Enter: **AT V1 Q1 EØ SØ = 1** (Verbose result codes, quiet mode, no echo in command mode, auto-answer on ring 1)

Therefore, it is recommended that you set the configuration switches once according to the operational mode that you will be using most frequently with your Smartmodem. Then, whenever desired, override the settings for switches 2, 3, 4 and 5 by command.

SWITCHES 1, 6 AND 7

The settings for configuration switches 1, 6 and 7 cannot be overridden by command; they can only be changed manually. The functions of these switch settings are discussed below in Notes A, B and C, respectively.

Note A Switch 1

For the Smartmodem to execute commands, it must receive a signal that the data terminal (terminal or computer) is ready to send or receive data. This signal is controlled by the RS-232C DTR (Data

Terminal Ready) lead (pin 2Ø). However, many terminals and computers do not support the DTR signal.

Placing configuration switch 1 in the DOWN (factory) setting overrides the DTR. Therefore, as soon as power to the Smartmodem is turned on, this override makes the Smartmodem "assume" DTR is on (logic TRUE) and enables the Smartmodem to execute commands.

If your computer does support DTR, configuration switch 1 may be left in the DOWN position. However, for some applications you may prefer to place this switch in the UP position. In this setting, when power to the computer is turned off, the Smartmodem will be disabled. You can also cause the Smartmodem to hang up when in the on-line state by setting DTR to the logic FALSE state.

Note B
Switch 6

Usually modems only send characters to your computer when they are in an on-line state; i.e., receiving characters from a distant modem and transmitting these characters to your computer. In this on-line state the RS-232C Carrier Detect lead (pin 8) sends a positive voltage indicating there is a carrier on-line. Most computers will not accept any transmitted characters unless this signal is ON (i.e., logic TRUE).

The Smartmodem, however, not only sends characters to your computer when on-line, it also sends characters when it is in command state. That is, the Smartmodem echoes locally received characters and sends result codes. In this command state there is no signal from the RS-232C Carrier Detect lead, since the data is not coming from a distant modem.

To make the computer accept the locally echoed characters and result codes, configuration switch 6 is placed in the DOWN position. This setting makes the RS-232C carrier lead TRUE (ON) at all times. In essence it "fools" the computer into thinking there is a carrier on-line thereby making it accept the data from the Smartmodem.

Some computers can read the status of the Carrier Detect lead *and* still receive and read data from the Smartmodem regardless of the status of that lead; i.e., carrier detect TRUE (ON), carrier detect FALSE (OFF). In other words, there is no need to force the computer into "thinking" there is a carrier on-line. If your computer has this capability, you may elect to place configuration switch 6 in the UP position. This will enable your computer to read the RS-232C carrier lead to determine if there actually is a carrier on-line.

Note C
Switch 7

The setting of this switch depends on the type of modular telephone jack you are plugged into. For single line installations connected to an RJ11 phone jack, the switch must be in the UP position; for multiline key set installations connected to an RJ12 or RJ13 phone jack, the switch should be in the DOWN position.

TYPICAL SETTINGS

The functions of the configuration switches in both the UP and DOWN positions are defined in Table 3. Typical settings for the various operational modes are specified in Table 4. For an explanation of Notes A, B and C in Tables 3 and 4, refer to the previous discussion of configuration switch 1 (Note A), switch 6 (Note B) and switch 7 (Note C).

TABLE 3
CONFIGURATION SWITCHES — FUNCTIONS

SWITCH	ASSOCIATED COMMAND	POSITION	FUNCTION
1	NONE	UP	Setting that may be used if your computer supports RS-232C DTR lead (pin 2Ø). If your computer supports this signal, then the Smartmodem can be made to hang up or not answer calls by making this lead false. TR indicator light only comes on when modem is powered on *and* power to the terminal or computer is on. (Note A.)
		DOWN	Setting that must always be used if your computer does not support RS-232C DTR lead (pin 2Ø). Makes Smartmodem ignore state of RS-232C Data Terminal Ready (pin 2Ø) lead and assume it's logic TRUE always. Terminal ready (TR) indicator light is always on when modem is powered. (Note A.)
2	V1	UP	Verbose. Result codes are sent in English words.
	VØ	DOWN	Non-verbose. Result codes are sent as single digits (Ø. . .4).
3	Q1	UP	Quiet. No result codes are sent. Used, for example, with a printer that only receives data and does not require printouts of result codes.
	QØ	DOWN	Non-quiet. Result codes are sent to your terminal screen.
4	E1	UP	Smartmodem will echo characters while in the local command state (i.e., on hook).

TABLE 3 continued
CONFIGURATION SWITCHES — FUNCTIONS

SWITCH	ASSOCIATED COMMAND	POSITION	FUNCTION
	E0	DOWN	Smartmodem will not echo characters unless half duplex is selected and the modem is in on-line state.
5	S0=1	UP	Smartmodem will automatically answer incoming calls on the first ring unless changed by the S command.
	S0=0	DOWN	Modem will not answer phone if it rings.
6	NONE	UP	In on-line mode enables computer connected to the Smartmodem to determine if a carrier signal is coming from a distant modem by reading the status of the RS-232C Carrier Detect lead. (Note B.)
		DOWN	Forces the computer to accept locally echoed characters and result codes from Smartmodem. (Note B.) The RS-232C Carrier Detect lead (pin 8) will be logic TRUE at all times even if no carrier is being received.
7	NONE	UP	Required setting for use with single line phone installations connected to an RJ11 jack.
		DOWN	Setting with multiline key set installations connected to an RJ12 or RJ13 phone jack; this setting will make the lamp on the phone light when the Smartmodem goes off hook; i.e., "picks up the phone."
8	—	DOES NOT MATTER	Switch not used.

TABLE 4
CONFIGURATION SWITCHES —
TYPICAL SETTINGS FOR VARIOUS MODES OF OPERATION

SWITCH NUMBER	POSITION	FUNCTION	FACTORY SETTING	TERMINAL MODE	COMPUTER REMOTE CONSOLE MODE	COMPUTER MODE ORIGINATE/ ANSWER
1	UP DOWN	See Table 3	X	X	Note A	Note A
2	UP DOWN	See Table 3	X	X	X	X
3	UP DOWN	See Table 3	X	X	X	X
4	UP DOWN	See Table 3	X	X	X	X
5	UP DOWN	See Table 3	X	Note D	X	X
6	UP DOWN	See Table 3	X	X	Note B	Note B
7	UP DOWN	See Table 3	X	Note C	Note C	Note C
8	NOT USED					

Notes A, B and C see text discussion of configuration switches 1, 6 and 7.
Note D: On only if auto-answer is desired.

Chapter 9
PROGRAMMING CONSIDERATIONS

PROGRAMMING CONSIDERATIONS

When using a computer to issue commands to the Smartmodem under program control, several subtle programming details must be considered.

1. Do not send any data to the Smartmodem while it is in local command state unless the data is intended to be a command. Random data can confuse the baud rate detector and the command decoder giving unpredictable results.

   Make certain the computer does not echo the Smartmodem result codes back to the Smartmodem! They are "random data" to the Smartmodem.

2. The Smartmodem will wait at least 250 milliseconds from the time a command is accepted and a result code is generated. For the computer to catch the result code, it must be ready within this time period.

   Also, the Smartmodem will not accept any commands or data until it has executed the previous command line and sent a result code. Some commands, such as "Dial", require a longer timeframe to execute.

3. Be sure the computer knows which major state (i.e., local command state or on-line state) the Smartmodem is in at all times. This is very important when using the Smartmodem in answer mode for remote console operation.

   For example, if the originating modem hangs up, the answering Smartmodem would also hang up and return to the local command state. If the computer was engaged in a memory dump, file listing, or other data transmission activity at that time, the Smartmodem would receive this as random data while in the local command state. To prevent this from occurring, you should allow the computer to sense the RS-232C Carrier Detect lead from the Smartmodem. If this lead goes FALSE, the computer should stop sending data immediately.

4. It may be desirable to disable the escape code operations completely if the Smartmodem is used in answer mode with a computer in full-duplex mode. Since the computer will echo all incoming characters back to the Smartmodem, any data which conformed to the escape code specifications would cause the Smartmodem to enter the local command state. The computer would probably not recognize this and continue to send data or wait forever for characters from the distant modem.

The Smartmodem will *not* detect loss of carrier when in the local command state, therefore, even if the distant modem hung up, the Smartmodem would remain on the line until the computer sent a hang up command or caused the RS-232C DTR lead (pin 2Ø) to go logic FALSE.

The escape code can be disabled by setting S2 to any number between 128 and 255. It is recommended that the computer be programmed so that it checks the RS-232C Carrier Detect lead (pin 8) and sets the DTR lead (pin 2Ø) FALSE to hang up if the carrier is lost. This will completely avoid the need for escape codes in answer only applications such as bulletin board systems.

5. To use the escape code immediately after a CONNECT result code, the escape code must be preceded by any character or key.

EXAMPLE:

Enter: **Any Character**

WAIT 1 SECOND

Enter: + + +

WAIT 1 SECOND

BIT MAPPED REGISTERS

Registers S13, S14 and S15 are bit mapped which means each bit in the 8 bit byte has a function or meaning. These registers are used by the Smartmodem's Z8 microprocessor to control various functions. They were made accessible to allow automatic factory testing and are not intended to be a means of controlling the Smartmodem. However, some potentially useful information can be obtained by reading these three registers.

The undefined bits may be 1 or Ø at random.

S13?	bit Ø		undefined
UART Status Register	bit 1		undefined
	bit 2	Ø	parity disabled
		1	parity enabled
	bit 3	Ø	odd parity
		1	even parity
	bit 4	Ø	7 data bits
		1	8 data bits
	bit 5		undefined

	bit 6	1	buffer overflow flag (causes 'ERROR' result code to be sent)
	bit 7	0	8th data bit set to space (if bit 4 = 1)
		1	8th data bit set to mark (if bit 4 = 1)
S14?	bit 0		holds the state of switch 5 (auto-answer) at the time power was first turned on or a reset command was executed.
Option Register		0	switch 5 down
		1	switch 5 up
	bit 1	0	local echo disabled
		1	local echo enabled
	bit 2	0	result codes enabled (non-quiet)
		1	result codes disabled (quiet mode)
	bit 3	0	result codes sent as digits 0. .4 (non-verbose)
		1	result codes sent as words (verbose)
	bit 4		undefined
	bit 5		undefined
	bit 6	1	speaker enabled until carrier detected
	bit 7	1	speaker enabled always

Note: Both bits 6 and 7 must be zero to turn off speaker.

S15?	bit 0	0	answer mode
		1	originate mode
Flag Register	bit 1		undefined
	bit 2	0	half-duplex
		1	full-duplex
	bit 3		undefined
	bit 4		undefined

bit 5		undefined
bit 6		internal ring indicator. Setting this bit triggers a "RING" result code.
bit 7	Ø	pulse dialing mode
	1	tone dialing mode

Chapter 10
BACKGROUND INFORMATION

MODEMS

A modem is a data transmission device that allows terminal-computer and computer-computer communicaton over a telephone line. The primary reason for the development and popularity of modems is economic. Modems allow information to be moved, on demand, from one place to another at very low energy cost.

To communicate over a telephone line, the computer or terminal at each end of the line must be equipped with a modem. The modem at the sending end converts binary digital data (ones and zeros) from the terminal or computer into analog signals (suitable for transmission over a telephone line). The modem at the receiving end reverses the process. The word modem is a contraction for MOdulator-DEModulator. A modulator is a device that changes digital data to analog signals and a demodulator changes analog signals back into digital data.

Traditionally modems only transmit characters to the local data terminal (computer or terminal) when in an on-line state; i.e., the modem is receiving characters from a distant modem over the phone line and in turn transmits these characters to the local computer or terminal.

The Smartmodem also communicates data to the local computer or terminal when it is not in the on-line state. In what is called the "local command state," commands sent to the Smartmodem via terminal keyboard or program control are echoed back locally. After analyzing and executing the commands, the Smartmodem sends result codes to the local computer or terminal.

The Hayes Stack Smartmodem is designed to be completely compatible with the communication frequencies and modulation techniques of the Bell System (Western Electric) Model 103 low speed modem. The Bell System 103 modem and its various equivalents are the most widely used type of modem in North America. It is used by virtually all time-sharing systems as their standard mode of access. This popularity is due to the simplicity of the 103's FSK (frequency shift keying) modulation technique, the reasonable cost of the circuitry required to implement it and the number of Model 103 compatible modems already installed with which to communicate.

The Smartmodem is designed for use with RS-232C compatible terminals, computers or receive-only devices. It is programmable and can be controlled in any language by a string of ASCII characters.

HISTORY

Modems were first developed by the telephone company which claimed that modems were a part of the telephone system and therefore a part of its protected monopoly. The claim was not disputed until the development of the acoustic coupler, a modem that is not directly wired to the telephone line. The acoustic coupler transmits and receives data by "listening" and "speaking" through the handset of a regular telephone. The telephone company claimed the acoustic coupler was an illegal device and use of one could result in termination of telephone service. As a result of this claim, the Carterphone Company, a manufacturer of an acoustically-coupled device for use with two-way mobile radios, was forced out of business and filed suit against the telephone company. The Supreme Court decided in favor of Carterphone and ruled the acoustic couplers were legal devices. More recent decisions have broadened the regulations for interconnect, giving the FCC power to license devices for use with the telephone network and limiting the telephone company's protected monopoly to the running of the network which connects telephones together.

As smaller, less expensive microcomputers have become more widespread, the Bell 103-type modem has become increasingly popular.

PULSE AND TOUCH-TONE DIALING

When used in originate (dialing) mode, most modems are only capable of utilizing pulse dialing. Both Touch-Tone and pulse dialing modes are used by the Smartmodem. This permits connection to any phone system in the United States.

TRANS-MISSION SPEED

Transmission speed is the speed at which data is transmitted over a communications line. This speed is expressed in bits per second. It takes several bits to determine a character, and the number of bits in a character depends on the transmission code and transmission techniques used. Each bit transmitted requires a specific amount of time on the line, and the bit rate or bits per second (bps) is the reciprocal of this amount of time. Normal data transmission is handled by 7 or 8 bits to produce a character plus added control bits which normally expand the number of bits per character by 2 or 3.

A modem that transmits data at 110 bits per second or 10 characters per second (cps) is referred to as having a 110 baud rate. Likewise, a 300 baud rate denotes that data is being transmitted at a speed of up to 300 or 30 cps.

By far, the largest number of modems in use are the 0-300 bps variety. These units are used for interactive terminal-computer and computer-computer communications, data acquisition, time sharing and data logging, financial transactions and information utility applications. Almost all 0-300 bps modems in the U.S., including acoustic couplers, are compatible with the Bell System standard 103-type modems.

COMMUNICATIONS LINES

The communication line is the connection between computers and terminals. This line is usually classified according to the direction in which it moves data: simplex, full-duplex and half-duplex. A simplex line is one which carries data from one point to another in only one direction. Mass media devices such as TVs and radios are examples of simplex communicatons.

FULL-DUPLEX

A full-duplex line provides two way communicaton by using two communications lines, one going in each direction. The prime example is two-way telephone conversation which allows communications from both directions at the same time. One important feature of a full-duplex modem is echo-plex. When a character is typed, it travels to the distant computer and is echoed back before it appears on the user's screen. The advantage of this echo-plex procedure is that a character garbled on the telephone line will appear garbled on the screen and a character lost in transmission will not appear at all. Most time-sharing and data access systems feature echo-plex.

HALF-DUPLEX

A half-duplex line allows two way communication with only one communicaton line. In most half-duplex systems, the terminal must wait for the computer on the other end to finish before it can transmit data. In other words, you cannot receive data while transmitting data. An example of half-duplex communications is the CB radio which only allows one person to communicate at a time.

The 1Ø3-type modem was designed to take advantage of full-duplex communications lines. Until recently, the Bell 1Ø3-type modem was the only full-duplex modem. Most faster modems for larger computers are half-duplex.

FULL- OR HALF-DUPLEX

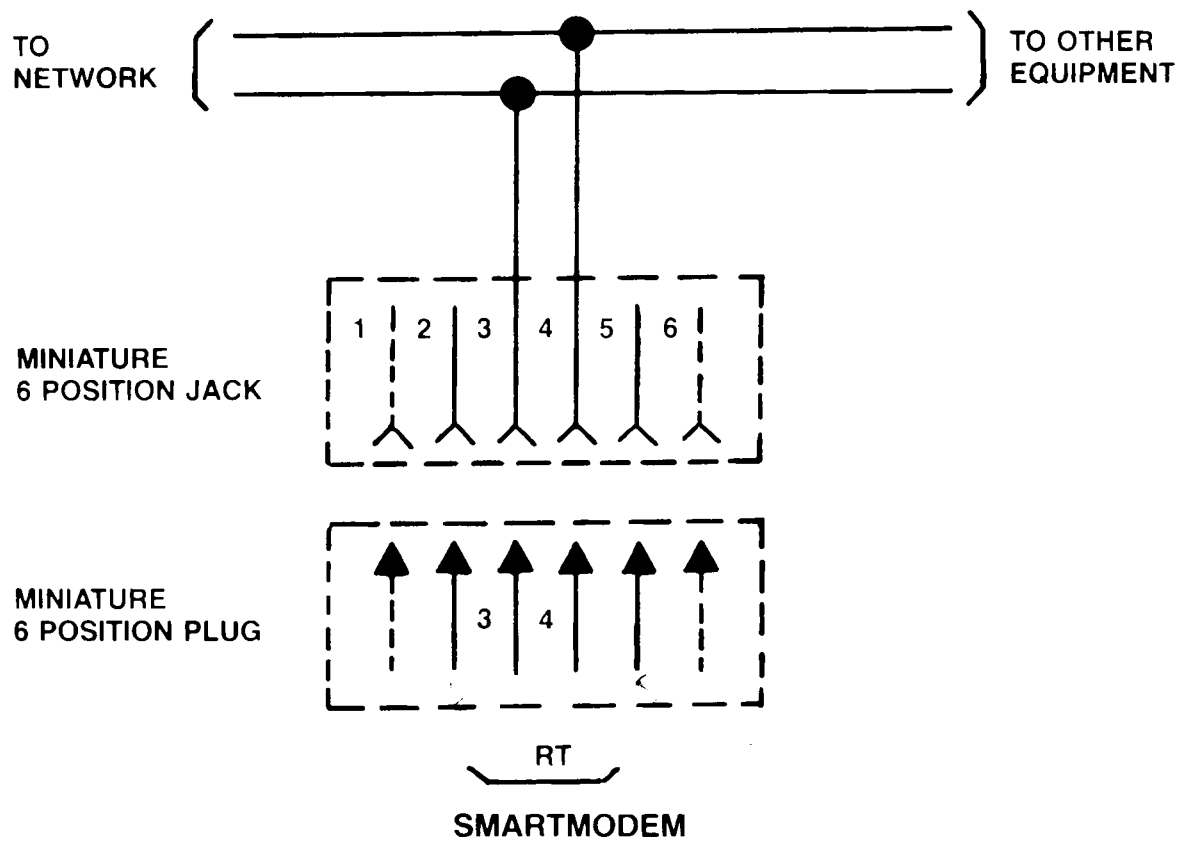
The Smartmodem operates in either full-duplex or half-duplex. Full-duplex is used most frequently since most time-sharing systems operate in full-duplex and feature echo-plex.

When the Smartmodem is connected to a full-duplex terminal or computer and communicates with a half-duplex system, placing the Smartmodem in half-duplex operation mode will force echo-back of characters that are transmitted.

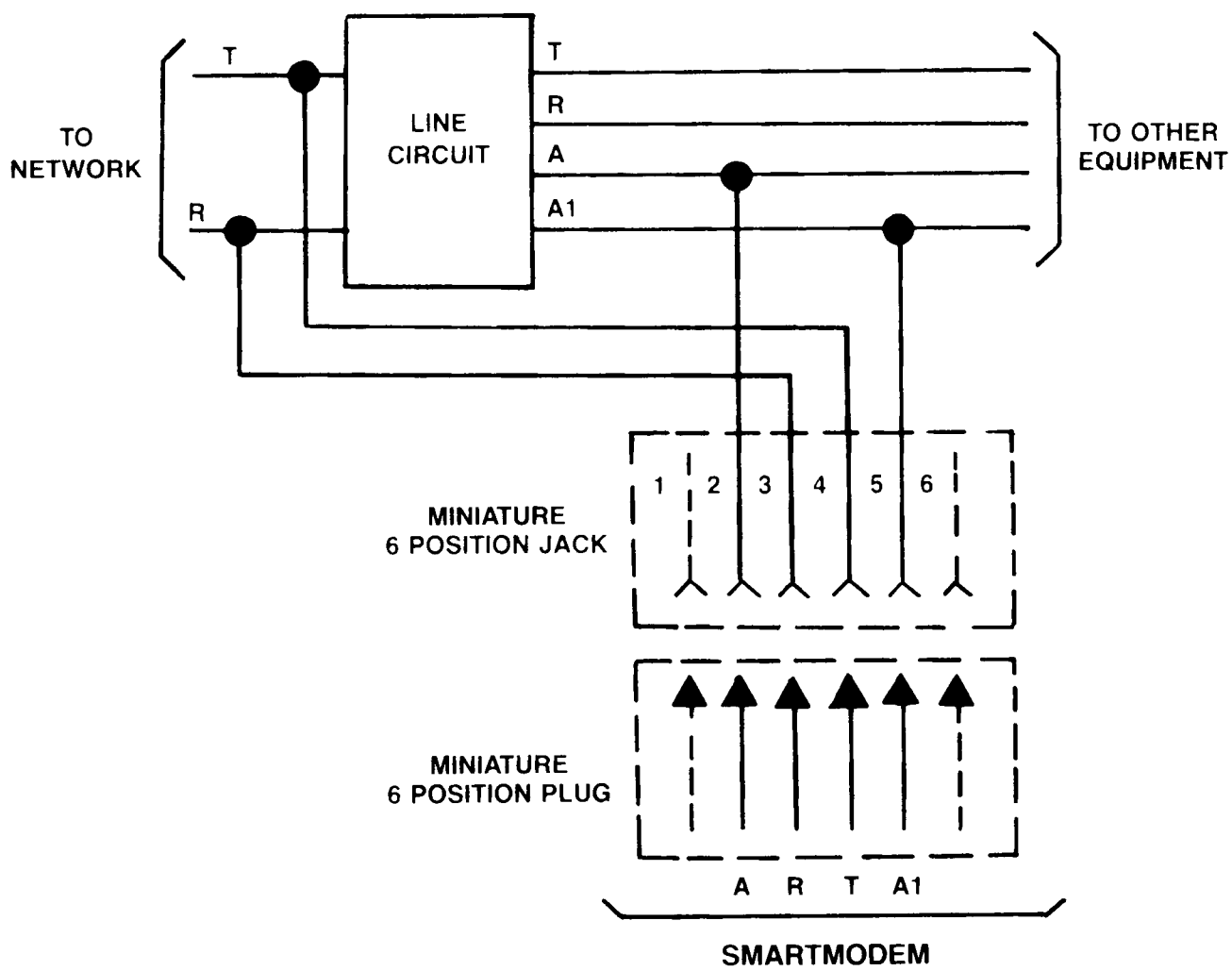
Appendix A
RS-232C CONNECTOR PIN ASSIGNMENTS

PIN NUMBER	CIRCUIT	DESCRIPTION	DIRECTION
1	AA	Protective Ground	NA
2	BA	Transmitted Data	To Smartmodem
3	BB	Received Data	From Smartmodem
5	CB	Clear To Send	From Smartmodem
6	CC	Data Set Ready	From Smartmodem
7	AB	Signal Ground (Common Return)	NA
8	CF	Received Line Signal Detector	From Smartmodem
20	CD	Data Terminal Ready	To Smartmodem
22	CE	Ring Indicator	From Smartmodem

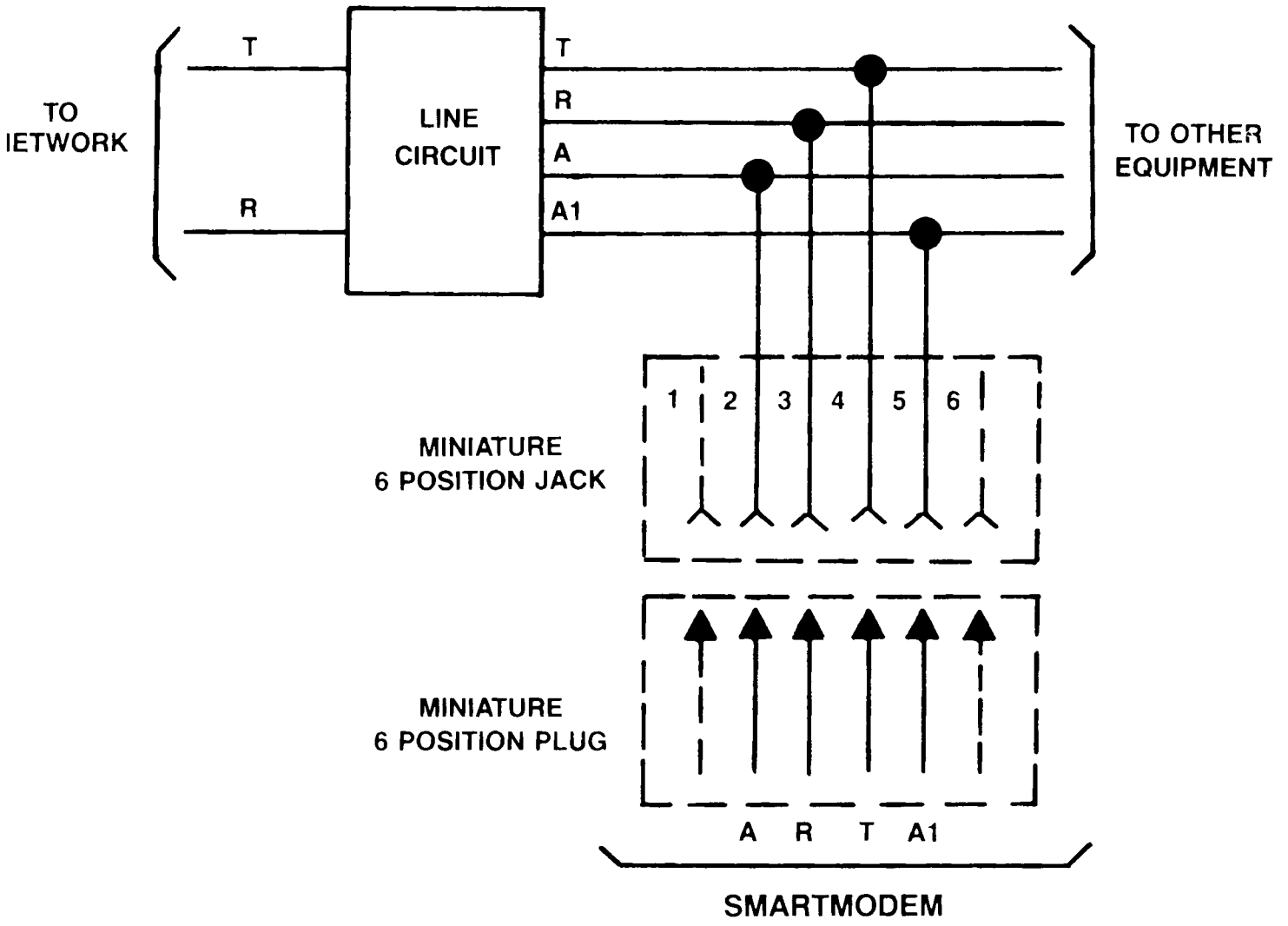
Appendix B
MODULAR PHONE DIAGRAMS, DIAL PULSES, FREQUENCIES



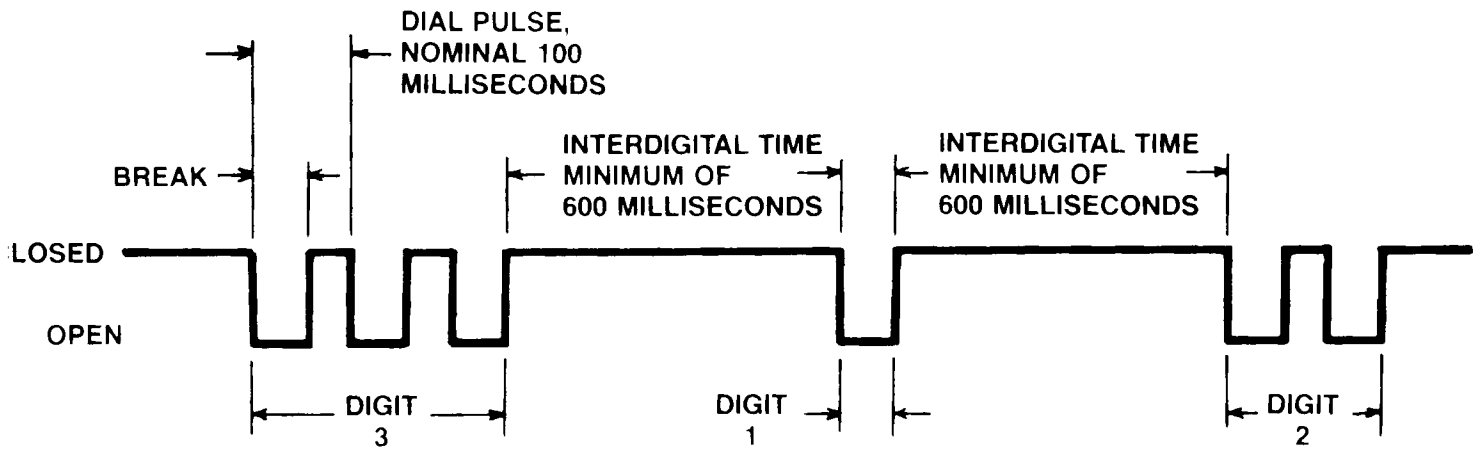
RJ11 Modular Phone Diagram



RJ12 Modular Phone Diagram



RJ13 Modular Phone Diagram



DIAL PULSE RATE-NOMINAL 10 PULSES PER SECOND (8 MIN - 11 MAX.)
PERCENT BREAK-50 MIN - 64 MAX.
INTERDIGITAL TIME - MINIMUM OF 600 MILLISECONDS

Dial Pulses

Low Group (Hz)			
697	1	2	3
770	4	5	6
852	7	8	9
941	*	0	#
	1209	1336	1477

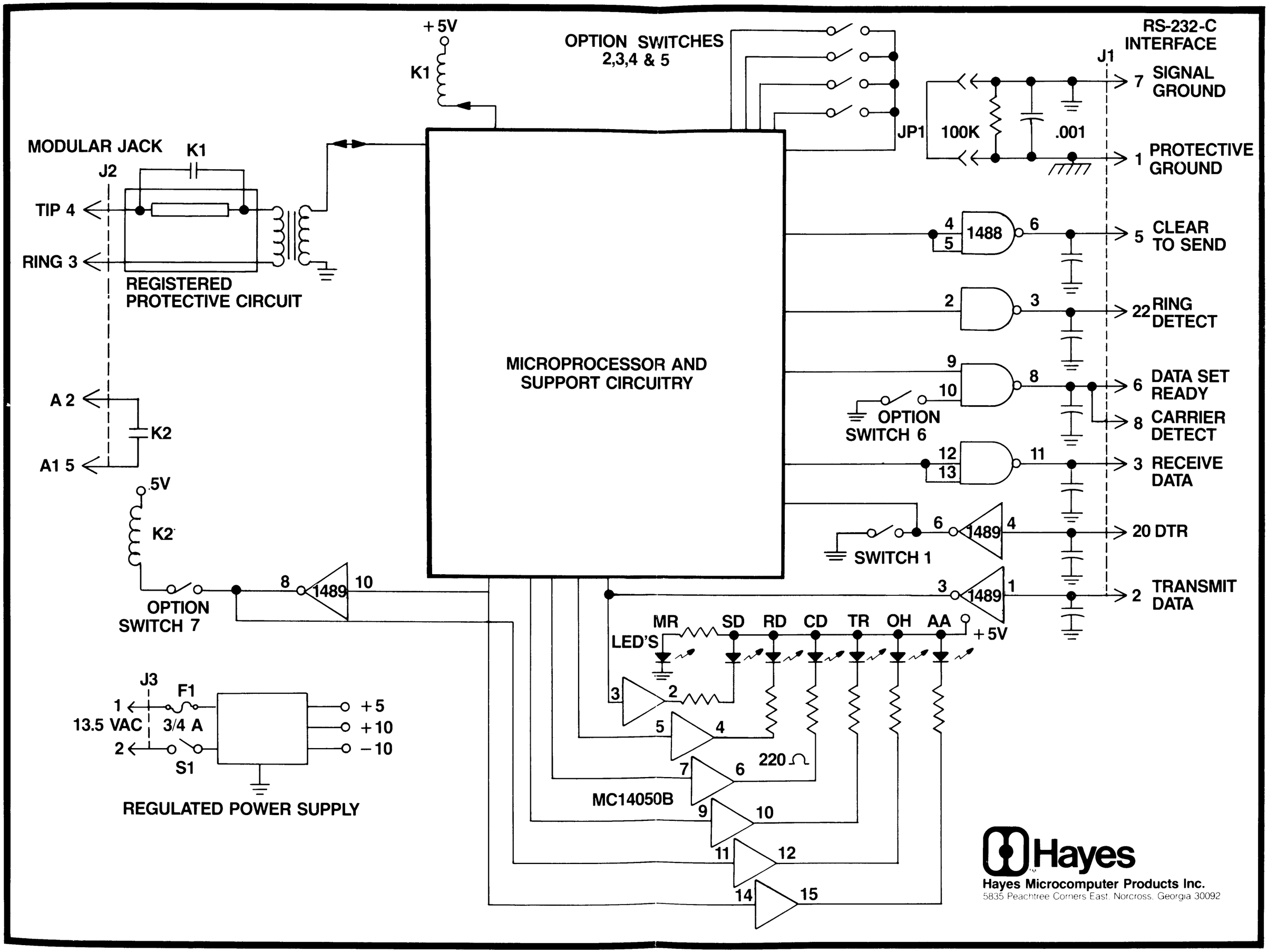
High Group (Hz)

TOUCH-TONE FREQUENCIES

		1 MARK (Hz)	0 SPACE (Hz)
ORIGINATE S16=0	TRANSMITTER RECEIVER	1270 2225	1070 2025
ANSWER S16=0	TRANSMITTER RECEIVER	2225 1270	2025 1070
ORIGINATE LOOPBACK S16=1	TRANSMITTER RECEIVER	2225 2225	2025 2025
ANSWER LOOPBACK S16=1	TRANSMITTER RECEIVER	1270 1270	1070 1070

SMARTMODEM CARRIER FREQUENCIES

Appendix C BLOCK DIAGRAM



Appendix D
SPECIFICATIONS SUMMARY

Data Format	Serial, binary, asynchronous 7 or 8 data bits, 1- or 2-stop bits, odd, even or no parity.
Dialing Capability	Touch-Tone and rotary dial-pulse dialing.
Command Buffer	4Ø characters.
Audio Monitor	Two-inch speaker with volume control.
Rear Panel	On-off switch, power jack, RS-232C connector, modular phone jack connector, monitor volume control.
Operation	Full- or half-duplex.
Data Rate	Ø-3ØØ baud.
Interface	RS-232C.
Intelligence	Z8 microprocessor with 2K byte control program.
Modem Compatibility	Bell System 1Ø3 compatibility originate or answer mode.
Receive Sensitivity	–5ØdBm.
Transmit Level	–1ØdBm.
Registration	FCC Registered for direct-connect to the nationwide phone system. Connects with modular jacks RJ11W, RJ11C, RJ12W, RJ12C, RJ13W, or RJ13C.
Power Pack	U.L. listed 12ØVAC, 6ØHz. 13.5VAC output.
Size	1.5″ × 5.5″ × 9.6″. 38.1 × 139.7 × 243.8 mm 3.81 × 13.97 × 24.38 cm

Appendix E
ASCII CONTROL CHARACTER CODE TABLE

CODE	DEC	CODE	DEC	CODE	DEC	CODE	DEC
NUL	Ø	SP	32	@	64	`	96
CTRL A	1	!	33	A	65	a	97
CTRL B	2	"	34	B	66	b	98
CTRL C	3	#	35	C	67	c	99
CTRL D	4	$	36	D	68	d	1ØØ
CTRL E	5	%	37	E	69	e	1Ø1
CTRL F	6	&	38	F	7Ø	f	1Ø2
CTRL G	7	'	39	G	71	g	1Ø3
CTRL H	8	(	4Ø	H	72	h	1Ø4
CTRL I	9	)	41	I	73	i	1Ø5
CTRL J	1Ø	*	42	J	74	j	1Ø6
CTRL K	11	+	43	K	75	k	1Ø7
CTRL L	12	,	44	L	76	l	1Ø8
CTRL M	13	-	45	M	77	m	1Ø9
CTRL N	14	.	46	N	78	n	11Ø
CTRL O	15	/	47	O	79	o	111
CTRL P	16	Ø	48	P	80	p	112
CTRL Q	17	1	49	Q	81	q	113
CTRL R	18	2	5Ø	R	82	r	114
CTRL S	19	3	51	S	83	s	115
CTRL T	2Ø	4	52	T	84	t	116
CTRL U	21	5	53	U	85	qu	117
CTRL V	22	6	54	V	86	v	118
CTRL W	23	7	55	W	87	w	119
CTRL X	24	8	56	X	88	x	12Ø
CTRL Y	25	9	57	Y	89	y	121
CTRL Z	26	:	58	Z	9Ø	z	122
ESC	27	;	59	[	91	{	123
FS	28	<	6Ø	\	92	|	124
GS	29	=	61	]	93	}	125
RS	3Ø	>	62	^	94	—	126
US	31	?	63	—	95	DEL	127

Appendix F
LOCAL NETWORK WITH TWO SMARTMODEMS

Two Smartmodems can be connected on a pair of wires to form a local network. In this configuration the Smartmodems can be used exactly as if they were connected by telephone lines. No ring signal can be generated with this hookup, so automatic answer is not possible.

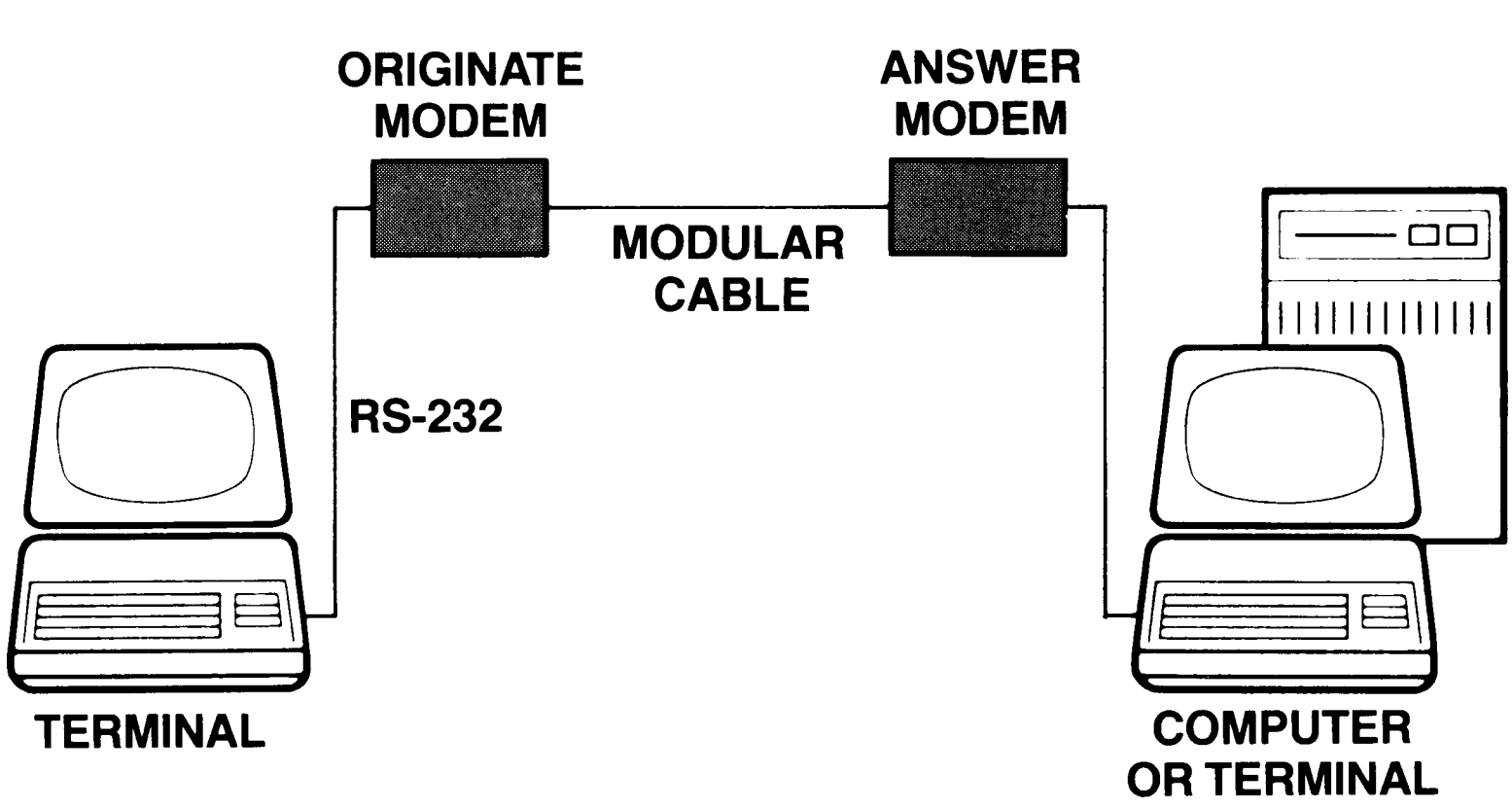
Commands to establish connection:

ORIGINATE MODEM:

Enter: **ATD** (carriage return)

ANSWER MODEM:

Enter: **ATA** (carriage return)



Appendix G
MONITORING A LOW SPEED DATA LINE

The Smartmodem can be used as a "receive only" device to monitor a data line up to 300 baud. For this application, the transmit carrier should be turned OFF; it can be set to ignore loss of carrier, if desired.

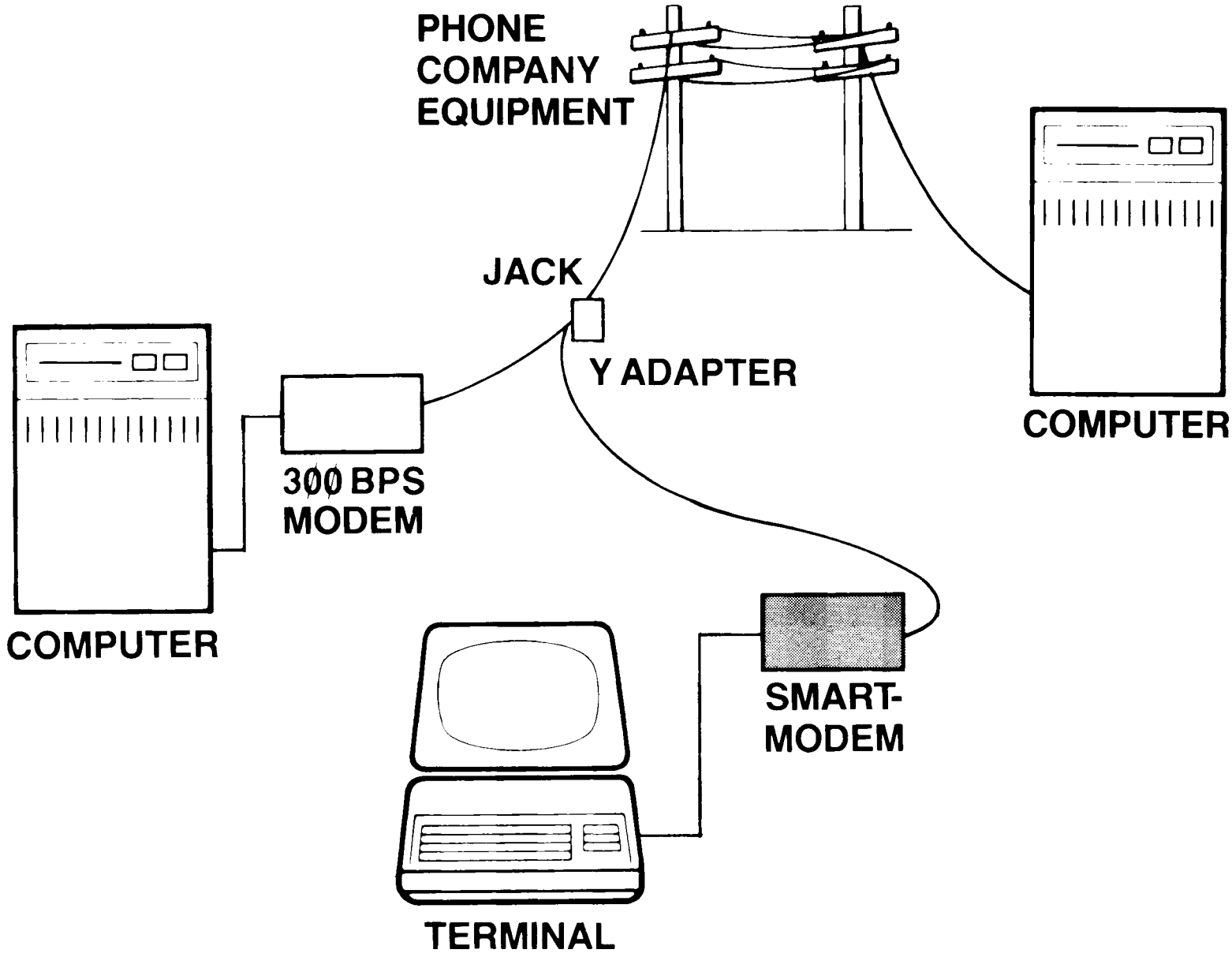
Commands for "receive only" mode:

FOR ORIGINATE:

Enter: **AT C0 S10=255 D** (carriage return)

FOR ANSWER:

Enter: **AT C0 S10=255 A** (carriage return)



Appendix H
AMATEUR RADIO

NOTE: The Smartmodem is specifically designed for direct connection to the telephone lines. If the user chooses, the Smartmodem can be used with radio equipment. Because of the wide variety of radio equipment, adjustments will be required to customize operation with specific equipment. Hayes does not provide hookup diagrams for radio equipment.

Some information pertinent to this application is presented in this Appendix.

The Smartmodem can be connected to amateur radio equipment for RTTY or computer-to-computer operations. Best results will be obtained with AFSK but Direct FSK can be accomplished by feeding the output of the Smartmodem into the microphone jack of an SSB transceiver. Care must be taken to avoid over-modulation.

Since radio is half-duplex, commands must be issued to switch between transmit and receive modes. You can use the auxiliary relay contacts (used for RJ12 or RJ13) to key the transmitter automatically. Caution: These contacts are rated at 10 watts, 1 amp and 250 volts maximum. Do not overload them.

Commands to receive 2225Hz mark, 2025Hz space

Enter: **AT S10=255 C0 H2 D** (carriage return)

- **S10=255** — Ignore carrier detect
- **C0** — Carrier off
- **H2** — Go off hook without closing contacts of aux relay.
- **D** — Originate mode, go on-line

Commands to receive 1270Hz mark, 1070Hz space

Enter: **AT S10=255 C0 H2 A** (carriage return)

- **S10=255** — Ignore carrier detect
- **C0** — Carrier off
- **H2** — Go off hook without closing aux relay contacts
- **A** — Answer Mode

Commands to transmit 2225Hz mark, 2025Hz space

Enter: **AT S10=255 A** (carriage return)

- **AT S10=255** — Ignore carrier detect
- **A** — Answer mode, go off hook (key transmitter)

Commands to transmit 1270Hz Mark, 1070Hz space

Enter: **AT S10=255 D** (carriage return)

- **AT S10=255** — Ignore carrier detect
- **D** — Originate mode, go off hook (key transmitter)

Command to stop transmitting

Enter: **AT H** (carriage return)

"Hang up" command

Station ID In Morse Code

The Smartmodem is capable of sending morse code as well as data. The speed is fixed at 16 baud or 20 words per minute. A "dit" in 62 ms and a "DAH" 186 ms. The frequency is either the originate or answer mark carrier frequencies (2225Hz or 1270Hz).

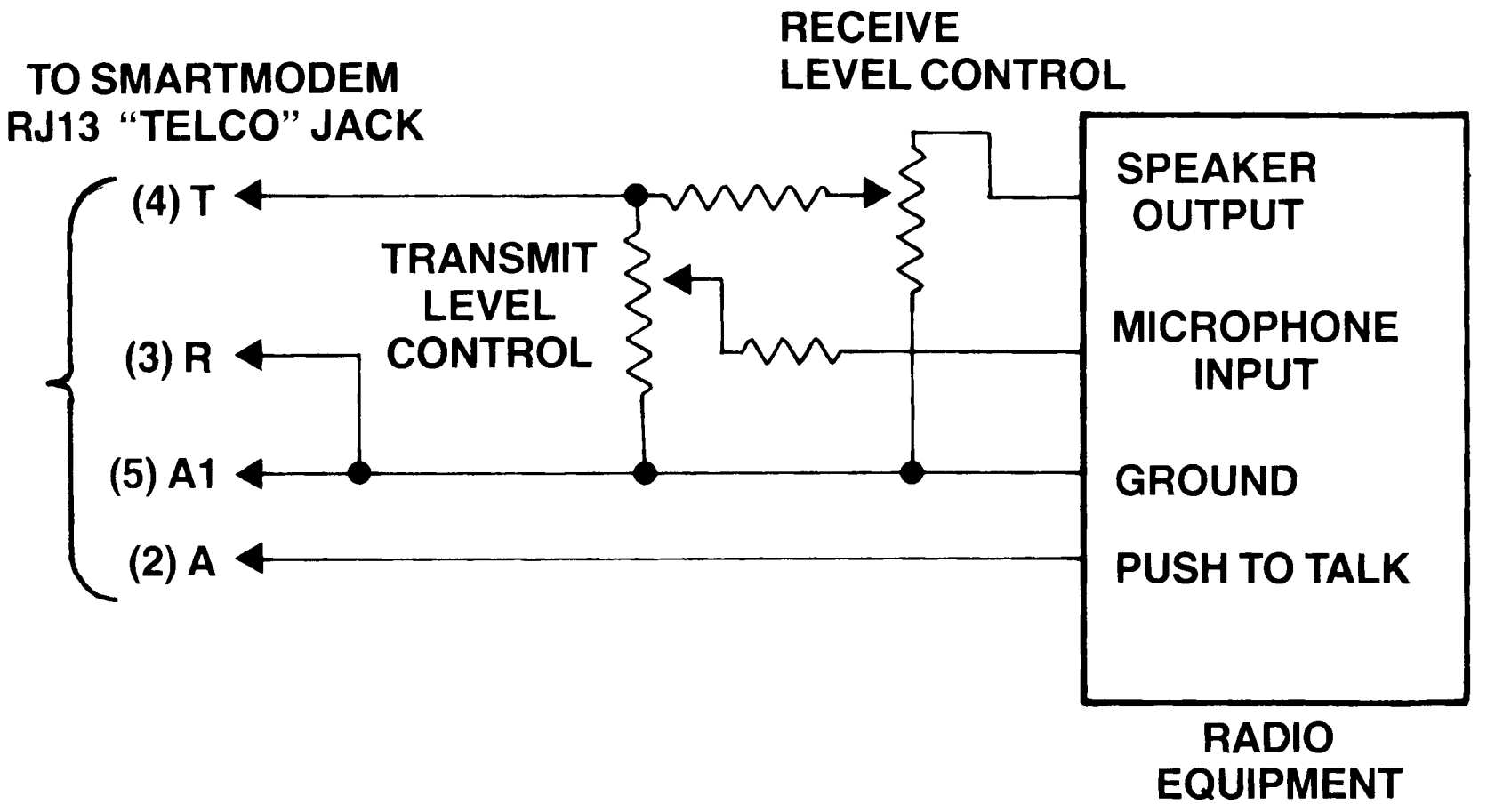
The following command line sends "CQ".

Enter: **AT D; C1 —. —. / — —. — H0** (carriage return)

- **AT D** — Set to originate mode and go "OFF HOOK" (key transmitter)
- **;** — Terminate dial command
- **C1** — Set up carrier
- **—.** — Character pause
- **—** — DIT
- **—** — DAH
- **H0** — Hang up (unkey transmitting)

The Smartmodem cannot *receive* Morse code.

The above example used 127Ø Hz as the tone frequency. To use 2225Hz put an **R** after the **D** command.



A, A1:	Auxiliary relay contacts in the Smartmodem. They are rated at Ø.5 amps max.
T, R:	6ØØ ohm audio lines. Output level – 1Ø dBm. Input level should be greater than – 4Ø dBm.

Appendix I
RETURN FOR REPAIR PROCEDURE

When returning a unit for repair, it must be accompanied by proof of date of purchase. Units returned without proof of date of purchase or out of warranty units will be repaired or replaced (at Hayes' option) and the customer will be charged for parts and labor.

Follow the procedures listed below when returning a Smartmodem to Hayes Microcomputer Products, Inc.

1. Call Hayes Customer Support for a return authorization number (RA number).
2. If possible, pack the Smartmodem in its original molded foam container.
3. If the original container is not available, pack the Smartmodem in a sturdy corrugated box and cushion it with NON-STATIC material such as newsprint. Do not use highly static materials such as plastic wrap or styrofoam based packaging materials (peanuts or beads), as they may further damage the modem in transit.
4. When returning a Smartmodem to the Hayes facility for repair, always include the following information:

   NAME
   ADDRESS
   CITY, STATE, ZIP
   TELEPHONE NUMBER
   RETURN AUTHORIZATION NUMBER
   PROBLEM DESCRIPTION

   A short description of the problem(s) experienced is adequate.
5. All Smartmodems returned to Hayes for repair should be shipped UPS or U.S. Postal Service prepaid. It is recommended that the unit be insured when shipped.

   HAYES MICROCOMPUTER PRODUCTS WILL NOT ACCEPT UNITS THAT HAVE BEEN SENT C.O.D.
6. Mail package to:

   Hayes Microcomputer Products, Inc.
   Attention: Warranty/Repair
   5835A Peachtree Corners East
   Norcross, Georgia 30092
   RA Number

   (Please include RA number on mailing label).
7. HAYES MICROCOMPUTER PRODUCTS WILL NOT ACCEPT UNITS SHIPPED FROM OUTSIDE THE UNITED STATES.

HAYES STACK™ SMARTMODEM
Quick Reference Card

LIST OF COMMANDS

PREFIXES		DESCRIPTION
AT		Attention code precedes all command lines.
A/		Repeat last command line. Replaces AT and no carriage return required.
COMMAND	**PARAMETERS**	**DESCRIPTION**
A		Answer phone in answer mode without any rings.
Cn	n=0..1	n=0 Transmitter off n=1 Transmitter on (default)
Ds	s=0..9 # * T P R , ;	Dial a phone number. T = Touch-Tone P = pulse dial R = reverse modes (answer originate) , = pause ; = terminate dial command
En	n=0..1	n=1 Echo back all characters in command state (default). n=0 Don't echo characters when in command state.
Fn	n=0..1	n= 1 Full duplex (default) n=0 Half duplex
Hn	n=0..1	n=1 Offhook n=0 Onhook (hang up) n=2 Special offhook
Mn	n=0..2	n=2 Speaker on always n=1 Speaker on until carrier detect (default) n=0 Speaker off always
O	NONE	Go on-line and wait for a carrier in the current mode.
P	NONE	Pulse dialing.
Qn	n=0..1	n=1 Quiet, no result codes n=0 Result codes issued (default)
R	NONE	Reverse the normal originate/answer mode.
Sr=n	r=0..16 n=0..255	Sets register "r" to value "n".
Sr?	r=0..16	Reads contents of register r and sends it to computer or terminal as a decimal number with a range of 0..255.
T	NONE	Sets autodialer for Touch-Tone dialing.
Vn	n=0..1	n=1 Result codes transmitted as words (verbose) (default). n=0 Result codes transmitted as single digits (non-verbose).
Z	NONE	Performs a software reset and applies all default values.

RESULT CODES

NON-VERBOSE	VERBOSE	MEANING
0	OK	Command line executed with no errors
1	CONNECT	Carrier has been detected
2	RING	Phone is ringing* (See Note below)
3	NO CARRIER	Carrier lost or never heard
4	ERROR	Error in command line
		Invalid command (command unrecognizable to Smartmodem)
		Command line exceeds command buffer i.e., greater than the maximum 40 characters.

*Note: When the phone rings, the Smartmodem will send a RING result code. However, the Smartmodem will **answer** the phone only if it is in auto-answer status or is given an **A** command.

"S" REGISTERS – FUNCTIONS

REGISTER	RANGE	UNITS	DEFAULT	DESCRIPTION
SØ	0..255	rings	1	Ring to answer on
S1	0..255	rings	Ø	Rings which have occurred
S2	0..127	ASCII	43	Escape code character
S3	0..127	ASCII	13	Character used as carriage return
S4	0..127	ASCII	10	Character used as line feed
S5	0..127	ASCII	8	Character used as back space
S6	1..255	seconds	2	Wait for dial tone time
S7	1..255	seconds	30	Wait for carrier after dialing or answering time
S8	0..255	seconds	2	Sets pause time for comma
S9	1..255	1/10 sec.	6	Carrier detector response time
S10	1..255	1/10 sec.	7	Delay between loss of carrier and hang up
S11	50..255	millisec.	70	Touch-Tone duration and spacing
S12	20..255	1/50 sec.	50	Escape code guard time
S13		bit mapped		UART status register
S14		bit mapped		Option register
S15		bit mapped		Flag register
S16	0..1	none		Loop back control; 1=loop back

CONFIGURATION SWITCHES — FUNCTIONS

SWITCH	ASSOCIATED COMMAND	POSITION	FUNCTION
1	NONE	UP	Supports RS-232C DTR lead.
		DOWN	Ignores RS-232C DTR lead.
2	V1	UP	Verbose result codes.
	VØ	DOWN	Non-verbose result codes.
3	Q1	UP	Quiet. No result codes sent.

	Q0	DOWN	Non-quiet. Result codes are sent.
4	E1	UP	Echo characters when in command state.
	E0	DOWN	No echo unless half duplex is selected and Smartmodem is in on-line state.
5	S0=1	UP	Auto answer first ring.
	S0=0	DOWN	Do not answer.
6	NONE	UP	Reads status of the RS-232C carrier detect lead.
		DOWN	RS-232C carrier detect lead (pin 8) will be logic TRUE at all times even if no carrier is being received.
7	NONE	UP	Setting for use with single line phone installations connected to an RJ11 jack.
		DOWN	Setting with multiline key set installations connected to an RJ12 or RJ13 phone jack.
8	—	DOES NOT MATTER	Not Used.

ASCII CONTROL CHARACTER CODE TABLE

CODE	DEC	CODE	DEC	CODE	DEC	CODE	DEC
NUL	0	SP	32	@	64	`	96
CTRL A	1	!	33	A	65	a	97
CTRL B	2	"	34	B	66	b	98
CTRL C	3	#	35	C	67	c	99
CTRL D	4	$	36	D	68	d	100
CTRL E	5	%	37	E	69	e	101
CTRL F	6	&	38	F	70	f	102
CTRL G	7	'	39	G	71	g	103
CTRL H	8	(	40	H	72	h	104
CTRL I	9	)	41	I	73	i	105
CTRL J	10	*	42	J	74	j	106
CTRL K	11	+	43	K	75	k	107
CTRL L	12	,	44	L	76	l	108
CTRL M	13	-	45	M	77	m	109
CTRL N	14	.	46	N	78	n	110
CTRL O	15	/	47	O	79	o	111
CTRL P	16	0	48	P	80	p	112
CTRL Q	17	1	49	Q	81	q	113
CTRL R	18	2	50	R	82	r	114
CTRL S	19	3	51	S	83	s	115
CTRL T	20	4	52	T	84	t	116
CTRL U	21	5	53	U	85	u	117
CTRL V	22	6	54	V	86	v	118
CTRL W	23	7	55	W	87	w	119
CTRL X	24	8	56	X	88	x	120
CTRL Y	25	9	57	Y	89	y	121
CTRL Z	26	:	58	Z	90	z	122
ESC	27	;	59	[	91	{	123
FS	28	<	60	\	92	|	124
GS	29	=	61	]	93	}	125
RS	30	>	62	^	94	~	126
US	31	?	63	—	95	DEL	127

RS-232C CONNECTOR PIN ASSIGNMENTS

PIN NUMBER	CIRCUIT	DESCRIPTION	DIRECTION
1	AA	Protective Ground	
2	BA	Transmitted Data	To Smartmodem
3	BB	Received Data	From Smartmodem
5	CB	Clear to Send	From Smartmodem
6	CC	Data Set Ready	From Smartmodem
7	AB	Signal Ground (Common Return)	
8	CF	Received Line Signal Detector	From Smartmodem
20	CD	Data Terminal Ready	To Smartmodem
22	CE	Ring Indicator	From Smartmodem

SPECIFICATIONS SUMMARY

Data Format	Serial, binary, asynchronous 7 or 8 data bits, 1-or 2-stop bits, odd, even or no parity.
Dialing Capability	Touch-Tone and rotary dial-pulse dialing.
Command Buffer	40 characters.
Audio Monitor	Two-inch speaker with volume control.
Rear Panel	On-off switch, power jack, RS-232C connector, modular phone jack connector, monitor volume control.
Operation	Full or half duplex.
Data Rate	0-300 baud.
Interface	RS-232C.
Intelligence	Z8 Microprocessor with 2K byte control program.
Modem Compatibility	Bell System 103 compatible originate or answer mode.
Receive Sensitivity	-50dBm.
Transmit Level	-10dBm.
Power Pack	U.L. listed 120VAC, 60Hz. 13.5VAC output.
Size	1.5"x5.5"x9.6" FCC Registered for direct-connect to the nationwide phone system. Connects with modular jacks RJ11W, RJ11C, RJ12W, RJ12C, RJ13W or RJ13C.

FCC Part 68 Registration #BFJ9D9-68737-DME

Certified to comply with the limits for a Class B computing device pursuant to Subpart J of Part 15 of FCC Rules.

SMARTMODEM CARRIER FREQUENCIES

		1 MARK (Hz)	0 SPACE (Hz)
Originate S16=0	Transmitter	1270	1070
	Receiver	2225	2025
Answer S16=0	Transmitter	2225	2025
	Receiver	1270	1070
Originate Loopback S16=1	Transmitter	2225	2025
	Receiver	2225	2025
Answer Loopback S16=1	Transmitter	1270	1070
	Receiver	1270	1070

™Hayes Stack is a trademark of Hayes Microcomputer Products, Inc.

Hayes
Hayes Microcomputer Products Inc.
5835 Peachtree Corners East Norcross, Georgia 30092
Phone: (404) 449-8791

TWO-YEAR LIMITED WARRANTY

Implied warranties limited to duration of express warranty (some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you).

Hayes Microcomputer Products, Inc., warrants to the original owner that each of its products, and all components therein contained will be free from defects in materials and or workmanship for two years from the date of purchase.

In the event of malfunction or other indication of failure attributable directly to faulty workmanship and or material, then, upon return of the product with proof of date-of-purchase to **Hayes Microcomputer Products, Inc.**, 5835 Peachtree Corners East, Norcross, Georgia 30092 (postage paid), **Hayes Microcomputer Products, Inc.**, will, at its option, repair or replace said products or components, to whatever extent it shall deem necessary to restore said product to proper operating condition. During the first two years after the date of purchase all labor and materials will be provided without charge. There shall be no warranty for either parts or labor after the expiration of two years from the date of purchase.

Units must be returned postage prepaid and insured. Units returned without proof of date-of-purchase, or out-of-warranty units returned will be repaired or replaced (at the option of **Hayes Microcomputer Products, Inc.**) and customer will be charged for parts and labor.

Products will be returned to customer after repair or replacement has been completed by carrier and method chosen by **Hayes Microcomputer Products, Inc.**, to any destination within the United States of America. Should the customer desire some other specific form of conveyance, or be located beyond the USA borders, then the customer must bear the cost of return shipment.

The responsibility for the failure of any **Hayes Microcomputer Products, Inc.** computer product, or component thereof, which at the discretion of **Hayes Microcomputer Products, Inc.**, shall have resulted from accident, abuse, or misapplication of the product, shall be assumed by the customer, and **Hayes Microcomputer Products, Inc.** shall assume no liability as a consequence of such events under the terms of this warranty.

While every effort on the part of **Hayes Microcomputer Products, Inc.** has been made to provide clear and accurate technical information on the application of its products, **Hayes Microcomputer Products, Inc.** assumes no liability in any events which may arise from the use of said technical information.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

This warranty is in lieu of all other express warranties which now or hereafter might otherwise arise with respect to this product. Any and all implied warranties, including the warranties of merchantability and fitness for particular use, shall have no greater duration than the duration period for the express written warranty applicable to this product as shown above, and shall terminate automatically at the expiration of such duration period. No action shall be brought for breach of any implied or express warranty after one year subsequent to the expiration of the duration period of the express written warranty.

Incidental and consequential damages caused by malfunction, defect or otherwise and with respect to breach of any express or implied warranty, are not the responsibility of **Hayes Microcomputer Products, Inc.**, and to the extent permitted by law, are hereby excluded both for property and, to the extent not unconscionable, for personal injury damage.

Please note that laws vary from state to state and that some of the provisions of this warranty may not be appropriate to the laws of your jurisdiction.

Hayes™

Hayes Microcomputer Products Inc.
5835 Peachtree Corners East Norcross, Georgia 30092
(404) 449-8791

FOR YOUR RECORDS

Fill out the following information for your records. It is very helpful when discussing repair questions with the factory.

PRODUCT

SERIAL NO.

PLACE OF PURCHASE

DATE OF PURCHASE

Hayes Microcomputer Products Inc.
5835 Peachtree Corners East, Norcross, Georgia 30092
98-107 1181
Printed in U.S.A.