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This Supplement is designed for use with the latest MAN0047 User Manual.

Supplement for ASCII BASIC Module MODEM Option

HE693ASC920, HE693ASC940

PREFACE

This manual explains how to use the MODEM option installed on the Horner Electric ASCII BASIC Module and accompanying software.

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ABOUT THE PROGRAMMING EXAMPLES

The example programs and program segments in this manual and provided on the accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner Electric cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the ASCII BASIC Module to appropriately design the end system, to appropriately integrate the ASCII BASIC Module and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

The programming examples shown in this manual have not been tested with the ASC900, ASC920 or the ASC940. Contact Horner Electric for specific help on an example or for an updated manual when available.

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|  CHAPTER 1 : INTRODUCTION                 |
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The ASCII BASIC Module that you have received is equipped with an on-board 2400 baud telecommunication device known as a "MODEM". The modem is an intelligent data communications system, that analyzes and executes commands and sends result codes in decimal digit or optional English word form. The modem commands can be executed from the ASCII BASIC command mode, or from within a BASIC program.

The modem can be used to call and communicate with time sharing systems, other modem-equipped ASCII BASIC Modules, or virtually any other modem-equipped computer. It can also automatically answer incoming calls from distant systems. The MODEM option has all the circuitry required for auto-answering, auto-dialing, DTMF Touch Tone generation and call progress monitoring.

1.2   Modem Option Features

The MODEM option uses the Hayes Standard Command Set, which is in widespread use by intelligent modems. All configuration settings and diagnostic features can be invoked using the PRINT# BASIC statement. All of the modem response messages can be accessed using the INPUT# BASIC statement. Both of these statements are discussed in CHAPTER 4 of the ASCII BASIC Module User's Manual.

The modem option is FCC Part 68 Registered and is fully Bell 212A/103 and CCITT V.22 bis, V.22 and V.21 compatible. See Appendix D and Appendix E for more information about the modem specifications.

1.2   Hardware Overview

The following block diagram illustrates the components that comprise your modem option.

```
+--------------+            +-----------+     +-------------+
| ASCII BASIC  |  Parallel  |           |     | Telephone   |    +-----------+
|   Module     | Interface  | 8250 UART |     | Interface   |    |   RJ11    |
|  Processor   |            |           |     | Circuitry   |    +-----------+
|              |            |           | Serial |  and     |    | Telephone |
|              |            |           | Interface| CMD PRC |    | Interface |
+--------------+            +-----------+     +-------------+
```
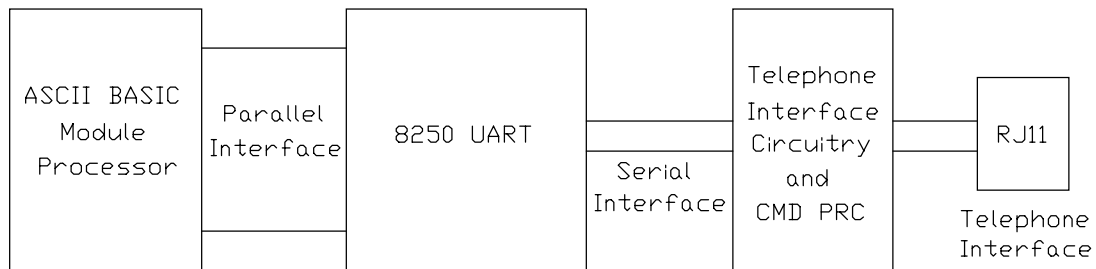
1.2.1   ASCII Basic Module Interface

The ASCII BASIC Module accesses the MODEM option via its parallel interface. The modem option's UART is "memory-mapped" which means that the modem's UART registers appear as memory to the ASCII BASIC Module processor.

1.2.2   The 8250B UART

The modem option is equipped with an 8250B Universal Asynchronous Receiver/Transmitter (UART). This device converts the data to be transmitted from the ASCII BASIC Module into a serial stream of bits and sends them at the proper data rate (baud rate). The UART also receives serial data from the remote device and converts it into parallel data for the ASCII BASIC Module. Although the UART performs many other related function, these are its primary tasks.

The modem's UART utilizes 8 byte-wide registers which are located at address 65024 (0FE00H) in the ASCII BASIC Module DATA memory. These UART registers are not to be confused with the modem's "S" registers", the UART registers are only discussed in this manual for completeness and should only be manipulated by very advanced users.

1.2.3   The Telephone Interface

The Telephone Interface is connected serially to the UART. This circuit converts the serial stream of data (both received and transmitted) into the proper frequencies required for telephone data exchange. An RJ11C telephone jack is provided for connection to a standard 2-wire modular telephone jack. The telephone interface circuit also contains the modem's command processor.

```
CHAPTER 2: MODEM OPERATION
```

This section provides information for operating the modem option using the built-in AT Commands and modem "S" Registers.

2.1   Functional Operation

The modem is always in one of two states, the COMMAND state or the ON-LINE state. At power up, the modem assumes the COMMAND state. When in this state, the modem will respond to COMMANDS. All modem COMMANDS must be preceded with the "AT" command specifier string.

Some of the commands may be issued which put the modem in the ON-LINE state (i.e, auto-dial or auto-answer). Once the modem is in the ON-LINE state, all information transmitted or received over the communication line is treated as data, not commands or result codes.

Once the modem is in the ON-LINE state, The escape code (discussed later in this chapter) can be entered to force the modem back into the COMMAND state.

2.1.1   Transmission Speed

Transmission speed (the speed at which data is transmitted and received through the modem, or baud rate) is configured using the SETCOM# BASIC statement. After power-up, the modem is configured for 2400 baud. The modem is only capable of communicating at 300, 1200 and 2400 baud, any attempt to configure other baud rates will cause an Invalid argument error. When the modem answers a call, it detects and adjusts to the transmission speed from the carrier signal of the originating modem.

2.1.2   Result Codes

Result codes are the modem's responses to commands. A command line, followed by a carriage return, causes the modem to execute the command. When the command has been completed, the modem sends a result code.

Result codes may be English words or digits (0-8). Word codes are preceded and followed by a carriage return/line feed sequence. Digit codes are only followed by a carriage return. The result codes and their meanings are summarized in the following table.

2.1.3   Command Guidelines

Attention Code

Commands must begin with the characters "AT" or "at" only. This is referred to as the "AT"tention code. The attention code alerts the modem to prepare for a command sequence.

Character Format

The modem option supports 7 or 8 Data Bits; Odd, Even or no parity, 1 or 2 Stop Bits. The character format is configured using the SETCOM# BASIC statement. At power-up, the modem is configured for no parity, 7 data bits, one stop bit and XON/XOFF handshaking.

Command Line Syntax

A command line may contain multiple commands, which may be separated by spaces (spaces are ignored), and must end with a carriage return <CR> (unless the modem is programmed to recognize a substitute character). Commands following the AT are not executed until a carriage return is received. The backspace character may be used to correct the command line as long as the carriage return has not been entered.

+++   (the ESCAPE code)

+++ is the ESCAPE code that changes the modem from the on-line state to the command state. This code must be preceded and followed by the programmable time guard. (The default time guard value is 1 second).

A/ Command

The A/ command instructs the modem to repeat the last command line stored in the 40 character command buffer. It is commonly used to redial the previous telephone number when a busy signal is encountered. A/ is the ONLY modem command that does not require the AT command specifier. **A carriage return should not be used when using the A/ command**. Each command remains in the command buffer until a new command is entered or power to the modem is turned off.

Carriage Return

The command line must be ended with a carriage return <CR>. The modem will not execute a command (except for the A/ command) until it receives a carriage return. The ASCII character used as carriage return is programmable and is initially set to character 13.

Backspace Key

Editing can be done with the backspace key, prior to pressing <CR>. The backspace key deletes the last character in the command buffer. The backspace key will not delete the AT at the beginning of the command line. The ASCII character used as backspace is programmable and is initially set to character 8.

Missing Parameter

A missing parameter evaluates to the default value. For example, the H command can have a parameter of zero (H0) or one (H1). Since 0 is the default value, ATH alone is the same as ATH0.

Command Buffer

The command buffer has a 40 character capacity which includes punctuation. If the command line exceeds 40 characters, the modem will send an error message and refuse to execute any portion of the command line.

Unimplemented AT Commands

No action will be taken by the modem if an unimplemented command is issued. Whenever an AT command is entered, the modem will respond with the OK result code if the operation was successful. If an unimplemented AT command is attempted, the ERROR result code is returned.

2.2   Modem "AT" Command Definitions

All of the COMMAND mode modem commands are described in this section. Where applicable, the default value for a command is denoted with an asterisk "*". See appendix A for a summary of the AT commands.

ATA
Go Off-Hook and Answer Phone Immediately

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

A/
Repeat Previous Command

The last command executed by the modem will execute again. This command does not require the AT prefix or <CR> termination.

ATBn
Bell/CCITT Mode Select

n = 0 Selects CCITT V.22 operation at 1200 bps, V.21 at 300 bps.
* n = 1 Selects BELL 212A operation at 1200 bps, 103 at 300 bps.

Most 1200 bps modems in the United States operate using the BELL 212A specification. In order to communicate with a modem conforming to the international CCITT V.22 or V.21 standard, issue the B0 command before dialing.

ATD*n*
Dial the Number Immediately Following this Command

Where *n* = digits 0 to 9, the symbols # and *, and may include the dial modifiers listed below.

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

Dial Modifiers:

P	Pulse dial
T	Tone dial
R	Originate call in answer mode
W	Wait for dial tone before dialing
,	Pause (time programmed in S8)
;	Return to command mode after dialing
@	Wait for quiet before dialing
!	Flash (go on hook for .5 seconds, then off hook)

Example: ATDP9WT713,123-4567;

In this example the modem pulse dials a 9 digit number, waits for a dial tone, then tone dials the digits 713. Next, the modem pauses the length of time specified in register S8. It then dials the number 123-4567. Finally, the modem returns to the command mode after the final digit has been dialed.

The **P** modifier causes the modem to pulse or rotary dial at a fixed rate of 10 pulses per second.

The **T** modifier causes the modem to dial using DTMF (Dual-tone multifrequency) signals (the same as those used by "touch-tone" telephones).

The **R** modifier is used to call modems which can communicate only by using the originate mode carrier frequencies. This limitation is common in older modems.

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

The **@** modifier causes the modem to wait, for the time specified by register S7, for one or more rings followed by 5 seconds of silence before processing the next symbol in the dial string. This is useful when accessing systems that do not provide a dial tone.

The **!** modifier causes the modem to go on-hook for 1/2 second. This is equivalent to holding the switch-hook button on your telephone down for 1/2 second. The flash is usually used for transferring calls.

The "**,**" modifier causes the modem to pause for the time specified by register S8. When dialing a long distance service, for example, the modem must first dial the local access number, then pause long enough for the services dial tone. The "," is also useful when dialing from a PBX system where considerable time may elapse between requesting and getting a secondary dial tone or "outside" line.

The "**;**" modifier causes the modem to return to command mode, after dialing without waiting for a carrier or hanging up.

ATE*n*
Echo Back Characters in Command Mode

        n = 0   No characters echoed back to host in command mode.
*   *n* = 1   Echoes back characters to host in command mode.

This command controls the echoing back of commands to the host computer or terminal. In most applications, E1 is set so the user can see what has been typed in. When running in half-duplex mode, the E0 command should be used to avoid having 2 copies of each character displayed on the screen.

ATH*n*
Activate Switch-Hook

*   *n* = 0   Go on-hook (hang-up)
        n = 1   Go off-hook (pick up the phone)

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

H0 may be used to terminate a call after issuing +++ to return to the command state.

Use of the H1 command is generally not required as the modem will automatically answer an incoming call if register S0 is a nonzero value.

ATI*n*
Request Product Code and ROM Checksum

        n = 0   Display product ID code.
        n = 1   Display firmware revision number.
        n = 2   Test internal modem memory.

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

ATL*n*
Volume Control

Not supported, this command controls the modem's speaker volume.

ATM*n*
Speaker On/Off Commands

Not supported, the M commands are used to control a monitor speaker.

ATO*n*
Return to the On-Line State Mode

        $n = 0$ Causes modem to return to the on-line state
* $n = 1$ Remote digital loopback off
        $n = 2$ Remote digital loopback request

When connected to another modem, it may be necessary to go back into command mode (using +++) to enter some command to the modem. After completion of the commands, an ATO command will return the modem to the on-line condition.

The ATO1 and AT02 commands are used in diagnostic testing of the modem. (See chapter 4).

ATQ*n*
Enable/Disable Result Codes (Quiet Mode)

* $n = 0$ Result codes are sent
        $n = 1$ No result codes are sent

The Q commands are used to enable or disable the sending of result codes (such as OK, CONNECT 1200, ERROR, etc.) to the host computer or terminal. In the Q0 default mode, result codes will be returned to the computer. In Q1 mode, no result codes are sent.

ATS*n*?
Read Value Stored in Register S*n*

Where *n* is 0 to 16 inclusive and specifies the register to be read. This command causes the modem to read the value stored in one of the S registers and display it on the screen in decimal format.

ATS*n*=*r*
Store the Value *r* in Register S*n*

Where *n* is 0 to 16 and specifies the register to which the value *r* is assigned. *r* must be between 0 and 255 inclusive and is the value to be stored in register S*n*.

ATV*n*
Sets Result Code Format

        $n = 0$ Selects short-form numeric result codes
* $n = 1$ Selects long-form verbal result codes

ATX *n*
Select Extended Result Code Set

Where *n* = 0,1,2,3, or 4 with the default being X0.

By using the X commands, the user can enable and disable the NO DIALTONE detect, BUSY detect or BLIND DIAL capability functions and send only the CONNECT message after connecting. The table below specifies which functions are enabled depending on which X command was last entered.

Function	X0	X1	X2	X3	X4
BUSY detect				*	*
NO DIALTONE detect			*		*
CONNECT message only	*				
BLIND DIAL enabled	*	*		*	

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

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

The BUSY message, when enabled, informs the user that a busy signal was encountered during the dialing process.

ATY *n*
Long Space Disconnect

*	*n* = 0	Long space disconnect disabled
	n = 1	Long space disconnect enabled

The long-space disconnect, is usually employed as a last resort to regain control of the modem at a remote, unattended location where a manual reset is impractical. In such installations, modems are usually permanently connected by leased lines. The software controlling the remote modem responds to the loss of carrier (caused by the long space) by resetting the modem and attempting to reestablish a data linkage.

When enabled, the modem immediately transmits a space (BREAK) for 4 seconds. If disabled, the modem drops the carrier and disconnects from the line upon receipt of 1.6 seconds of space.

ATZ
Software reset

The Z command causes the modem to perform a software reset and restore all of the default settings. The modem performs a self-test and responds with the OK result code.

2.3   Modem S-Register Definitions

The modem S registers determine the modem's variable parameters. All of the modem's S registers may be read at any time while in the command state. Except for those that are bit mapped, the value of the registers may be changed using modem commands.

S0   Ring to Answer On

The value stored in register S0 determines how many incoming rings are required before the modem will go off-hook and answer the phone. A value of 1 to 255 enables auto-answer mode, and a value of 0 will disable auto-answer mode. The default value is 0.

S1   Ring Count

Register S1 is incremented each time the modem detects an incoming ring signal. This register is cleared if no rings occur over an 8 second interval. The default value is 0.

S2   Escape Code Character

The value stored in register S2 determines the ASCII character which will cause the modem to escape from on-line data mode back to command mode. A string of 3 escape characters preceded and followed by the programmed "guard time" are required to cause an escape. The default value stored in this register is 43 which corresponds to an ASCII "+". S2 can be set to any value from 0 to 127. Values greater than 127 will disable escape code detection. When the escape code is disabled, hang-up can be achieved if the remote modem drops the carrier.

S3   Carriage Return Character

Register S3 stores the ASCII value of the carriage return character and can be set to any value from 0 to 127. The default value is 13.

S4   Line Feed Character

Register S4 stores the ASCII value of the line feed character. The default value is 10. Register S4 may be set to any value from 0 to 127.

S5   Backspace Character

Register S5 stores the ASCII value of the backspace character. The default value is 8. Register S5 may be set to any value from 0 to 32.

S6   Wait for Dial Tone

The value stored in register S6 determines how many seconds, after going off-hook, the modem will wait before dialing the first digit. The delay is used to allow the central office time to detect the off-hook condition and send a dial tone. The default is 2 seconds. Register S6 can be set to any value from 2 to 255.

S7   Wait-Time for Carrier Before Abort

The value stored in register S7 represents how many seconds after it has gone off-hook, the modem will wait to see a carrier signal, or, when using extended result code options X3 or X4, represents how many seconds the originating modem waits for ring-back. The default value is 30 seconds. Register S7 may be set to any value from 1 to 255 seconds.

S8   Pause Time for Comma

Register S8 determines the duration of the dialing pause caused by detecting a "," dial modifier in the dial string. The comma is usually used to wait for a second dial tone when dialing through a PBX. The default value is 2 seconds. Values from 0 to 255 are acceptable.

S9   Carrier Detect Response Time

The value stored in register S9 determines the length of time an incoming data carrier must be present before the modem will recognize it and turn on DCD (Data Carrier Detect). The default value is 6 (tenths of a second). Increasing this value will decrease the chance of detecting a false carrier such as noise or a busy signal. Register S9 may be any value from 1 to 255.

S10   Carrier Loss to Hang Up Delay

Register S10 establishes the delay between the detection of a loss of data carrier and the time when the modem will disconnect. The default value is 7 (tenths of a second). Setting register S10 to 255 causes the modem to ignore the carrier detect status and behave as though a carrier were present.

If register S10 is set to a smaller value than Register S9, any loss of carrier causes a disconnect (the modem times out before the carrier detect response delay expires). The difference between registers S10 and S9 represents the actual length of a momentary loss that can be tolerated. Register S10 can be any value from 1 to 255. The default is 14.

S11   DTMF Digit Duration

Register S11 stores the value which determines the duration for each DTMF (Dual-Tone Multi Frequency) digit in milliseconds and the silence interval between adjacent digits. This represents the speed at which the modem can dial. The default is 75 msec (same as Hayes) and can be any value from 50 to 255 msecs.

S12   Escape Code Guard Time

The S12 register contains the time delay (in units of 20 milliseconds) required both before and after the escape code (+++). Values from 20 to 255 are acceptable and the default value is 50 (1 second).

Registers 13, 14 and 15 are bit-mapped, which means that each individual bit has a separate function or meaning. They are accessible to allow automatic factory testing and verification of modem status. In most cases, however, the modem parameters should be set through the AT command set rather than setting these registers directly. Undefined bits in these registers are not shown in the tables and may be returned as 0 or 1.

S13   Bit-mapped

The S13 register is used to configure the character format used by the modem. The SETCOM# BASIC statement should be used instead of manipulating this register. This register can, however be read to obtain the current state of the modem character format.

Bit	State	Meaning
2	0 1	Parity Disable Parity Enable
3	0 1	Odd Parity Even Parity
4	0 1	7 Data Bits 8 Data Bits
6	1	Buffer Overflow (generates EROR result code)
7	0 1	Space Parity Mark Parity

S14   Bit-mapped

Register S14 is a bit mapped register that returns the state of several of the modem status conditions.

Bit	State	Meaning
1	0 1	No Command Echo Command Echo
2	0 1	Result Codes Enabled Result Codes Disabled
3	0 1	Result Codes Returned as Numbers Result Codes Returned as Words
4	0 1	Enable Command Recognition DIsable COmmand Recognition
5	0 1	67/33% Pulse Dial Make/Break Ratio 61/39% Pulse Dial Make/Break Ratio
6	0 1	CCITT V.22/V.21 Mode Bell 212A/103 Mode
7	0 1	Long Space Disconnect Disabled Long Space Disconnect Enabled

CAUTION: Writing to S14 may produce unpredictable results.

S15   Bit-mapped

Bit	State	Meaning
0 and 1	00 10 01 11	Undefined 110 Baud 300 Baud 1200 Baud
2	0 1	Answer Mode Originate Mode
3	0 1	Half Duplex Full Duplex
4 and 5	0 1	Same as bits 0 and 1
6	0 1	No Connection Conection Established

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CHAPTER 3: TUTORIAL
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This chapter provides ASCII BASIC commands and programming examples that demonstrate how to use the modem option.

3.1   Initial Modem Operation

Install the ASCII BASIC module into the Series 90-30 backplane and establish communications with the module as described in the ASCII BASIC Module User's Manual. Enter the following program **EXACTLY** as shown. Make sure that a comma is placed after both INKEY$ operators in lines 20 and 30.

```
example        0>10 SETCOM# 2400,N,8,1,S        : REM  Configure the modem
               0>20 PRINT INKEY$#,                    : REM  Display data from modem
               0>30 PRINT# INKEY$,                    : REM  Send data to modem
               0>40 GOTO 20                           : REM  Do this forever
               0>RUN
```

This simple program will configure the modem option's communications characteristics and then will send all characters typed at the console device to the modem option. All characters received from the modem will be displayed on the console device. The remainder of this manual assumes that this program is being used.

In order to verify that the modem option is installed and the interface between the modem and the ASCII BASIC Module is functional, type the following modem command string:

```
example        ATZ
```

After a short delay, the modem should respond with the "OK" response. This verifies that the modem/ASCII BASIC Module interface is working correctly. If no response is obtained, make sure that the program was entered correctly and try again. If the modem option still does not respond, refer to chapter 4 for testing and diagnostic procedures.

If the ATZ command was successfully completed, enter the following commands to instruct the modem to return its product ID code and firmware revision number.

```
example        ATII1
               248
               000
               OK
```

3.2   Dialing

The dial command causes the modem to originate a telephone call. With the modem connected to a telephone line, enter the following modem command (if a voice telephone extension is available, the user may "listen in" on the dialing sequence.

```
example        ATD1234567
```

In response to this command, the modem dials the telephone number 1234567 and then waits for a carrier from a distant modem. If no carrier is detected within a given time (the default time is 30 seconds), the modem automatically releases the line and sends a NO CARRIER result code. If a carrier is detected, the modem gives a CONNECT result code and goes on-line, permitting communication with the distant modem.

```
example        ATD9,1234567
```

When placing a call from an office with a telephone connected to a PBX, it is necessary to dial an access code (usually the digit 9) to get an outside line. You can command the modem to pause and wait for the second dial tone by inserting a comma in the telephone number. The default pause time is 2 seconds.

Multiple commas may be used for a greater delay time.

example   ATD 9,,1234567

The modem is capable of using DTMF (touch-tones) or dial pulses when dialing a telephone number. If the dial command does not specify which type to use, the modem defaults to the type last specified. The power-on default value is T.

The T and P commands determine the dialing type. They can be inserted into the telephone number at any point, allowing the dialing type to be changed during the dialing operation.

example   ATDP9,T1234567

The D command forces the modem into the originate mode. To call someone with an originate-only modem, dial the number and set the modem to answer mode (even though you will be originating the call) with the R command. Enter the R (reverse) command at the end of the telephone number.

example   ATD1234567R

Ending the dial command with a carriage return causes the modem to wait for a carrier. Terminate the process by pressing any key.

The modem can be forced to reenter the command state after dialing (without hanging up) by ending the dial command with a semicolon. This is useful when using the modem as an auto-dialer.

Listen for a telephone ringing using a telephone extension. When it is heard, issue the hang up command to the modem. You may then talk to a person on the telephone.

example   ATDT9,1234567;
                   ATH

Another auto-dial command sequence is to dial normally without the semicolon, wait for the ringing signal, pick up the telephone, and press any key to cause the modem to hang up.

The following example combines Pulse and Touch tone dialing. The W modifier insures that no action will be taken by the modem until it has acknowledged connection to an outside line after pulse dialing 9. Once dialing is complete, the modem returns to command mode and executes E0 command which tells the modem that from now on, characters sent to it in command mode are not to be echoed to the screen. The W modifier is necessary when the modem must wait for a second dial tone before transmitting the rest of the number.

example   ATDP9 WT 1234567;E0

The @ modifier is used on systems that do not provide a dial tone. In this example the modem dials the first number and waits for 5 seconds of silence before continuing. The modem will only continue if it detects 5 seconds of silence within the time specified by the value in Register S7.

example   ATDT 1234567 @ 12345

3.3   S-Register Programming

ATS*n*?

To read the current value of a register, use the command S*n*? where "*n*" is the number of the register. The decimal value of the register content is then displayed.

For example, if you wish to read the current value in registers S0 (ring to answer on) and S7 (wait time for carrier), perform the following:

example   AT S0? S7?

                 001   <Modem answer on first ring>

                 030   <Modem will wait 30 seconds for a carrier>

                 OK   <Command completed>

ATS*n* = *r*

To set or change a parameter, use the command S*n*=*r* where "*n*" is the number of the register and "*r*" is a value between 0 and 255.

In the previous example, the value in the S0 register had been set so that the modem would answer the call on the first ring. If you want the modem to answer on the fifth ring:

example   AT S0 = 5

                 OK

To signal that the command has been executed, the modem sends the result code OK .

The S command can be used without the ? or = . The S command actually sets a pointer to the address of the register specified. The ? and = are separate commands that either read data from or put data in the address specified by the pointer. The following command illustrates this:

example   AT S7
                 AT S?

                 001

                 OK

A pointer is set to the address of the seventh register. As long as no other S command is entered, the value of that register can be requested at any time without specifying the number.

In response, the modem displays the current value in the S7 register. Similarly, if you enter the command:

example   AT = 10

The modem will change the value in the S7 register to 10.

3.4   Answering

You can set the modem to automatically answer the phone, or you can use the A command to manually answer an incoming call. Register S0 determines whether or not the modem will answer automatically.

The S0 register controls the number of rings, if any, that must occur before the modem answers a call. The register may range in value from 0-255.

example   S0=0   Do not answer telephone
                 S0=1   Answer on ring 1
                 S0=2   Answer on ring 2
                 S0=3   Answer on ring 3
                  .
                  .
                 S0=255   Answer on ring 255

When register S0 is set to 0, the auto-answer option is not in effect.

The following example will assign the value "6" to S0 to set the modem to answer on the sixth ring.

example   AT S0 = 6 <CR>

                 OK

3.5   Moving from On-Line Mode to Command Mode

Use the following procedure to move to the command mode from the on-line mode.

1)   Pause for the time guard to elapse.

2)   Enter the following quickly (do not allow more than the time guard to elapse between each character).

        +++

3)   Do not prefix the three pulses with any characters. Also, do not press the <CR> key to end the line.

4)   The modem is now in the command mode.

The escape code is the only way to return from the on-line to the command state without breaking a connection. When the escape code is disabled, you may wish to force the modem into the command state even if it breaks the connection. Software can force the modem into the command state by writing to one of two bits in the Modem Control Register in the modem's UART. Refer to the appendix C for more information on the UART.

3.6   Moving from Command Mode to On-Line Mode

From the command mode, issue the following command to place the modem in the on-line mode:

example   ATO

The modem is now in the on-line mode.

3.7   Changing Between Voice and Data

You can change operation between voice and data communication without breaking the connection to another system.

3.7.1   Switching from Data to Voice

To change from data to voice use the following procedures:

1)   Type a message requesting the other person to pick up the phone.

2)   Pick up the phone handset.

3)   Type +++ and wait for the OK response from the modem.

4)   Type ATH and wait for the OK message.

5)   You are now ready to talk to the remote operator.

3.7.2   Switching from Voice to Data

To change from voice to data use the following procedures:

1)   Request the other person to type ATA to put the modem in answering mode.

2)   Listen for a high pitch tone and then type ATD to put the modem in the originate mode.

3)   Both operators hang up their phone handsets.

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┌─────────────────────────────────────────────────────────┐
│  CHAPTER 4: TESTING AND TROUBLESHOOTING                  │
└─────────────────────────────────────────────────────────┘
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This chapter describes some of the common problems that occur in the installation, configuration, or regular use of the modem.

If errors in data transmission happen, the performance of the modem option and the remote modem can be tested to determine the source of the errors. The telecommunications link can be tested with the digital loopback tests. Each modem can be tested with the analog loopback tests.

4.1 Testing the Modem

The Local Digital Loopback and the Remote Digital Loopback tests check the entire communications circuit. Data sent from one modem is looped by the other modem back to the sending modem. If the sending modem receives no data errors, both modems and the telephone connection are working correctly. If errors are detected with the Digital or Remote digital loopback tests, each modem user should run the Local Analog Loopback test to check their modems. If each modem is working correctly, the users should disconnect and try another telephone connection. If errors are still detected, there may be a problem with the telephone line.

4.1.1 Checking the Product Code, Firmware Revision and Internal Memory

This test can be used to confirm the modem option's product identification code, firmware revision number, and internal memory functionality.

Use the command ATI0 to display the product identification code. The modem returns a three-digit code that represents this code.

The ATI1 command is used to display the modem option's firmware revision number. The modem will return a three-digit number that represents this code.

The ATI2 command will perform a functional test of the modem's internal memory. This modem will return two carriage return\line feeds and then the "OK" response.

4.1.2 Local Digital Loopback Test

To test the remote modem and the telephone circuit perform the Local Digital Loopback test. This test causes the internal modem to loop data from the remote modem back to the remote modem. None of the data received from the remote system is sent to the ASCII BASIC Module processor.

Begin the test by going on-line to the remote modem, and entering the command state with the escape code (+++). Then enter the following command to begin the test and return to the on-line state.

example   ATS16=4 O

This test can be exited by sending any character to the modem from the ASCII BASIC Module.

Provisions could be made in a BASIC program to allow the local system to enter this mode as a result of a remote system request.

4.1.3   Remote Digital Loopback Test

The Remote Digital Loopback test allows the testing of the local modem option and the telephone circuit. In this test, your modem sends a message to the remote modem requesting that it perform a local digital loopback test so that all data transmitted is sent back.. To execute this test, the remote modem must be capable of performing a the local digital loopback test.

To perform this test, attain an on-line state with the remote modem, enter the command state with the escape code (+++), and enter the following command:

example   ATO2

To exit this test and go back on line, enter the command:

example   ATO1

4.1.4   Local Analog Loopback Test

Test the modem option whenever it is suspected of causing errors in data transmission by performing the Local Analog Loopback test. The telephone line should be disconnected, as normal telephone line signals may disrupt the modem performance during this test. The test is started by entering the following commands:

example   ATS0=0
                     ATS16=1 O

At this point the CONNECT message is displayed and all characters typed on the keyboard are displayed on the screen. The test is exited by entering the escape code (+++).

4.1.5   Remote Analog Loopback Test

This test is useful in the event that the modem option is on-line with a remote system and is receiving many errors. The test is started by entering the command:

example   ATS16=1 O

The O command puts the modem option back on-line. All characters sent from the ASCII BASIC Module to the modem option should be transmitted to the remote system and at the same time displayed on the local screen. If the information is correctly displayed, the modem option is working properly and the problem will be either in the phone line or with the remote modem. To finish the test and return on-line with the remote system, enter the following command:

example   ATS16=0 O

4.2   Troubleshooting

The following section addresses common problems encountered and possible solutions for them.

4.2.1   The Modem Does Not Dial

Insure that you can communicate with your modem by performing the various tests described in the previous sections. Having done that, check the following:

       A)   Make sure that your modem is connected to a live phone line.

       B)   Make sure that the modem option is configured for either 300, 1200 or 2400 baud.

4.2.2   The Modem Dials But Does Not Connect

This problem might be caused by any of the following:

A)   The remote station may not recognize your baud rate.

B)   The carrier wait count (register S7) might be too short as the default setting is 30 seconds, often it is too short for long distance connections.

C)   You may have a noisy phone line.

D)   Check your phone cord using a regular telephone.

4.2.3   The Modem Connects to the Remote Station But Can Not Sign-In

Check the communication parameters of the remote station and make sure your software is configured for the same number of data bits, start bits, stop bits, and parity.

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┌─────────────────────────────────────────────────────┐
│  CHAPTER 5: BASIC PROGRAMMING EXAMPLES                │
└─────────────────────────────────────────────────────┘
```

5.1   Automatic Answer Program Example

This program will automatically answer the phone, accept and check a password entry and then allow the remote system to enter ASCII BASIC COMMAND mode.

```
10      SETCOM 19200,N,8,1,S                : REM Setup primary port.
20      SETCOM # 2400,N,8,1,N,2               : REM Setup modem port.
30      S=50 : L=100                          : REM Initialize variables.
40      STRING (((L+1)*S)+1),L                : REM Allocate string space.
50      PRINT #"ATZ" : DELAY(2000)            : REM Reset modem.
60      PRINT #"ATE0V0S0=1" : DELAY(2000)     : REM Set modem to no echo, short result codes.
70      IF INKEY$#<>"" THEN 70                : REM Clear input buffer.

100     DO                                    : REM Do loop 1.
110     $(0)="" : $(1)=""                     : REM Clear strings.
120     $(0)=INKEY$#                          : REM Input a character.
130     IF $(0)="" THEN 120                   : REM If no character repeat.
140     $(1)=$(0)                             : REM Initialize string 1.
150     DO                                    : REM Do loop 2.
160     $(0)=INKEY$#                          : REM Input a character.
170     IF $(0)="" THEN 160                   : REM If no character repeat.
180     $(1)=$(1)+$(0)                        : REM Build string 1.
190     WHILE ASC($(0))<>13                   : REM While character not <CR>, loop 2.
195     WHILE VAL($(1))<>10                   : REM While modem response not 10, loop 1.

200     $(2)="PSWRD"                          : REM Initialize password.
210     X=0                                   : REM Clear X.
220     PRINT #"Enter password"               : REM Print string to remote terminal.
230     $(1)=""                               : REM Clear string 1.
240     $(0)=INKEY$#                          : REM Input character.
250     IF $(0)="" THEN 240                   : REM If no character repeat.
260     DO                                    : REM Do loop 3.
270     $(1)=$(1)+$(0)                        : REM Build string 1.
280     $(0)=INKEY$#                          : REM Input character.
290     WHILE ASC($(0))<>13                   : REM While character not <CR>, loop 3.
300     IF UCASE$($(1))=$(2) THEN 400         : REM If password correct goto 400.
310     X=X+1                                 : REM Increment X.
320     PRINT #"WRONG PASSWORD!!"             : REM Print string to remote terminal.
330     IF X<3 THEN 220                       : REM If not 3 mistakes repeat.

340     DELAY(2000)                           : REM 2 second delay.
350     PRINT #"+++",                         : REM Send attention code to modem.
360     DELAY(2000)                           : REM 2 second delay.
370     GOTO 50                               : REM Start over.

400     CMDPORT#                              : REM Give control to remote terminal.
410     END                                   : REM End program.
```

5.2   Automatic Originate Program Example

The following BASIC program example will automatically call a remote system at 12:00 midnight every day and will transfer the 8 INP() registers to the remote system.

```
10      SETCOM 19200,N,8,1,S                 : REM Setup primary port.
20      SETCOM # 2400,N,8,1,N,2              : REM Setup modem port.
30      S=50 : L=100                         : REM Initialize variables.
40      STRING (((L+1)*S)+1),L               : REM Allocate string space.
50      PRINT #"ATZ" : DELAY(2000)           : REM Reset modem.
60      PRINT #"ATE0V0" : DELAY(2000)        : REM Set modem to no echo, short result codes.
70      IF INKEY$#<>"" THEN 70               : REM Clear input buffer.

100     $(0)=LEFT$(TIME$,5)                  : REM Assign hours and minutes to string 0.
110     IF $(0)<>"00:00" THEN 100            : REM Check if midnight.

200     TIME=0 : CLOCK 1                     : REM Reset and start timer.
210     PRINT #"ATDT 9,15552345678"          : REM Dial remote system.
210     DELAY(1000)                          : REM 1 second delay.

220     IF TIME>45 THEN 400                  : REM If too much time goto 400.
230     $(0)="" : $(1)=""                    : REM Clear strings.
240     $(0)=INKEY$#                         : REM Input a character.
250     IF TIME>45 THEN 400                  : REM If too much time goto 400.
260     IF $(0)="" THEN 240                  : REM If no character repeat.
270     $(1)=$(0)                            : REM Initialize string 1.
280     $(0)=INKEY$#                         : REM Input a character.
290     IF TIME>45 THEN 400                  : REM If too much time goto 400.
300     IF $(0)="" THEN 280                  : REM If no character repeat.
310     $(1)=$(1)+$(0)                       : REM Build string 1.
320     IF ASC($(0))<>13 THEN 280            : REM If not <CR> then repeat.
330     IF VAL($(1))<>10 THEN 220            : REM If modem response is not 10 then repeat.
340     GOSUB 1000                           : REM Goto transfer routine.
350     CLOCK 0                              : REM Stop clock.
360     GOSUB 2000                           : REM Goto hang-up routine.
370     GOTO 100                             : REM Start again.

400     GOSUB 2000                           : REM Goto hang-up routine.
440     TIME=0                               : REM Reset clock.
450     IF TIME<120 THEN 450                 : REM If not 2 minutes then repeat.
460     GOTO 200                             : REM Try again.

1000    DELAY(5000)                          : REM Wait 5 seconds.
1010    PRINT #"GO"                          : REM Send "GO" to remote system.
1020    FOR X=0 TO 7                         : REM
1030    Y=INP(X)                             : REM Input 1 of 8 values.
1040    PRINT # STR$(Y)                      : REM Send ASCII version of number.
1050    NEXT X: REM
1060    PRINT #"DONE"                        : REM Send "DONE" to remote system.
1070    RETURN                               : REM Return to main routine.

2000    DELAY(2000)                          : REM 2 second delay.
2010    PRINT #"+++",                        : REM Send attention code to modem.
2020    DELAY(2000)                          : REM 2 second delay.
2030    PRINT #"ATH0" : DELAY(2000)          : REM Hang-up.
2040    RETURN                               : REM Return to main routine.
```

> **APPENDIX A: MODEM AT COMMAND SUMMARY**

AT   Command line prefix (attention code); precedes Command lines except +++ (escape) and A/ (repeat) Commands.

A/   Re-execute last command line; (A/ is not followed by a carriage return).

A   Off-hook in answer mode.

B0   Selects CCITT V.22 operation when communicating at 1200 bps.
B1 *   Selects BELL 212A operation when communicating at 1200 bps.

D   Dial number which follows D in the command line.

E0   Modem does not echo commands back to terminal.
E1 *   Modem echoes commands back to terminal.

H0   On-hook (Hang-up) command.
H1   Go Off-hook.

I0   Request product ID code.
I1   Performs checksum on firmware; returns checksum.
I2   Performs checksum on firmware; returns OK or ERROR.

O0   Return to on-line state.
O1   Return to on-line state and initiate retain sequence.

Q0 *   Modem returns result codes.
Q1   Modem does not return result codes.

Sn=r Set register n to value r.

Sn?   Request contents of register n.

V0   Short form numeric result codes.
V1 *   Full word result codes.

X0 *   Basic response set, blind dialing.
X1   Extended response set, blind dialing.
X2   Extended response set, dial tone detection.
X3   Extended response set, blind dialing & busy signal detection.
X4   Extended response set, dial tone & busy signal detection.

Y0   Long space disconnect disabled.
Y1   Long space disconnect enabled.

Z   Resets modem to factory defaults.

&C0   DCD forced on at all times.
&C1   DCD indicates the presence of remote carrier signal.

&D0   Modem ignores DTR.
&D1   Modem returns to command mode on an On-to-Off transition of DTR.
&D3   Modem goes on-hook, turns off automatic answer, and returns to command mode on an On-to-Off transition of DTR.
&D4   Modem resets and returns to command mode on an On-to-Off transition of DTR.

&S0   DSR forced on at all times.
&S1   DSR indicates modem connection to the telephone line.

&T0   End test in progress.
&T1   Perform Local Analog Loopback Test.
&T3   Perform Local Digital Loopback Test.
&T4   Accept remote modem request for Digital Loopback Test.
&T5   Ignore remote modem request for Digital Loopback Test.
&T6   Perform Remote Digital Loopback Test.
&T7   Perform Remote Digital Loopback Test with self test.
&T8   Perform Remote Analog Loopback Test with self test.

  NOTE :   **A "*" denotes the default state.**

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APPENDIX B: MODEM S-REGISTER SUMMARY

S-Register	Range	Units	Default	Description
S0	0 through 255	Rings	0	Ring to Answer on
S1	0 through 255	Rings	0	Ring Count
S2	0 through 127	ASCII	43	Escape Code Character
S3	0 through 127	ASCII	13	<CR> Character
S4	0 through 127	ASCII	10	<LF> Character
S5	0 through 32, and 127	ASCII	8	Back Space Character
S6	2 through 255	Seconds	2	Wait for Dial Tone
S7	1 through 255	Seconds	30	Wait for Data Carrier
S8	0 through 255	Seconds	2	Pause Time for Comma
S9	1 through 255	1/10 Seconds	6	Carier Detect Response Time
S10	1 through 255	1/10 Seconds	14	Carrier Lost to Hang-Up Delay
S11	50 through 255	Milliseconds	75	DTMF Digit Duration
S12	20 through 255	1/50 Seconds	50	Escape Code Guard Time
S13	Bit-mapped		30H	UART Configuration
S14	Bit-mapped		6AH	General Modem Configuration
S15	Bit-mapped		3BH	General Modem Configuration
S16	Bit-mapped		0	Modem Test Options

Following power-up or RESET, the modem option is configured as follows:

Bell 212A/103 operation at 1200 BPS   Parity disabled
7 Data bits   1 Stop bit
Autoanswer Disabled   Command Echo On
All Result Code Enabled   Does Not Wait for Dial tone before Dialing
Does Not Detect Busy Signal   Full Word Result Code
Pulse Dial Make/Break Ratio=39/61%   Long Space Disconnect Disabled
Ring count = 00   Escape code character = 43
Carriage return character = 13   Line feed character = 10
Back space character = 08   Duration of wait for dial tone = 02 Sec.
Duration of wait for carrier after dialing = 30 Sec.   Duration of dial pause (comma) = 02 Sec.
Carrier detect response time = 0.6 Sec.   Lost carrier to hang-up delay = 1.4 Sec.
Escape code guard time = 01 Sec.

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┌──────────────────────────────────────────────────────────┐
│     APPENDIX C:  INTERNAL UART REGISTER SUMMARY            │
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```

This section contains information regarding the modem option's 8250B UART registers. This information is only provided for completeness, these registers should only be manipulated by very advanced users.

The modem option's UART contains ten byte-wide registers mapped at address 0FE00H in the ASCII BASIC Module's DATA memory. Only seven bytes of the ASCII Basic module's address space are consumed by these ten registers. Most of these registers are bit-mapped. The registers and their addresses are shown below (the registers denoted with a "*****" are accessed by setting bit 7 of the LCR register):

Register Name	Address	Read or Write	Description
RBR	0FE00H	Read Only	Receiver Buffer Register
THR	0FE00H	Write Only	Transmitter Holding Register
* BDL	0FE00H	Read/Write	Baud Rate Divisor (low byte)
* BDH	0FE01H	Read/Write	Baud Rate Divisor (high byte)
IER	0FE01H	Read/Write	Interrupt Enable Register
IIR	0FE02H	Read/Write	Interrupt Identification Register
LCR	0FE03H	Read/Write	Line Control Register
MCR	0FE04H	Read/Write	Modem Control Register
LSR	0FE05H	Read Only	Line Status Register
MSR	0FE06H	Read Only	Modem Status Register

The bit-mapped registers are defined in the table below.

Register	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RBR	8-bit data							
THR	8-bit data							
BDL	16-bit data (30H=2400 baud, 60H=1200 baud, 180H=300 baud)							
BDH								
IER	0	0	0	0	MSI	LSI	THI	RBI
IIR	0	0	0	0	0	II1	II0	/IP
LCR	DLAB	SB	SP	EPS	PEN	SBS	1	WL
MCR	0	0	0	N/A	HIZ	N/A	RTS	DTR
LSR	0	TSRE	THRE	BI	FE	PE	OE	DR
MSR	RLD	RI	1	1	DRLD	TRI	0	0

All of the UART register values are used by the ASCII BASIC Module's firmware and those values that are of use to the BASIC programmer are accessible via BASIC statements. We strongly recommend that programmers DO NOT directly manipulate the UART registers.

For more information regarding the UART registers, obtain an 8250B data sheet.

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APPENDIX D: ELECTRICAL SPECIFICATIONS

Parameter   **Specifications**

Transmission Rate: 2400, 1200 and 300 bps asynchronous

Transmission Channel: Full Duplex PSK and FSK for two wire dial up

Modulation Protocol: V.22 and Bell 212A at 1200 bps
                                            V.21 and Bell 103 at 300 bps

Data Formats: 7 or 8 Data Bits; Odd, Even, No parity and 1 or 2 stop Bits

Dialing Capability: DTMF or Pulse Dialing

DTMF Tone Symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, *, #

Equalization: Fixed Compromised Equalization for Transmitter and Adaptive Equalization for Receiver

Guard Tone: 550 or 1800 HZ

Receive Sensitivity: -45 dbm

Transmit Level: -10 dbm

Command Buffer: 40 characters

Approvals: FCC part 68, 15 and DOC for domestic use approved for direct connection to the PSTN

Jack number: RJ-11C

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APPENDIX E: FCC PART 68 REGISTRATION

The modem option is registered with the Federal Communications Commission regarding connection to the switched telephone network as regulated by FCC rules and regulations, part 68. FCC places two restrictions on its use:

1   The modem cannot be connected to a party line or a payphone.

2   You should notify your local telephone company when connecting a modem device to your phone line.

If you experience trouble with this modem, please contact your local distributor for information on obtaining service or repairs. The telephone company may ask that you disconnect this equipment from the network until the problem has been corrected or you are sure that the modem is not malfunctioning.

The REN (Ring Equivalence Number) is useful in determining the quantity of device that you may connect to your telephone line and still have all those devices ring when your number is called. In most, but not all areas, the sum of the REN's of all device connected to one line should not exceed five (5.0). To be certain of the number of devices that you may connect to your line, you may want to contact your telephone company.

Both REN and FCC Registration Number are printed on a foil label that is affixed to the ASCII BASIC Module's modem option case. Please refer to these numbers in all communications involving your local telephone company or their authorized agents.

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