



536EX Chipset

Developer's Manual

October 2001

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Revision History

Date	Revision	Description
August 2001	001	Initial release

This developer's manual describes the software interface for Intel® 536EX (controllerless and controller) chipset solutions. The controllerless-based solutions include the 536EP for PCI and Mini-PCI. Refer to the chipset datasheets for the detailed chipset descriptions (public order numbers 273503-001, 273xxx-001, 273xxx-001, 273xxx-001, and 273xxx-001).

The controllerless-based chipset, as the name implies, does not have a dedicated hardware controller. The controller functions are executed by the CPU. This developer's manual includes the AT command sets for data, fax, and voice and the UART interface and emulation. Like the earlier solutions from Intel, the 536EX chipsets support a variety of applications without the need of additional firmware development. Note, the supported AT commands are firmware or driver version dependent.

1.1 Controllerless Modem Driver Overview

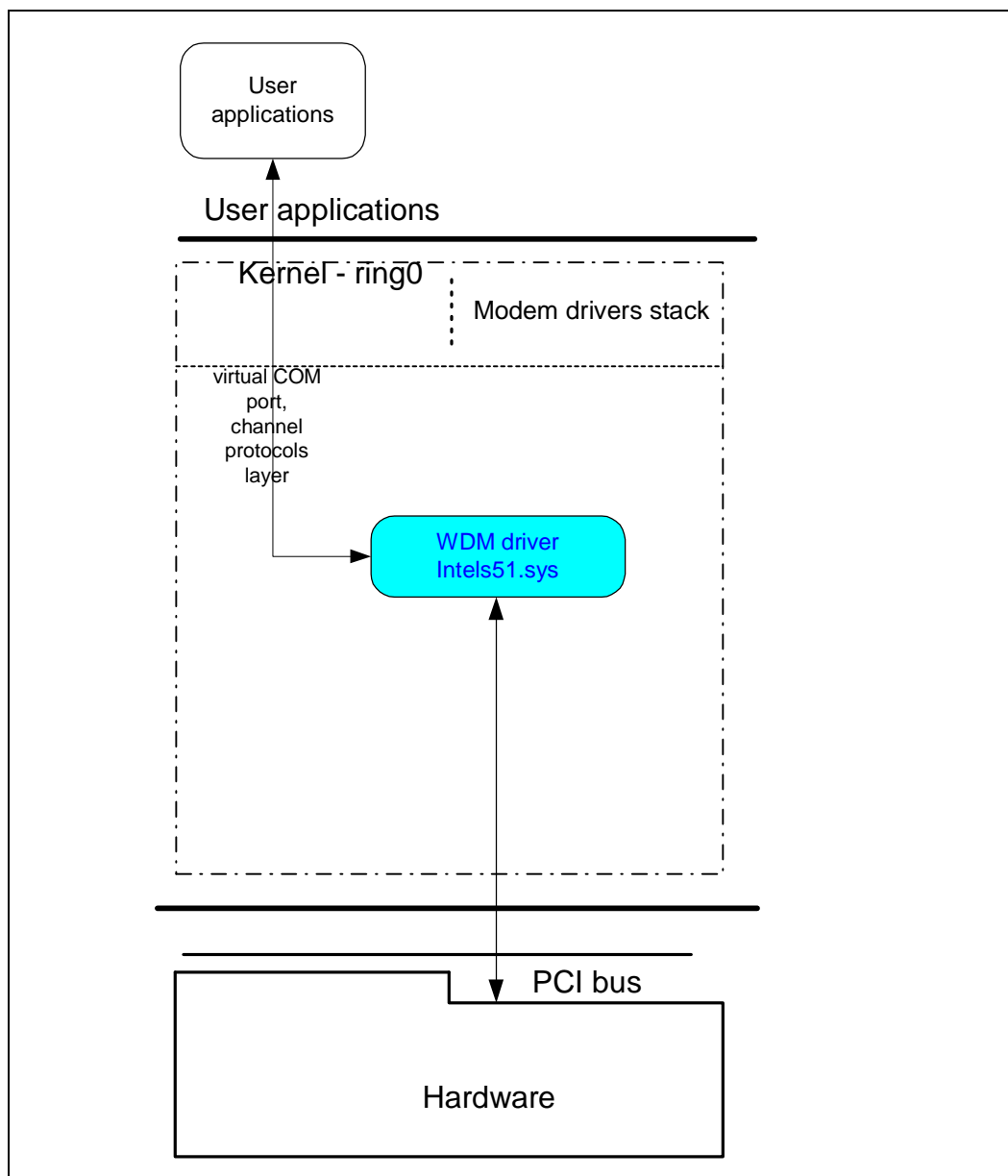
1.1.1 Windows* Millennium Edition (Windows Me), Windows 2000, Windows XP, and Windows NT* 4

The controllerless modem chipsets are integrated into the Microsoft* Windows* Me, Windows 2000, Windows XP, and Windows NT* 4 operating systems via proprietary Intel® Windows Driver Model (WDM) modem drivers. These drivers are fully plug and play capable and conform to all Microsoft WHQL certification requirements.

The functional block diagram in [Figure 1](#) shows the common WDM architecture for the Microsoft's operating systems supporting common WDM drivers model.

User-mode application, via special Windows API (FILE, TAPI, UNIMODEM), can access a virtual COM port provided by the Intel WDM driver. The data flow is converted inside the driver in accordance with some compression and a channel level protocol and passed to the DSP. The control flow follows the common Microsoft WDM driver model. The Intel WDM driver is installed as a stack of filter drivers below the system modem.sys driver.

Figure 1. WDM Driver Block Diagram

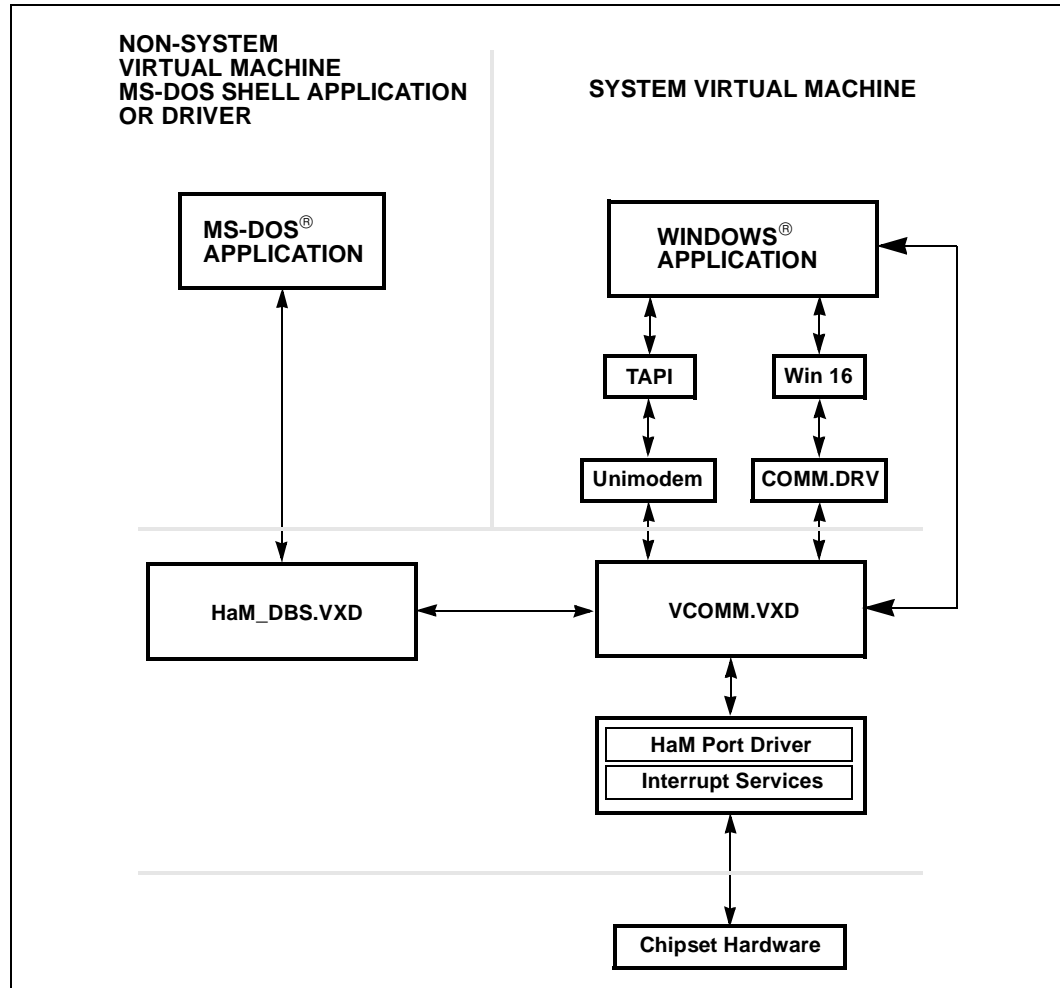


1.1.2 Windows 95 and Windows 98

When the controllerless modem chipsets are used with Microsoft Windows 95 and Windows 98 applications, the traditional UART and serial port emulations are replaced by the proprietary HaM Mini Port driver (see Figure 2). Instead of transferring commands to UART virtual registers, then to a serial port, the HaM Port Driver sends commands directly to the Windows virtual machine driver VCOMM.VxD. This low-level communication driver supports the Win16 and Win32 Communication APIs. Like the WDM drivers, the Mini Port VxD drivers are fully plug and play and conform to Microsoft WHQL certification requirements.

When the controllerless chipsets are used with MS-DOS* applications, however, a UART emulation is required. Intel provides an additional driver called HaM_DBS.VxD, which includes a UART emulation. Please refer to [Section 9.1, “UART Emulation in the Controllerless Modem”](#) on [page 92](#) for an explanation of the 536EX UART emulation. The HaM_DBS.VxD driver interacts directly with the VCOMM.VxD driver using the Win16 and Win32 Communication APIs.

Figure 2. VxD Mini Port Driver Block Diagram



1.2 V.90/V.92 and V.34 Data Modes

The 536EX chipset defaults to the V.90 or V.92 mode depending on the driver version. The V.90/V.92 mode allows receive data rates of up to 56,000 kbps over the PSTN (public switched telephone network) only in connections with equipment-compatible ISPs (Internet Service Providers); however, FCC regulations limit receive speeds to 53,333 kbps due to excessive power demands at higher speeds. In modem-to-modem connections, V.90/V.92 mode falls back to V.34 mode in both the transmit and receive directions. The chipsets implement all data rates and modulation schemes for ITU-T (International Telecommunications Union-Telecommunications) standards V.34, V.32 bis, V.32, V.22 bis, V.22, V.21, Bell 212A, and Bell 103.

1.3 Modem Connection Overview

The DCE (modem) operates in one of two states: command or online. In each state, both data and commands (including DCE responses) are transferred through the UART THR (Transmit Holding register) and the RBR (Receiver Buffer register).

The modem defaults to the command state. In the command state, the DTE (host) communicates to the modem through AT commands and S-registers. AT commands are character strings that help guide modem operation. S-registers are internal modem registers that the DTE can access. The S-registers contain modem status and configuration information. Many of the AT commands indirectly affect the contents of the S-registers. The AT command set and S-registers are divided into the following modes: Group 3 fax, data, V.44/V.42 bis/V.42/MNP, and voice. Note that supported AT commands are firmware revision-dependent (that is, not all commands are supported by all modem models or all firmware revisions).

All command lines sent to the modem, except for **A/**, must be preceded by an 'AT' (which stands for 'attention') and terminated by the contents of S-register **S3** (typically a carriage return <CR>). The 'AT' prompts the modem to receive a command line from the DTE. A <CR> informs the modem that the entire command string has been transmitted and that the modem should start processing all the commands within the command line.

A command line may include one or more AT commands that may or may not be separated by a space. AT commands may be either upper- or lower-case characters, but all characters for a given command must use the same case. If there are multiple commands in a line, a semicolon (;) must be placed after each fax or voice command. The modem can be configured to send back (echo) to the DTE any data that the DTE sends to the modem (while in command state only). The last command may be repeated by typing **A/** without using a carriage return. Each command line may include up to 80 characters and spaces.

Examples of AT command strings:

```
ATS1?<CR>
A/
AT &C1 &D2 +FCLASS=? <CR>
AT &C1 &D2 +FCLASS=?; S0=1 <CR>
```

The modem provides status information to the DTE in the form of response codes. These response codes can be expressed in text or numeric form. The supported response codes are provided in [Table 4 on page 12](#).

Examples of modem responses:

```
+MCR: V90
+MRR: 28800
CONNECT 50666
```

In the online state, the DCE is off-hook and communicating with a remote modem. Any data sent from the DTE to the DCE is transmitted to the remote modem. Similarly, any data that the DCE receives from the remote modem is transmitted to the DTE.

Note: In the online state, the DCE does not 'echo-back' any of the data that the DTE sent to the DCE.

The modem recognizes AT commands from the DTE at any valid data rate from 300 bps to 115,200 bps (that is, the modem autobauds up to 115,200 bps); however, the DTE should use the data rate specified for each mode according to the transmitting direction—DTE-to-modem (Table 1) or modem-to-modem (Table 2). The V.90 and V.92 data rates are effective only in DCE-to-ISP connections.

Table 1. DTE-to-DCE Data Rates for Each Mode

Mode	Data Rate (bps)	Affected Data
Data (V.34)	2400–115,200	DTE-to-modem data rate
Data (V.90)	28,800–115,200	
Data (V.92)	28,800–115,200	
Fax	19,200	
Voice	19,200–115,200	AT commands, playback and record modes (varies according to compression type)

Table 2. DCE-to-DCE Data Rates for Each Mode

Mode	Data Rate (bps)	Affected Data
Data (V.34) (transmit and receive)	2400–33,600	DTE-to-modem data rate
Fax	300–14,400	
Voice	19,200–115,200	AT commands, playback and record modes (varies according to compression type)

Table 3. DCE-to-ISP Data Rates for V.90 Mode

Mode	Data Rate (bps)	Affected Data
Data (V.90) transmit	4800–33,600	ISP-to-modem data rate
Data (V.90) receive	28,000–56,000	
Data (V.92) transmit	24,000–48,000	
Data (V.92) receive	28,000–56,000	

Each command may have one or more parameters associated with it. If a parameter is not sent for a command requiring a numeric parameter, then the modem assumes a zero ('0') parameter (only if zero is a valid parameter for the command). For example, **ATZ** and **ATZ0** commands perform identical functions (that is, the modem sees 'ATZ' and automatically uses the '0' parameter during processing the command). Other commands do not use parameters.

1.4 AT Commands Overview

The AT command set and S-registers are divided into four categories: data, Group 3 fax, voice, and V.42/MNP. Summaries of all commands are provided later on in this chapter.

1.4.1 Sending Commands

All command lines sent to the modem, except for **A/**, must be preceded by an 'AT' and terminated by the contents of S-register **S3** (typically a carriage return <CR>). AT stands for 'attention' and prompts the modem to receive a command line from the DTE. A <CR> informs the modem that the entire command string has been transmitted and to begin processing all the commands in the command line. A command line can include one or more AT commands. The commands can be separated by a space, if desired, but no punctuation is needed except for extended commands. Extended commands begin with a '+', such as fax, voice, and V.250 commands. In a multiple-command line, extended AT commands must be separated from following commands by a semicolon(;).

Examples:

```
ATS1?<CR>
A/
AT &F &D2 +FCLASS=?<CR>
AT +FCLASS=0; S0=1<CR>
```

The modem provides status information to the DTE in the form of response codes, as listed in [Table 4](#). Response codes take two (2) forms, text (**ATV1**) or numeric (**ATV0**), depending on how the modem is configured.

[Table 4](#) lists basic format response codes. These response codes have numeric equivalents that are displayed depending on the value of ATV. In addition to the basic format response codes, there are extended syntax result codes that indicate connection status of the DCE-DCE connection that are not effected by numeric response reporting. These result codes have no numeric equivalent and are always issued in text form. The result codes display modem mode, transmit connection rate, error correction, compression, DTE rate, and receive rate. Note that the final connection message only indicates receive rate if ATXn is greater than 0. The format for the result codes code depends on the Wn command. The setting of the Wn command will determine which of the following connect results codes are displayed (+MCR, +MRR, +ER, +DR, +ILRR). Refer to the Wn command for the detailed description of the command. Note that the supported carrier modes for +MCR can be found in parameter 1 of +MS. The last result code is the CONNECT <text>, where text is the DCE receive rate. Note, the CONNECT <text> is not displayed when ATX0 is indicated, just CONNECT is displayed and is reported by the rules in [Table 4](#).

Table 4. DTE-Modem Data Rate Response Codes

Numeric	Text	Numeric	Text
0	OK	9	DELAYED CALL
1	CONNECT	10	BLACKLISTED
2	RING	11	+FCERROR
3	NO CARRIER	12	RINGBACK
4	ERROR	13	CPON=
6	NO DIALTONE	14	CPOF=
7	BUSY	15	DRON=
8	NO ANSWER	16	DROF=

After sending an AT command string to the modem, the DTE must wait for a response code from the modem before sending a new AT command string to the modem.

1.4.2 AT Escape Sequences

The 536EX provides the industry-standard escape sequence, TIES (Time Independent Escape Sequence). TIES is designed to work with existing communication software written for the Hayes Escape Sequence.

Upon special request, Ambient provides the Hayes* Escape Sequence; however, please note that licensing can be required.

TIES/Hayes* Escape Sequences

The 536EX modem chipset is manufactured with TIES (Time Independent Escape Sequence) as the default setting. It is Hayes' position that you must have a valid license from Hayes Micro Computer of Norcross, Georgia, before producing modem systems that use the Hayes Escape Sequence.

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1.4.3 Dial Modifier

Command	Function
0 to 9	Dialing digits
A, B, C, D, *, #	Tone dial characters
P	Pulse dial
R	Reverse Originate mode
S=n	Dial NVRAM telephone number
T	Tone dial
W	Wait for dial tone
,	Pause
!	Flash hook
@	Wait for quiet answer
;	Return to command state
- ()	Ignored by modem

AT Command Summary Tables

2

This section contains summary tables of all AT commands, S-registers, and between AT commands and S-registers. These commands are fully described in the relevant sections of the 536EX Developer's Manual.

Table 5. Data Mode Command Summary

Note	Command	Function	Default	Range	Reported by &Vn
**	A/	Repeat last command	none	—	no
	A	Answer	none	—	no
	Cn	Carrier control option	1	0, 1	no
	C0	Transmit carrier always off			
	C1	Normal transmit carrier			
	D	Dial command	none	—	no
*	En	Command mode echo	1	0, 1	yes
	E0	Disables echo			
	E1	Enables echo			
	Hn	Switch hook control	0	0, 1	no
	H0	Hangs up the telephone line			
	H1	Picks up the telephone line			
	In	Identification/checksum option	0	0–7, 10–11, 14, 20–23	no
	I0	ROM Checksum			
	I1	Modem Name			
	I2	Manufacturer			
	I3	Chipset			
	I4	Firmware Version			
	I5	Modem Chip Hardware Configuration			
	I6	DSP Patch Level			
	I12	Country Code			
	I7–I11, I13, I14, I20–I25	Reserved			
*	Ln	Speaker volume control	2	0–3	yes
	L0	Low speaker volume			
	L1	Low speaker volume			
	L2	Medium speaker volume			
* Value saved in NVRAM.					
** Command not preceded by an 'AT.'					

Table 5. Data Mode Command Summary (Continued)

Note	Command	Function	Default	Range	Reported by &Vn
	L3	High speaker volume			
*	Mn	Speaker control	1	0–3	yes
	M0	Speaker always off			
	M1	Speaker on until carrier present			
	M2	Speaker always on			
	M3	Speaker off during dialing; speaker on until carrier present			
	On	Go online	0	0, 1, 3	no
	O0	Returns modem to Data mode			
	O1	Retrains equalizer and then returns to Data mode			
	O3	Renegotiates rate and then returns to Data mode			
*	P	Select pulse dialing	none	–	yes
*	Qn	Result code display control	0	0, 1	yes
	Q0	Enables result codes			
	Q1	Disables result codes			
	Sn	Select an S-register	none	0–33	no
	Sn=x	Write to an S-register	none	n = 0–33 x = 0–255	no
	Sn?	Read from an S-register	none	0–33	no
*	T	Select tone dialing	none	–	no
*	Vn	Result code form	1	0, 1	yes
	V0	Choose numeric form			
	V1	Choose verbose (text) form			
*	Wn	Response code data rate	0	0–4	yes
	W0, W1	DTE data rate			
	W2	Modulation, DCE TX rate			
	W3	Modulation, DCE TX rate, Error Correction, Compression and DTE data rate			
	W4	Modulation, DCE TX rate, Error Correction, Compression			
* Value saved in NVRAM.					
** Command not preceded by an 'AT.'					

Table 5. Data Mode Command Summary (Continued)

Note	Command	Function	Default	Range	Reported by &Vn
*	Xn	Result code type	4	0–4	yes
	X0	Enables result codes 0–4; disables detection of busy and dial tone			
	X1	Enables result codes 0–5, 10, and above; disables busy and dial tone detection			
	X2	Enables result codes 0–6 and 10 and above; disables busy detection and enables dial tone detection			
	X3	Enables result codes 0–5, 7, and 10 and above; enables busy detection and disables dial tone detection			
	X4	Enables result codes 0–7 and 10 and above; enables busy and dial tone detection			
*	Yn	Long space disconnect	0	0, 1	yes
	Y0	Disables long space disconnect			
	Y1	Enables long space disconnect			
	Zn	Recall stored profile	0	0, 1	no
	Z0	Resets modem and recalls user profile 0			
	Z1	Resets modem and recalls user profile 1			
*	&Cn	DCD (data carrier detect) option	1	0, 1	yes
	&C0	Ignores remote modem status; DCD always on			
	&C1	DCD set according to remote modem status			
	&Dn	DTR (data terminal ready) option	2	0–3	yes
	&D0	In Async mode, modem ignores DTR			
	&D1	Modem switches from data mode to command mode when an on-to-off transition of DTR occurs			
	&D2	When DTR switches off, the modem goes on-hook and disables Auto-answer mode; when DTR switches on, auto-answer is enabled			
	&D3	Turning off DTR re-initializes the modem and resets values except UART registers			
	&F	Load factory defaults	none	–	no
*	&Gn	Guard tone option (1200 bps and 2400 bps only)	0	0–2	yes
	&G0	Disables guard tone			
	&G1	Enables 550 Hz guard tone			
	&G2	Enables 1800 Hz guard tone			
	&Kn	Select serial flow control	3	0, 3, 4	yes
* Value saved in NVRAM.					
** Command not preceded by an 'AT.'					

Table 5. Data Mode Command Summary (Continued)

Note	Command	Function	Default	Range	Reported by &Vn
	&K0	Disables flow control			
	&K3	Bidirectional hardware flow control			
	&K4	XON/XOFF software flow control			
*	&Pn	Dial pulse ratio	0	0, 1	yes
	&P0	Sets 10 pps pulse dial with 39%/61% make-break			
	&P1	Sets 10 pps pulse dial with 33%/67% make-break			
*	&Sn	DSR (data set ready) option	0	0, 1	yes
	&S0	DSR is always active			
	&S1	DSR active only during handshaking and when carrier is lost			
	&Tn	Self test commands	0	0–1, 8	no
	&T0	Terminates test in progress			
	&T1	Initiates local analog loopback			
*	&Un	Disable Trellis coding	0	0, 1	no
	&U0	Enables Trellis coding with QAM as fallback			
	&U1	QAM modulation only			
	&Vn	View active and stored profiles	0	0, 1, 3	no
	&V0	View active profile and stored profile 0			
	&V1	View active profile and stored profile 1			
	&Wn	Stored active profile	0	0, 1	no
	&W0	Store in user profile 0			
	&W1	Store in user profile 1			
*	&Yn	Select stored profile on power up	0	0, 1	yes
	&Y0	Recall stored profile 0 on power-up			
	&Y1	Recall stored profile 1 on power-up			
	&Zn=x	Store telephone number (up to 30 digits) to location 'n' (0–3)	none	n = 0–3 x = 0–9 A B C D # * T P R W @ , ! ;	no
*	%En	Auto-retrain control	1	0, 1	yes
	%E0	Disables auto-retrain			
	%E1	Enables auto-retrain			
*	%Gn	Rate renegotiation	1	0, 1	yes
	%G0	Disabled			
	%G1	Enabled			
* Value saved in NVRAM.					
** Command not preceded by an 'AT.'					

Table 5. Data Mode Command Summary (Continued)

Note	Command	Function	Default	Range	Reported by &Vn
*	-Cn	Generate data mode calling tone	0	0–2	no
	-C0	Calling tone disabled			
	-C1	1300 Hz calling tone enabled			
	-C2	V.8 calling tone and 1300 Hz calling tone			
	+A8E=m	V.8 and V.8 bis operation controls	1, 1, C1, 0, 0	See note	no
	+EB	Controls break handling	1, 0, 30	See note	no
	+ESA	Synchronous access mode configuration	0, 0, 1, , 0, 0, 0,		no
	+ESR	Controls selective repeat option in V.42	1	0–2	no
	+ETBM	Controls call termination buffer management	1, 1, 20	See note	no
	+GCAP	Request complete capabilities list	none		no
	+GCI	Country of installation	none		no
	+GMI	Identify modem manufacturer	none	–	no
	+GMM	Identify product model	none	–	no
	+GMR	Identify firmware version	none	–	no
	+GSN	Identify product serial number ID	none	–	no
	+IFC	Controls DTE-DCE flow control	2, 2	See note	no
	+ILRR=m	Controls local rate reporting	0	0, 1	no
	m=0	Disabled			
	m=1	Enabled			
	+MA	Controls modulation automode	–	See note	no
	+MR=m	Selects modulation	0	See note	no
	m=0	Disabled			
	m=1	Enabled			
	+MS=m	Modulation selections	V92, 1, 0, 0, 0, 0	See note ^a	no
	+PCW=m	Call waiting enable	0		no
	+PHSW=m	Controls 2C relay	none	0, 1	no
	+PIG=m	PCM upstream ignore	1		no
	+PMH=m	Modem on hold enable	0		no
	+PMHF	V.92 modem on hold hook flash	none		no
	+PMHR	Initiate modem on hold	none		no
	+PMHT=m	Modem on hold timer	0		no
	+PQC=m	V.92 phase 1 and phase 2 control	0		no
	+PSS=m	Use short sequence	2		no
* Value saved in NVRAM.					
** Command not preceded by an 'AT.'					

- a. For Data mode, the factory default setting is AT+MS=V92, 1, 0, 0, 0, 0 to send at speeds of 33,600 bps or below and receive at speeds of 53,333 bps and below.

Note: See the relevant sections in the 536EX Developer's Manual for full command description and parameter ranges.

Table 6. V.44/V.42/V.42 bis MNP Command Summary

Note	Command	Function		Default	Range	Reported by &Vn	
*	%An	Set auto-reliable fallback character			13	0–127	yes
*	%Cn	MNP 5 data compression control			1	0, 1	yes
	%C0	No compression					
	%C1	Enables MNP5 data compression					
*	\An	MNP block size			3	0–3	yes
	\A0	Maximum 64 characters					
	\A1	Maximum 128 characters					
	\A2	Maximum 192 characters					
	\A3	Maximum 256 characters					
	\Bn	Set transmit break			3	0–9	
*	\Cn	Set auto-reliable buffer			0	0–2	yes
	\C0	No data buffering					
	\C1	Four-second buffer until 200 characters in the buffer or detection of a SYN character					
	\C2	No buffering. Connects non-V.42 modems to V.42 modem					
*	\Gn	Set modem port flow control			0	0, 1	yes
	\G0	Disables port flow control					
	\G1	Sets port flow control to XON/XOFF					
*	\Jn	bps rate adjust control			0	0, 1	yes
	\J0	Disables rate adjust					
	\J1	Enables rate adjust					
	\Kn	Set break control			5	0–5	no
	\K0	connect state, transmits	Enters command mode, no break sent				
		command state, transmits	Destructive/expedited				
		connect state, receives					
	\K1	connect state, transmits	Destructive/expedited				
		command state, transmits					
		connect state, receives					
* Value saved in NVRAM.							

Table 6. V.44/V.42/V.42 bis MNP Command Summary (Continued)

Note	Command	Function		Default	Range	Reported by &Vn
	\K2	connect state, transmits	Enters command mode, no break sent			
		command state, transmits	Nondestructive/expedited			
		connect state, receives				
	\K3	connect state, transmits	Nondestructive/expedited			
		command state, transmits				
		connect state, receives				
	\K4	connect state, transmits	Enters command mode, no break sent			
		command state, transmits	Nondestructive/nonexpedited			
		connect state, receives				
	\K5	connect state, transmits	Nondestructive/nonexpedited			
		command state, transmits				
		connect state, receives				
*	\T0	Disables inactivity timer		0	0–90	yes
*	\Xn	Set XON/XOFF pass-through		0	0, 1	yes
	\X0	Processes flow control characters				
	\X1	Processes flow control characters and passes to local or remote				
*	-Jn	Set V.42 detect phase		1	0, 1	yes
	-J0	Disables the V.42 detect phase				
	-J1	Enables the V.42 detect phase				
*	“Hn	V.42 bis compression control		3	0–3	yes
	“H0	Disables V.42 bis				
	“H1	Enables V.42 bis only when transmitting data				
	“H2	Enables V.42 bis only when receiving data				
	“H3	Enables V.42 bis for both transmitting and receiving data				
	“On	V.42 bis string length		32	6–250	no
	+DR=m	Controls data compression reporting		0	0, 1	no
	m=0	Disabled				
	m=1	Enabled				
*	+DS=m	Controls V.42 bis data compression		3, 0, 2048, 6	See note	yes
* Value saved in NVRAM.						

Table 6. V.44/V.42/V.42 bis MNP Command Summary (Continued)

Note	Command	Function		Default	Range	Reported by &Vn
	+DS44=m	V.44 Data Compression		3, 0, 0, 471, 942, 140, 140, 1884, 3768		no
	+EFCS	Controls the 32-bit frame check sequence option in V.42		0	0–2	no
	+ER=m	Controls error control reporting		0	0, 1	no
	m=0	Disabled				
	m=1	Enabled				
*	+ES=m	Error control selection		3, 0, 2	See note	yes
* Value saved in NVRAM.						

Table 7. Fax Identity Command Summary

Command	Function	Default	Range	Reported by &Vn
+FMDL?	Identifies product model	none	–	no
+FMFR?	Identifies modem manufacturer	none	–	no
+FMI	Identifies modem manufacturer	none	–	no
+FMM	Identifies product model	none	–	no
+FMR	Identifies product version number	none	–	no
+FREX?	Identifies product version number	none	–	no

Table 8. Fax Class 1 Command Summary

Command	Function	Default	Range	Reported by &Vn
+FCLASS=1	Mode selection	0	0, 1, 8	no
+FRH=m	Receive HDLC data	none	3	no
+FRM=m	Receive data	none	24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146	no
+FRS=m	Wait for silence	none	1–255	no
+FTH=m	Transmit HDLC data	none	3	no
+FTM=m	Transmit data	none	24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146	no
+FTS=m	Stop transmission and pause	none	0–255	no

Table 9. IS-101 Voice Command Summary

Command	Function	Default	Range	Reported by &Vn
+FCLASS=8	Voice mode selection	0	0, 1, 8	no
+FLO=m	Flow Control Select	1	0–2	no
+VBT=m	Buffer threshold setting	192, 320	192, 320	no
+VCID=m	Caller ID selection	0*	0–2	no
+VDR=m	Distinctive Ring selection	0,0	0–255, 0–255	no
+VEM=m	Event reporting and masking	'C' BB860980 BFE63883 BB863EE0	–	no
+VGM=m	Speakerphone microphone gain	128	121–131	no
+VGR=m	Receive gain selection	128	121–131	no
+VGS=m	Speakerphone speaker gain	128	121–131	no
+VGT=m	Volume selection	128	121–131	no
+VIP	Initialize parameter	–	–	no
+VIT=m	DTE/DCE inactivity timer	0	0–255	no
+VLS=m	Hardware type control	0	0–15	no
+VNH=m	Automatic hang-up control	0	0–2	no
+VRA=m	Ringback-goes-away timer	50	0–50	no
+VRN=m	Ringback-never-appeared timer	10	0–255	no
+VRX	Record mode	none	–	no
+VSD=m	Silence detection (quiet and silence)	128, 50	See note	no
+VSM=m	Compression method selection	140, 8000, 0, 0	See note	no
+VSP=m	Speakerphone on/off control	0	0, 1	no
#VSPS=m	Speakerphone type selection	1	0, 1	no
+VTD=m	Beep tone duration timer	100	5–255	no
+VTS=m	DTMF and tone generation	none	See note	no
+VTX	Play mode	none	–	no

* The noted parameters, commands, and responses depend on the capability to receive.

Note: See the complete command description in the 536EX Developer's Manual for range information.

Table 10. Voice DTE→DCE Character Pairs

Response	Hex Code	Function
<NUL>	00	Do nothing
<DLE>	10	Two contiguous <DLE><DLE> codes indicate a single <DLE> in the data stream
<SUB>	1A	<DLE><DLE> in data stream
<ETX>	03	End transmit data state
/	2F	Start of DTMF tone shielding

Table 10. Voice DTE→DCE Character Pairs (Continued)

Response	Hex Code	Function
	7F	DTMF transition to off
u	75	Bump up the volume
d	64	Bump down the volume
<ESC>	1B	End receive data state
!	21	Receive data abort
<CAN>	18	Clear transmit buffer of voice data
?	3F	Transmit buffer space available query

Table 11. Voice DTE←DCE Character Pairs

Response	Hex Code	Function
<DLE>	10	Single <DLE> character in the data stream
<SUB>	1A	<DLE><DLE> in data stream
<ETX>	3	End of Record mode data
X	58	Packet header for 'Complex Event Detection Report'
.	2E	Packet terminator for the 'Complex Event Detection Report'
/	2F	Start of DTMF tone shielding
	7F	DTMF transition to off
0–9	30–39	DTMF tones 0–9
A–D	41–44	DTMF tones A–D
*	2A	DTMF tone *
#	23	DTMF tone #
o	6F	Receive buffer overrun
c	63	1100 Hz fax calling tone
e	65	1300 Hz data calling tone
h	68	Local phone goes on hook
H	48	Local phone goes off hook
s	73	Presumed hang-up silence time-out
q	71	Presumed end-of-message quiet time-out
l	6C	Loop current interruption
L	4C	Loop current polarity reversal
r	72	Ringback
b	62	Busy/reorder/fast busy
d	64	Dial tone detected
u	75	Transmit buffer under-run
p	70	Line voltage increase (extension phone goes on-hook)
P	50	Line voltage decrease (extension phone goes off-hook)
a	61	Fax or data answer tone (2100 Hz)

Table 11. Voice DTE←DCE Character Pairs (Continued)

Response	Hex Code	Function
f	66	Data answer detected (2225 Hz)
R	52	Incoming ring
% ' (,)	25, 26, 27, 28, 29	Manufacturer-specified

Table 12. Dial Modifiers

Command	Function
0 to 9	Dialing digits
A, B, C, D, *, #	Tone dial characters
P	Pulse dial
R	Reverse Originate mode
S=n	Dial NVRAM telephone number
T	Tone dial
W	Wait for dial tone
,	Pause
!	Flash hook
@	Wait for quiet answer
;	Return to command state
- ()	Ignored by modem

Table 13. S-Register Summary

Note	Register	Function	Default	Range	Units	Reported by &Vn
*	S0	No. of rings to auto-answer on	0	0–255	ring	yes
	S1	Ring count	0	0–255	ring	yes
*	S2	Escape character	43	0–127	ASCII	yes
	S3	Carriage return character	13	0–127	ASCII	yes
	S4	Line feed character	10	0–127	ASCII	yes
	S5	Backspace character	8	0–32, 127	ASCII	yes
*	S6	Wait before dialing	2	2–255	second	yes
*	S7	Wait for carrier	60	1–255	second	yes
*	S8	Pause time for dial modifier	2	0–255	second	yes
*	S9	Carrier recovery time	6	1–255	0.1 second	yes
*	S10	Lost carrier hang up delay	14	1–255	0.1 second	yes
*	S11	DTMF dialing speed	70	50–255	ms	yes
*	S12	Guard Time	50	0–255	(0.02 second)	yes
*	S14	Bit-mapped options	138	–	–	no
* Value saved in NVRAM.						

Table 13. S-Register Summary (Continued)

Note	Register	Function	Default	Range	Units	Reported by &Vn
	S16	Modem test options	0	–	–	no
*	S18	Modem test timer	0	0–255	second	yes
*	S21	Bit-mapped options	48	–	–	no
*	S22	Bit-mapped options	118	–	–	no
*	S25	Detect DTR change	5	0–255	0.01 second	yes
*	S30	Disconnect inactivity timer	0	0–255	minute	yes
*	S33	Sleep mode timer	10	0–90	second	yes
* Value saved in NVRAM.						

Data Mode AT COMMANDS

3

The 536EX chipsets implement:

- Standard Hayes*-compatible AT commands and S-registers in data mode
- Standard EIA/TIA-578 AT commands in Class 1 fax mode
- Additional AT command sets for error correction, data compression and voice mode

In data mode, the AT commands configure the DCE (modem) to establish a connection with a remote data modem. In data mode, the 536EX chipsets execute the AT commands for error correction (MNP 2-4, V.42) and data compression (MNP 5, V.42 bis) described in [Table 21 on page 57](#), as well as the fax and voice mode commands **AT+FCLASS=1** (fax) and **AT+FCLASS=8** (voice).

3.1 Using AT Commands to Access the S-Registers [Sn?, Sn=x, ?]

The DTE can access the S-registers through the **ATSn?**, **ATSn=x**, and **?** commands. For example, to configure the modem to automatically answer a data modem call after two rings, type **ATS0=2**.

Examples:

```

ATS0=2      Configures S-register S0 to '2'
ATS0?       Reads the contents of S-register S0
ATS0=       Configures S-register S0 to '0'
AT?         Reads the contents of the last accessed (read or write) S-register

```

3.2 Modem Responses and Command Echo [En, Vn, Xn, Wn, Qn]

The **ATEn** command configures the DCE to send back to the DTE any data that the DTE sent to the DCE while in command mode. The **ATVn** command sets the DCE response codes to either text or numeric form. For example, upon successfully processing an AT command string, the DCE sends an 'OK' (text) or a '0' (numeric) to the DTE.

Examples:

Modem Setup	Host Command	Modem Response
Echo, Numeric (E1, V0)	AT<CR>	AT<CR>0<CR>
	ATS0?<CR>	ATS0?<CR>000<CR><LF>0<CR>
Echo, Text (E1, V1)	AT<CR>	AT<CR><CR><LF> OK<CR><LF>
	ATS0?<CR>	ATS0?<CR><CR><LF>000<CR><LF><CR><LF>OK<CR><LF>

Modem Setup	Host Command	Modem Response
No Echo, Numeric (E0, V0)	AT<CR>	0<CR>
	ATS0?<CR>	000<CR><LF>0<CR>
No Echo, Text (E0, V1)	AT<CR>	<CR><LF>OK<CR><LF>
	ATS0?<CR>	<CR><LF>000<CR><LF><CR><LF>OK<CR><LF>

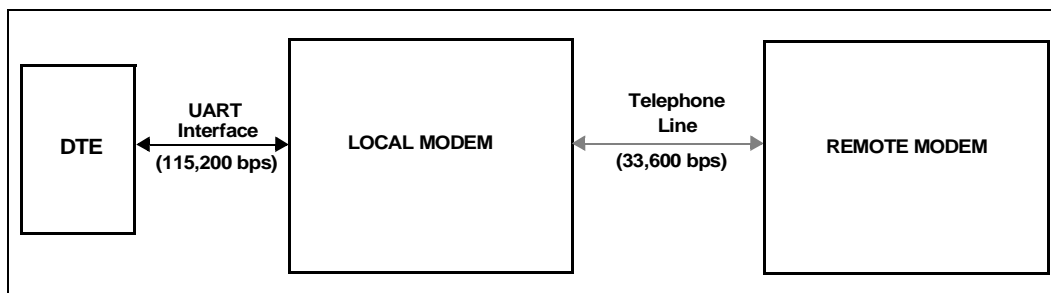
The DCE can be configured to use different response codes depending on the V.250 command that is enabled (**AT+MR**, **AT+ER**, **AT+DR**, and **AT+ILRR**). Alternatively, the **ATWn** command can be used to set these V.250 commands. The mapping for the **ATWn** command to V.250 commands is shown in [Table 14](#). The setting for the **ATXn** command ([page 43](#)) can affect which **ATWn** response codes are reported to the DCE. The **ATXn** command configures the modem call progress detection and reporting requirements during dialing (for example, dial tone and busy tone detection). The **ATQn** command selects whether the modem sends result codes to the DTE.

Table 14. Data Reporting Wn Mapping

Wn	+ER	+DR	+MR	+ILRR
W0	Disable	Disable	Disable	Disable
W2	Disable	Disable	Enable	Enable
W3	Enable	Enable	Enable	Enable
W4	Enable	Enable	Enable	Disable

For example, a connection is established with the remote modem as shown below (with LAPM error correction and V.42 bis data compression). The telephone line (or modem-to-modem connection) data rate is 33,600 bps and the local UART (DTE-to-modem) connection rate is 115,200 bps.

Figure 3. Example of a Remote Connection



The modem then sends the ‘CONNECT’ messages for the following four **Wn** commands:

- ATW0
ILRR: 115200
CONNECT 50666
- ATW2
+MCR: V90
+MRR: 28800
CONNECT 50666

- ATW3
+MCR: V90
+MRR: 28800
+ER: LAPM
+DR: V42B
+ILRR: 115200
CONNECT 50666
- ATW4
+MCR: V90
+MRR: 28800
+ER: LAPM
+DR: V42B
CONNECT 50666

3.3 Modem Reset and NVRAM Commands [DS=m, Zn, &F, &Vn, &Yn, &Wn, &Zn=x]

On powering-up, the DCE defaults to the configuration specified in NVRAM. The DCE may then be configured as needed. The DTE stores the DCE configuration in the NVRAM by first setting up the current configuration and then sending an **AT&Wn** command. The DCE configuration stored in the NVRAM is called a user profile. Two independent user profile configurations and four telephone numbers can be stored. Either user profile configuration can be used for the power-up defaults (**AT&Yn**). While in command mode, the DCE can be re-initialized at any time and the user profile changed using the **ATZn** command. To configure the modem to factory defaults, the **AT&F** command is used. A summary of the active user profile, two NVRAM user profiles, and previously-saved telephone numbers can be read from the modem using the view command, **AT&Vn**. The **AT&Zn=x** command stores one of four telephone numbers in the NVRAM. To dial these telephone numbers, use the **ATDS=m** command.

If the active profile is not stored in one of the two user profiles after setting up the modem, then the current settings are lost when the commands **ATZ** or **AT&F** are issued or when the modem is powered down.

Examples:

ATZ	Resets and then configures the modem to NVRAM user profile 0.
AT&F S0=1 &W1 &Y1	&F configures the modem for factory defaults. S0=1 configures the modem to answer after one ring. &W1 saves the active configuration to user profile 1. &Y1 configures the modem to use NVRAM user profile 1 as the power-up defaults.
AT&Z2 = 9, (408)444-5555	Stores a telephone number into the NVRAM as phone number 2, which can be re-dialed later using ATDS=2 .

3.4 Modem Identification Commands [In, +FMI, +FMR, +FMM, +GMI, +GMM, +GMR, +GSN, +FMFR?, +FMDL?, +FREV?]

The modem provides product identification AT commands that help determine the modem's manufacturer, model number, and product revision. To provide flexibility with older software application programs, the modem supports several commands that can be used to request a single item of identification (such as a modem model number). Table 15 lists the commands used to obtain product information (all identification commands are usable in data, fax, or voice mode).

Table 15. Product Identification Information

Product Information	AT Commands			
	ATIn Command	Data Mode	Class 1 Fax Mode	Legacy Modems
Modem Manufacturer	ATI2	AT+GMI	AT+FMI	AT+FMFR?
Model ID	ATI1	AT+GMM	AT+FMM	AT+FMDL?
Revision Number	ATI4	AT+GMR	AT+FMR	AT+FREV?

Example:

```

ATI1                Causes the modem to send the modem's name to the DTE.
Intel HaM Data      Response to the modem name request.
Fax Voice
```

3.5 Establishing a Modem Connection [A, D, DS = n, S0]

Data mode provides several methods for establishing a connection with a remote modem. For each modem, a connection can be initiated manually or automatically in both answer and originate modes. A manual-to-manual connection is useful when both modems (that are on-hook) are connected to an off-hook telephone line. For example, if two people are talking on the telephone, they can manually establish a modem connection without first hanging up. When establishing a manual connection, one modem must be designated as the originating modem and the other as the answering modem. Manual originate mode is initiated by sending an **ATD** to the DCE. Manual answer mode is accomplished by sending an **ATA** to the DCE.

Automatic originate mode is initiated by sending an **ATD <telephone number & dial modifiers>** or **ATDS=m** to the DCE. Automatic-answer mode is accomplished by setting S-register **S0** to a non-zero value. **S1** keeps track of how many ring signals are detected. If the content of **S0** is non-zero and the number of ring signals (as defined by **S0**) are detected (that is, **S1 = S0**), then the DCE goes off-hook and attempts to connect to the remote modem (with the following exceptions):

- The time period between the ring signals is greater than 8 seconds, which causes the **S1** counter to reset and thus never reach the value for **S0**.
- Caller ID is enabled and **S0=1**, the modem answers on the second ring signal instead of the first ring signal. This happens because Caller ID puts a signal on the telephone line between the first and second ring signal.

Example:

ATDT 9,444-5555	Automatically dials the telephone number with DTMF tones. After dialing a '9', the comma (,) causes the modem to pause two seconds before dialing the rest of the telephone number.
modem 1: ATD; modem 2: ATA	When establishing a manual-to-manual connection, the designated originating modem should receive the ATD command from its DTE just before the designated answering modem receives the ATA command from its DTE. It is important that the time between the ATD and ATA commands is less than 2 seconds.
AT-C1DT 123	Causes the modem to dial the telephone number 123 and immediately start sending a data calling tone. Calling tone can then be detected by the remote voice mail system. After detecting the calling tone, the remote system can change to data mode and start the data modem connection handshake.

3.6 Online Command Mode [Escape Codes, On]

After establishing a connection with a remote modem, the DTE sends the appropriate escape sequence to the DCE, which causes the DCE to enter the online command mode. The online command mode is used to send AT commands to the DCE while the DCE is still connected to the remote modem. The supported escape sequences are described in [Section 3.10, "AT Escape Sequences" on page 38](#). To re-enter the online data mode, use the **ATOn** command.

Example:

1 second +++	Hayes Escape Sequence. Guard times (in which the DTE does not send data to the DCE) of 1 second are needed before and after the three escape characters '+'. TIES (Time Independent Escape Sequence).
1 second	
+++AT<CR>	TIES (Time Independent Escape Sequence).
ATO	Causes the modem to re-enter online data mode.

3.7 Hanging Up [Hn, S10, Zn, &D2]

A modem connection terminates when the modem hangs up or when the remote modem transmit carrier is off longer than the duration specified in S-register **S10**. To hang up, the DTE typically sends an escape code sequence that causes the DCE to enter online command mode. Upon receiving an 'OK' message, the DTE sends either **ATH** or **ATZn** to the DCE. When the **AT&D2** command is used, the modem goes on-hook (hangs up) after an on-to-off transition of the DTR occurs.

Note: The **ATZn** command causes the DCE to hang up and re-initialize itself to the user profile specified by 'n'.

3.8 Modem-to-Modem Connection Data Rates

The data rates differ for each data mode selected. The 536EX chipsets either default to V.90 or V.92 mode depending on the driver version. For non-ISP connections, the chipsets fall back to V.34 mode. The modem defaults to whatever mode is issued by the **+MS=m** command (see the supported modulation types on [Table 16 on page 35](#)).

In Data mode, the 56K chipsets can transmit up to 48,000 bps (V.92 mode) or 33,600 bps (V.90 mode) and receive up to 53,333 bps. Note that the chipsets are capable of achieving 56,000 bps, but power limitations by the FCC limit actual speeds to 53,333 bps. The 56K receive data rates can be achieved only in connections with equipment-compatible ISPs (Internet Service Providers). In V.92 mode, the 536EX supports three new features: Quick Connect, Modem-on-Hold and Pulse Code Modulation (PCM) Upstream.

The Quick Connect (QC) feature reduces the time it takes to make a connection to your service provider. The modem retains information of the line conditions from your previous connection and uses this information to bypass parts of the training sequence. As a result, this provides faster connections. Normal V.90 connections take about 25–30 seconds. With V.92 Quick Connect, your connect times can be up to 50% faster.

The V.92 Quick Connect feature is controlled by the **+PSS** and **+PQC** commands. The **+PQC** command enables and disables the shorten phase 1 and or phase 2 startup procedures. The **+PSS** command forces either a short or full startup procedure on the next and subsequent connections. To enable the modem for V.92 Quick Connect, set **+PSS=0 or 1** and **+PQC=0**. Refer to [Table 5](#) for the detailed description of these commands.

The Modem-on-Hold (MOH) feature allows you to receive an incoming voice call and stay connected to the Internet and then return online after your conversation without having to re-dial. This is very convenient where the same phone line is used for voice calls and data connections. To receive an incoming call as described above requires that you have the Call-Waiting service from your telephone company. In addition, the Caller ID service from your telephone company is recommended but not required for MOH. This feature allows you to determine who is calling. The “hold” time for your incoming call is define by your service provide. The MOH feature also allows you put you data connection on hold and initiate a voice call and then return online after completing your voice conversation. These two scenarios are described in detail in [Figure 4](#) and [Figure 5](#).

Figure 4. Modem-on-Hold: Incoming Voice Call in Data Mode

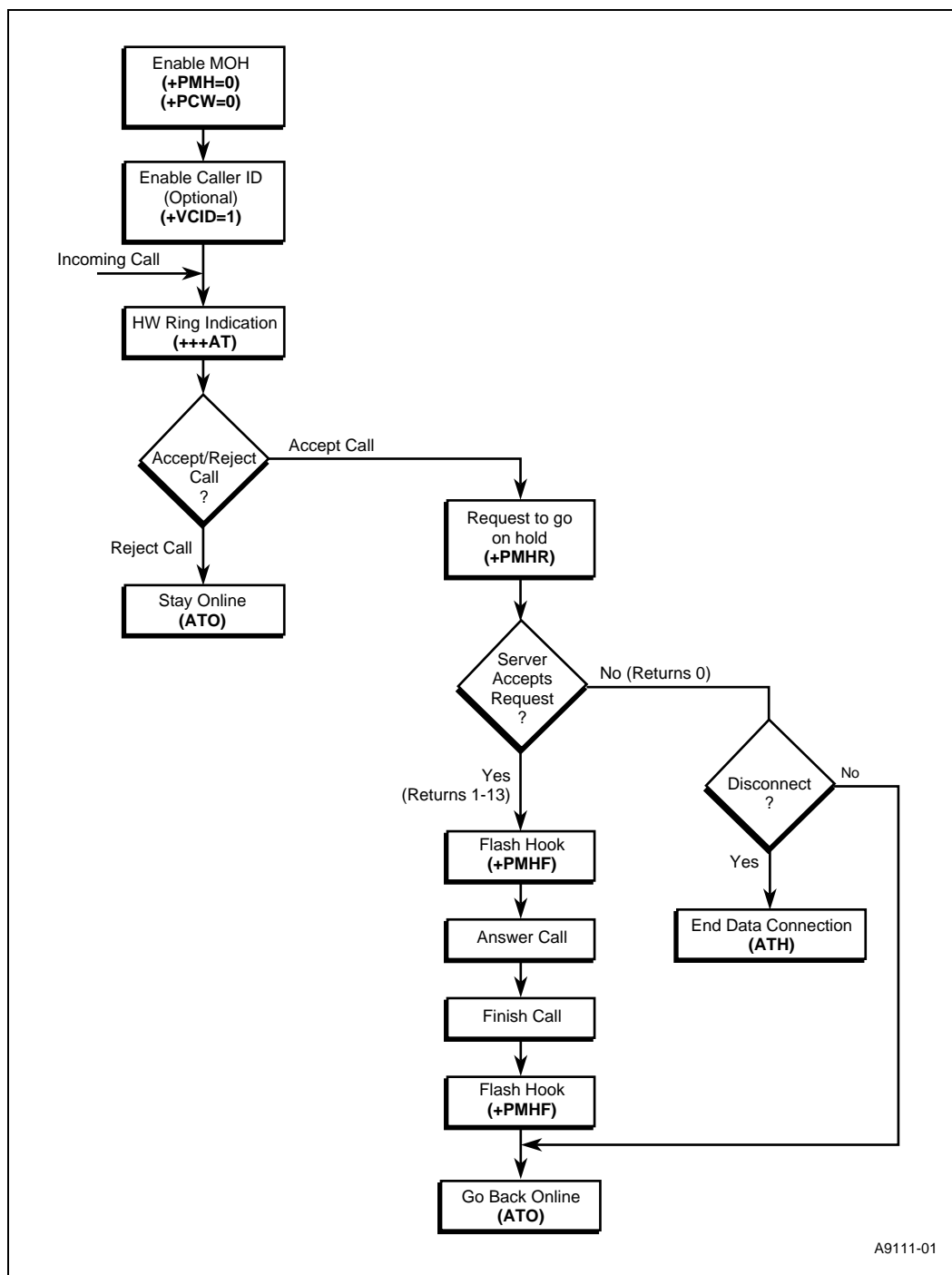
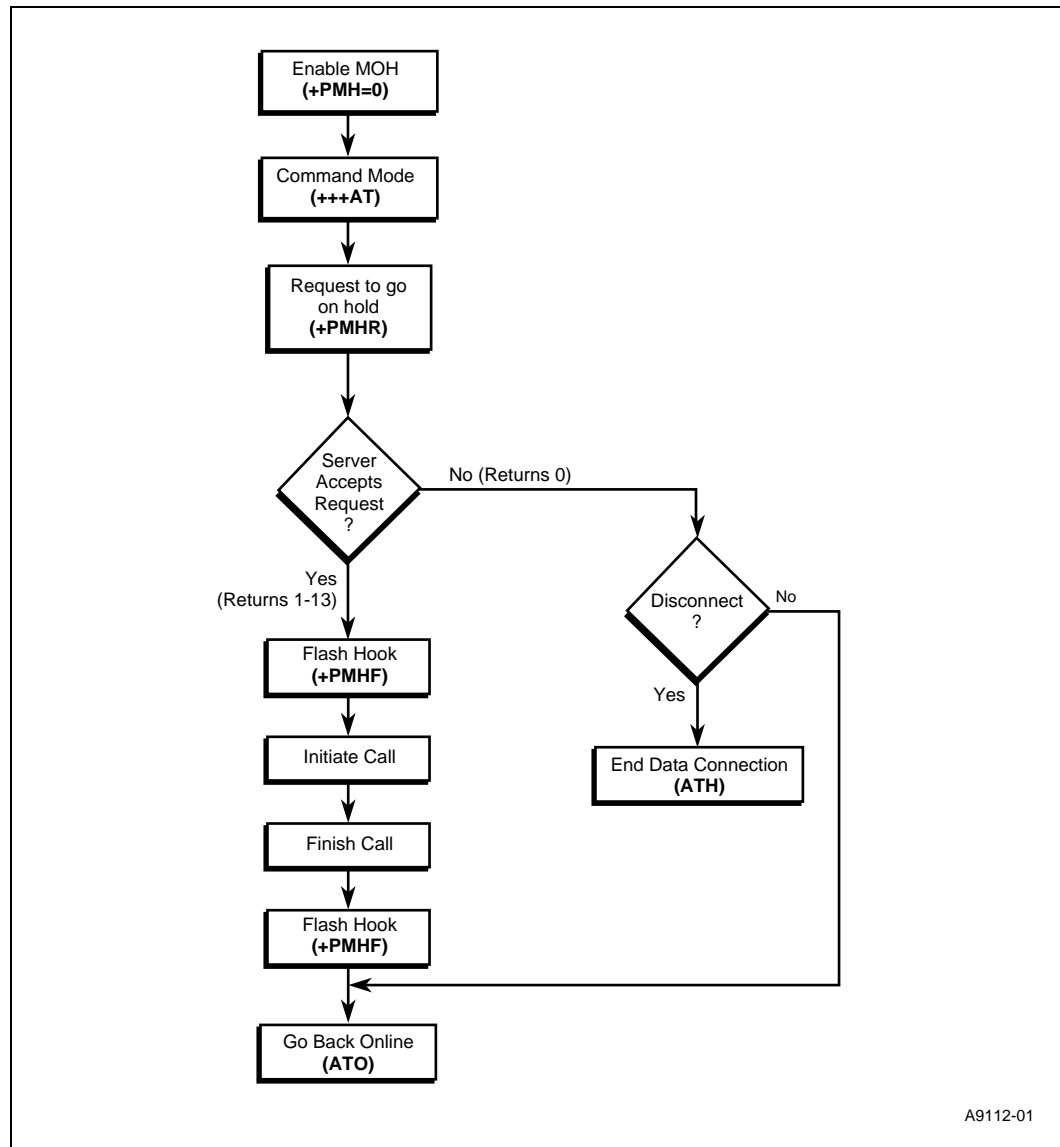


Figure 5. Modem-on-Hold: Initiating a Voice Call in Data Mode



The following sequence describes how to configure the modem for MOH to process an incoming voice call while online. First, MOH must be enabled. The **+PMH** and **+PCW** commands are used to enable MOH and to capture the Call Waiting tone which is sent when the voice call comes in. To enable MOH, set **+PMH=0** and **+PCW=0**. Next, to enable Caller ID information (optional), by setting **+VCID=1**. Now the modem is configured for the incoming call. When you receive the incoming call, the modem will get a ring indication and the software/application will issue a **+++AT** to put the modem in command mode. Then, you will be prompted to either “Accept” or “Reject” the call based on the Caller ID information (if enabled). If you reject the call, an **ATO** command is issued to perform a Quick Connect to stay online. If you accept the call, the data connection is put on hold, and the modem send a request to the server to go on hold using the **+PMHR** command. The server will accept enable (1–13 returned) or reject (0 returned) the request. If the server accepts the request to go on hold, the modem issues the **+PMHF** to flash the

hook to connect the call. Now you can answer the phone and talk. After completing your voice conversation, the modem will issue another **+PMHF** and **ATO** command to initiate a Quick Connect. If the server rejects the request to go on hold, the user can stay on line (**ATO** command issued) or disconnect from his initial data connection (**ATH** command issued).

The next sequence describes how to initiate a voice call while online. First, enable the MOH feature by setting **+PMH=0**. When online, the user can initiate a voice call by first issuing **+++AT** to put the modem in command mode. Then request the server to go on hold by issuing the **+PMHR** command. The server will either accept (1–13 returned) or reject (0 returned) the request. If the server accepts the request to go on hold, the modem issues the **+PMHF** to flash the hook and get dial tone. You can then make a voice call. After completing the voice conversation, the modem will issue another **+PMHF** and **ATO** command to initiate a Quick Connect. If the server rejects the request to go on hold, the user can stay on line (**ATO** command issued) or disconnect from his initial data connection (**ATH** command issued). Refer to [Table 5](#) for the detailed description of the V.92 commands.

The PCM Upstream feature allows you to upload data to the network up to 48,000 bps. This is an improvement over the 33,600 bps maximum with V.90. This is beneficial when you are sending large file, email attachments and gaming on the Internet. The **+PIG** command is used to enable and disable the PCM Upstream feature. To enable PCM Upstream, set **+PIG=0**. To disable PCM Upstream, set **+PIG=1**.

Several V.34 modes are available (see [Table 16](#)). These provide different speeds. For example, V34S offers a modem-to-modem data rate of 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, and 28,800 bps. For V.42, MNP, and Buffer (Normal) modes, the modem provides speed buffering (see [Section 4](#) starting on [page 56](#)), which allows the DTE-to-modem data rate to be different from the modem-to-modem data rate. Users can take advantage of this feature by setting the DTE-to-modem rate to a high speed like 115,200 bps and letting the modem negotiate the best line rate.

The 536EX chipsets can be configured (by the **+MS=m** command) to support either asymmetrical or symmetrical connections. The modem transmits and receives at the same speed in symmetrical connections and at different speeds in asymmetrical mode. V.90 and V.92 connections are always asymmetrical. V.34 mode connections can be either symmetrical or asymmetrical. The modem uses six parameters for asymmetrical modes and four parameters for symmetrical modes. Note that the transmitter speed and receiver speeds typically are different for most V.34 connections over the PSTN.

To configure the DTE-to-modem data rate (in data on-hook command mode), change the terminal program COM port speed selection or write the appropriate divisor latch values for a given speed to the UART Divisor Latch registers. Then send an **AT<CR>** or any other valid AT command to the modem. The modem responds with an OK at the new data rate. All commands and modem responses that follow use the new data rate.

Note: In command mode, the modem only changes its DTE-to-modem data rate after the Divisor Latch register values change and the DTE sends a valid AT command.

The **+MS=m** command defines which modem-to-modem data rates are supported by the modem. The table below shows the supported modulation types. Each modulation supports one or more data rates. Refer to [page 53](#) for the **+MS** command description.

Table 16. Supported Modulation Types

<carrier >	Description
Bell 103	300 bps
Bell 212A	1200 bps
V21	V.21 300 bps
V22	V.22 1200 bps
V22B	V.22 bis 1200 and 2400 bps
V23C	V.23, with constant carrier; 1200 bps forward and 75 bps reverse
V32	V.32 4800 and 9600 bps
V32B	V.32 bis 7200, 9600, 12,000, and 14,400 bps
V34	V.34 asymmetrical connections: 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps
V90	56K V.90 asymmetrical connections (transmit): 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, and 28,800, 31,200, and 33,600 bps 56K V.90 asymmetrical connections (receive): 28,000, 29,333, 30,666, 32,000, 33,333, 34,666, 36,000, 37,333, 38,666, 40,000, 41,333, 42,666, 44,000, 45,333, 46,666, 48,000, 49,333, 50,666, 52,000 53,333, 54,666, and 56,000 bps
V92	56K V.92 asymmetrical connections (transmit): 24,000, 25,333, 26,666, 28,000, 29,333, 30,666, 32,000, 33,333, 34,666, 36,000, 37,333, 38,666, 40,000, 41,333, 42,666, 44,000, 45,333, 46,666, 48,000 and 49,333 bps 56K V.92 asymmetrical connections (receive): 28,000, 29,333, 30,666, 32,000, 33,333, 34,666, 36,000, 37,333, 38,666, 40,000, 41,333, 42,666, 44,000, 45,333, 46,666, 48,000, 49,333, 50,666, 52,000, 53,333, 54,666, and 56,000 bps

If the **+MS=m** parameters contain conflicting information like “+MS=V34,1,14400,0” with a DTE data rate of 2400 bps, then the modem’s connection attempts always fail, and the modem reports a “NO CARRIER” message. This happens because when the modem receives the **+MS=m** command, the modem does not check for conflicts of valid parameter information.

Table 17 shows the resulting connection data rate when using non-default values. Because of impairments on the telephone line, the actual connection speeds may be lower than the speeds defined in this table.

For V.92, V.90, and V.34 modulation, the modem can receive data at a different data rate than the transmit data rate. All other modulation types besides V.23 and V.34 use the same data rate for the transmitter and receiver. Use **ATW3** to see the modem’s actual receive and transmit data rates (the modem must be configured for **ATV1** text response codes). Table 17 shows examples of the resulting connection rate when non-default values are used.

Table 17. Resulting Modem-to-Modem Connection Rates with Non-Default Values

Originating Modem	Answering Modem	Resulting Connection Speed
+MS = V34, 1, 0, 0, 0, 0; the UART data rate = 115,200 bps	+MS = V32, 1, 0, 9600, 0, 0; the UART data rate = 14,400 bps	9600 bps: the originating modem is configured to attempt a maximum 28,800 bps connection, but the answering modem is configured to attempt a maximum data rate of 9600 bps.
+MS = V34, 0, 33,600, 33,600, 0, 0; UART data rate = 115,200 bps	+MS = V32B, 1, 0, 9600, 0, 0; B1 and UART data rate = 14,400 bps	No connection: the originating modem is configured to attempt only a 33,600 bps connection, but the answering modem is configured to attempt a maximum data rate of 9600 bps.
+MS = V32, 1, 7200, 9600, 0, 0; and UART data rate = 7200 bps	+MS = V34, 1, 0, 0, 0, 0; UART data rate = 9600 bps	9600 bps: the originating modem is configured to attempt connection at between 7200 to 9600 bps or below. The answering modem is configured to attempt a data rate of 9600 bps or below. The connection takes place at 7200 bps, the highest speed supported by both modems.

3.9 Diagnostic Testing [S18, &Tn]

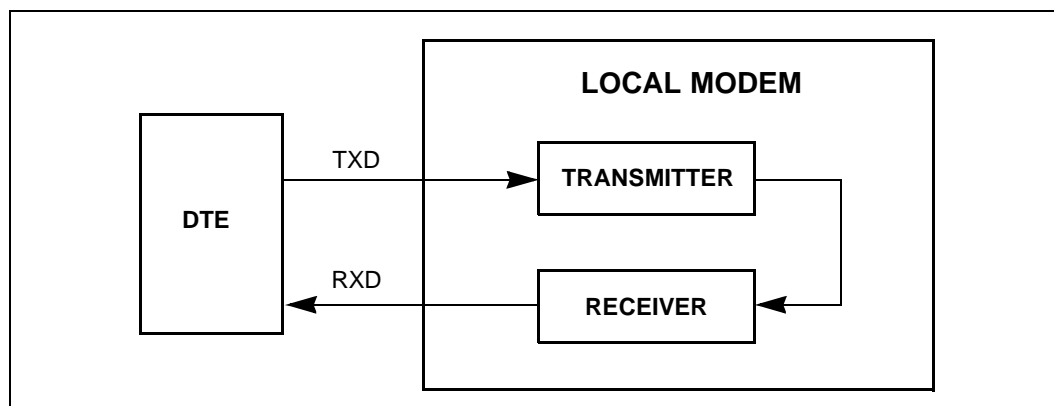
The **&Tn** command initiates loopback tests. Setting S-register **S18** to a non-zero value determines the length of testing after the modem receives the **&Tn** command. After the testing period elapses, the modem halts the test and returns to command mode. To abort the test before the test timer has timed out, enter the escape code sequence followed by **AT&T0**. Setting **S18** to an '0' disables the test timer. In this case, the loopback test continues to run until an escape code, followed by **AT&T0** (or **ATH**), is sent to the modem.

The modem provides a local analog loopback test (see [Section 3.9.1, “Local Analog Loopback \[AT&T1\]” on page 36](#)) for testing modem-to-modem integrity in all modes except V.90 and V.92. After entering the loopback mode, the communication integrity is checked by the DTE sending data to the modem and then checking the looped-back data for errors. In addition, in the self-test mode the modem implements an internal data pattern generator and checker that detects errors. When a data error occurs in self-test mode, the modem increments an internal error counter. Upon completing the test, the modem sends a three-digit error count to the DTE. These tests are illustrated in the following examples.

3.9.1 Local Analog Loopback [AT&T1]

This test is used by the local DTE to check the DTE-to-modem communication integrity. The local DTE will not initiate the test from online command mode.

Figure 6. Local Analog Loopback Test



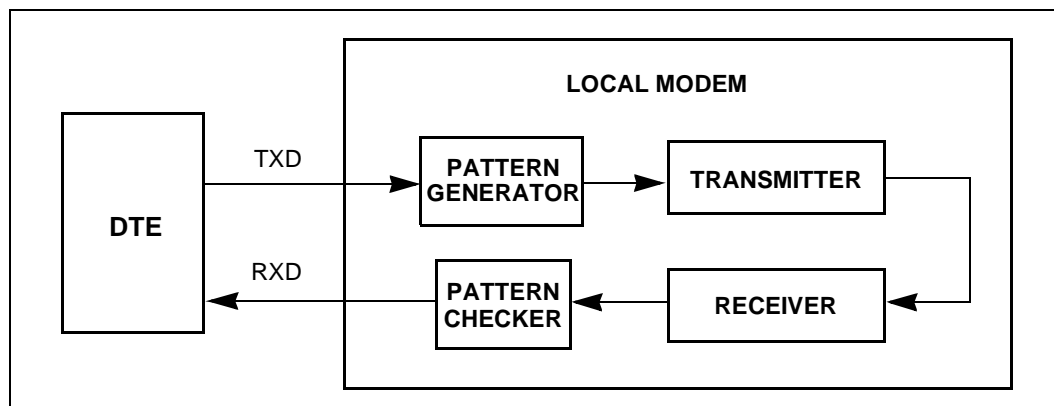
Local Modem (or Test Modem)

AT&F &W<CR>	Returns the modem to the factory defaults.
AT S18 = 0 &T1	Causes the modem to run local analog loopback without self-test.
CONNECT 115200	Modem response code indicates that analog loopback is enabled with a DTE speed of 115200.
This is a test.	Test string that the user could type at the keyboard. If the received data is the same as the test string, then the DTE-to-modem communication channel is working properly.
+++AT	TIES Escape Sequence is used to return to command mode.
OK	Modem enters command mode.
AT&T0	Terminates any loopback test.
OK	Modem aborts analog loopback and stays in command mode.

3.9.2 Local Analog Loopback With Self-Test [AT&T8]

This test is used by the local DTE to check the DTE-to-modem communication integrity.

Figure 7. Local Analog Loopback with Self-Test



Local Modem (or Test Modem)

AT&F &W<CR>	Returns the modem to the factory defaults.
AT S18=20 &T8	Causes the modem to start local analog loopback with self-test for 20 seconds.
OK	After starting analog loopback, the modem goes back to command mode.
AT	The modem responds to new commands.
OK	
000	After 20 seconds, the modem stops analog loopback, sends an error count to the DTE, and enters command mode.
AT S18=0 &T8	Causes the modem to start local analog loopback with self-test, which is only terminated by AT&T0 or ATH.
OK	After starting analog loopback, the modem goes back to command mode.
AT	The modem responds to new commands.
OK	
AT&T0	After receiving AT&T0 or ATH, the modem stops analog loopback, sends an error count to the DTE, and enters command mode.
000	
OK	

3.10 AT Escape Sequences

The 56K family provides the industry-standard Time Independent Escape Sequence (TIES). The DTE sends the escape sequence to return the modem to command state while in the online data state (that is, connected to another modem) or in diagnostic mode (**&Tn** commands).

Intel also makes the Hayes[®] Escape Sequence available to customers; however, see the following statement regarding licensing requirements.

Licensing Requirements for Hayes Escape Sequence

The Intel chipsets are manufactured with TIES as the default setting. It is Hayes' position that you must either have or obtain a valid license from Hayes Microcomputer Products, Inc., of Norcross, Georgia, before producing modem systems that use the Hayes Escape Sequence.

Intel accepts no responsibility and does not indemnify nor in any way provide protection for patent or possible patent violations to its customers or users of its products.

3.10.1 Time-Independent Escape Sequence

The TIES (Time-Independent Escape Sequence), implemented with +++**AT**, was developed by a group of modem manufacturers as an alternative to the Hayes Escape Sequence. TIES was designed for compatibility with existing communication software written for the Hayes Escape Sequence.

The DTE implements the escape sequence by sending the escape character (as defined in **S2**) three times, followed by a valid AT command, and then the contents of **S3** (typically a <CR>). Upon detecting the three consecutive escape characters, the modem changes to TIES command mode and starts an internal EPD (Escape Prompt Delay) timer (with the time limit defined by **S12**). The modem then looks for one of the following conditions to occur:

- *No additional data is received and the EPD timer times out:* the modem sends an 'OK' message to the DTE and then waits indefinitely for an incoming valid AT command string from the DTE. Until the modem receives a valid AT command, it monitors any data received from the DTE and passes on the data to the remote modem (that is, the modem does not echo back the received character to the DTE).
 - If the subsequent character received by the modem is not an 'A' or 'a', the modem returns to data mode and sends a 'CONNECT' message back to the DTE.
 - If the modem receives an 'A' or 'a', it stores any additional data received from the DTE in the modem's internal command buffer and continues to send the data to the remote modem. The modem then waits until the DTE sends a <CR>, or up to 39 data characters, before deciding whether to go to command mode or to return to data mode. Upon detecting a <CR> or receiving the 39 data characters, the modem determines if a valid AT command has been received. If a non-AT command string or an invalid command string has been received, then the modem changes back to data mode and sends a 'CONNECT' message to the DTE. If a valid AT command has been received, the modem changes to command mode and sends an 'OK' message. After sending the 'OK' message, the modem echoes any received data from the DTE while in command mode.
- *An 'A' or 'a' is received from the DTE.* The modem disables the EPD timer and sends the character to the remote modem. The modem then stores any received data from the DTE into the modem internal command buffer and sends the data to the remote modem. Upon detecting a <CR> or receiving up to 39 data characters, the modem determines if a valid AT command has been received; if so, it processes the valid commands. If a non-AT command string or an invalid command string has been received, then the modem remains in data mode. If a valid AT command has been received, then the modem changes to command mode and sends an 'OK' message. After sending this, the modem (while in command mode) echoes back any data received from the DTE.
- *Any character except an 'A' or 'a' is received from the DTE.* The modem disables the EPD timer and changes back to data mode.

If an AT command string is received while in TIES command mode, the modem processes any valid AT command. Upon detecting an invalid AT command, the modem changes back to data mode and issues a 'CONNECT' message to the DTE. While in TIES command mode, the modem ignores certain characters that may cause the modem to incorrectly decide that an incoming AT string is invalid. The ignore characters are <LF>, <space>, and <CR> (<CR> is ignored only when **S3** is not equal to <CR>). Not all AT commands are supported during TIES command mode. The following is a list of supported commands:

En, Hn, Mn, On, Qn, Sn, Vn, Xn, and '&' commands (except &Tn and &F)

The escape character is determined by the value stored in S-register **S2**, and it is typically a '+' character. The following is an example of the TIES Escape Sequence:

Format:

<char1><char2><char3><AT command><contents of S3>
char1 = char2 = char3 = escape character (S2)

Example:

```
DTE:    +++ AT<CR>
DCE:    OK
```

Note: TIES requires that the three-character escape sequence be contiguous and not repeated. The character immediately preceding the first character of the three-character sequence **cannot** be the same as the escape character. Therefore, '+++ AT<CR>' is valid, but '++++ AT<CR>' is not.

3.10.2 Hayes* Escape Sequence

In this escape sequence, implemented with +++, the DTE sends the modem an escape character three times, preceded and followed by guard times. Upon detecting the escape sequence, the modem sends an 'OK' response to the DTE. To re-enter the online data state, the DTE then sends the modem **ATO** followed by the contents of S-register **S3** (typically a <CR>).

The escape character is determined by the value stored in S-register **S2** and is typically a '+' character. Guard times are silence times when the DTE does not send any data to the modem. Guard times ensure that the modem does not falsely detect an escape sequence if three consecutive escape characters are received from the DTE. The preceding and following guard times are defined in S-register **S12**. Typically, these guard times are 1 second. In addition to the preceding and ending guard times, there are inter-character time-outs between each escape character sent. The inter-character time-outs define the maximum amount of time allowed between characters before the modem ignores the previous escape characters. This inter-character delay time is set to 1 second. An example of the Hayes Escape Sequence follows:

Format:

```
<gt1><char1><tm 2><char2><tm3><char3><gt4>
gt1 = gt4 ≥ preceding and following guard times (S12)
tm2 = tm3 ≤ inter-character time-out (= 1 second)
char1 = char2 = char3 = escape character (S2)
```

Example:

```
DTE:    1 second +++ 1 second
DCE:    OK
```

Table 18. Data Mode Command Descriptions

Command	Default	Description
A/	none	Repeat Last Command: This command re-executes the last AT command string stored in the command buffer. A/ is the only command not preceded by AT and ended by a carriage return. Sending any character (such as a carriage return) after A/ and before a modem response is sent to the DTE causes the modem to abort the remainder of the command string in the modem internal command buffer.
A	none	Answer Command: This command causes the modem to immediately go off-hook and initiate an answer mode handshake without waiting for an incoming ring signal. This command is useful for manually answering a call or establishing a back-to-back connection with an originate-mode modem.
Cn	1	Carrier Control Option: This command is reserved for selecting between controlled carrier or constant carrier modes. This modem supports only constant carrier mode. n = 0 Transmit carrier always off (returns an ERROR message) n = 1* Normal transmit carrier (constant carrier)
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
D	none	<p>Dial Command: This command causes the modem to immediately go off-hook as an originating modem and dial a telephone number with corresponding dial modifiers. Dial modifiers are parameters that define how the modem should dial the telephone number.</p> <p>Dial Modifiers</p> <p>0–9 Dialing Digits</p> <p>A, B, C, Tone Dial Characters</p> <p>D, *, #</p> <p>P Pulse Dial—configures the modem to use pulse dialing to dial a telephone number.</p> <p>R Reverse Originate Mode—places the modem in answer mode. This modifier should be the last character in the dialing string (for example, ATDT 12345678R). After dialing the telephone number, the modem goes into data modem answer mode instead of originate mode.</p> <p>S = n Dial NVRAM Telephone Number—causes the modem to dial a telephone number previously stored in the NVRAM with the AT&Zn=x command.</p> <p>T Tone Dial—configures the modem to use DTMF tones to dial a telephone number.</p> <p>W Wait for Dial Tone—causes the modem to look for dial tone for a specified amount of time. If dial tone or the amount of time specified by the S-register, S6, times out, the modem processes the next command in the dial string. If a busy signal is detected, the modem responds to the DTE with a busy response code and then goes into off-line command mode.</p> <p>, Pause—causes the modem to pause or delay implementing the next parameter in the dial string by the time specified in S-register S8.</p> <p>! Flash Hook—causes the modem to go on-hook for 0.75 seconds.</p> <p>@ Wait for Quiet Answer—causes the modem to wait for specified amount of time (S-register S7) followed by 5 seconds of silence before processing the next dial modifier.</p> <p>; Return to Idle State—causes the modem to enter online command mode without initiating a data modem handshake (used for phone directory auto-dialers).</p> <p><space> - () Ignored by Modem—these four characters are ignored by the modem. Spaces also may be included in the dial string to separate area codes and numbers.</p>
En	1	<p>Command Mode Echo: This command selects whether the modem echoes AT commands back to the host in either online or off-line command mode.</p> <p>n = 0 Echo disabled</p> <p>n = 1* Echo enabled</p>
Hn	0	<p>Switch Hook Control: This command controls the telephone line relay (OHREL*) and causes the modem to either hang up or pick up the telephone line.</p> <p>n = 0* Hang up telephone line (go on-hook)</p> <p>n = 1 Pick up telephone line (go off-hook)</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
In	0	Identification/Checksum Option: This command causes the modem to send product code and hardware setup information to the DTE. n = 0* ROM Checksum n = 1 Modem name n = 2 Manufacturer n = 3 Chipset n = 4 Firmware version n = 5 Modem chip hardware configuration n = 6 DSP patch level n = 12 Country code n = 7–11, 13, 14, 20–25 Reserved Example: ATI2 Intel Corporation OK
Ln	2	Speaker Volume Control: This command selects the modem's speaker volume. n = 0 Low speaker volume n = 1* Low speaker volume n = 2 Medium speaker volume n = 3 High speaker volume
Mn	1	Speaker Control: This command specifies when the speaker is turned on and off. n = 0 Speaker always off n = 1* Speaker on until carrier present n = 2 Speaker always on n = 3 Speaker off during dialing, and on until carrier
On	0	Go Online: This command causes the modem to return back to online data mode from online command mode. n = 0* Returns the modem to data mode n = 1 Begins an equalizer retrain sequence; then returns to data mode n = 3 Renegotiates rate and then returns to data mode
P	none	Select Pulse Dialing: This command configures the modem to use pulse dialing next time the modem dials a telephone number.
Qn	0	Result Code Display Control: This command selects whether the modem sends result codes to the DTE. n = 0* Result codes enabled n = 1 Result codes disabled
Sn	none	Select an S-Register: This command selects the current S-register. n = 0–33
Sn=x	none	Write to an S-Register: This command writes a decimal number 'x' to S-register 'n'. n = 0–33 x = 0–255
Sn?	none	Read an S-Register: This command is used to read a decimal number from S-register 'n'. n = 0–33
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
T	none	Select Tone Dialing: This command configures the modem to use DTMF tones the next time the modem dials a telephone number (touch tone dialing).
Vn	1	Result Code Form: This command selects whether the modem's basic syntax response codes are in numeric or verbose form. n = 0 Numeric form n = 1* Text form
Wn	0	Response Code Data Rate: This command selects whether the modem sends the DTE independent modem connection extended syntax result codes for modulation mode, speed, error control protocol, or data compression before the final 'CONNECT' message. This command does the selection by enabling and disabling the appropriate V.250 reporting commands (+MR , +ER , +DR , and +ILRR). n = 0*, 1 CONNECT result code reports DTE speed. For example: +ILRR: 115200 CONNECT 50666 n = 2 CONNECT result code reports modulation mode and DCE transmitter speed. For example: +MCR: V90 +MRR: 28800 CONNECT 50666 n = 3 CONNECT result code reports DTE data rate, modulation mode, error correction, data compression, DCE transmitter speed and DCE receiver speed. For example: +MCR: V90 +MRR: 28800 +ER: LAPM +DR: V42B +ILRR: 115200 CONNECT 50666 n = 4 CONNECT result code reports modulation mode, error correction, data compression, DCE transmitter speed and DCE receiver speed. For example: +MCR: V90 +MRR: 28800 +ER: LAPM +DR: V42B CONNECT 50666 Please refer to +MR=m , +ER=m , +DR=m and +ILRR=m for a detailed description of each command.
Xn	4	Result Code Type/Call Progress: This command determines which modem result codes are enabled. Additionally, this command specifies whether busy and dial tone detection are enabled or disabled. n = 0 Result codes 0–4 enabled. Busy and dial tone detect disabled. n = 1 Result codes 0–5, 10 and above enabled. Busy and dial tone detect disabled. n = 2 Result codes 0–6, 10 and above enabled. Busy detect disabled and dial tone detect enabled. n = 3 Result codes 0–5, 7, 10 and above enabled. Busy detect enabled and dial tone detect disabled. n = 4* Result codes 0–7, 10 and above enabled. Busy and dial tone detect enabled.
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
Yn	0	<p>Long Space Disconnect: This command determines whether the modem disconnects after receiving 1.6 seconds of silence and whether the modem sends a period of silence to the remote modem before disconnecting.</p> <p>n = 0* Disables long space disconnect</p> <p>n = 1 Enables long space disconnect. The modem disconnects after receiving 1.6 seconds of silence from the remote modem. Additionally, after receiving an ATH0 command, the modem sends at least 4 seconds of silence before hanging up.</p>
Zn	0	<p>Reset Modem/Recall Stored Profile: This command causes the modem to go on-hook (hang-up), perform a warm reset, and load user-configuration profile 'n' (previously stored in the NVRAM) into the active profile. The Zn command must be the last command in command string, as it causes all subsequent commands to be ignored.</p> <p>n = 0* Resets the modem and recalls user profile 0</p> <p>n = 1 Resets the modem and recalls user profile 1</p>
&Cn	1	<p>DCD (Data Carrier Detect) Option: This command controls how the modem functions in relation to the DCD or RLSD signal.</p> <p>n = 0 State of carrier from remote modem is ignored. DCD is always on.</p> <p>n = 1* State of carrier from remote modem is tracked. DCD reflects the state of the received carrier.</p>
&Dn	2	<p>DTR (Data Terminal Ready) Option: This command controls how the modem responds to DTR. After toggling DTR, the host should wait 200 ms before modifying the UART registers or sending a new command to the modem. This is done because the modem does <i>not</i> send an 'OK' message to indicate it has performed the requested function.</p> <p>n = 0 In asynchronous mode (&Q0), the modem ignores DTR.</p> <p>n = 1 The modem switches from data mode to command mode when an on-to-off transition of DTR occurs.</p> <p>n = 2* An on-to-off transition of DTR causes the modem to go on-hook (hang up). While DTR is off, auto-answer is disabled.</p> <p>n = 3 An on-to-off transition of DTR re-initializes the modem. The re-initialize procedure performs the same function as a power-up reset, except that the UART registers are not reconfigured.</p>
&F	none	<p>Load Factory Defaults: This command loads command defaults and S-register factory defaults into the active configuration and configures the modem for data mode.</p>
&Gn	0	<p>Guard Tone Option: This command controls whether the modem sends out guard tones while connected to a remote modem (for ITU-T V.22 bis [1200 bps] and V.22 bis [2400 bps] connections only). Guard tones may be required in some countries but are not needed in the United States. Guard tones are sent by the answer modem to disable Central Office echo cancelers.</p> <p>n = 0* Guard tone disabled</p> <p>n = 1 550 Hz guard tone enabled</p> <p>n = 2 1800 Hz guard tone enabled</p>
&Kn	3	<p>Select Serial Port Flow Control: This command specifies the DTE-to-modem flow control. Software flow control uses the characters XOFF (13h) and XON (11h) to stop and start data transmission, respectively, both to and from the DTE. Bidirectional hardware flow control uses RTS/CTS to stop and start data from the modem.</p> <p>n = 0 Disables flow control</p> <p>n = 3* Bidirectional hardware flow control—RTS/CTS</p> <p>n = 4 XON/XOFF software flow control</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
&Pn	0	<p>Dial Pulse Ratio: This command determines the make/break (that is, off-hook/on-hook) ratio during pulse dialing.</p> <p>n = 0* Make = 39%; Break = 61% at 10 pulses per second—for use in the United States. n = 1 Make = 33%; Break = 67% at 10 pulses per second—for use in the United Kingdom and Hong Kong.</p>
&Sn	0	<p>DSR (Data Set Ready) Option: This command controls how the modem treats the DSR signal.</p> <p>n = 0* DSR circuit always on n = 1 DSR circuit is on during handshaking, off in test or idle modes. DSR is off when the carrier is lost.</p>
&Tn	0	<p>Data Mode Self-Test Command: This command is used in data mode (except x2 and V.90 connections) to initiate and terminate loopback tests for testing modem-to-modem and DTE-to-modem data communication integrity.</p> <p>n = 0* Terminates test in progress n = 1 Local analog loopback n = 8 Local analog loopback with self-test</p>
&Un	0	<p>Disable Trellis Coding: This command selects whether the modem transmits or receives modulated 9600 bps carrier with QAM or Trellis encoding for V.32.</p> <p>n = 0* Enabled (Trellis modulation with QAM modulation as a fallback) n = 1 Disabled (QAM modulation only)</p>
&Vn	0	<p>View Active Configuration and Stored Profiles: This command causes the modem to display the command and S-register information contained in the active user profile and in one of two stored profiles. The command &V0 displays the active profile and the stored profile 0; &V1 displays the active profile and the stored profile 1. The information in the active profile is stored into the user profiles with the &Wn command. &W0 stores the active profile into the stored profile 0; &W1, the stored profile 1.</p> <p>n = 0* Stored profile 0 n = 1 Stored profile 1</p> <p>AT&V0 ACTIVE PROFILE: E1 L2 M1 T Q0 V1 W0 X4 Y0 &C1 &D2 &G0 &J0 &K3 &P0 &S0 &Y0 %A013 %C1 %E1 \A3 \C0 \G0 \J0 \T000 \X0 -J1 S00:000 S01:000 S02:043 S03:013 S04:010 S05:008 S06:002 S07:060 S08:002 S09:006 S10:014 S11:070 S12:050 S18:000 S25:005 S27:064 S32:032 S33:010 +ES=003,000,002 +DS=003,000</p> <p>STORED PROFILE 0: E1 L2 M1 T Q0 V1 W0 X4 Y0 &C1 &D2 &G0 &J0 &K3 &P0 &S0 %A013 %C1 %E1 \A3 \C0 \G0 \J0 \T000 \X0 -J1 S00:000 S02:043 S06:002 S07:060 S08:002 S09:006 S10:014 S11:070 S12:050 S14:138 S18:000 S21:048 S22:118 S23:048 S25:005 S27:064 S30:000 S32:032 S33:010 +ES=003,000,002 +DS=003,000</p> <p>TELEPHONE NUMBERS: &Z0 = &Z1 = &Z2 = &Z3 =</p>

NOTE: An asterisk (*) denotes the factory-default setting.

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
&Wn	0	Store Active Profile: This command causes the modem to store a subset of the active profile command and S-register configurations into the NVRAM user profile 'n'. n = 0* Store in user profile 0 n = 1 Store in user profile 1
&Yn	0	Select Stored Profile on Power-up: This command selects the particular stored user profile from the NVRAM to be loaded into the active profile upon modem power-up. n = 0* Select profile 0 n = 1 Select profile 1
&Zn=x	none	Store Telephone Number: This command stores a telephone number up to 30 digits (including dial modifiers) in the NVRAM. To dial the stored telephone number, use the ATDS=m command. Use the &V command to see the stored telephone number. n = 0–3 x = 0–9 A B C D # * T P R W @ , ! ;
%En	1	Auto-Retrain Control: This command controls whether the modem automatically initiates a modem retrain whenever the received data signal quality falls below a threshold that may affect data reliability. The value for 'n' is stored in the NVRAM. n = 0 Disabled n = 1* Enabled
%Gn	1	Rate Renegotiation: This command selects whether the modem automatically initiates a change to a higher speed or lower speed depending on received signal quality (that is, rate negotiation). The modem always responds to any rate change initiated by the remote modem. n = 0 Disabled n = 1* Enabled
-Cn	0	Generate Data Modem Calling Tone: This command allows the DTE to select whether the modem sends a 1300 Hz calling tone or V.8 calling tone when originating a data modem connection. n = 0* Calling tone disabled n = 1 1300 Hz calling tone sent for all data modem connections n = 2 V.8 calling tone sent for V.34 modulation and 1300 Hz calling tone sent for all other modulations

NOTE: An asterisk (*) denotes the factory-default setting.

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
+A8E=m	see 'm'	V.8 and V.8 bis Operation Controls: This command configures V.8 and V.8 bis operation. If issued when the DCE is on-hook, this command is a compound parameter used to precondition V.8 and V.8 bis originating and answering operation. It is not supported as an action command while the DCE is off-hook. If enabled, V.8 negotiation does not preclude simultaneous implementation of other means of negotiation (for example, V.8 bis, V.18, and V.32 bis Annex A).
		For the +A8E default values, the signal indicators are not generated by the DCE. When the parameters <v8o>=6 and <v8a>=5, the +A8I , +A8C , +A8A , +A8J , and +A8M indications are sent from the DTE, but the +A8M command is not used because the DCE controls the V.8 section.
		m = <v8o>, <v8a>, <v8cf>, <v8b>,<cfrange>, <protrange>
		Defaults: 1, 1, C1, 0, ,
		<v8o> V.8 origination selection.
		Range: 0, 1, 6
		0 Disable V.8 origination negotiation
		1* DCE-controlled V.8 origination negotiation
		6 DCE-controlled V.8 origination negotiation, enable indications only
		<v8a> V.8 answer selection.
		Range: 0, 1, 5
		0 Disable V.8 answer negotiation
1* DCE-controlled V.8 answer negotiation		
5 DCE-controlled V.8 answer negotiation, enable indications only		
<v8cf> V.8 call function		
Range: 0x21, 0xC1		
0x21 Sets the V.8 call function to indicate H.324.		
0xC1* Sets the V.8 call function to indicate standard data mode.		
<v8b> V.8 bis control		
Range: 0		
0* Disable V.8 bis negotiation		
<cfrange> Not supported.		
<protrange> Not supported.		
Indication	Definition	
+A8A:1	Indicates V.8 ANSam has been detected. This indication is only sent to the DTE if +A8E<v8o>=6 and operating in originate mode.	
+A8A:2	Indicates V.25 answer tone (2100 Hz) has been detected. This indication is only sent to the DTE if +A8E<v8o>=6 and operating in originate mode.	
+A8I:<v8cf>	Indicates the detection of a V.8 CI-signal and the recovered call function (only if +A8E<v8a>=5 and operating in answer mode).	
+A8M:<CM>	Indicates the hexadecimal-coded CM signal (only if +A8E<v8a>=5 and operating in answer mode)	
+A8M:<JM>	Indicates the hexadecimal-coded JM signal (only if +A8E<v8o>=6 and operating in originate mode)	
+A8J:[0,1]	Indicates the modem is transmitting the V.8 termination signal. +A8J:1 indicates transmission or detection of CJ while +A8J:0 indicates time-out while waiting for a CJ signal.	
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
+EB	1, 0, 30	<p>Break Handling: Controls break handling in error control operation. It accepts three numeric subparameters:</p> <p>Syntax: +EB = <break selection>, <timed>, <default length></p> <p><break selection> specifies the type of break to be signaled to the remote DCE upon detecting one from the local DTE.</p> <ul style="list-style-type: none"> 0 Ignore Break (do not signal to remote DCE) 1 Non-expedited, non-destructive 2 Expedited, non-destructive 3 Expedited and destructive <p><timed> specifies if the break signal to be signaled to the remote DCE is timed or not.</p> <ul style="list-style-type: none"> 0 Sent without a break signal length 1 Sent with break signal length <p><default length> specifies the amount of time in tens of milliseconds that a break should be signaled to the local DTE when an indication of a break is received from the remote DCE without explicitly indicated.</p> <ul style="list-style-type: none"> 0 Do not deliver received break to DTE 1 Default break length 0.01 to 2.54 seconds. Used for default to signal DTE when break received from the remote DCE without break length <p>Controls the use of breaks in V.42.</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
	0, 0, 1, 0, 0, 0, 0	<p>Synchronous Access Mode Configuration: controls the manner of operation of the Synchronous Access Mode in the DCE (if present).</p> <p>Syntax: +ESA=[<trans_idle>,<framed_idle>,<framed_un_ov>,<hd_auto>,<crc_type>,<nrzi_en>,<syn1>,<syn2>]]]]]]</p> <p><trans_idle> specifies the bit sequence transmitted by the DCE when a transmit data buffer underrun condition occurs, while operating in Transparent sub-Mode.</p> <p>0 In Transparent sub-Mode, DCE transmits 8-bit SYN sequence on idle. DCE receiver does not hunt for synchronization sequence</p> <p>1 In Transparent sub-Mode, DCE transmits 8-bit SYN sequence on idle. DCE receiver hunts for 8-bit SYN sequence</p> <p>2 In Transparent sub-Mode, DCE transmits 16-bit SYN sequence on idle. DCE receiver hunts for 16-bit SYN sequence</p> <p><framed_idle> specifies the bit sequence transmitted by the DCE when a transmit data buffer underrun condition occurs immediately after a flag, while operating in Framed sub-Mode.</p> <p>0 In Framed sub-Mode, DCE transmits HDLC flags on idle</p> <p>1 In Framed sub-Mode, DCE transmits marks (ones) on idle</p> <p><framed_un_ov> specifies the actions undertaken by the DCE when a transmit data buffer underrun or overrun condition occurs immediately after a non-flag octet, while operating in Framed sub-Mode.</p> <p>0 In Framed sub-Mode, DCE transmits abort on underrun in middle of frame</p> <p>1 In Framed sub-Mode, DCE transmits a flag on underrun in middle of frame, and notifies DTE of underrun or overrun</p> <p><hd_auto> specifies whether or not, in V.34 half duplex operation, additional procedures besides those specified in clause 12/V.34 shall be performed by the DCE when switching from primary channel to secondary channel operation, and vice versa.</p> <p>0 When switching between primary and secondary channel operation in V.34 half duplex, the DCE only executes those procedures defined in clause 12/V.34</p> <p>1 When switching between primary and secondary channel operation in V.34 half duplex, the DCE executes additional procedures as described in 8.8.5 besides those defined in clause 12/V.34</p> <p><crc_type> specifies the CRC polynomial used while operating in Framed sub-Mode.</p> <p>0 CRC generation and checking disabled</p> <p>1 In Framed sub-Mode, the 16-bit CRC specified in 8.1.1.6/V.42 is generated by the DCE in the transmit direction, and checked by the DCE in the receive direction</p> <p>2 In Framed sub-Mode, the 32-bit CRC specified in 8.1.1.6/V.42 is generated by the DCE in the transmit direction, and checked by the DCE in the receive direction</p> <p><nrzi_en> specifies if Non Return to Zero Inverted (NRZI) encoding is to be used by the DCE for transmit and receive data.</p> <p>0 NRZI encoding and decoding disabled</p> <p>1 NRZI encoding enabled in the DCE in the transmit direction, and NRZI decoding enabled in the DCE in the receive direction</p> <p><syn2> specifies the octet value(s) to be used while performing character-oriented framing.</p> <p>0–255 When <trans_idle>=0, specifies the 8-bit transmit idle sequence to be used by the DCE. When <trans_idle>=1, specifies the 8-bit synchronization sequence to be used by the DCE. When <trans_idle>=2, specifies first 8 bits of 16-bit synchronization sequence to be used by the DCE</p> <p><syn1> specifies the octet value(s) to be used while performing character-oriented framing.</p> <p>0–255 When <trans_idle>=2, specifies last 8 bits of 16-bit synchronization sequence to be used by the DCE</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
+ESR	1	Selective Repeat: Controls the use of selective repeat (SREJ) option in V.42. 0 Do not use SREJ 1 Use SREJ if available in remote DCE; continue without it if not 2 Use SREJ if available in remote DCE; disconnect if SREJ is not available
+ETBM	1, 1, 20	Call Termination Buffer Management: Controls the handling of data remaining in the DCE buffers upon call termination. It accepts three numeric parameters: Syntax: +ETBM = <pending TD>, <pending RD>, <timer> <pending TD> controls how previously transmitted data remaining in the DCE buffers should be handled when the local DTE requests disconnection of the call. 0 Discard all buffered data immediately and disconnect 1 Attempt until all data is delivered and acknowledged (ignoring timer); if remote DCE disconnects discard remaining data 2 Attempt until all data is delivered and acknowledged; if timer expires or remote DCE disconnects, discard remaining data <pending RD> controls how previously received data remaining in the DCE buffers should be handled when the remote DCE disconnects the call. 0 Discard all buffered data immediately and disconnect 1 Attempt until all data is delivered (ignoring timer); if local DTE requests disconnect discard remaining data 2 Attempt until all data is delivered; if timer expires or local DTE requests disconnect discard remaining data <timer> sets a maximum time limit that the DCE will attempt to deliver the buffered data before disconnecting and discarding the remaining 0–30 Delivery timer value in seconds
+GCAP	none	Request Complete Capabilities List: This extended-format command causes the DCE to transmit a list of additional capabilities commands. AT+GCAP +GCAP: +FCLASS, +MS, +ES, +DS OK
+GCI=m	see 'm'	Identify Country of Installation: This extended command is used to indicate and select the country of installation for the DCE. The DTE may use this value to determine country-specific functions. To determine what countries the DCE supports, issue the AT+GCI=? command. Refer to the ITU-T T.35 recommendation for the details on what country code is used for each country. Default: country of installation m = country code, e.g., United States AT+GCI=B5
+GMI	none	Identify Modem Manufacturer: This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to AT+FMFR? and AT+FMI . AT+GMI Intel Corporation OK
+GMM	none	Identify Product Model: This command causes the DCE to report the modem chipset name. This command is identical to AT+FMDL? and AT+FMM commands. AT+GMM Intel HaM Data Fax Voice OK
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
+GMR	none	Identify Product Revision: This command causes the DCE to report the modem chipset revision level. This command is identical to AT+FREV? and AT+FMR . AT+GMR HaM Release 318 FCC-Dec 15 1999 OK
+GSN	none	Request Product Serial Number Identification: This command causes the DCE to transmit a message to the DTE indicating the product serial number identification. Syntax: AT+GSN +GSN: PCI\VEN_1813&DEV_4000&SUBSYS_00011813&REV_02 OK The modem responds with the hardware Id key from the registry that contains the VendorID, SubVendor Id, Subsystem VendorId, Device ID, and hardware revision.
+IFC	2, 2	DTE-DCE Local Flow Control: Controls the flow control between local DTE and DCE when V.42 error control or normal mode (buffering mode or speed matching) is being used. In addition to acting locally the flow control characters can be passed on to remote DCE to act upon. It accepts two numeric subparameters: <DCE_by_DTE> specifies the method to be used by the DTE to control the flow of received data from the DCE; and <DTE_by_DCE> specifies the method to be used by the DCE to control the flow of transmitted data from the DTE. <DCE_by_DTE> 0 none 1 DC1/DC3 software flow control; do not pass DC1/DC3 characters to the remote DCE 2 RTS/CTS—hardware flow control 3 DC1/DC3 software flow control with DC1/DC3 characters being passed to the remote DCE in addition to being acted upon for local flow control <DTE_by_DCE> 0 None 1 DCI/DC3 software flow control 2 RTS/CTS hardware flow control
+ILRR=m	0	DTE to DCE Local Rate Reporting: Controls whether the “+ILRR:” result code is transmitted from the DCE to the DTE once a connection has been made. If enabled the result code displayed shall represent the current negotiated DTE-DCE rate, and is issued after any Modulation (+MR:), Error Control (+ER:) or Data Compression (+DR:) reports and before the final result code “CONNECT”. +ILRR accepts one numeric parameter decimal value and the format is as follows: 0 Disables reporting of local port rate (no +ILRR intermediate result code transmitted) 1 Enables reporting of local port rate (+ILRR intermediate result code transmitted) Example response message when +ILRR = 1, +ILRR: 19200
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
+MA=m	none	<p>Modulation Automode Control: This command specifies the alternative to the preferred modulation specified in the +MS=<carrier> command. Alternative modulations are only available when +MS=<automode> enables automode. The alternative modulations available for the +MA command are limited to all modulations the modem supports below the preferred modulation specified by +MS=<carrier>. The +MA parameters are reset to all modulations supported by the modem below the preferred modulation whenever the +MS=<carrier> changes the preferred modulation. The order of priority of alternative modulations is determined by such mechanisms as V.8 and PN2330, not the order in which they were entered for this command. <carrier> values omitted are no available as alternative modulations.</p> <p>m= <carrier>,<carrier>,...<carrier></p> <p>Defaults: all modulations below +MS=<carrier> and allowed by the DCE limits in the +MS command</p> <p><carrier> specifies the alternative modulations that are available. A table of these modulations are given in +MS command description.</p> <p>+MA? will display a list of enabled alternative modulations</p> <p>+MA=? will display a list of available alternative modulations. This list is determined by the current values of the +MS parameters for preferred modulation, automode and DTE rate limits. For example:</p> <p>If +MS=<V32B>, V.34, V.90, and V.92 will not be available because they are above V.32 bis.</p> <p>If +MS = ,0,, no alternative modulations will be available.</p> <p>If +MS=V34,1,4800,33600, V.22 bis will not be available because its maximum DCE bit rate is 2400bps.</p>
+MR=m	0	<p>Modulation Reporting Control: Controls whether the "+MCR: and +MRR" result codes are transmitted from the DCE to the DTE once a connection has been made. If enabled the result code displayed shall represent the current negotiated DCE-DCE modulation and rate, and are issued before the Error Control (+ER:) or Data Compression reports (+DR:) and before the final result code "CONNECT". The format is as follows:</p> <p>0 Disables reporting of modulation (no +MCR and +MRR intermediate result code transmitted)</p> <p>1 Enables reporting of modulation (+MCR and +MRR intermediate result code transmitted)</p> <p>Example if +MR = 1</p> <p>+MCR: V34</p> <p>+MRR: 33600</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description																								
+MS=m	see 'm'	<p>Modulation Selection: This command sets the preferred modulation, whether alternative modulations can be tried, and the transmit and receive DCE bit rates.</p> <p>m = <carrier>,<automode>,<min rate>,<max rate>,<min rx rate>, <max rx rate></p> <p>Defaults: m = V92,1,0,0,0,0</p> <p>+MS? will display the current +MS parameter settings</p> <p>+MS=? will display the +MS parameter settings supported by the modem</p> <p><carrier> specifies the preferred modulation. The following table contains the modulations supported.</p> <table><tr><th><carrier></th><th>Description</th></tr><tr><td>BELL103</td><td>Bell 103 300bps (FSK)</td></tr><tr><td>BELL212</td><td>Bell 212A (DPSK)</td></tr><tr><td>V21</td><td>V.21 300bps (FSK)</td></tr><tr><td>V22</td><td>V.22 1200bps (QAM)</td></tr><tr><td>V22B</td><td>V.22 bis 1200 or 2400bps (QAM)</td></tr><tr><td>V23C</td><td>V.23 1200bps forward and 75bsp reverse channel (FSK)</td></tr><tr><td>V32</td><td>V.32 4800 or 9600bps (QAM) or 9600bps (TCM)</td></tr><tr><td>V32B</td><td>V.32 bis 4800 or 9600bps (QAM) or 7200, 9600, 12000 or 14400bsp (TCM)</td></tr><tr><td>V34</td><td>V.34 2400, 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 31200 or 33600bps</td></tr><tr><td>V90</td><td>V.90 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 31200 or 33600 bps on the transmit channel and 28000, 29333, 30666, 32000, 33333, 34666, 36000, 37333, 38666, 40000, 41333, 42666, 44000, 45333, 46666, 48000, 49333, 50666, 52000, 53333, 54666 or 56000 bps (PCM) on the receive channel</td></tr><tr><td>V92</td><td>V.92 24000, 25333, 26666, 28000, 29333, 30666, 32000, 33333, 34666, 36000, 37333, 38666, 40000, 41333, 42666, 44000, 45333, 46666 and 48000 bps on the transmit channel and 28000, 29333, 30667, 32000, 33333, 34667, 36000, 37333, 38667, 40000, 41333, 42667, 44000, 45333, 46667, 48000, 49333, 50667,52000, 53333, 54667 or 56000 bps (PCM) on the receive channel</td></tr></table> <p><automode> enables or disable automatic modulation negotiation. Automatic modulation negotiation allows the modem to connect with an alternative modulation to the preferred modulation. Alternative to the preferred modulations are specified by the +MA command. The +MA parameters are reset to all modulations supported by the modem below the preferred modulation whenever the +MS=<carrier> changes the preferred modulation.</p> <p>Range: 0, 1</p> <p>Default: 1</p> <p><automode> = 0 Disable automatic modulation negotiation</p> <p><automode> = 1 Enable automatic modulation negotiation</p> <p><min rate> and <min rx rate> specifies the lowest bit rate, in decimal units of bits/s, that may be established on the DCE. If 0, they are determined by the modulation selected by <carrier>, <automode> and the +MA command. These values are reset to 0 whenever +MS=<carrier> changes the preferred modulation. <min rx rate> is only used for modulations that support unequal minimum bit rate limits for the transmit and receive channel like V.23 and V.90 and is used to specify limits for the receive channel as distinct from the transmit channel.</p> <p>Range: 0 and the DCE bps given in the <carrier> description table above</p> <p>Default: 0</p> <p><max rate> and <max rx rate> specifies the highest bit rate, in decimal units of bits/s, that may be established on the DCE. If 0, they are determined by the modulation selected by <carrier>. These values are reset to 0 whenever the +MS=<carrier> changes the preferred modulation. <max rx rate> is only used for modulations that support unequal maximum bit rate limits for the transmit and receive channel like V.23 and V.90 and is used to specify limits for the receive channel as distinct from the transmit channel.</p> <p>Range: 0 and the DCE bps given in the <carrier> description table above</p> <p>Default: 0</p>	<carrier>	Description	BELL103	Bell 103 300bps (FSK)	BELL212	Bell 212A (DPSK)	V21	V.21 300bps (FSK)	V22	V.22 1200bps (QAM)	V22B	V.22 bis 1200 or 2400bps (QAM)	V23C	V.23 1200bps forward and 75bsp reverse channel (FSK)	V32	V.32 4800 or 9600bps (QAM) or 9600bps (TCM)	V32B	V.32 bis 4800 or 9600bps (QAM) or 7200, 9600, 12000 or 14400bsp (TCM)	V34	V.34 2400, 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 31200 or 33600bps	V90	V.90 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 31200 or 33600 bps on the transmit channel and 28000, 29333, 30666, 32000, 33333, 34666, 36000, 37333, 38666, 40000, 41333, 42666, 44000, 45333, 46666, 48000, 49333, 50666, 52000, 53333, 54666 or 56000 bps (PCM) on the receive channel	V92	V.92 24000, 25333, 26666, 28000, 29333, 30666, 32000, 33333, 34666, 36000, 37333, 38666, 40000, 41333, 42666, 44000, 45333, 46666 and 48000 bps on the transmit channel and 28000, 29333, 30667, 32000, 33333, 34667, 36000, 37333, 38667, 40000, 41333, 42667, 44000, 45333, 46667, 48000, 49333, 50667,52000, 53333, 54667 or 56000 bps (PCM) on the receive channel
		<carrier>	Description																							
BELL103	Bell 103 300bps (FSK)																									
BELL212	Bell 212A (DPSK)																									
V21	V.21 300bps (FSK)																									
V22	V.22 1200bps (QAM)																									
V22B	V.22 bis 1200 or 2400bps (QAM)																									
V23C	V.23 1200bps forward and 75bsp reverse channel (FSK)																									
V32	V.32 4800 or 9600bps (QAM) or 9600bps (TCM)																									
V32B	V.32 bis 4800 or 9600bps (QAM) or 7200, 9600, 12000 or 14400bsp (TCM)																									
V34	V.34 2400, 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 31200 or 33600bps																									
V90	V.90 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 31200 or 33600 bps on the transmit channel and 28000, 29333, 30666, 32000, 33333, 34666, 36000, 37333, 38666, 40000, 41333, 42666, 44000, 45333, 46666, 48000, 49333, 50666, 52000, 53333, 54666 or 56000 bps (PCM) on the receive channel																									
V92	V.92 24000, 25333, 26666, 28000, 29333, 30666, 32000, 33333, 34666, 36000, 37333, 38666, 40000, 41333, 42666, 44000, 45333, 46666 and 48000 bps on the transmit channel and 28000, 29333, 30667, 32000, 33333, 34667, 36000, 37333, 38667, 40000, 41333, 42667, 44000, 45333, 46667, 48000, 49333, 50667,52000, 53333, 54667 or 56000 bps (PCM) on the receive channel																									
NOTE: An asterisk (*) denotes the factory-default setting.																										

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description																														
+PCW=m	0	Call Waiting Enable: This command controls the action to be taken upon detection of call waiting in a V.92 DCE. 0 Toggle V.24 Circuit 125 and collect Caller ID if enabled by +VCID 1 Hang up 2 Ignore V.92 call waiting																														
+PHSW=m	none	This command causes the DCE to activate/de-activate the hook relay for supporting the 2C relay. 0 connects the telco terminals to the modem 1 connects the telco terminals to the phone terminals																														
+PIG=m	1	PCM Upstream Ignore: This command controls the use of PCM upstream in a V.92 DCE. 0 Enable PCM upstream 1 Disable PCM upstream																														
+PMH=m	0	Modem on Hold Enable: This command controls whether or not modem on hold procedures are enabled during V.92 operation. 0 Enables V.92 modem on hold 1 Disables V.92 modem on hold																														
+PMHF	none	V.92 Modem on Hold Hook Flash: This command causes the DCE to go on-hook for a specified period of time, and then return on-hook. The specified period of time is normally one-half second, but may be governed by national regulations. If this command is initiated and the modem is not On Hold, ERROR is returned. This command applies only to V.92 Modem on Hold.																														
+PMHR	none	Initiate Modem on Hold: This command requests the DCE to initiate or to confirm a modem on hold procedure. The DCE shall return ERROR if Modem on Hold is not enabled or if the DCE is in an idle condition. The DCE shall return the string response +PMHR: <value> where <value> is a decimal value corresponding to the Modem on Hold timer value received or the request status during the DCE's modem on hold exchange procedure as defined below. This response may be delayed depending upon the context under which the +PMHR command is made, i.e., if the +PMHR is in response to an incoming Modem on Hold or if it is initiating a request. <table><tr><th><value></th><th>Description</th></tr><tr><td>0</td><td>V.92 Modem on Hold Request Denied or not available</td></tr><tr><td>1</td><td>MOH with 10 second time-out Granted</td></tr><tr><td>2</td><td>MOH with 20 second time-out Granted</td></tr><tr><td>3</td><td>MOH with 30 second time-out Granted</td></tr><tr><td>4</td><td>MOH with 40 second time-out Granted</td></tr><tr><td>5</td><td>MOH with 1 minute time-out Granted</td></tr><tr><td>6</td><td>MOH with 2 minute time-out Granted</td></tr><tr><td>7</td><td>MOH with 3 minute time-out Granted</td></tr><tr><td>8</td><td>MOH with 4 minute time-out Granted</td></tr><tr><td>9</td><td>MOH with 6 minute time-out Granted</td></tr><tr><td>10</td><td>MOH with 8 minute time-out Granted</td></tr><tr><td>11</td><td>MOH with 12 minute time-out Granted</td></tr><tr><td>12</td><td>MOH with 16 minute time-out Granted</td></tr><tr><td>13</td><td>MOH with indefinite time-out Granted</td></tr></table>	<value>	Description	0	V.92 Modem on Hold Request Denied or not available	1	MOH with 10 second time-out Granted	2	MOH with 20 second time-out Granted	3	MOH with 30 second time-out Granted	4	MOH with 40 second time-out Granted	5	MOH with 1 minute time-out Granted	6	MOH with 2 minute time-out Granted	7	MOH with 3 minute time-out Granted	8	MOH with 4 minute time-out Granted	9	MOH with 6 minute time-out Granted	10	MOH with 8 minute time-out Granted	11	MOH with 12 minute time-out Granted	12	MOH with 16 minute time-out Granted	13	MOH with indefinite time-out Granted
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3	MOH with 30 second time-out Granted																															
4	MOH with 40 second time-out Granted																															
5	MOH with 1 minute time-out Granted																															
6	MOH with 2 minute time-out Granted																															
7	MOH with 3 minute time-out Granted																															
8	MOH with 4 minute time-out Granted																															
9	MOH with 6 minute time-out Granted																															
10	MOH with 8 minute time-out Granted																															
11	MOH with 12 minute time-out Granted																															
12	MOH with 16 minute time-out Granted																															
13	MOH with indefinite time-out Granted																															
NOTE: An asterisk (*) denotes the factory-default setting.																																

Table 18. Data Mode Command Descriptions (Continued)

Command	Default	Description
+PMHT=m	0	<p>Modem on Hold Timer: This command controls whether or not the modem will grant or deny a Modem on-hold (MOH) request as well as setting the Modem-on-Hold-Time-Out.</p> <p>0 Deny V.92 Modem-on-hold Request</p> <p>1 Grant MOH with 10 second time-out</p> <p>2 Grant MOH with 20 second time-out</p> <p>3 Grant MOH with 30 second time-out</p> <p>4 Grant MOH with 40 second time-out</p> <p>5 Grant MOH with 1 minute time-out</p> <p>6 Grant MOH with 2 minute time-out</p> <p>7 Grant MOH with 3 minute time-out</p> <p>8 Grant MOH with 4 minute time-out</p> <p>9 Grant MOH with 6 minute time-out</p> <p>10 Grant MOH with 8 minute time-out</p> <p>11 Grant MOH with 12 minute time-out</p> <p>12 Grant MOH with 16 minute time-out</p> <p>13 Grant MOH with indefinite time-out</p>
+PQC=m	0	<p>V.92 Phase 1 and Phase 2 Control: This command controls the global enabling or disabling of the V.92 shortened Phase 1 and Phase 2 startup procedures, not the initiation thereof. This command is used in conjunction with the +PSS command.</p> <p>0 Enable Short Phase 1 and Short Phase 2</p> <p>1 Enable Short Phase 1</p> <p>2 Enable Short Phase 2</p> <p>3 Disable short Phase 1 and Short Phase 2</p>
+PSS=m	2	<p>Use Short Sequence: This command causes a calling DCE to force either a V.92 short or full startup sequence as defined by the +PQC command on the next and subsequent connections.</p> <p>0 The DCEs decide whether or not to use the short startup procedures. The short startup procedures shall only be used if enabled by the +PQC command.</p> <p>1 Forces the use of the short startup procedures on the next and subsequent connections if they are enabled by the +PQC command.</p> <p>2 Forces the use of the full startup procedures on the next and subsequent connections independent of the setting of the +PQC command.</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Error Correction and Data Compression

4

The 536EX chipsets support two types of data mode error correction (MNP 2–4 and V.42) and data compression (V.44, MNP 5, and V.42 bis). V.42 error correction uses LAPM as the primary error-control protocol and uses MNP 2-4 as an alternative. V.44 provides enhanced data compression over the existing V.42 bis standard. Data compression is up to on average 40% faster than previous methods. This provides for faster web browsing and data downloading. The **+DS44** command configures the operation of V.44. There are nine parameters associated with the **+DS44** command. For a detailed description of this command, refer to [Table 6](#). V.42 bis data compression requires V.42 (LAPM only). MNP 5 requires MNP 2-4.

The 536EX chipsets support four operating modes: buffer (normal), MNP reliable, V.42 auto-reliable, and V.42 reliable. They allow the DCE to communicate with remote modems that may or may not support error correction and data compression. Speed buffering, which is used for all operating modes, allows the DTE-to-modem data rate to be different from the modem-to-modem data rate. This is accomplished by using transmitter and receiver buffers in the modem. Thus, the DTE-to-modem data rate can be set for 2400 bps when the modem-to-modem data rate is 300 bps without causing any data errors. In all data modes, the DTE-to-modem data rate can be set for any valid speed between 300 bps to 115,200 bps (that is, the modem autobauds up to 115,200 bps). See [Table 1 on page 11](#) for all DTE-to-DTE data rates. The modem-to-modem data rates are listed in [Table 2 on page 11](#). See [Table 3 on page 11](#) for the modem-to-ISP data rates. Each operating mode is explained in more detail in the following tables.

Table 19. Operating Modes

Mode	Features
Buffer (Normal) +ES=1, 0, 1	No error correction/data compression, but speed buffering is supported.
MNP Reliable +ES=4, 4, 6	MNP 2–5 connection only. If an MNP connection cannot be established, the modem hangs up.
V.42 Auto-Reliable +ES=3, 0, 2	V.42/V.42 bis with fallback to MNP 2–5 or normal mode.
V.42 Reliable +ES=3, 2, 4	V.42, V.42 bis or MNP 2–5 only connection. If a V.42/V.42 bis/MNP 2–5 connection cannot be established, the modem hangs up.

[Table 20](#) lists connection types corresponding to **+ES** settings.

Table 20. Resulting +ES Connection Types

+ES Settings (Originate Modem)	+ES Settings (Answer Modem)			
	+ES=1, 0, 1 (Buffer)	+ES=4, 4, 6 (MNP Reliable)	+ES=3, 0, 2 (V.42 Auto- reliable)	+ES=3, 2, 4 (V.42 Reliable)
+ES=1, 0, 1 (Buffer)	Buffer (normal) mode	Modem hangs up	Buffer (normal) mode	Modem hangs up
+ES=4, 4, 6 (MNP Reliable)	Modem hangs up	MNP 2–5	MNP 2–5	MNP 2–5
+ES=3, 0, 2 (V.42 Auto-reliable)	Buffer (normal) mode	MNP 2–5	V.42/V.42 bis	V.42/V.42 bis
+ES=3, 2, 4 (V.42 Reliable)	Modem hangs up	MNP 2–5	V.42/V.42 bis	V.42/V.42 bis
NOTES: <ul style="list-style-type: none"> • MNP 5 requires the modem to be configured for %C1. • V.42 bis requires the modem to be configured for "H3. • Refer to \Cn and %An commands for more information about auto-reliable mode. 				

The list of commands needed to enter a specific error correction or data compression mode are as follows:

V.42 bis with fallback to MNP5, &F +ES=3,0,2 or +ES=3,0,2 "H3 %C1
MNP2-4 or V.42:

V.42 bis with fallback to V.42/MNP2-4: &F +ES=3,2,4 %C0 or +ES=3,2,4 %C0 "H3
-J1

V.42 bis only: &F +ES=3,2,4 -J0 or +ES=3,2,4 -J0 "H3
V.42 only: &F +ES=3,2,4 or +ES=3,2,4 -J0 "H0
-J0 "H0

MNP5 with fallback to MNP2-4: &F +ES=4,4,6 or +ES=4,4,6 %C1
MNP2-4 only: &F +ES=4,4,6 %C0 or +ES=4,4,6 %C0

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions

Command	Default	Description
%An	13	Set Auto-Reliable Fallback Character: In auto-reliable mode (+ES=3,0,2) with auto-reliable fallback character enabled (\C2), receipt of the fallback character from the line during the V.42 detection phase causes the modem to switch to buffer (normal) mode. This allows a remote user with a non-V.42 modem to connect immediately with a V.42 modem. A space or carriage return is usually chosen for the fallback character. n = 0–127 (ASCII character)
%Cn	1	MNP 5 Data Compression Control: This command controls whether the data sent during the MNP frames is compressed using MNP Class 5 compression standard. MNP 5 data compression can improve throughput by as much as 150%. Range: 0, 1 n = 0 No compression n = 1* MNP Class 5 compression
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions (Continued)

Command	Default	Description
\An	3	<p>MNP Block Size: This command specifies the maximum number of data bytes in an MNP data frame. A smaller frame size may improve throughput on high-impairment (noisy) telephone lines.</p> <p>Range: 0–3</p> <p>n = 0 Maximum 64 characters</p> <p>n = 1 Maximum 128 characters</p> <p>n = 2 Maximum 192 characters</p> <p>n = 3* Maximum 256 characters</p>
\Bn	3	<p>Transmit Break: This command causes the modem to send a break (attention signal) to the remote for duration specified by 'n'. 'n' is specified in 100 ms units. When n = 0, the default break length is used.</p> <p>Range: 0–9</p>
\Cn	0	<p>Set Auto-Reliable Buffer (requires a license from Microcom*): In auto-reliable mode (+ES=3,0,2), this command determines the fallback method and enables data buffering. The settings for this command are used by the modem during the V.42 detection phase.</p> <p>Range: 0–2</p> <p>n = 0* Does not buffer data.</p> <p>n = 1 Reserved.</p> <p>n = 2 Does not buffer data. Switches to buffer (normal) mode upon receipt of auto-reliable fallback character and passes it to serial port. This feature allows non-V.42 modems to connect immediately to a V.42 modem without data loss.</p>
\Gn	0	<p>Set Modem Port Flow Control: In buffer (normal) mode (either +ES=1,0,1 or after fallback), this command enables modem-to-modem flow control using XOFF (13h) to stop and XON (11h) to start transmission between modems.</p> <p>n = 0, 1</p> <p>n = 0* Disables port flow control</p> <p>n = 1 Sets port flow control to XON/XOFF</p>
\Jn	0	<p>bps Rate Adjust Control: If this command is enabled, the serial port speed automatically changes to the modem-connection speed. This forces the user to change the DTE-to-modem bps rate, if needed. If the command is disabled, the serial port speed is independent of the connection speed, which allows much greater throughput when using error correction and data compression.</p> <p>n = 0, 1</p> <p>n = 0* Turns off feature</p> <p>n = 1 Turns on feature</p>
<p>NOTE: An asterisk (*) denotes the factory-default setting.</p>		

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions (Continued)

Command	Default	Description
\Kn	5	<p>Set break control: Defines what action the modem takes when a break (attention signal) is sent or received, as described below:</p> <p>where n =,</p> <p>In connect state, transmits break to remote (if in reliable mode):</p> <p>0, 2, 4 Enters command mode, no break sent</p> <p>1 Destructive/expedited</p> <p>3 Nondestructive/expedited</p> <p>5 Nondestructive/nonexpedited</p> <p>In command state, transmits break to remote (if in reliable mode):</p> <p>0, 1 Destructive/expedited</p> <p>2, 3 Nondestructive/expedited</p> <p>4, 5 Nondestructive/nonexpedited</p> <p>In connect state, receives break at modem port and sends to serial port:</p> <p>0, 1 Destructive/expedited</p> <p>2, 3 Nondestructive/expedited</p> <p>4, 5 Nondestructive/nonexpedited</p>
\Tn	0	<p>Set Inactivity Timer: During a buffer (normal) or reliable connection, if no data is sent or received within the inactivity time period, the link is disconnected. The default, '0', disables this feature.</p> <p>Range: 0–90 Length in minutes</p> <p>n = 0* Disables inactivity timer</p>
\Xn	0	<p>Set XON/XOFF Pass-Through: If software flow control is enabled (\Q1), this command defines whether the XON (11h) and XOFF (13h) characters received from the DTE are sent to the remote modem. In addition, if the modem port flow control is enabled (\G1) in normal mode, the command specifies whether the XON and XOFF characters received from the remote modem are sent to the DTE. In both cases, flow control operation is not affected.</p> <p>Range: 0, 1</p> <p>n = 0* Processes flow control characters*</p> <p>n = 1 Processes flow control characters and passes them through to the local or remote so they can process the characters.</p>
-Jn	1	<p>Set V.42 Detect Phase: In V.42 modes (+ES=3,0,2 and +ES=3,2,4), this command specifies whether the modem detects V.42, MNP, or no error-correcting protocols from the remote modem and changes to the appropriate mode. Otherwise, only V.42 is attempted.</p> <p>Range: 0, 1</p> <p>n = 0 Disables the V.42 detect phase</p> <p>n = 1* Enables the V.42 detect phase</p>
"Hn	3	<p>V.42 bis Compression Control: This command specifies whether the data in the LAPM frames are compressed using V.42 bis data compression. This can improve throughput by as much as 400%. Compression can be negotiated to operate in one direction or both.</p> <p>Range: 0–3</p> <p>n = 0 Disables V.42 bis</p> <p>n = 1 Enables V.42 bis only when transmitting data</p> <p>n = 2 Enables V.42 bis only when receiving data</p> <p>n = 3* Enables V.42 bis for both transmitting and receiving data</p>
"On	32	<p>V.42 bis String Length: This command specifies the maximum number of characters that can be compressed into one V.42 bis code word. The default value of 32 optimizes throughput for most file types.</p> <p>Range: 6–250 Number of characters</p> <p>n = 32* Usual number of characters</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions (Continued)

Command	Default	Description
+DR=m	0	<p>Data Compression Reporting: Controls whether the “+DR:” result code is transmitted from the DCE to DTE once a connection with has been made. If enabled the result code displayed shall represent the current negotiated DCE-DCE data compression type and is issued after the Error Control Report (+ER) and before the final result code CONNECT. +DR accepts one numeric parameter decimal value and the format is as follows:</p> <p>0 Disables Data compression reporting—No +DR result code transmitted</p> <p>1 Enables Data compression reporting—+DR result code transmitted</p> <p>Display messages when +DR = 1,</p> <p>+DR: NONE Data compression not in use</p> <p>+DR: V42B V.42 bis is in use in both directions</p> <p>+DR: V42B RD V.42 bis is in use in receive direction only</p> <p>+DR: V42B TD V.42 bis is in use in transmit direction only</p> <p>+DR: MNP5 MNP5 in use</p>
+DS=m	see ‘m’	<p>Data Compression: This command sets multiple parameters for the control of data compression.</p> <p>m = <direction>, <compression negotiation>, <max dict>, <max string> Default: m = 3, 0, 2048, 6</p> <p><direction> Specifies the direction of the data compression from the DTEs point of view.</p> <p>Range: <direction> = 0–3</p> <p>Default: <direction> = 3</p> <p><direction> = 0 Negotiated, no compression</p> <p><direction> = 1 Transmit only</p> <p><direction> = 2 Receive only</p> <p><direction> = 3* Both directions, accept any direction</p> <p><compression negotiation> Specifies whether the modem should stay connected or disconnect based on the desired result.</p> <p>Range: <compression negotiation> = 0, 1</p> <p>Default: <compression negotiation> = 0</p> <p><compression negotiation> = 0* Do not disconnect</p> <p><compression negotiation> = 1 Disconnect</p> <p><max dictionary> Specifies the maximum number of dictionary entries that should be negotiated.</p> <p>Range: <max dictionary> = 512 to 65535</p> <p>Default: <max dictionary> = 2048</p> <p><max string> Specifies the maximum string length to be negotiated.</p> <p>Range: <max string> = 6–250</p> <p>Default: <max string> = 6</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions (Continued)

Command	Default	Description
+DS44=m	3, 0, 0, 471, 942, 140, 140, 1884, 3768	<p>V.44 Data Compression: This command controls the V.44 data compression function if provided in the DCE. It accepts the following sub parameters:</p> <p>m=[<direction>[,<compression_negotiation>[,<capability>[,<max_codewords_tx>[,<max_codewords_rx>[,<max_string_tx>[,<max_string_rx>[,<max_history_tx>[,<max_history_rx>]]]]]]]]]</p> <p><direction> specifies the desired direction(s) of operation of the data compression function.</p> <p>0 Negotiated... no compression</p> <p>1 Transmit only</p> <p>2 Receive only</p> <p>3 Both directions, accept any direction</p> <p><compression_negotiation> specifies whether or not the DCE should continue to operate if the desired result is not obtained.</p> <p>0 Do not disconnect if Rec. V.44 is not negotiated by the remote DCE as specified in <direction>. Always set to 0.</p> <p><capability> specifies the use of stream method, packet method, multi-packet method.</p> <p>0 Stream method</p> <p>1 Packet method</p> <p>2 Multi-packet method</p> <p><max_codewords_tx> specifies the maximum number of codewords which should be negotiated in the transmit direction.</p> <p>256 to 65536</p> <p><max_codewords_rx> specifies the maximum number of codewords which should be negotiated in the receive direction.</p> <p>256 to 65536</p> <p><max_string_tx> specifies the maximum string length to be negotiated in the transmit direction.</p> <p>32 to 255</p> <p><max_string_rx> specifies the maximum string length to be negotiated in the receive direction.</p> <p>32 to 255</p> <p><max_history_tx> specifies the maximum size of the history buffer to be negotiated in the transmit direction.</p> <p>≥ 512</p> <p><max_history_rx> specifies the maximum size of the history buffer to be negotiated in the receive direction.</p> <p>≥ 512</p>
+EFCS=m	0	<p>32-bit Frame Check Sequence: Controls the use of 32-bit frame check sequence option in V.42.</p> <p>0 Use 16-bit FCS</p> <p>1 Use 32-bit FCS if available in remote DCE; otherwise use 16-bit FCS</p> <p>2 Use 32-bit FCS if available in remote DCE; otherwise disconnect</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions (Continued)

Command	Default	Description
+ER=m	0	<p>Error Control Reporting: Controls whether the "+ER:" result code is transmitted from the DCE to the DTE once a connection has been made. If enabled the result code displayed shall represent the current negotiated DCE-DCE error control type and is issued after the Modulation Report (+MCR and +MRR) and before the final result code Data Compression Report (+DR:). +ER accepts one numeric parameter decimal value and the format is as follows:</p> <p>0 Disables error control reporting (no +ER intermediate result code transmitted)</p> <p>1 Enables error control reporting (+ER intermediate result code transmitted)</p> <p>Display messages when +ER = 1,</p> <p>+ER: LAPM V42 LAPM protocol in use</p> <p>+ER: MNP 2 MNP 2 protocol in use</p> <p>+ER: MNP 2 4 MNP 2 and 4 protocol in use</p> <p>+ER: MNP 3 MNP 3 protocol in use</p> <p>+ER: MNP 3 4 MNP 3 and 4 protocol in use</p> <p>Example if +ER = 1</p> <p>+ER: LAPM</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 21. V.44/V.42/V.42 bis and MNP Data Modem Command Descriptions (Continued)

Command	Default	Description
+ES=m	see 'm'	<p>Error Control Selection: The +ES=m command controls the operation of the V.42 error detection and correction protocol in the DCE. Once a connection has been established between the DCE and DTE, the <orig_rqst> subparameter can put the interface into synchronous access mode. In the default settings, synchronous access mode is disabled. To change modes, send another +ES command.</p> <p>+ES=1,0,1 Buffered mode +ES=4,4,6 MNP reliable mode +ES=3,0,2* V.42 autoreliable mode +ES=3,2,4 V.42 reliable mode +ES=2,3,5 LAPM reliable mode +ES=6, ,8 Synchronous access mode</p> <p>m = <orig_rqst>, <orig_fbk>, <ans_fbk> Defaults: m = 3, 0, 2</p> <p><orig_rqst> Specifies the initial requested mode of operation when the DCE is the originator. If <orig_rqst>=6, the modem ignores the <orig_fbk> setting. Range: 1–4, 6</p> <p>0 Reserved. 1 Initiate call with buffered mode only. 2 Initiate V.42 without detection phase. If V.80 mode is in use, this is a request to disable V.42 detection phase. 3* Initiate V.42 with detection phase. 4 Initiate alternate protocol. 6 Initiate synchronous access mode when connection is completed and when in data state.</p> <p><orig_fbk> Specifies the acceptable fallback mode of operation when the DCE is the originator. This setting is ignored if <orig_rqst>=6. Range: 0–2, 4</p> <p>0* Error control optional (either LAPM or alternative acceptable). If error control is not established, maintain the DTE-DCE data rate and use the V.14 buffered mode with flow control during non-error control operation. 1 Error control optional (either LAPM or alternative acceptable). If error control is not established, change the DTE-DCE data rate to match the line rate and use direct mode. 2 Error control required (either LAPM or alternative acceptable). If error control is not established, disconnect. 3 Reserved. 4 Error control required (only alternative protocol acceptable). If error control is not established, disconnect.</p> <p><ans_fbk> Specifies the acceptable fallback mode of operation when the DCE is the answerer. Range: 1, 2, 4–6, 8</p> <p>0 Direct mode. 1 Error control disabled, use buffered mode. 2* Error control optional (either LAPM or alternative acceptable). If error control is not established, maintain the DTE-DCE data rate and use local buffering and flow control during non-error control operation. 3 Reserved. 4 Error control is required (either LAPM or alternative is acceptable). If error control is not established, disconnect. 5 Error control required (only LAPM acceptable). If error control is not established, disconnect. 6 Error control required (only the alternative protocol is acceptable). If error control is not established, disconnect. 8 Initiate synchronous access mode when the connection is complete and data state is entered.</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Fax Class 1 AT Commands

5

The 536EX chipsets implement the EIA-578 data/fax Class 1 AT command set standard. This AT command set allows a DTE (with Class 1 communication software) and a 536EX-based modem to communicate with Group 3 fax machines. In addition, these chipsets provide fax identity and test commands. Fax identity commands are described in [Table 22](#); all other fax AT commands are provided in [Table 24 on page 67](#).

5.1 Fax Identity Commands

The fax identity commands are **AT+FMFR?**, **AT+FMDL?**, **AT+FMI**, **AT+FMM**, **AT+FMR**, and **AT+FREV?**. These commands respond back with modem manufacturer, product model, and product revision information.

Table 22. Fax Identity Command Descriptions

Command	Default	Description
+FMFR?/+FMI	none	Identifies Modem Manufacturer: This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to ATI2 and AT+GMI . AT+FMFR? Intel Corporation OK
+FMDL?/+FMM	none	Identifies Product Model: This command causes the DCE to report the modem chipset name. This command is identical to ATI1 and AT+GMM . AT+FMDL? Intel HaM Data Fax Voice OK
+FREV?/+FMR	none	Identifies Product Version Number: This command causes the DCE to report the modem chipset revision level. This command is identical to ATI4 and AT+GMR . AT+FREV? HaM Release 4.02 OK

5.2 Fax Class 1 Commands

The fax Class 1 AT commands are divided into three types: class selection and capabilities, data stream transfers, and silence-time timers. All fax mode commands, except the silence-time timers, must be the last command on the command line.

Each command may be used as follows:

```
+F<command>?           Reads current setting
+F<command> = ?         Reads permissible settings
+F<command> = <parameter> Sets parameters
```

Note: To originate a call, answer, and hang up, use the **ATD**, **ATA**, and **ATHn** commands, respectively.

The fax **AT+FCLASS** command is used for changing between fax classes, determining the current class selection, and determining the supported fax classes. Both data/fax Class 0 (data modem mode) and Class 1 (fax modem mode) are implemented by the modem. In Class 0, the DTE-to-modem data rate can be set from 300 bps to 115,200 bps. In Class 1, it is recommended that the DTE-to-modem data rate is set to 19,200 bps.

The silence-time timers consist of **AT+FTS=<TIME>** and **AT+FRS=<TIME>**. Silence time is defined as the length of time when the modem neither receives nor transmits energy (that is, modem transmit carrier) on the telephone line.

The modem exchanges streams of data with the DTE while executing the data transfer commands **AT+FTM=<mod>**, **AT+FTH=<mod>**, **AT+FRM=<mod>**, and **AT+FRH=<mod>**. The values supported for <mod> are provided in [Table 23](#).

During data transfer, an ASCII <DLE> character (\$10h) is used as a special character to shield other special characters.

Special characters in the data stream are used in the following way:

any data ... <DLE><ETX>	end of data stream
any data ... <DLE><DLE>	single 10h<DLE> in data stream
any data ... <DLE>	
<not DLE or ETX>	delete both <DLE> and next character

When the DTE transfers data to the modem, the DTE must insert a <DLE> for each <DLE> in the original data stream. In addition, when data is no longer available, the DTE must add the stream terminator <DLE><ETX> to the end of the data stream. The modem buffers up to one thousand bytes of fax data before sending it to the remote modem (**AT+FTM** command). If the modem detects the two terminating characters <DLE><ETX> within the data stream, it transmits the data immediately to the remote modem without waiting for the buffer to fill up.

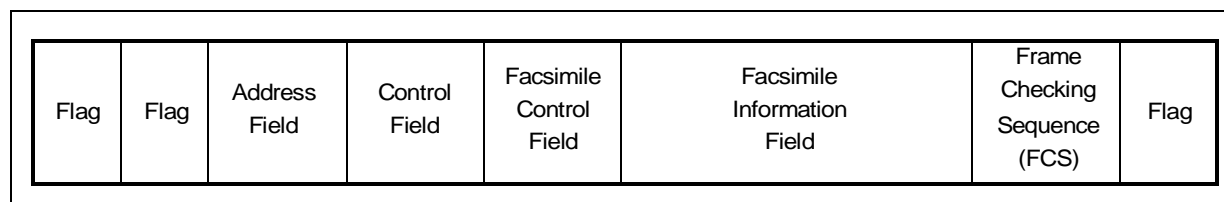
Table 23. <mod> Selection Table

Value	Modulation	Speed (bps)
3	V.21 ch 2	300
24	V.27 ter	2400
48	V.27 ter	4800
72	V.29	7200
73	V.17	7200
74	V.17 with short train	7200
96	V.29	9600
97	V.17	9600
98	V.17 with short train	9600
121	V.17	12,000
122	V.17 with short train	12,000
145	V.17	14,400
146	V.17 with short train	14,400

When the modem transfers data to the DTE, the DTE must filter the data stream by removing all character pairs beginning with <DLE>. The DTE also must recognize <DLE><ETX> as the stream terminator. Upon detecting <DLE><DLE>, the DTE must reinsert a single <DLE> in its place. The modem buffers up to 512 bytes of fax data received from the remote modem if the DTE cannot read the data immediately (**AT+FRM** command).

For the **AT+FTH** and **AT+FRH** commands, data is sent and received using HDLC formatting. The format for HDLC framing is provided below. When sending the HDLC data, the modem automatically generates the flags and the frame checking sequence (Frame Check Sum). All the other fields are transmitted to or received from the DTE (that is, these fields are under the control of the DTE).

Figure 8. T.30 HDLC Frame Format



After receiving a frame correctly using the **AT+FRH** command (FCS is OK), the DCE returns an 'OK' message to the DTE. If the frame is received in error (FCS is not OK, carrier is lost, or data is lost due to data overflow), the DCE returns an 'ERROR' message to the DTE; the DTE should then discard the frame.

Note: If the telephone line is on-hook, the modem responds back to the DTE with an 'ERROR' message whenever any of the fax AT commands, except the **+FCLASS** command, are sent to the modem.

Figure 9. CLASS 1 DTE-Generated HDLC Frame Information (AT+FTH=<mod>)

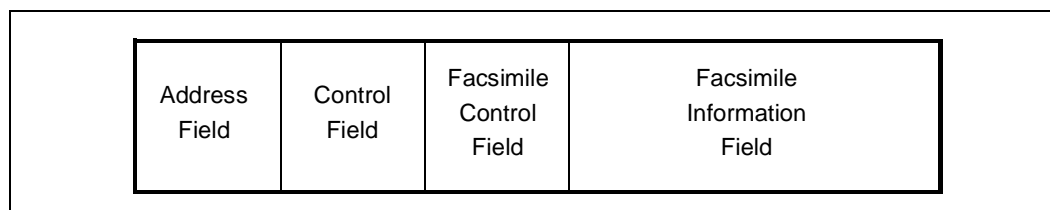
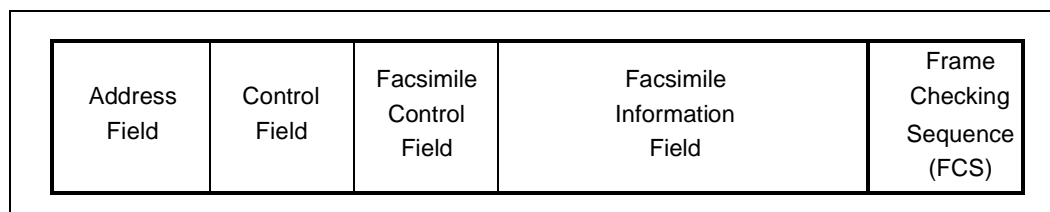


Figure 10. CLASS 1 DTE Reception of HDLC Frame Information (AT+FRH=<mod>)



Like the data modem mode, the DTE needs to issue an **ATD** string or **ATA** command to the modem to originate or answer a fax call. Unlike the data modem mode, auto-answering is not supported by the modem while in fax mode. It is recommended that S-register **S0** be set to '0' (that is, use 'ATA') whenever the modem is expected to receive a fax call.

The **ATDT <telephone number>** command string causes the modem to originate a fax call. After dialing the telephone number, the modem sends out a calling tone (1100 Hz), recognizes the remote fax modem answer tone, and looks for the remote fax HDLC flags at 300 bps. If the HDLC flags are detected, the modem sends the DTE a 'CONNECT' message followed by the Class 1 HDLC frame information. If the HDLC flags are not detected within the time limit defined by S-register **S7**, the modem sends a 'NO CARRIER' message to the DTE and then hangs up the line. If the modem hangs up the line while processing the ATD command (that is, while the modem is on-hook), the modem responds back with an 'ERROR' message whenever the DTE issues one of the data stream AT commands.

The **ATA** command causes the modem to answer a fax call. After going off-hook, the modem sends the answer tone followed by HDLC flags. The modem then sends a 'CONNECT' message to the DTE and waits to receive the HDLC frame information from the DTE. In general, the ATA command performs three functions:

1. It places the modem off-hook.
2. It causes the modem to transmit the answer tone.
3. It causes the modem to act as if it received an **AT+FTH=3** command from the DTE.

The following data mode and voice mode AT commands are supported in fax mode:

Data: All

Voice: +FCLASS, +VDR, +VNH, +VIP, and +VCID

Table 24. Fax Mode Command Descriptions

Command	Default	Description
+FCLASS =1	0	<p>Fax Mode Selection: This command is used to select a fax class, indicate current fax class mode setting, and indicate supported fax classes. All fax mode commands, except for +FCLASS, are valid only in fax mode.</p> <p>+FCLASS? Indicates current fax class selection</p> <p>+FCLASS = ? Indicates supported fax classes</p> <p>+FCLASS = n Configures DCE for selected fax class. The modem responds back with an 'OK' message at the same DTE-to-modem data rate used to issue this command</p> <p>Range: 0, 1, 8</p> <p>n = 0* Configures DCE for data modem operation</p> <p>n = 1 Configures DCE for fax Class 1 modem operation</p> <p>n = 8 Configures DCE for IS-101 voice mode</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 24. Fax Mode Command Descriptions (Continued)

Command	Default	Description
+FRH=m	none	<p>Receive HDLC Data: The +FRH=<mod> command causes the modem to receive HDLC-framed data using the modulation mode selected in <mod>. The modem then delivers the next-received frame to the DTE.</p> <p>If the modem detects the selected carrier signal with an HDLC flag, the modem sends a 'CONNECT' result code to the DTE. If the modem detects a different signal, the modem sends the '+FCERROR' (fax connect error) result code to the DTE and returns to command mode. Upon loss of carrier, the modem returns to command mode and sends a 'NO CARRIER' result code to the DTE.</p> <p>After receiving the HDLC flags, the modem strips away the flags and buffers the received frames. The modem then transfers the received data to the DTE, starting with the first non-flag byte and continuing through the last FCS byte. The DTE should ignore the value of the FCS bytes. The modem also performs HDLC zero-bit deletion and error checking.</p> <p>After the FCS bytes are transferred, the modem marks the end of the frame with <DLE><ETX> and reports the status of the frame reception to the DTE. If the frame was received correctly (FCS is correct), the modem returns a 'OK' result code. If the frame was received in error (FCS is not correct, carrier lost, or data lost due to data overflow), the DCE returns an 'ERROR' result code. The DTE should then discard this frame.</p> <p>After sending the status result code, the modem is ready to accept new commands from the DTE.</p> <p>The modem obeys the configured flow control from the DTE. If the DTE sends any character to the modem other than DC1 or DC3 while the modem is in this mode, the modem enters command mode and return an 'OK' result code.</p> <p>After sending the result code indicating that frame reception is complete, the modem continues to receive and buffer the data in the selected mode. If the DTE issues another +FRH=<mod> command, the modem returns another 'CONNECT' result code and continues with HDLC reception. If the DTE issues any command that changes modulation, the DCE stops the receive process; the DCE then discards any buffered data and processes the command.</p> <p>Range: <mod> = 3 Refer to Table 23 on page 65.</p>
+FRM=m	none	<p>Receive Data: The +FRM=<mod> command causes the modem to enter receive mode using the modulation scheme specified in <mod>. <mod> may have the values shown in Table 23 on page 65.</p> <p>When the selected carrier is detected, the modem sends a 'CONNECT' result to the DTE. If a different signal is detected, the modem sends a '+FCERROR' (connect error) result code to the DTE and returns to command mode.</p> <p>After receiving the selected carrier, the modem transfers all received data patterns to the DTE as consecutive start-stop framed bytes, including leading marking conditions or flags. The modem marks the end of the data stream with <DLE><ETX>.</p> <p>Upon loss of carrier, the modem returns to command state and sends a 'NO CARRIER' result code to the DTE.</p> <p>NOTE: If the modem is on-hook, then the modem always returns an 'ERROR' message to the DTE after receiving the +FRM=<mod> command.</p> <p>Range: <mod> = 24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146 Refer to Table 23 on page 65.</p>
+FRS=m	none	<p>Wait for Silence: The +FRS=<TIME> command causes the modem to send an 'OK' result code to the DTE when silence has been detected on the line for the amount of time specified. The value <TIME> is in 10 ms intervals. The command terminates when the required amount of silence has been detected on the line or the DTE sends the modem another character that is discarded. In either event, the DTE returns the 'OK' result code.</p> <p>Range: <TIME> = 1–255 (10 ms)</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 24. Fax Mode Command Descriptions (Continued)

Command	Default	Description
+FTH=m	none	<p>Transmit HDLC Data: The +FTH=<mod> command causes the modem to transmit data framed in HDLC protocol using the modulation mode selected. <mod> may have the values shown in Table 23 on page 65.</p> <p>After receiving the +FTH command, the modem sends a 'CONNECT' result code to the DTE. The modem then transmits signal converter training (if required) followed by flags until the first byte of data is sent by the DTE. The modem terminates the +FTH command upon detecting <DLE><ETX> characters in the data stream.</p> <p>When the buffer is empty, the modem computes and appends the FCS (Frame Check Sequence) and a closing flag to the frame. The modem ensures that the minimum number of flags required by T.30 are sent before the data from the DTE begins to be transmitted.</p> <p>The modem checks the final frame bit in the control field of each frame; this is the fifth-received bit of the second byte of each frame. If the final frame bit is a '1', the modem ceases transmission after the frame is sent, returns to command state, and sends the 'OK' result code to the DTE. If the final frame bit is a '0', the modem sends another 'CONNECT' result code to the DTE after the current frame is sent. The modem continues to transmit flags until the DTE takes one of the following actions:</p> <ul style="list-style-type: none"> • The DTE sends additional data. The modem then transmits another frame. • The DTE sends only <DLE><ETX> (a null frame). The modem then turns off the transmit carrier and send the 'OK' result code to the DTE. • If the DTE transmits no additional data within 5 seconds from when the modem reported the 'CONNECT' result code, the modem turns off the transmit carrier mode, returns to command mode, and sends the 'ERROR' result code to the DTE. <p>In HDLC transmit mode, the modem performs HDLC transparency functions, FCS generation, and buffers the transmit data. The modem uses the configured method of flow control to pause the DTE as necessary.</p> <p>NOTE: If the modem is on-hook, it always returns an 'ERROR' message to the DTE after receiving the +FTH=<mod> command.</p> <p>Range: <mod> = 3 Refer to Table 23 on page 65.</p>
+FTM=m	none	<p>Transmit Data: The +FTM = <mod> command causes the modem to transmit data using the modulation selected in <mod>.</p> <p>The modem returns a 'CONNECT' result code and transmits the proper training sequence in the selected mode, followed by constant '1' bits until data is received from the DTE. The modem terminates this command upon detecting <DLE><ETX> characters in the data stream.</p> <p>If the modem's transmit buffer empties and the last transmitted character is an ASCII NULL (00), the modem continues to transmit NULLs until the DTE sends more data or 5 seconds have elapsed. After 5 seconds have elapsed with an empty transmit buffer, the DCE turns off the transmit carrier, returns to command state, and returns an 'ERROR' result code to the modem.</p> <p>NOTE: Hex \$00 replication does <i>not</i> provide the required timing needed for generating the TCF frame (1.5 seconds of '0's').</p> <p>If the modem's transmit buffer empties and the last transmitted character was not a NULL, the modem turns off the transmit carrier, returns to command state, and sends the 'OK' result code to the DTE.</p> <p>NOTE: If the modem is on-hook, the modem always returns an 'ERROR' message to the DTE after receiving the +FTM = <mod> command.</p> <p>Range: <mod> = 24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146 Refer to Table 23 on page 65.</p>
+FTS=m	none	<p>Stop Transmission and Pause: The +FTS=<TIME> command causes the modem to stop all transmissions. The modem waits for the specified amount of time, then sends an 'OK' result code to the DTE. The value <TIME> is in 10 ms intervals.</p> <p>Range: <TIME> = 0–255 (in 10 ms intervals)</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

IS-101 Voice Mode AT Commands

6

The 536EX chipsets implement a voice mode AT command set that allows a DTE to record and play back voice messages. This product is compatible with the EIA/TIA IS-101 voice command set. This section lists supported commands and a detailed description of each command (see [Table 25 on page 71](#)). When multiple commands are placed on a line, a semicolon (;) must be placed after each voice (and fax) command.

Note: To originate a call, to answer, and to hang up, use the **ATD**, **AT+VLS≠0**, and **AT+VLS=0** commands, respectively.

Each command may be used as follows:

```
+V<command>?           Read current setting
+V<command> = ?         Read permissible settings
+V<command> = <parameter> Set parameter
```

For example, **AT+FCLASS?** determines whether the modem is configured for data (or fax) mode or voice mode. **AT+FCLASS=?** determines which data/fax/voice modes are supported by the modem. **AT+FCLASS=m** switches between voice mode and data mode.

The modem exchanges streams of data with the DTE while executing the commands for voice playback (**AT+VTX**) and record (**AT+VRX**) and while in voice command mode (with either the modem being off-hook or using the local phone—**AT+VLS=m**). In these modes, the DCE searches for DTMF, calling tone, and dial tones and reports them to the DTE whenever they are detected. Detection information and data stream terminators are passed between the DTE and DCE by first sending an ASCII <DLE> character (\$10h) followed by a special character. Special characters in the data stream are used as follows:

```
any data ... <DLE><ETX>      end of data stream
any data ... <DLE><DLE>      single 10h<DLE> in data stream
any data ... <DLE><X>        X is a special character,
delete both <DLE> and X from
the data stream
```

When the DTE transfers data to the modem during playback mode (**AT+VTX** command), the DTE must insert a <DLE> for each <DLE> in the original data stream. When data is no longer available, the DTE must add the stream terminator <DLE><ETX> to the end of the data stream. If the modem detects the two terminating characters <DLE><ETX> within the data stream, it transmits the data immediately to the remote modem without waiting for the buffer to fill up. To abort playback mode without waiting for the modem to empty the internal modem buffer, send <DLE><CAN><DLE><ETX>. Immediately aborting the playback mode eliminates long delays between receiving a DTMF tone or keyboard abort and starting a new function such as playing back or recording a new message.

When the modem transfers data to the DTE during record mode (**AT+VRX** command), the DTE must filter the data stream by removing all character pairs beginning with <DLE>. The DTE also must recognize <DLE><ETX> as the stream terminator. Upon detecting <DLE><DLE>, the DTE must reinsert a single <DLE> in its place. The modem buffers up to 512 bytes of voice data received from the SAFE analog-to-digital converters if the DTE cannot read the data immediately.

6.1 DTMF Detection Reporting

DTMF detection information is reported by the modem to the DTE by a <DLE> shielded command as outlined in Section 6.5 of the ITU V.253 specification. When the DTMF burst is detected in Voice mode, the modem sends to the DTE a <DLE></> followed by a sequence of <DLE><-> is inserted to indicate the end of the determination interval.

For example, a single 280ms burst of DTMF 5 would report:

```
<DLE></><DLE><5><DLE><5><DLE><5><DLE><5><DLE><->
```

6.2 Relay Control

To originate a call (that is, to originate call forwarding or auto-dialing) and to generate tones, use the dialing command:

```
ATDT <telephone number>
```

If the modem was not already off-hook, then this command automatically configures the value for **AT+VLS=m** to m = 1 or m = 5 depending on the value for **Mn**.

To answer a call, use the **AT+VLS=m** command. Unlike data mode, the modem (when configured for voice mode) does not automatically answer an incoming call (that is, the modem ignores the contents of S-register **S0**).

Remote playback/record takes place whenever the modem is off-hook (OHREL* is activated). For local playback/record, the modem is on-hook, and the user uses a local telephone or handset. The LPHREL* relay driver may be used to control the local telephone or handset when implementing local playback/record mode (**AT+VLS=m**). Additionally, voice messages may be played through the modem/computer speaker. The 536EX chipsets also provide a microphone interface that can be used for local recording.

In voice mode, all voice AT commands can be issued by the DTE at any valid speed between 300 bps to 115,200 bps. Typically, the DTE-to-modem data rate is set for 19,200 bps, which is the recommended data rate for Class 1 fax mode. The DTE-to-modem data rate may need to be set to 115,200 bps in certain instances, such as during playback or during record mode for a CL1 compression scheme.

The following data and fax AT commands are supported in voice mode:

```
Data:      All except ATA, ATIn
Fax:      +FCLASS
```

Table 25. Voice Mode Command Descriptions

Command	Default	Description
+FCLASS =8	0	Voice Mode Selection: This command enables or disables voice mode. All voice mode commands (except for +FCLASS=m) are valid only in voice mode. 0* Data mode 1 Class 1 fax mode 8 Voice mode enabled
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+FLO=m	1	<p>Flow Control Select: This command allows the DTE to identify and select the types of flow control used. DCEs using the IS-101 standard must support in-band XON/XOFF flow control. XON is the ASCII <DCI> character (11h); XOFF is the ASCII <DC3> character (13h). The DCE may provide ITU-Ts V.24 CTS (circuit 106) and RTS (circuit 133) for flow control.</p> <p>0 Disables XON/XOFF and CTS/RTS flow control</p> <p>1* Enables XON/XOFF flow control in either direction</p> <p>2 The DTE uses ITU-Ts RTS to control flow to the modem; the modem uses ITU-T CTS to control flow to the DTE.</p>
+VBT=m	see 'm'	<p>Buffer Threshold Setting: This command specifies the flow control assert and deassert points inside the DCE's internal transmit buffer. The internal buffer is 512 bytes. The +VBT=m parameters are fixed in firmware and cannot be changed.</p> <p>m = <deassert>, <assert> Defaults: <deassert> = 192, <assert> = 320</p> <p><assert>: This parameter stops data transfer from the DTE when the number of bytes in the buffer reaches the lower number of the range specified by the <assert> parameter. So that no data is lost before the modem stops the flow of data, the <assert> parameter allows more data to enter the buffer until it reaches the larger number in its range. Range: <assert> = 192</p> <p><deassert>: This parameter starts data transfer from the DTE after the number of bytes in the transmit buffer falls below the <deassert> value. Range: <deassert> = 320</p>
+VCID=m	0	<p>Caller ID Selection: This command controls the reporting and presentation of data in the ICLID (Incoming Call Line ID) data format used by the Caller ID services in the United States and Canada. At a minimum, the data sent to the DCE includes the date, time, and the caller's telephone number. Caller ID information is sent to the DTE during the first and second ring signals when the modem is in voice, data, or fax mode.</p> <p>0* Disables Caller ID</p> <p>1 Enables Caller ID with formatted presentation to the DTE. The modem presents the data items in a <Tag><Value> pair format. The expected pairs are data, time, caller code (phone number), and name.</p> <p>2 Enables Caller ID with unformatted presentation to the DTE. The modem presents the entire packet of information, excluding the leading Us, in ASCII-printable hex numbers.</p> <p>NOTE: If S0=1 (auto-answer mode) and Caller ID is enabled in data modem mode, then the modem answers only after the second ring signal.</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description															
+VDR=m	see 'm'	<p>Distinctive Ring Selection: This command contains two parameters. The first selects whether the modem reports distinctive ring cadence information. The second parameter controls the timing of the RING event code report.</p> <p>m=<enable>, <report> Defaults = 0, 0</p> <p><enable> Ring Reporting: The DCE reports the length of the ring period.</p> <p>Range: <enable> = 0–255 (enables/disables distinctive ring reporting in the form DROF=<number in units of 0.1 seconds><CR><LF>)</p> <p><report> Time Ring Reporting: The DCE reports the silence period's length. The DCE may produce a RING event code after the DRON message if enabled by the <report> parameter. The <report> parameter should be set to a value larger than the expected off-times within a single pattern so the RING even reports are issued only during the off-times between the complex patterns.</p> <p>Range: <report> = 0–255 (reporting type in the form DROF=<number in units of 0.1 seconds>)</p> <table> <tr> <th><enable></th><th><report></th><th>Function</th></tr> <tr> <td>0</td><td>–</td><td>Distinctive ring disabled</td></tr> <tr> <td>1</td><td>0</td><td>The modem reports DROF and DRON messages but does not report RING messages</td></tr> <tr> <td>1</td><td>non-0</td><td>The modem reports DROF, DRON and RING messages</td></tr> <tr> <td>2–255</td><td>–</td><td>Reserved</td></tr> </table> <p>Regardless of its setting, the +VDR command can be disabled by the +VEM command.</p>	<enable>	<report>	Function	0	–	Distinctive ring disabled	1	0	The modem reports DROF and DRON messages but does not report RING messages	1	non-0	The modem reports DROF, DRON and RING messages	2–255	–	Reserved
<enable>	<report>	Function															
0	–	Distinctive ring disabled															
1	0	The modem reports DROF and DRON messages but does not report RING messages															
1	non-0	The modem reports DROF, DRON and RING messages															
2–255	–	Reserved															
NOTE: An asterisk (*) denotes the factory-default setting.																	

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description			
+VEM=m	see 'm'	Event Reporting and Masking: This command selects which detection events are supported in voice mode. Each event is represented by a single bit of a four-digit hex number (see the following table). Setting an event number bit to 0 means that event is not reported. Setting a bit to 1 indicates that a detected event is reported. While the event settings affect all modes (that is, playback, record, and command modes), not just voice command mode, the mask can be changed each time the mode is changed. Not all events are supported in each mode. See the following table for supported events. This modem supports more features than an IS-101 Class C-compliant modem. (Class C is the highest IS-101 compliant modem, and Class A is the lowest.) See the following examples for more information. m = <mask> Defaults = 'C', BB860980, BFE63883, BB863EE0			
		Hex Digit Location	Event Number (Bit Number)	Event Description	DCE Voice Mode(s)
		1	0	Caller ID report	Command
			1	Reserved	
		2	2	Distinctive ringing	All
			3 *	RING	All
			4 *	DTMF received	All
		3	5 *	Receive buffer overrun	Receive
			6 *	Fax calling (for example, 1100 Hz)	All
			7	Data calling (for example, 1300 Hz)	All
		4	8	Local phone on/off hook	All
			9 *	Presumed hang-up (SILENCE) time-out	Receive
			10 *	Presumed end of message (QUIET) time-out	Receive and command
		5	11	Reserved	
			12	Reserved	
			13	Loop current interruption	All
		6	14	Loop current polarity reversal	All
			15	Reserved	
			16	Reserved	
		7	17	Reserved	
			18 *	Ringback/remote ring	All
			19 *	BUSY reorder/fast busy	Receive and Command
		8	20 *	DIALTONE	Receive and Command
			21	Reserved	
			22	Reserved	
		9	23*	Transmit buffer under-run	Transmit
			24	Extension phone on/off hook	All
			25 *	Fax or data answer (for example, 2100 Hz)	Command
		A	26	Data answer (for example, 2225 Hz)	Command
			27	Reserved	
			28	Reserved	
		B	29	Reserved	
			30	Reserved	
			31	Reserved	
		C	32	Reserved	
			33	Reserved	
			34	Reserved	
		D	35	Reserved	
			NOTES: <ul style="list-style-type: none">Items marked with an asterisk (*) meet IS-101 Class C specifications.All: Playback, record, and command modes.		
			NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+VEM=m (cont.)	see 'm'	Event Reporting and Masking: (cont.) Example 1. Viewing Supported Events: To determine what events are supported by the modem, send 'AT+VEM=?'. <pre>AT+VEM=? 'C' ← Feature Class DB860980 ← Playback mode events OFEE0883 ← Record mode events BB863EE0 ← Command mode events OK</pre> Example 2. Setting the Event Mask: To set the event mask, issue AT+VEM=m, where 'm' is eight hex digits. This command is issued only in command mode and is followed when changing between voice modes. That is, the modem uses the event mask previously set by the +VEM=m command when entering playback or record mode. The modem ignores any event bit set when that feature is not supported in that voice mode. <pre>AT+VEM=BB863EE0</pre> Example 3. Reading the Event Mask Settings: To read the settings for each event, type: <pre>AT+VEM? BB863EE0 OK</pre> Example 4. Understanding the +VEM Hexadecimal Code: The following illustration shows how the hexadecimal eight-digit code (BB863EE0) is derived from the bit setting for each event: HEX DIGIT LOCATION: 1 2 3 4 5 6 7 8 EIGHT-DIGIT HEX CODE: B B 8 6 3 E E 0
		The following example shows how to read the string.
		<div><div>EX VALUE</div><div>B B 8 6 3 E E 0</div><div><div>BIT VALUE</div><div>1 0 1 1 1 0 1 1 1 0 0 0 0 1 1 0 0 0 1 1 1 1 1 0 1 1 1 0 0 0 0 0</div></div><div><div>EVENT</div><div>0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31</div></div><div><div>HEX DIGIT LOCATION</div><div>1 2 3 4 5 6 7 8</div></div></div>
		<div><div>+VGM=m</div><div>128</div><div>Speakerphone Microphone Gain: This command sets the speakerphone's microphone gain. Range: 121–131 128* Nominal value</div></div>
<div><div>+VGR=m</div><div>128</div><div>Receive Gain Selection: This command sets the recording level for the modem's voice mode. A different recording level may be needed for each type of recording device. This includes telephone line, local handset, local telephone, or microphone. Range: 121–131 128* Nominal recording level</div></div>		
<div><div>+VGS=m</div><div>128</div><div>Speakerphone Speaker Gain: This command sets the speakerphone's speaker gain. Range: 121–131 128* 121 Gain smaller than normal 131 Gain larger than normal</div></div>		
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+VGT=m	128	<p>Volume Selection: This command sets the volume level for the modem's playback voice mode. A different playback level may be needed for each type of playback device (telephone line, local handset, local telephone, or speaker).</p> <p>Range: 121–131</p> <p>128* Nominal transmit level</p>
+VIP	none	<p>Initialize Parameter: This command causes the modem to initialize all voice parameters to the factory default values. This command does not change relay or speaker setup (that is, if the modem is off-hook, then the modem remains off hook after processing this command).</p>
+VIT=m	0	<p>DTE/DCE Inactivity Timer: This command sets the length of time the modem can be inactive in voice mode before the modem resets its relays +VLS=0 and changes to data mode (FCLASS=0) with autobauding. The purpose of this timer is to ensure that the DTE does not leave the DCE in a mode that cannot be accessed by voice-unaware software. This timer is supported in playback, record and voice command mode. Sending any data (such as a <DLE><NUL> string) to the modem re-initializes this timer.</p> <p>Range: 0–255 (units of 1.0 second)</p> <p>m = 0* Disables inactivity timer</p> <p>m ≠ 0 Inactivity timer active</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description		
+VLS=m	0	Relay/Playback Control: This command controls the four μP relay drivers and controls hardware paths for voice playback/record transmit and receive.		
		Preassigned Voice I/O Labels		
		<label>	Primitive Code	Description
		0	None	DCE on hook. Local phone connected to Telco.
		1	T	DCE off hook. DCE connected to Telco. Local phone provided with power to detect the hook condition.
		2	L	DCE on hook. Local phone connected to DCE.
		3	LT	DCE off hook. Local phone connected to Telco. DCE connected to Telco. (Not implemented. Return error.)
		4	S	Internal speaker connected to DCE. DCE on-hook. Local phone connected to Telco.
		5	ST	Internal speaker connected to Telco. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
		6	M	Internal microphone connected to DCE. DCE on hook. Local phone connected to Telco.
		7	MST	Internal microphone and internal speaker connected to Telco. Squelching active. DCE off hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
		8	S1	External speaker connected to DCE. DCE on-hook. Local phone connected to Telco. (Implemented as 4. Speaker jack determines.)
		9	S1T	External speaker connected to Telco. DCE off hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 5. Speaker jack determines.)
		10	MS1T	Internal microphone and external speaker connected to Telco. Squelching active. DCE off hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 7. Speaker jack determines.)
		11	M1	External microphone connected to DCE. DCE on hook. Local phone connected to Telco. (Implemented as 6. Mic jack determines.)
		12	M1ST	External microphone and internal speaker connected to Telco. Squelching active. DCE off hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 7. Mic jack determines.)
		13	M1S1T	External microphone and external speaker connected to Telco. Squelching active. DCE off hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (implemented as 7)
		14	H	Handset or headset connected to DCE. DCE on hook. Local phone connected to Telco.
		15	HT	Handset or headset connected to Telco. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
		16	HT	Handset or headset connected to Telco with microphone muted. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
NOTE: An asterisk (*) denotes the factory-default setting.				

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description																
+VLS=m (<i>cont.</i>)	0	Relay/Playback Control: (<i>cont.</i>)																
		Voice I/O Primitive Codes																
		<table><thead><tr><th>Primitive Code</th><th>Description</th></tr></thead><tbody><tr><td>L</td><td>Local phone</td></tr><tr><td>T</td><td>Telco line</td></tr><tr><td>M0</td><td>Internal microphone</td></tr><tr><td>M1</td><td>External microphone</td></tr><tr><td>S0</td><td>Internal speaker (requires squelch on any microphone activity)</td></tr><tr><td>S1</td><td>External speaker (requires squelch on any microphone activity)</td></tr><tr><td>H0</td><td>External microphone and speaker combination (handset or headset)</td></tr></tbody></table>	Primitive Code	Description	L	Local phone	T	Telco line	M0	Internal microphone	M1	External microphone	S0	Internal speaker (requires squelch on any microphone activity)	S1	External speaker (requires squelch on any microphone activity)	H0	External microphone and speaker combination (handset or headset)
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H0	External microphone and speaker combination (handset or headset)																	
NOTE: For speakerphone applications, see ATI10 , +VSP , and “Speakerphone AT Command Requirements” in the Voice Application Note for more details.																		
+VNH=m	0	Automatic Hang-Up Control: This command changes the way the modem responds to hang-up commands after it switches from voice mode to fax or data modes. Range: 0–2																
		0* The modem retains automatic hang-ups as normal in data and fax modes																
		1 The modem disables automatic hang-ups usually found in non-voice modes																
		2 The modem disables all automatic hang-ups usually found in non-voice modes except a 'logical' hang-up																
+VRA=m	50	Ringback-Goes-Away Timer: After originating a call in voice mode, this command selects the length of time the DCE waits between ringbacks before the DCE assumes the remote party has gone off hook. After dialing a phone number and detecting a ringback, the modem sends <DLE><0> to the DTE if another ringback is not detected within this timer value. This indicates that the remote telephone has been picked up (that is, gone off-hook). The ringback-goes-away timer is reset every time a new ringback is detected. Range: 0–50 (in 100 ms increments)																
		0 The DCE returns the 'OK' code immediately after ringback.																
		50* (50 = 5.0 seconds)*																
+VRN=m	10	Ringback-Never-Appeared Timer: This command sets the length of time the DCE waits for ringback when originating a call in voice mode. After dialing a phone number, the modem sends an 'Error' result code to the DTE if ringback is not detected before the timer value elapses. This may indicate one of several conditions: the remote telephone was picked up before the ringback tone was generated; the number is no longer in service; or the number was incomplete. This timer is disabled after detecting the first ringback. Range: 0–255 (in 1 second increments)																
		0 The DCE immediately returns the OK result code after dialing																
		10* (10 = 10 seconds)*																

NOTE: An asterisk (*) denotes the factory-default setting.

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+VRX	none	<p>Record Mode: This command causes the modem to enter record mode to record voice messages. Upon receiving the AT+VRX command, the modem responds to the DTE with a 'CONNECT' message at the current DTE-to-modem rate. It is important that the UART DTE-to-modem rate be equal or higher to the compression-scheme-required UART data rate (for example, CL1 at 4800 samples/second requires 57,600 bps). If the DTE-to-modem data rate is lower than the compression-scheme-required UART data rate, then data may be lost or may be garbled during playback of the message. After sending the 'CONNECT' message, the modem then sends digitized voice data that is <DLE>-shielded to the DTE. The modem buffers the data to ensure steady voice delivery even though the voice data may be transferred to the DTE in bursts. The DTE may use the <DLE><NUL> shielded code as a no-operation command to refresh the inactivity timer.</p> <p>During voice receive mode, the modem informs the DTE about pertinent events that may prompt the DTE to terminate the voice receive state. The DCE sends <DLE> codes for detection of signals such as busy tone, dial tone, DTMF tone, and codes for 'Presumed End of Message' or 'Presumed Hang-up.' Record mode is terminated whenever the modem issues a <DLE><ESC> command or provides a DTE/DCE inactivity timer time-out. Upon detecting the terminating character, the modem stops sampling the analog data. The modem then terminates record mode by sending the remaining voice data stored in its internal buffer, <DLE><ETX>, and an 'OK' message to the DTE.</p> <p>In some situations, the application software may want to abort record mode and immediately perform a new function without first reading all the recorded voice data from the modem's internal buffer (for example, after detecting fax calling tone). This is accomplished by sending <DLE><!> to the modem while in record mode. Upon seeing <DLE><!>, the modem terminates record mode, clears the modem's internal record buffer, and issues a <DLE><ETX> to the DTE followed by an 'OK' message.</p> <p>The modem may immediately abort record mode if it receives either an AT+VIT=m time-out or a DTR toggle. If +VIT≠0 and the modem has not received any data or a <DLE><NUL> code before the +VIT timer times out, then the modem immediately aborts record mode. The modem then hangs up the line and changes to data mode (+FCLASS=0). If the UART DTR signal is toggled on-off-on, then the modem follows the &Dn setting. If configured for &D2 or &D3, the modem immediately aborts record mode, hangs up the line, and changes to data mode (+FCLASS=0).</p> <p>NOTE: The voice sampling rate and sampling mode must be the same values as used during record mode.</p>
+VSD=m	see 'm'	<p>Silence Detection (Quiet and Silence): This command allows the DTE to set two parameters: <sds> reports the sensitivity for silence detection, and <sdi> reports the length of silence required for the DCE to report silence when receiving voice.</p> <p>The <DLE><s> silence timer starts immediately after entering record mode. The modem stops using the <DLE><s> timer and starts using the <DLE><q> timer if:</p> <ul style="list-style-type: none"> the <DLE><s> silence timer has timed out and a <DLE><s> code has been sent to the DTE, or if noise or voice energy has been detected above the silence detection threshold (as defined by <sds>). <p>m = <sds>, <sdi> Defaults: m = 128, 50</p> <p><sds> Silence Sensitivity: If the received analog signal stays below this specified level for a user-specified time delay, the modem sends <DLE><q> to the DTE. The modem sends only one <DLE><q> to the DTE each time record mode +VRX is entered.</p> <p>Range: 121–131 128* Nominal level</p> <p><sdi> Length of Silence: This parameter sets the period of silence that must elapse before the DCE reports silence (as detected by 'Quiet' or 'Silence').</p> <p>Range: 0–255 (units of 0.1 second) 0 Silence detection disabled 50* Silence detection enabled</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+VSM=m	manuf- turer- specified	<p>Compression Method Selection: This command contains four parameters that specify the voice compression method, voice sampling rate, silence compression sensitivity, and the degree of silence expansion. The DCE can support different capabilities for each compression method.</p> <p>m= <cm1>, <vsr>, <scs>, <sel> Defaults: m = 140, 8000, 0, 0</p> <p><cm1> Compression Method: This parameter selects a voice compression method. The DTE can obtain the label and a string constant identifier by using the +VSM? command. Range: 0–2, 128, 129, 132, 140, 141</p> <p>0 LIN1: 8-bit Linear PCM (pulse code modulation) sampling using twos-complement signed numbers</p> <p>1 LIN2: 16-bit Linear PCM sampling using unsigned numbers</p> <p>2 AD4: 4-bit Adaptive differential pulse code modulation</p> <p>128 LIN1: 8-bit Linear PCM (pulse code modulation) sampling using twos-complement signed numbers</p> <p>129 LIN2: 16-bit Linear PCM sampling using unsigned numbers</p> <p>132 AD4: 4-bit Adaptive differential pulse code modulation</p> <p>140* CL1: 8-bit Intel A-law</p> <p>141 AD3: 3-bit Adaptive differential pulse code modulation</p> <p><vsr> Sampling Rate: This parameter selects the DCE voice sampling/digitizing rate for the voice signal. The supported sampling rates are dependent on the compression schemes used. Use the +VSM=? command to obtain supported sampling rates. Range: 4800, 7200, 8000, and 11025 samples/second</p> <p>4800 Default used by previous Intel modems</p> <p>7200</p> <p>8000* Used by some bulletin boards</p> <p>9600</p> <p>11025 Used by many Windows* WAV files</p> <p><scs> Silence Sensitivity: The function of this parameter depends on whether the DTE is transmitting or receiving in voice mode. The DTE can modify the silence expansion using the <sel> parameter. When transmitting voice, a non-zero value of this parameter informs the DCE that the data stream was recorded with silence compression.</p> <p>Transmission: Range: 0</p> <p>0* Disabled</p> <p>When receiving voice, this parameter changes the level of noise that the DCE treats as silence. A higher 'n' number raises the threshold of noise detection.</p> <p>Reception: Range: 0</p> <p>0* Disables DCE silence compression</p> <p>increments of 1 Raises noise detection threshold</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description																																																																																																																				
+VSM=m (cont.)	manufac- turer- specified	Compression Method Selection: (cont.) <sel> Silence Expansion: This command enables the DTE to modify the amount of silence expansion. This parameter represents the maximum period of silence the DCE expands a period of silence compressed by the <scs> parameter. The DCE ignores the <sel> parameter if <scs> is zero.																																																																																																																				
		<table><tr><th><cml> Compression</th><th><vsr> Sampling Rate</th><th>Serial Data Rate (bps)</th><th>UART Data Rate (bps)</th><th>Hard Disk (Bytes/sec.)</th><th>Note</th></tr><tr><td rowspan="5"><cml> = CL1*</td><td>4800</td><td>48,000</td><td>57,600</td><td>4800</td><td></td></tr><tr><td>7200</td><td>72,000</td><td>115,200</td><td>7200</td><td>1</td></tr><tr><td>8000</td><td>80,000</td><td>115,200</td><td>8000</td><td>1</td></tr><tr><td>9600</td><td>96,000</td><td>115,200</td><td>9600</td><td>1</td></tr><tr><td>11025</td><td>110,250</td><td>115,200</td><td>11,025</td><td>1</td></tr><tr><td rowspan="5"><cml> = AD3</td><td>4800</td><td>18,000</td><td>19,200</td><td>1800</td><td></td></tr><tr><td>7200</td><td>27,000</td><td>38,400</td><td>2700</td><td></td></tr><tr><td>8000</td><td>30,000</td><td>38,400</td><td>3000</td><td></td></tr><tr><td>9600</td><td>36,000</td><td>38,400</td><td>3600</td><td></td></tr><tr><td>11025</td><td>41,344</td><td>57,600</td><td>4135</td><td></td></tr><tr><td rowspan="5"><cml> = AD4</td><td>4800</td><td>24,000</td><td>38,400</td><td>2400</td><td></td></tr><tr><td>7200</td><td>36,000</td><td>38,400</td><td>3600</td><td></td></tr><tr><td>8000</td><td>40,000</td><td>57,600</td><td>4800</td><td></td></tr><tr><td>9600</td><td>48,000</td><td>57,600</td><td>4800</td><td></td></tr><tr><td>11025</td><td>55,125</td><td>57,600</td><td>5513</td><td></td></tr><tr><td rowspan="5"><cml> = LIN1</td><td>4800</td><td>48,000</td><td>57,600</td><td>4800</td><td></td></tr><tr><td>7200</td><td>72,000</td><td>115,200</td><td>7200</td><td>1</td></tr><tr><td>8000</td><td>80,000</td><td>115,200</td><td>8000</td><td>1</td></tr><tr><td>9600</td><td>96,000</td><td>115,200</td><td>9600</td><td>1</td></tr><tr><td>11,025</td><td>110,250</td><td>115,200</td><td>11,025</td><td>1</td></tr><tr><td><cml> = LIN2</td><td>4800</td><td>96,000</td><td>115,200</td><td>9600</td><td>1</td></tr></table>	<cml> Compression	<vsr> Sampling Rate	Serial Data Rate (bps)	UART Data Rate (bps)	Hard Disk (Bytes/sec.)	Note	<cml> = CL1*	4800	48,000	57,600	4800		7200	72,000	115,200	7200	1	8000	80,000	115,200	8000	1	9600	96,000	115,200	9600	1	11025	110,250	115,200	11,025	1	<cml> = AD3	4800	18,000	19,200	1800		7200	27,000	38,400	2700		8000	30,000	38,400	3000		9600	36,000	38,400	3600		11025	41,344	57,600	4135		<cml> = AD4	4800	24,000	38,400	2400		7200	36,000	38,400	3600		8000	40,000	57,600	4800		9600	48,000	57,600	4800		11025	55,125	57,600	5513		<cml> = LIN1	4800	48,000	57,600	4800		7200	72,000	115,200	7200	1	8000	80,000	115,200	8000	1	9600	96,000	115,200	9600	1	11,025	110,250	115,200	11,025	1	<cml> = LIN2	4800	96,000	115,200	9600	1
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NOTES: 1. Because of the high UART data rates, these compression/sample rates may not be applicable to the serial host interface (that is, serial box modem) designs (see ATi5 to determine if the modem is using the serial host interface). For parallel and PC Card host interfaces, the modem ignores the UART data rate. 2. DTMF detection is provided for all sample rates.																																																																																																																						
+VSP=m	0	Speakerphone On/Off Control: This command turns on the speakerphone function. This feature provides full-duplex speakerphone capabilities with internal adaptive echo cancellers. This command takes the received voice signal and loops it back to the analog transmit pins. The host must configure the relays and microphone interface as necessary using the AT+VLS=m command. Typically, this means setting the off-hook relay driver, speaker, and microphone inputs with AT+VLS=13 . After enabling the speakerphone mode (+VSP=1), the modem remains in voice command mode and provides information about local off-hook detection, DTMF detection, and tone detection—if supported by the modem board. Range: 0, 1 0* Speakerphone mode disabled 1 Speakerphone mode enabled																																																																																																																				
NOTE: An asterisk (*) denotes the factory-default setting.																																																																																																																						

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
#VSPS=m	1	<p>Speakerphone Type Selection: This command determines which speakerphone type is used when the modem receives a +VSP=m command. This allows the application software to select whether telephone emulation or digital speakerphone is used for +VSP=m. Upon powering-up, the modem determines whether it can support a digital speakerphone mode. If digital speakerphone is supported, then the factory default value is equal to '1'. If the digital speakerphone is not supported, then the factory default is '0'.</p> <p>Range: 0, 1</p> <p>0 Telephone Emulation Mode speakerphone</p> <p>1* Digital speakerphone</p>
+VTD=m	100	<p>Beep Tone Duration Timer: This command sets the default duration of all DTMF tones.</p> <p>Range: 5–255 (units of 0.01 seconds)</p> <p>100* Default value (1 second)</p>
<p>NOTE: An asterisk (*) denotes the factory-default setting.</p>		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+VTS=m	none	<p>DTMF and Tone Generation: This command causes the modem to generate DTMF tones or pulse tones in voice mode. The <DLE><!> code aborts the playback of tones, sends the 'OK' result code, and returns the modem to the voice command state. The DTE/DCE inactivity timer is in place during tone production. The command +VTS sent without a parameter assumes the default value, which is a null string. The DTE may use the <DLE><NUL>-shielded code to refresh the timer.</p> <p>m=<string> The <string> is made up of a list of <freq> and <duration> parameters. <freq> is in units of Hz, and <duration> is in units of 0.01 seconds.</p> <p>The tone string consists of up to three types of elements: a single ASCII character, a string in brackets, and a string in braces. Commas must separate the elements. Missing elements assume the value of zero. The following list explains each element and how it can be used.</p> <ol style="list-style-type: none"> Single ASCII character in the set, 0–9, #, *, ! and A–D, which is interpreted as a single DTMF tone. DTMF tones are sent as a single element expressed in the form: AT+VTS=<DTMF or !> For example, to send a DTMF 1 tone, issue AT+VTS=1 to the modem. String drawn from the first set but not including a flash hook code '!' and enclosed in brackets "[]", which can produce a single or dual tone. The string includes three parameters, which set the frequency of two non-standard DTMF or single tones and a common duration for both. The quantity in brackets consists of a three-element list that is expressed in the following format: AT+VTS=[<first tone freq 1>, <second tone freq 2>,<duration>] If the duration is not specified in the <duration> parameter, the modem sends tones for the duration specified by the +VTD=m command. <ol style="list-style-type: none"> Single tones can be sent in brackets using the following format: AT+VTS=[<first tone freq 1>] or AT+VTS=[<first tone freq 1>, <space>, <duration>] For example: AT+VTS=[3000] This sends a single tone of 3000 Hz with a default duration specified by +VTD=m. For example: AT+VTS=[3000,,50] This sends a single tone of 3000 Hz with a duration of 500 ms (50 x 0.01 second). Dual tones may be sent using the following format: AT+VTS=[<first tone freq 1>,<second tone freq 2>] or AT+VTS=[<first tone freq 1>,<second tone freq 2>,<duration>] For example: AT+VTS=[3000,3300] This sends a dual tone of 3000 Hz and 3300 Hz with the default duration set by the +VTD=m command. For example: AT+VTS=[3000,3300,50] This sends a dual tone of 3000 Hz and 3300 Hz with a duration of 500 ms (50 x 0.01 second). This command can be used to send a period of silence in a tone string. Use the following format: AT+VTS=[, <duration>] AT+VTS=[] For example: AT+VTS=[, 50] This sends a 500 ms period of silence.
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 25. Voice Mode Command Descriptions (Continued)

Command	Default	Description
+VTS=m (<i>cont.</i>)	none	<p>DTMF and Tone Generation: (<i>cont.</i>)</p> <p>3. Single DTMF tones or hook flashes are sent enclosed in braces "{ }". A duration must be included, as the duration set in +VTD=m does not apply.</p> <p>Use the following format:</p> <p>AT+VTS={<DTMF or !>,<duration>}</p> <p>For example: AT+VTS={2,30}</p> <p>This command sends DTMF tone 2 with a duration of 300 ms.</p> <p>For example: AT+VTS={!,50}</p> <p>This command sends a hook flash with a duration of 500 ms.</p> <p>Send multiple DTMF signals and tones by combining elements in a given +VTS=m command string.</p> <p>For example:</p> <p>AT+VTS={!,30}, 1, 2, [1000,1300,50], !, {*,6}, [1000], 9</p> <p>This command line programs the following events:</p> <ol style="list-style-type: none"> 1. Hook-flash with a duration of 300 ms. 2. Send DTMF 1 for the duration specified by +VTD command. 3. Send DTMF 2 for the duration specified by +VTD command. 4. Send tone pair 1000 Hz and 1300 Hz for a duration of 500 ms. 5. Hook-flash with a duration specified by +VTD command. 6. Send DTMF * for a duration of 60 ms. 7. Send tone 1000 Hz for a duration specified by the +VTD command. 8. Send DTMF 9 for the duration specified by +VTD command. <p>For example:</p> <p>AT+VTS=1, [, ,50], 2, [], 9</p> <p>This command line programs the following events:</p> <ol style="list-style-type: none"> 1. Send DTMF 1 for the duration specified by +VTD command. 2. Play silence for a duration of 500 ms. 3. Send DTMF 2 for the duration specified by +VTD command. 4. Play silence for a duration specified by +VTD command. 5. Send DTMF 9 for the duration specified by +VTD command.
+VTX	none	<p>Play Mode: This command causes the modem to start voice transmission (playback mode) and play back a previously recorded voice message.</p> <p>Upon receiving the AT+VTX command, the modem responds to the DTE with a 'CONNECT' message at the current DTE-to-modem rate. It is important that the UARTs DTE-to-modem rate be equal to or higher than the compression-scheme-required UART data rate (for example, CL1 at 4800 samples/second requires 57,600 bps). If the DTE-to-modem data rate is lower than the compression-scheme-required UART data rate, then data may be lost or the playback message may be garbled. After receiving the 'CONNECT' message, the DTE then sends the voice file to the modem. To ensure that data is not overwritten, the modem provides both hardware or software flow control with AT+FLO=m. The modem also buffers the data to ensure steady voice delivery, even though the voice data may be transferred from the DTE in bursts.</p> <p>Playing mode is terminated when the data is exhausted and the modem receives the two terminating characters <DLE><ETX> from the DTE. Upon detecting <DLE><ETX>, the modem issues an 'OK' result code. After the modem's internal buffer is empty, it returns to the command mode.</p> <p>To abort playback mode immediately without waiting for the modem to empty its internal buffer, send <DLE><CAN><DLE><ETX>. The modem aborts playback mode immediately in two other situations: during a AT+VIT=m time-out or a DTR toggle. The modem immediately aborts playback mode if +VIT=0 and the modem has not received any data or if the modem receives a <DLE><NUL> code before the +VIT timer time-out. The modem then hangs up the line and switches to data mode (+FCLASS=0). If the UART DTR signal is toggled from on-off-on, then the modem follows the &Dn setting. If configured for &D2 or &D3, then the modem immediately aborts playback mode, hangs up the line, and switches to data mode (+FCLASS=0).</p> <p>NOTE: The voice sampling rate and sampling mode must be the same values used during record mode.</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

S-Registers

7

The 536EX chipsets provide direct access to the internal registers known as S-registers. The DTE uses S-registers to set up and check modem configurations. The contents of these registers can be changed using the **ATS_n=x** command, where ‘n’ is the register number and ‘x’ is the value to be stored. The contents of the S-registers can be read using the **ATS_n?** command. Most S-registers can be read from or written to; however, some S-registers (such as **S14**) are read-only. Writing to a read-only register may cause the modem to act improperly (that is, even though the contents of a read-only S-register may be changed using the **ATS_n=x** command, changing the contents of the S-register does not normally configure the entire modem).

Reserved S-registers are used by the modem and provide no valuable information to the DTE. These registers have been removed from the following table. Reserved S-registers should never be written to, as they cause the modem to lock up.

Table 26. S-Register Command Descriptions

Command	Default	Description
S0	0	<p>Number of Rings to Auto-Answer On: Assigning S0 a value from 1 to 255 configures the modem for auto-answer mode. The modem automatically goes off-hook and initiates a data mode-answer mode handshake after detecting the specified number of rings. This S-register is meant for data modem mode only and should be set to ‘0’ for fax and voice modes.</p> <p>Range: 0–255 rings</p> <p>0 Auto-answer mode disabled</p> <p>1–255 Auto-answer mode enabled</p> <p>NOTES:</p> <ul style="list-style-type: none"> • If Caller ID is enabled (+VCID=m), then the modem only answers after the second ring even if S0=1. • Setting n > 2 causes the modem to answer on the nth ring signal.
S1	0	<p>Ring Count: Reports the number of ring signals detected by the modem. This register is cleared to zero if no new ring signals are detected within an 8 second time interval.</p> <p>Range: 0–255 rings</p> <p>Default: 0 rings</p>
S2	43	<p>Escape Character: S2 specifies an ASCII value for the Hayes or TIES escape character. The factory default is ‘+’ or ASCII decimal 43. The escape character may range between 0–127. Any value over 127 disables the escape sequence.</p> <p>Range: 0–127</p> <p>Default: 43 (‘+’)</p>
S3	13	<p>Carriage Return Character: S3 specifies the AT command string terminator and modem response code terminator. The factory default is a <CR> or carriage return (ASCII decimal 13).</p> <p>Range: 0–127</p> <p>Default: 13 (carriage return)</p>
S4	10	<p>Line Feed Character: S4 specifies the line feed character, which is used for verbose (text) modem result codes.</p> <p>Range: 0–127</p> <p>Default: 10 (line feed)</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 26. S-Register Command Descriptions (Continued)

Command	Default	Description
S5	8	Backspace Character: S5 specifies the backspace character that is used to delete the last-entered character. After receiving a backspace character, the modem sends three characters to the DTE: a backspace character, a space character, and then another backspace character. Range: 0–32, 127 Default: 8 (BS)
S6	2	Wait Before Blind Dialing: S6 specifies the amount of time that must elapse after the modem goes off-hook before the modem starts dialing the first telephone number. The modem waits for at least 2 seconds before dialing the first number, even if S6 is set for a value less than 2. S6 is only used for result code type commands X0 , X1 , and X3 (that is, blind-dialing types of result codes). Result code types X2 and X4 enable dial-tone detection and ignore the contents of S6. Range: 2–255 seconds Default: 2 seconds
S7	60	Wait for Carrier/Dial Tone: S7 specifies the length of time that the modem waits to detect the remote modem carrier after dialing the telephone number. If the remote modem carrier is not detected within the S7 time limit, the modem hangs up and sends a 'NO CARRIER' response code to the DTE. If the remote modem carrier is detected, the modem goes into online data mode and sends a 'CONNECT' message to the DTE. S7 also specifies the time duration for the '@' (wait for quiet answer) dial modifier. Range: 1–255 seconds Default: 60 seconds
S8	2	Pause Time for Dial Modifier: S8 specifies the length of time that the modem pauses during the dialing process each time the ',' dial modifier is detected in the dialing string. Range: 0–255 seconds Default: 2 seconds
S9	6	Carrier Detect Recovery Time: S9 specifies how long the remote modem carrier must be present on the telephone line before the modem detects it and turns on DCD. The greater the time duration, the less likely that a false carrier detection occurs due to noise on the telephone line. Range: 1–255 (1/10 of a second) Default: 6 (equals 0.6 seconds)
S10	14	Lost Carrier Hang Up Delay: For modes V.32 and below, S10 specifies the length of time the modem waits before hanging up after the loss of the remote modem carrier. This delay allows for the temporary loss of the remote modem carrier without causing the local modem to hang up. S10 reports the time in 1/10 second units beyond 20 seconds. For example, when S10 = 0, the wait time is 20 seconds. When S10 = 100, the wait time is 30 seconds. In V.34 and V.90 modes, the modem automatically retries the connection for the time specified in S10 (Plus the mode-specific base time) before hanging up. In V.34 mode, the base time is 20 seconds. In V.90 mode the base time is 45 seconds. For all modes, the modem does not disconnect upon loss of the remote modem carrier if S10 is 255. Range: 0–255 (1/10 of a second) Default: 14 (equals 1.4 seconds plus the 20 second minimum)
S11	70	DTMF Dialing Speed: S11 specifies the duration of dual-tone multi-frequency (DTMF) dialing. This register is not used for pulse dialing. Range: 50–255 ms Default: 70 ms
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 26. S-Register Command Descriptions (Continued)

Command	Default	Description
S12	50	<p>Guard Time: S12 is used to specify guard and detect times used for the Hayes and TIES escape sequences.</p> <p>For the Hayes Escape Sequence, S12 specifies the minimum-delay timer (or guard time) before and after the three escape characters that is required for the modem to detect the Hayes Escape Sequence.</p> <p>For TIES, S12 specifies the maximum time limit that must elapse after receiving the three escape characters (and no other characters) before sending an OK message to the DTE.</p> <p>Range: 0–255 (1/50 of a second)</p> <p>Default: 50 (equals 1 second)</p>
S14	138	<p>Bit-Mapped Options: S14 is a read-only register that indicates AT command settings.</p> <p>Bit 0 Reserved</p> <p>Bit 1 0 E0 is selected 1* E1 is selected</p> <p>Bit 2 0* Q0 is selected 1 Q1 is selected</p> <p>Bit 3 0 V0 is selected 1* V1 is selected</p> <p>Bit 4 Reserved</p> <p>Bit 5 0* T (tone) dial is selected 1 P (pulse) dial is selected</p> <p>Bit 6 Reserved</p> <p>Bit 7 0 Answer 1* Originate</p>
S16	0	<p>Modem Test Options: S16 indicates the test in progress.</p> <p>Bit 0 0* Local analog loopback disabled 1 Local analog loopback enabled (&T1)</p> <p>Bit 1 Reserved</p> <p>Bit 2–5 Reserved</p> <p>Bit 6 0* Analog loopback with self-test disabled 1 Analog loopback with self-test enabled (&T8)</p> <p>Bit 7 0* Reserved 1 Reserved</p>
S18	0	<p>Modem Test Timer: S18 specifies the length of time that the modem conducts a data mode (except for V.90 and V.92) loopback test using the &Tn command. After timing out, the modem returns to command mode. Setting S18 to '0' disables the modem test timer; the loopback test must be terminated by issuing the appropriate escape sequence followed by an AT&T0 or ATH.</p> <p>Range: 0–255 seconds</p> <p>Default: 0 seconds</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 26. S-Register Command Descriptions (Continued)

Command	Default	Description
S21	48	<p>Bit-Mapped Options: S21 is a read-only register that indicates AT command settings.</p> <p>Bit 0 Reserved</p> <p>Bit 1 Reserved</p> <p>Bit 2 Reserved</p> <p>Bits 4–3 00 &D0 is selected</p> <p> 01 &D1 is selected</p> <p> 10* &D2 is selected</p> <p> 11 &D3 is selected</p> <p>Bit 5 0 &C0 is selected</p> <p> 1* &C1 is selected</p> <p>Bit 6 0* &S0 is selected</p> <p> 1 &S1 is selected</p> <p>Bit 7 0* Y0 is selected</p> <p> 1 Y1 is selected</p>
S22	118	<p>Bit-Mapped Options: S22 is a read-only register that indicates AT command settings.</p> <p>Bits 1–0 00 L0 is selected</p> <p> 01 L1 is selected</p> <p> 10* L2 is selected</p> <p> 11 L3 is selected</p> <p>Bits 3–2 00 M0 is selected</p> <p> 01* M1 is selected</p> <p> 10 M2 is selected</p> <p> 11 M3 is selected</p> <p>Bits 6–4 000 X0 is selected</p> <p> 001 Reserved</p> <p> 010 Reserved</p> <p> 011 Reserved</p> <p> 100 X1 is selected</p> <p> 101 X2 is selected</p> <p> 110 X3 is selected</p> <p> 111* X4 is selected</p> <p>Bit 7 0* &P0 is selected</p> <p> 1 &P1 is selected</p>
S25	5	<p>Detect DTR Change: S25 defines the minimum amount of time that DTR has to remain off (that is, on-to-off-to-on transitions) before the modem performs the function specified by &Dn command. A change in DTR that persists for a shorter time than the value specified in S25 is ignored by the modem (see the &Dn command).</p> <p>Range: 0–255 (1/100 of a second)</p>
S30	0	<p>Disconnect Inactivity Timer: This S-register sets the length of time (in minutes) that the modem stays online/off-hook before disconnecting when no data is being transmitted or received. In data and fax modes, any data transmitted or received between the DTE-DCE interface resets the timer. In all other modes (except Telephone-Emulation mode), any data transmitted resets the timer. In Telephone-Emulation mode, S30 is ignored (that is, the modem does <i>not</i> automatically hang up the line after a given time delay).</p> <p>Range: 0–255 minutes</p> <p>0 Disabled</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Table 26. S-Register Command Descriptions (Continued)

Command	Default	Description
S33	10	<p>Sleep Mode Timer: S33 determines when the modem enters sleep or power-down mode. When enabled (S33 \neq 0), the controller enters sleep mode whenever the modem has been inactive for a user-programmable time delay (S33). The modem is considered to be in an inactive state when:</p> <ul style="list-style-type: none"> • No internal processing is being performed; • No activity occurs between the host and the modem within a specified time period; • The modem is off-line. <p>The modem exits sleep mode whenever the host reads or writes to the modem or when a ring signal is detected.</p> <p>Sleep mode is disabled by setting S33 to '0'.</p> <p>Range: 0–90 seconds</p>
NOTE: An asterisk (*) denotes the factory-default setting.		

Caller ID

8

This section describes Caller ID for the United States. Caller ID is a service that lets the called party know the telephone number of the caller before the call is answered. The information transmitted to the called party via Caller ID includes the caller's name, call date, the call time, and the call number. This service is not available everywhere due to central office telephone equipment limitations and legal prohibition in some locations.

The **+VCID = n** command controls the reporting and presentation of data associated with the Caller ID services in United States and Canada in the ICLID (incoming call line ID) data format. The ICLID data comes in one of two formats: SDM (single data message) format or MDM (multiple data message) format. In both formats, data is provided as data items and packet control information.

When enabled, the DCE reports any Caller ID information detected after the first ring message (note that more <CR> <LF> combinations may occur after the RING result code). All data items are reported using the <tag> <=> <value> pair format. Spaces are present on both sides of the equal sign.

This chipset allows for two types of Caller ID reporting formats, formatted and unformatted. In formatted reporting, DCE does not report any Caller ID information if a check sum error is detected in the Caller ID packet. If the DCE receives multiple copies of the Caller ID packets, the DCE sends only one of the correct packets to the DTE. If the DCE has never presented a correct packet but has received the line seizure information at least once, the DCE returns <MSG> <=> <CALID_202>.

The DCE breaks up the presentation of the date and time into two separate <Tag><Value> pairs for those data items where the date and time appear together.

Table 27. Caller ID Tags for Formatted Reporting

Tag	Description
DATE	DATE = MMDD where MM is the month number, 01 through 12, and DD is the day number, 01 through 31. All numbers are in ASCII decimal. For numbers less than 10, a filling ASCII zero is used.
TIME	TIME = HHMM where HH is the hour number, 00 through 23, and MM is the minute number, 00 through 59. All numbers are in ASCII decimal format. For numbers less than 10, a filling ASCII zero is used.
NMBR	NMBR = <number> or P or O (ASCII 4Fh) where <number> is the telephone number of the caller, where P indicates that the calling number information is not available since the originating caller has requested private service, and where O indicates that the calling number information is not available since the out of area code or the service is unavailable.
NAME	NAME = <listing name> where <listing name> is the subscription listing name.
MSG	MSG = <data tag> <length of message> <data> <checksum> in printable ASCII (to avoid possible problems with binary output numbers).

If a data tag is unrecognizable, the DCE presents the given data item's information using the MSG tag. The DCE follows the conventions of the unformatted reporting form (defined below) where applicable for the given data item only.

Example 1: The following example of formatted form report (**AT+VCID=1**) illustrates the case when the DCE does not recognize the tag of one given data item from a packet of data items (data or fax command mode).

```
RING
DATE = 0321
TIME = 1405
NMBR = 5045551234
NAME = DOE JOHN
MSG = 060342424231
RING
RING
```

Example 2: The following example illustrates the unsolicited response (**AT+VCID=1**) form of voice mode (voice, command, playback, and record modes).

```
<DLE> R
<DLE> X
DATE = 0321
TIME = 1405
NMBR = 5045551234
NAME = DOE JOHN
MSG = 060342424231
<DLE> .
<DLE> R
<DLE> R
```

Example 3: The following example of formatted form reporting illustrates the case when the DCE does not recognize the tag of the packet (data or fax command mode).

```
RING
MSG = 060342424231
RING
RING
```

For unformatted form reporting (**AT+VCID=2**), the DCE presents all information contained in the Caller ID packet as ASCII hex in printable characters. This information includes all message type information, message length, data and checksum.

Example 4: The following example illustrates unformatted form reporting (data or fax command mode).

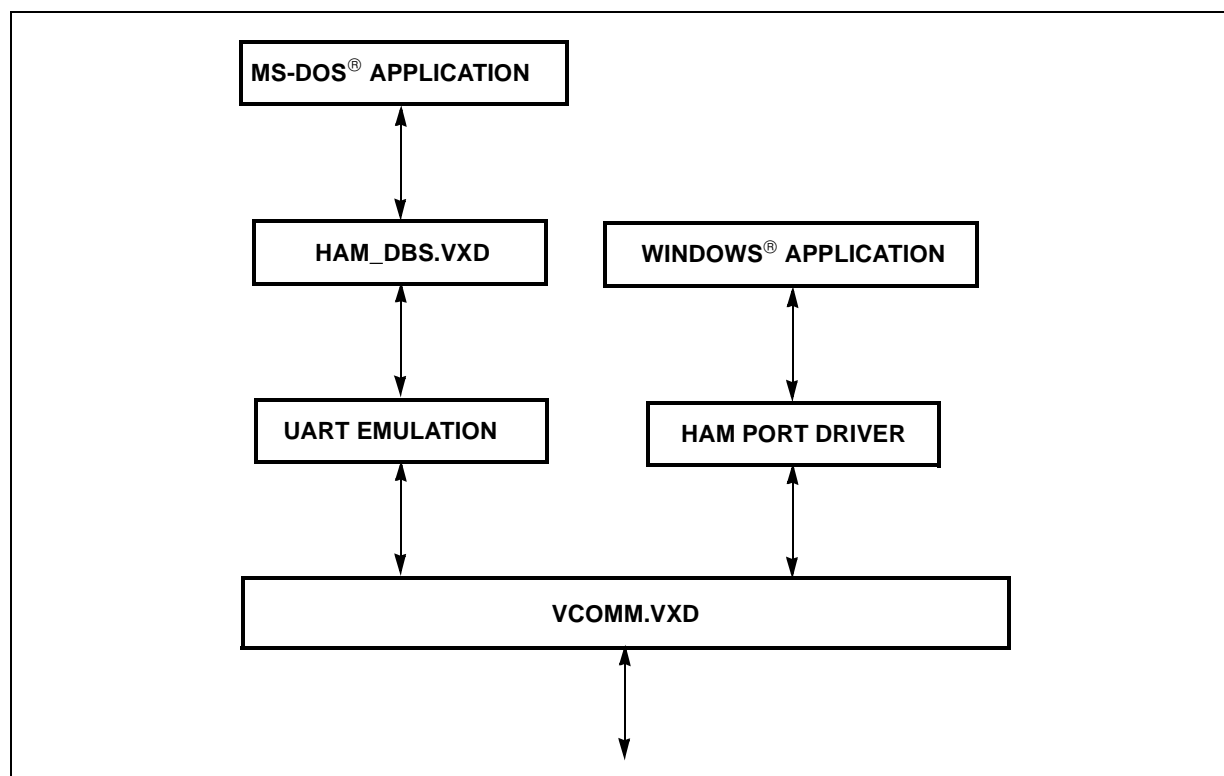
```
RING
MSG = 04123033323131334303539313435353132333435
RING
RING
```

Parallel Host Interface 16C450/16C550A UART 9

9.1 UART Emulation in the Controllerless Modem

When controllerless modems are used with Windows applications, the communication driver architecture eliminates the need for a UART emulation (see [Section 1.1, “Controllerless Modem Driver Overview” on page 7](#)). However, MS-DOS applications used with controllerless modems retain the need for a UART emulation. Therefore, Intel provides the HAM_DBS.VXD driver, which includes this UART emulation and also interacts directly with the Windows VCOMM.VxD driver (see [Figure 11](#)).

Figure 11. UART Emulation in CLM_DBS.VxD

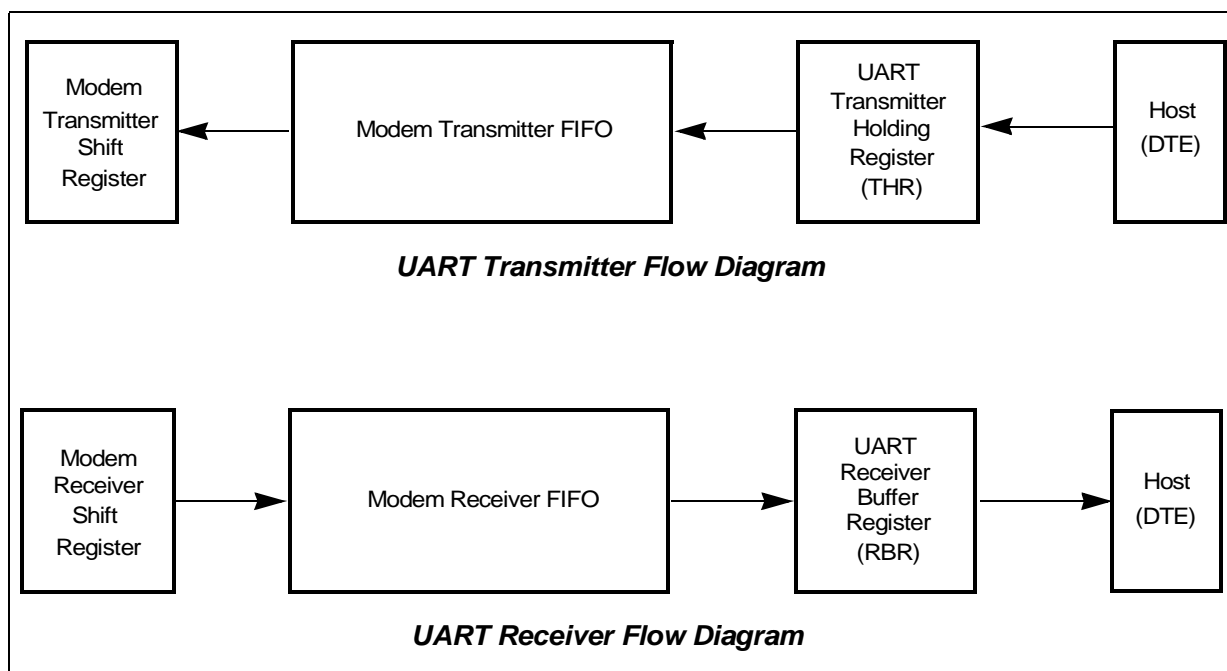


The parallel host interface of the FastPath family emulate the electrical and register functions of a 16550A and 16C450 UART. Upon modem reset, the modem defaults to a 16C450. The host (DTE) can then configure the UART to function as a 16C550A UART.

In 16C450 emulation mode, the DTE and modem transfer data back and forth a byte at a time. In 16C550A emulation mode, the modem provides two 16-byte FIFO buffers, one for the transmitter and another for the receiver. Thus, up to 16 bytes of data may be sent to or received from the

modem for each data interrupt, instead of only a single byte, as in 16C450 mode. The following diagram shows how the FIFO is used. Host software using this FIFO capability can significantly reduce system overhead by reducing the number of times that interrupt service routines are called.

Figure 12. FIFO Buffers for Transmitter and Receiver



The register addresses are divided into two types: single-register access and multiple-register access. Most of the UART registers are single-register access (that is, only one internal register is accessible for a given register address). UART register addresses 3–7 are used to access a single internal register. The remainder of the UART register addresses (0–2) are used to access two or more internal registers.

Register address 2 is used to write FIFO control information into the FCR (FIFO Control register) and to read the IIR (Interrupt Identity register).

Register address 1 is used to read and write data to the IER (Interrupt Enable register) [when DLAB = 0] and the MS DLM (Divisor Latch register) [when DLAB = 1].

Register address 0 is used to read data from the RBR (Receiver Buffer register) [when DLAB = 0], write data to the THR (Transmitter Holding register) [when DLAB = 0], and read and write to the LS DLL (Divisor Latch register) [when DLAB = 1]. The UART registers and FIFO usage are described in the following sections.

Figure 13. Parallel Host Interface UART Register Bit Assignments

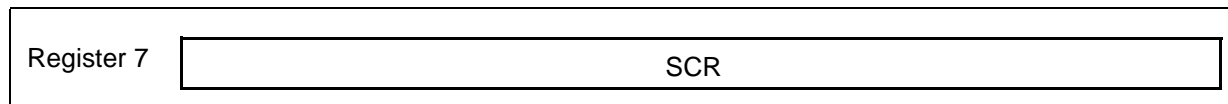
REGISTER ADDRESS	REGISTER NAME	BIT NUMBER							
		7	6	5	4	3	2	1	0
7	Scratch register (SCR)	Scratch register (SCR)							
6	Modem Status register (MSR)	Data Carrier Detect (DCD)	Ring Indicator (RI)	Data Set Ready (DSR)	Clear to Send (CTS)	Delta Data Carrier Detect (DDCDD)	Trailing Edge of Ring Indicator (TERI)	Delta Data Set Ready (DDSR)	Delta Clear to Send (DCTS)
5	Line Status register (LSR)	Error in RCVR FIFO (Note 1)	Transmitter Empty (TEMT)	Transmitter Holding register Empty (THRE)	Break Interrupt (BI)	Framing Error (FE)	Parity Error (PE)	Overrun Error (OE)	Data Ready (DR)
4	Modem Control register (MCR)	0	0	0	Loop	Out 2	Out 1	Request to Send (RTS)	Data Terminal Ready (DTR)
3	Line Control register (LCR)	Divisor Latch Access bit (DLAB)	Set Break (SBRK)	Stick Parity (SPAR)	Even Parity Select (EPS)	Parity Enable (PEN)	Number of Stop bits (STB)	Word Length Select bit 1 (WLS1)	Word Length Select bit 0 (WLS0)
2	FIFO Control register [write only] (FCR)	RCVR Trigger (MSB)	RCVR Trigger (LSB)	Reserved	Reserved	Reserved	XMIT FIFO Reset (XFIFOR)	RCVR FIFO Reset (RFIFOR)	FIFO Enable (FIFOE)
2	Interrupt Identity register [read only] (IIR)	FIFOs Enabled (Note 1)	FIFOs Enabled (Note 1)	0	0	Interrupt ID bit 2 (Note 1)	Interrupt ID bit 1	Interrupt ID bit 0	'0' if Interrupt pending
1 DLAB=0	Interrupt Enable register (IER)	0	0	0	0	Modem Status Interrupt Enable (MSIE)	Receiver Line Status Interrupt Enable (RLSIE)	Transmitter Holding Reg. Empty Int. Enable (THREIE)	Received Data Available Int. Enable (RDAIE)
0 DLAB=0	Transmit Holding register [write only] (THR)	Transmit Holding register (THR) [Write only]							
0 DLAB=0	Receiver Buffer register [read only] (RBR)	Receiver Buffer register (RBR) [Read only]							
1 DLAB=1	Divisor Latch (MS) (DLM)	MS Divisor Latch (DLM)							
0 DLAB=1	Divisor Latch (LS) (DLL)	LS Divisor Latch (DLL)							

NOTE: These bits are always '0' in 16C450 mode.

9.2 UART Register Definitions

9.2.1 Scratch Register (SCR)

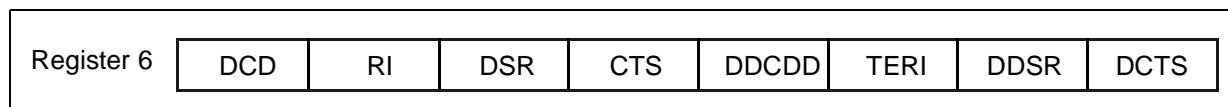
Figure 14. Scratch Register (SCR)



This is an 8-bit read/write register used by the DTE for temporary storage of data.

9.2.2 Modem Status Register (MSR)

Figure 15. Modem Status Register (MSR)



This register provides four bits (bits 7:4) that show current modem state and four bits (bits 3:0) that provide modem change information. Bits 3:0 are set to '1' whenever the control information changes state. These bits are reset to '0' whenever the DTE reads the MSR register. If the modem status interrupt is enabled (IER3), the modem generates an interrupt on the μ P HINT pin whenever MSR bits 3:0 are set to '1.'

Bit 7	Data Carrier Detect (DCD) —When this bit is set to '1', it indicates that the remote modem data carrier has been detected (refer to the &C command).
Bit 6	Ring Indicate (RI) —This bit indicates when a ring signal has been detected.
Bit 5	Data Set Ready (DSR) —This bit indicates when the modem is ready to establish a communication link. When entering voice mode, DSR is set to 1. DSR is used for voice playback/record DMA mode to indicate when the DTE has not responded to a modem DMA data transfer request. DSR is set to 1 when DMA data are being transferred; DSR is set to 0 when a new DMA transfer has not occurred with 1.7 ms after the previous DMA transfer. DSR works similarly to a DMA terminal count.
Bit 4	Clear To Send (CTS) —When this bit is set to '1', it indicates to the DTE that the modem is ready to receive data.
Bit 3	Delta Data Carrier Detect (DDCDD) —When this bit is set to '1', it indicates that the DCD bit has changed its value since the DTE last read the MSR register.
Bit 2	Trailing Edge of Ring Indicator (TERI) —This bit is set to '1' after the RI signal goes from a high to low state.
Bit 1	Delta Data Set Ready (DDSR) —When this bit is set to '1', it indicates that the DSR bit has changed its value since the DTE last read the MSR register.
Bit 0	Delta Clear to Send (DCTS) —When this bit is set to '1', it indicates that the CTS bit has changed its value since the DTE last read the MSR register.

9.2.3 Line Status Register (LSR)

Figure 16. Line Status Register (LSR)

Register 5	RCVR Err	TEMT	THRE	BI	FE	PE	OE	DR
------------	----------	------	------	----	----	----	----	----

This read-only register provides UART status information to the host. Bits 4:1 report error conditions. These bits are reset to '0' any time the host reads this register. An interrupt is generated to the host whenever any one of the bits (4:1) is set to '1' and the RLSIE (receiver line status interrupt) has been enabled. Bits 0, 5, and 6 provide status information for sending and receiving data through the THR (Transmit Holding register) and the RBR (Receiver Buffer register). Bits 0, 5, 6 are reset to '1' only when the host performs a specified action.

In FIFO mode, the modem keeps track of the character in which an error has occurred and does not report the error to the DTE until the associated character gets to the top of the stack.

Note: In FIFO mode, the DTE must write a data byte in the RX FIFO by the loopback mode to write to LSR2–LSR4. LSR0 and LSR7 cannot be written to in FIFO mode.

Bit 7	Error in RCVR FIFO —In 16C450 emulation mode, this bit is always a '0'. In FIFO mode, this bit is set to '1' by the DCE whenever at least one parity error, framing error, or break indication has occurred in the RCVR FIFO. This bit is cleared when the DTE reads the LSR register and there are no subsequent FIFO errors.
Bit 6	TEMT (Transmitter Empty) —This bit is set to '1' by the DCE whenever the THR (Transmit Holding register) and transmitter shift register are empty. This bit is automatically reset to '0' by the DCE whenever the host writes a byte to the THR. In FIFO mode, this bit is set to '1' whenever the transmitter FIFO and shift register are both empty.
Bit 5	THRE (Transmitter Holding Register Empty) —This bit is set to '1' whenever the THR (Transmit Holding register) is empty. This bit is set to '0' whenever the host writes data into the THR. Additionally, if the THREIE (Transmitter Holding Register Empty Interrupt Enable) is set to '1', the modem causes an interrupt to the host whenever THRE goes to '1'. In FIFO mode, this bit is set to '1' whenever the XMIT FIFO is empty. This bit is then reset to '0' when at least one byte is written to the XMIT FIFO.
Bit 4	BI (Break Interrupt) —This bit is set to '1' whenever the received data are spaces (logic 0) for at least $2M + 3$ bits (M = start bit + # of data character bits + parity bit + # of stop bits). This bit is reset to '0' whenever the host reads the LSR register. The modem waits for the valid start bit, before again transferring data to the FIFO. When a break occurs in FIFO mode, a single null character is placed in the RVCR FIFO. The BI bit is then set when the zero character gets to the top of the FIFO stack.
Bit 3	FE (Framing Error) —This bit is set to '1' whenever a valid stop bit (logic 1) has not been detected after the last data bit or parity bit. This bit is reset to '0' whenever the host reads the LSR register. The UART tries to re-synchronize after a framing error. In FIFO mode, the modem FE bit is set to '1' whenever the associated framing error character has reached the top of the stack.
Bit 2	PE (Parity Error) —This bit is set to '1' whenever the received data character does not have the correct even or odd parity, as selected by the EPS (even parity select) bit [LCR4] and the stick parity bit [LCR 5]. This bit is reset to '0' whenever the host reads the LSR register. In FIFO mode, the modem PE bit is set to '1' whenever the associated framing error character has reached the top of the stack.
Bit 1	OE (Overrun Error) —Not supported.
Bit 0	Data Ready —This bit is set to '1' whenever the modem writes a new received data character into the RBR (Receiver Buffer register) or FIFO. This bit is reset to '0' whenever the DTE reads the RBR or FIFO.

9.2.4 Modem Control Register (MCR)

Figure 17. Modem Control Register (MCR)

Register 4	0	0	0	Loop	Out 2	Out 1	RTS	DTR
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This register controls the DTE-DCE UART interface.

Bit 7:5	Not used —These bits are permanently set to '0'.
Bit 4	Loop Bit —When set to '1', this bit configures the UART for loopback diagnostic testing. In diagnostic mode, any data that is written to the THR (Transmit Holding register) is looped back to the RBR (Receiver Buffer register). After writing a data byte to the THR register in loopback mode, the DTE must read the RBR register before writing a new data byte to the THR. Unlike a real 16C450 UART, the modem signals OUT1*, OUT2*, RTS*, and DTR* are not looped back to the MSR register.
Bit 3	Out 2 —This bit, when set to '1' by the DTE, enables the HINT output pin. When set to '0', this bit causes the HINT pin to be in a high-impedance state.
Bit 2	Out 1 —This read/write bit is not used for any specific functions.
Bit 1	RTS (Request to Send) —This bit when set to '1', indicates that the DTE is ready to send data to the modem.
Bit 0	DTR (Data Terminal Ready) —When set to '1', this bit indicates that the DTE is read to establish a communication link.

9.2.5 Line Control Register (LCR)

Figure 18. Line Control Register (LCR)

Register 3	DLAB	SBRK	SPAR	EPS	PEN	STB	WLS1	WLS0
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This register specifies the asynchronous data communication exchange format. The modem supports up to 10-bit data characters (1 start bit + # of data character bits + parity + # of stop bits).

Bit 7	Divisor Latch Access Bit (DLAB) —This bit must be set to '1' to access the divisor latches of the baud rate generator during a read or write operation. The UART registers 1 and 0 are used for the divisor latches. This bit must be set to '0' to access the Receiver Buffer register (RBR), the THR (Transmitter Holding register) or the IER (Interrupt Enable register).
Bit 6	SBRK (Set Break) —This bit is used to send a long-space disconnect message to the remote modem. The procedure is as follows: <ul style="list-style-type: none"> After the THRE bit has been set to '1' by the DCE and before setting the SBRK bit, the DTE needs to write a NULL (\$00h) character to the THR. The DTE then sets the SBRK bit after the next time the THRE bit is set by the DCE (a long space is now being transmitted). To return to normal transmission mode, wait for the TEMT to be equal to '1', then reset the SBRK bit.
Bit 5	SPAR (Stick Parity) —When this bit is set to '1', stick parity is enabled. When configured for stick parity (SPAR = 1), even parity (EPS = 1) with parity enable (PEN = 1), then the parity bit is transmitted and checked as a logic '0'. When configured for stick parity (SPAR = 1), odd parity (EPS = 0) and parity enable (PEN = 1) are set to '1', then the parity bit is transmitted and checked as a logic '1'.

Bit 4	EPS (Even Parity Select) —When even parity select (LCR4) and parity enable (LCR3) are set to '1', an even number of logic 1's are transmitted or checked. When even parity select (LCR4) is a '0' and parity enable (LCR3) is a '1', an odd number of logic 1's are transmitted or checked.		
Bit 3	PEN (Parity Enable) —When this bit is set to '1', a parity bit is generated (transmitted data) or checked (receive data) between the last data character word bit and stop bit of the serial data. NOTE: The parity bit is used to produce an even or odd number of 1's when the data word bits and the parity bits are summed.		
Bit 2	Number of Stop Bits (STB) —This bit specifies the number of stop bits transmitted and received in each serial character. When STB is set to '0', one stop bit is generated for each transmitted data character. When STB is set to '1' and the word length (WLS1 and WLS0) is equal to 6, 7, or 8 bits, then two stop bits are generated for each transmitted data character. When STB is set to '1' and the word length (WLS1 and WLS0) is equal to 5 bits, then one and a half stop bits are generated for each transmitted data character. The receiver only checks for the first stop bit, regardless of the number of stops bits transmitted.		
Bits 1:0	Word Length Select Bits (WLS1 and WLS0) —These two bits specify the data character word length of the transmitted and received data. The supported word lengths are provided below.		
	Bit 1	Bit 0	Word Length
	0	0	5 bits
	0	1	6 bits
	1	0	7 bits
	1	1	8 bits

9.2.6 FIFO Control Register (FCR)

Figure 19. FIFO Control Register (FCR)

Register 2 (write-only)	RCVR Trig.	RCVR Trig.	Reserved	Reserved	DMA	XFIFOR	RFIFOR	FIFOE
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This write-only register is used to enable the receiver and transmitter FIFOs, clear the FIFOs, set the RCVR FIFO trigger level, and select the DMA signaling type.

MSB and LSB (RCVR Trigger Bits) —FCR bits 7 and 6 are used to set the trigger level for the RCVR FIFO interrupt.			
Bits 7:6	Bit 7	Bit 6	RCVR FIFO Trigger Level (Bytes)
	0	0	01
	0	1	04
	1	0	08
	1	1	14
Bits 5:3	Reserved —Bits 5, 4, and 3 are reserved for future enhancements.		
Bit 2	XFIFOR (XMIT FIFO Reset) —When set to '1', this bit clears all the bytes in the XMIT FIFO and resets the internal counter logic to '0'. The internal shift register is not cleared by the XFIFOR bit. This bit is automatically cleared by the modem.		
Bit 1	RFIFOR (RCVR FIFO Reset) —When set to '1', this bit clears all the bytes in the RCVR FIFO and resets the internal counter logic to '0'. The internal shift register is not cleared by the RFIFOR bit. This bit is automatically cleared by the modem.		
Bit 0	FIFOE (FIFO Enable) —This bit when set to '1', enables both the XMIT and RCVR FIFOs. This bit must be a '1' whenever writing to any other FIFO bit. If FIFO is not set to '1', then the DTE can not program any of the FIFO functions.		

9.2.7 Interrupt Identity Register (IIR)

Figure 20. Interrupt Identity Register (IIR)

Register 2 (read-only)	FIFO EN	FIFO EN	0	VDMA	Int. ID 2	Int. ID 1	Int. ID 0	Int. Pen.
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This read-only register indicates when the transmitter and receiver FIFOs are enabled, and the source of highest-priority pending interrupt to the DTE. Five levels of modem interrupt sources in order of priority are: receiver line status, received data ready, character time-out indication, transmitter holding register empty, and modem status. When the DTE reads the IIR, the modem freezes all interrupts and indicates the highest-priority pending interrupt. While the DTE is reading the IIR register, the modem records new interrupts but does not change its current indication until the read process is completed.

Table 28. Interrupt Control Functions

FIFO Mode Only	Interrupt Identification Register			Interrupt Source and Reset Functions			
Bit 3 ID 2	Bit 2 ID1	Bit 1 ID0	Bit 0 Int. Pend.	Priority Level	Interrupt Type	Interrupt Source	Interrupt Reset Control
0	0	0	1	—	None	None	—
0	1	1	0	Highest	Receiver Line Status	Overrun Error, Parity Error, Framing Error or Break Interrupt	Reading the LSR (Line Status register)
0	1	0	0	Second	Received Data Available	Receiver Data Available or Trigger Level Reached	Reading the RBR (Receiver Buffer register) or the FIFO Drops below the Trigger Level
1	1	0	0	Second	Character Time-out Indication	No characters have been removed from or entered into the RCVR FIFO during the last four character times, and there is at least one character in it during this time	Reading the RBR (Receiver Buffer register)
0	0	1	0	Third	Transmitter Holding Register Empty	Transmitter Holding Register Empty	Reading the IIR register (if the source of interrupt) or writing into the Transmitter Holding register
0	0	0	0	Fourth	Modem Status	Clear to Send, Data Set Ready, Ring Indicator, or Data Carrier Detect	Reading the MSR (Modem Status register)

Bits 7:6	FIFOs Enable Bits —These two bits are set whenever FCR0 = 1.
Bits 5	Not used —This bit is permanently set to '0'.
Bit 4	Reserved

Bit 3	Interrupt ID Bit 2 —In 16C450 mode, this bit is always a '0'. In FIFO mode, both this bit and bit IIR2 are set whenever a time-out interrupt is pending.
Bits 2:1	Interrupt ID Bits ID0 and ID1 —These two bits are used to identify the highest-priority interrupt as shown in Table 28 .
Bit 0	Interrupt Pending —This bit indicates when a modem interrupt is pending. Whenever this bit is equal to '0', then one or more interrupts are pending. Whenever this bit is equal to '1', then no interrupts are pending. When an interrupt has occurred, the host can determine the cause of the interrupt by looking at the IIR interrupt ID bits 0 and 1 (and interrupt ID bit 2 for FIFO mode).

9.2.8 Interrupt Enable Register (IER)

Figure 21. Interrupt Enable Register (IER)

Register 1 (DLAB = 0)	0	0	0	0	MSIE	RLSIE	THREIE	RDAIE
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This register is used to enable up to five types of UART interrupts: receiver line status, received data available, character time-out indication (FIFO mode only), Transmitter Holding register empty, and modem status. Each enabled interrupt can individually cause an interrupt to host on the μ P HINT output pin. To cause an interrupt to the host (HINT), both the interrupt enable bit and OUT2 (MCR2) must be set to '1'.

Bits 7:4	Not used —These bits are permanently set to '0'.
Bit 3	MSIE (Modem Status Interrupt Enabled) —when set to '1', this bit enables the modem status interrupt.
Bit 2	RLSIE (Receiver Line Status Interrupt Enabled) —when set to '1', this bit enables the receiver line status interrupt.
Bit 1	THREIE (Transmitter Holding Register Empty Interrupt Enabled) —when set to '1', this bit enables the Transmitter Holding register empty interrupt.
Bit 0	RDAIE (Received Data Available Interrupt Enabled) —when set to '1', this bit enables the received data available interrupt.

9.2.9 Transmitter Holding Register (THR)

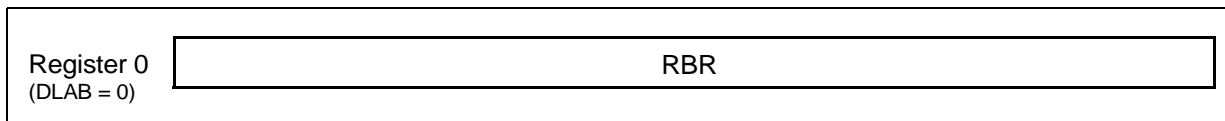
Figure 22. Transmitter Holding Register (THR)

Register 0 (DLAB = 0)	THR
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The THR (Transmitter Holding register) is a write-only register used for sending data and AT commands to the modem.

9.2.10 Receiver Buffer Register (RBR)

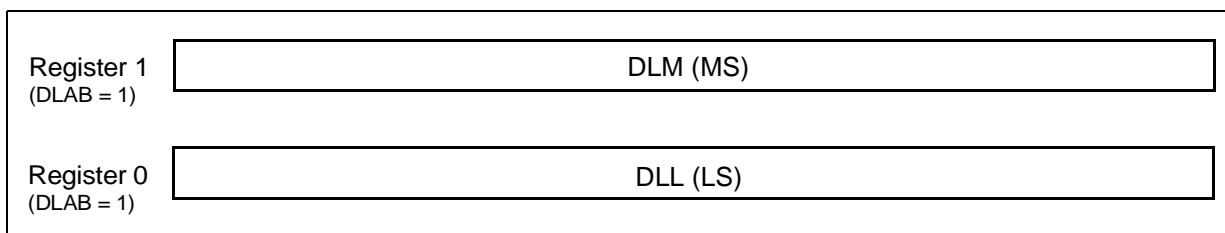
Figure 23. Receiver Buffer Register (RBR)



The RBR (Receiver Buffer register) is a read-only register used for receiving data and AT command responses from the modem.

9.2.11 Divisor Latch Registers (DLM and DLL)

Figure 24. Divisor Latch Registers (DLM and DLL)



The LS divisor latch (least-significant byte) and MS divisor latch (most-significant byte) are two read/write registers used to set the modem data rate. The data rate is selected by loading each divisor latch with the appropriate hex value. The programmable data rates are provided in the following table. For example, to use a data rate of 2400 bps, load a \$00h into the DLM and a \$30h into the DLL.

Table 29. Programmable Data Rates

Data Rate	Divisor Number (Decimal)	Divisor Latch (Hex)	
		MS	LS
300	384	01	80
1200	96	00	60
2400	48	00	30
4800	24	00	18
7200	16	00	10
9600	12	00	0C
19200	6	00	06
38400	3	00	03
57600	2	00	02

9.3 16C550A UART FIFO Operation

The modem 16C550A UART FIFO works in both interrupt and polled operation. A description of each type of operation is provided below.

9.3.1 FIFO Interrupt Mode Operation

Both the modem receiver and transmitter UART FIFOs can be set up for interrupt mode operation. The RCVR FIFO trigger level and character time-out interrupts have the same priority as the current received data available interrupt. The XMIT FIFO empty interrupt has the same priority as the Transmitter Holding register empty interrupt. Information pertaining to using the receiver and transmitter FIFO interrupts is provided below.

1. When both the receiver FIFO and the receiver interrupts are enabled ($FCR0 = 1$, $IER0 = 1$), the UART initiates RCVR interrupts under the following conditions:
 - a. The receive data available interrupt ($IIR = 04$) is issued to the DTE when the FIFO has reached its programmed trigger level; the interrupt clears as soon as the FIFO drops below the programmed trigger level
 - b. The data ready bit, DR ($LSR0$), is set as soon as a character is transferred from the Internal Shift register to the RCVR FIFO. DR is reset when the FIFO is empty.
2. When the RCVR FIFO and receiver interrupts are enabled, the UART initiates a RCVR FIFO time-out interrupt under the following conditions:
 - a. A RCVR FIFO time-out occurs when:
 - At least one character is in the FIFO.
 - The most recent serial character received was longer than four continuous character times ago.
 - The most recent DTE read of the FIFO was longer than four continuous character times ago.
 - b. When a time-out interrupt has occurred, then it is cleared and the timer is reset when the DTE reads one character from the RCVR FIFO.
 - c. The time-out timer is reset after a new character is received or after the DTE reads the RCVR FIFO.
3. When the transmitter FIFO and the transmitter interrupt are enabled ($FCR0 = 1$, $IER1 = 1$), the UART initiates XMIT interrupts under the following conditions:
 - a. The Transmitter Holding register interrupt ($IIR = 02$) occurs when the XMIT FIFO is empty; it is cleared as soon as the transmitter holding register is written to or the IIR is read. During servicing, the 1–16 character interrupt can be written to the XMIT FIFO.

9.3.2 FIFO Polled Mode Operation

Both the modem receiver and transmitter UART FIFOs can be set up for polled mode operation. The UART FIFO is set for polled mode when $FIFOE$ ($FCR0$) = 1 and the respective interrupt enable bit (IER) = 0.

In polling mode, the DTE checks the LSR for receiver and/or transmitter status. The LSR register provides the following information:

- LSR7 indicates when any errors occur in the RCVR FIFO.
- TEMT indicates when both the XMIT FIFO and Shift registers are empty.
- The THRE bit (LSR5) is set to '1' whenever the XMIT FIFO is empty.
- LSR1 through LSR4 specify when a break interrupt, framing error, parity error, or overrun error occurs.
- The DR bit (LSR0) is set to '1' as long as there is at least one byte in the RCVR FIFO.

Unlike FIFO interrupt mode, FIFO polled mode does not support buffer trigger levels or time-out conditions.

