



# **Programmer's Guide**

**MD566X**

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*July 2001*



## Revision History

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Date	Revision
May 2001	Revise layout.
July 2001	Update for V.92

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## CONVENTIONS

This section lists conventions used in this data book.

*Note:* S-registers and AT commands are in bold typeface throughout this document.

### Abbreviations

Symbol	Units of measure
°C	degree Celsius
μF	microfarad
μs	microsecond (1,000 nanoseconds)
Hz	hertz (cycle per second)
K (memory)	kilobit (1,024 bits)
kbits/second	kilobit (1,000 bits) per second
kHz	kilohertz
kΩ	kilohm
Mbyte (memory)	megabyte (1,048,576 bytes)
MHz	megahertz (1,000 kilohertz)
mA	milliampere
ms	millisecond (1,000 microseconds)
ns	nanosecond
pV	picovolt
V	volt
W	watt

### Acronyms

Acronym	Definition
AC	alternating current
AT	'Attention' command prefix for Hayes AT <sup>®</sup> command set (for example, 'ATDT 123')
CMOS	complementary metal-oxide semiconductor
DC	direct current
DAA	data access arrangement

**Acronyms**

<b>Acronym</b>	<b>Definition (Continued)</b>
DRAM	dynamic random-access memory
EPROM	electrically programmable read-only memory
FIFO	first in/first out
HDLC	high-level data link control
ISA	industry standard architecture
LSB	least-significant bit
MSB	most-significant bit
NVRAM	non-volatile random-access memory
PPP	point-to-point protocol
RAM	random-access memory
ROM	read-only memory
R/W	read/write
SDLC	synchronous data link control
SQFP	shrink quad flat pack
SRAM	static random-access memory
TTL	transistor-transistor logic
UART	universal asynchronous receiver transmitter
VQFP	very-tight-pitch quad flat pack

## 1. INTRODUCTION

The *MD566X Programmer's Guide* describes the software interface of Intel's V.90/V.92 56K solution. The programmer's guide includes the AT command sets for data, fax, and voice and the 16C450/16C550A UART emulation. The programmer's guide should be used with the following Intel publications: the *MD566X Datasheet*, the *IS-101 Voice Application Note*, and the *Class 1 Fax Application Note*. Please note that supported AT commands are firmware revision-dependent.

**IMPORTANT:** The AT commands in this document are supported by firmware versions 6.06 and above for V.90 and 7.XX for V.92.

Like the earlier solutions from Intel, the V.90/V.92 56K family of products supports a variety of applications without the need of additional firmware development. The MD566X solutions described in Table 1-1 are currently available except as noted.

**Table 1-1. Intel® V.90/V.92 56K Chipsets**

Chipset	Contents (Qty)	Notes
MD5660AM-S101	MD4450C-SC-B (1) MD5660T-M-A (1) MD1724-11VC-B (1)	Data, Fax, Voice Parallel/Serial (RS232) interfaces
MD5661AM-V101	MD4451C-VC-B (1) MD5661DT-L-A (1) MD1724-11VC-B (1)	Data, Fax, Voice PCMCIA interface
MD5662AM-S101	MD4450C-SC-B (1) MD5660DT-M-A (1) MD1724-11VC-B (2)	Data, Fax, Voice, Speakerphone Parallel/Serial (RS232) interfaces
MD5663AM-V101	MD4450C-SC-B (1) MD5661DT-L-A (1) MD1724-11VC-B (1)	Data, Fax, Voice
MD5664GL-V101	MD4452C-VC-B (1) MD5661DT-L-A (1) S13014 (1) S13021 (1)	CompactFlash Data, Fax
MD5664US-V101	MD4452C-VC-B (1) MD5661DT-L-A (1) S13012 (1) S13021 (1)	CompactFlash Data, Fax

## 1.1 V.92, V.90 and V.34 Data Modes

Intel® MD566X chipsets default to the ITU-T V.90 or V.92 data transmission mode depending on the firmware version. The V.90/V.92 mode allows receive data rates of up to 56 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 the V.34 mode in both the transmit and receive directions.

## 1.2 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 MD566X's AT command set and S-registers are divided into the following modes: Group 3 fax, data, V.42/MNP, voice. See Chapter 2 on page 8 for command table summaries.

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 for V.90 mode are provided in Table 2-10 on page 21 and V.34 response codes are included in Table 2-11 on page 22.

Examples of modem responses:

```
OK
ERROR
CONNECT 28800
0
```

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 1-2) or modem-to-modem (Table 1-3).

**Table 1-2. 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 1-3. 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
Data (V.90) transmit	4800–33,600	
Data (V.90) receive (ISP connections only)	28,800–56,000	
Data (V.92) transmit	24,000–48,000	
Data (V.92) receive (ISP connections only)	28,800–56,000	
Fax	2400–14,400	Not applicable
Voice	Not applicable	

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.

## 2. AT COMMAND SUMMARY TABLES

This section contains summary tables of all AT commands, S-registers, and manufacturing-only commands. These commands are described fully in the relevant sections of the Programmer's Guide.

**Table 2-1. Data Mode Command Summary**

Note	Command	Function	Default	Range	Reported by &Vn
**	A/	Repeat last command	none	–	no
	A	Answer	none	–	no
*	Bn	Select ITU-T or Bell*	1	0–3	yes
	B0	Selects ITU-T V.22 at 1200 bps and ITU-T V.21 at 300 bps			
	B1	Selects Bell 212A at 1200 bps and Bell 103J at 300 bps			
	B2	Selects ITU-T V.23 only. The originating modem transmits at 75 bps (and receives at 1200 bps); the answering modem receives at 75 bps (and transmits at 1200 bps)			
	B3	Selects ITU-T V.23 only. The originating modem transmits at 1200 bps (and receives at 75 bps); the answering modem receives at 1200 bps (and transmits at 75 bps)			
	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			
	Fn	Online echo	1	0, 1	no
	F0	Enables online echo			
	F1	Disables online 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	0–8, 10, 11, 14, 20–23	no
	I0	Reports product code			
	I1	Reports modem chip firmware version			
	I2	Verifies ROM checksum			
	I3	Reports chipset name			



**Table 2-1. Data Mode Command Summary (Continued)**

Note	Command	Function	Default	Range	Reported by &Vn
	I4	Reserved			
	I5	Reserved for modem chip hardware configuration			
	I6	Country code			
	I7	Version of board manufacturer firmware			
	I8	Modem firmware features			
	I10	Modem board configuration — bits set by board manufacturer			
	I11	Modem board configuration — bits set by board manufacturer			
	I12	Reserved			
	I13	Reserved			
	I14	SAFE device			
	I20	Intel silicon version			
	I21	Intel firmware version			
	I22	Intel manufacturer name			
	I23	Intel product model			
*	Ln	Speaker volume control	1	0–3	yes
	L0	Low speaker volume			
	L1	Low speaker volume			
	L2	Medium speaker volume			
	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			
*	Nn	Select data rate handshake	1	0, 1	yes
	N0	Handshake only at DTE-to-modem data rate			
	N1	Begins handshake at DTE-to-modem data rate and falls to highest compatible rate			
	On	Go online	0	0, 1	no
	O0	Returns modem to Data mode			
	O1	Retrains equalizer 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			

Table 2-1. Data Mode Command Summary (Continued)

Note	Command	Function	Default	Range	Reported by &Vn
	Q1	Disables result codes			
	Sn	Select an S-register	none	0–37	no
	Sn=x	Write to an S-register	none	n=0–37 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, 2–4	yes
	W0	Reports DTE speed response codes			
	W2	Reports DCE speed response codes			
	W3	Reports DTE speed response codes and information on error correction and data compression			
	W4	Reports protocol, data compression, and DTE data rate			
*	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

**Table 2-1. Data Mode Command Summary (Continued)**

Note	Command	Function	Default	Range	Reported by &Vn
	&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
	&K0	Disables flow control			
	&K3	Bidirectional hardware flow control			
	&K4	XON/XOFF software flow control			
*	&M0	Communication mode option — modem supports only Async mode	0	0	no
*	&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			
*	&Q0	Communication mode option — modem supports only Async mode	0	0	yes
*	&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			
	&T8	Initiates local analog loopback with self-test			
*	&Un	Disable Trellis coding	0	0, 1	yes
	&U0	Enables Trellis coding with QAM as fallback			
	&U1	QAM modulation only			
	&Vn	View active and stored profiles	0	0, 1	no
	&V0	View active profile and stored profile 0			
	&V1	View active profile and stored profile 1			

Table 2-1. Data Mode Command Summary (Continued)

Note	Command	Function	Default	Range	Reported by &Vn
	&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			
*	-Cn	Generate data mode calling tone	0	0–2	yes
	-C0	Calling tone disabled			
	-C1	1300-Hz calling tone enabled			
	-C2	V.8 calling tone and 1300-Hz calling tone			
	+GMI?	Identify modem manufacturer	none	–	no
	+GMM?	Identify product model	none	–	no
	+GMR?	Identify product revision	none	–	no
	+MS=m	Modulation selections	V90, 1, 0, 0	See note <sup>a</sup>	no
	+PCW=m	Call waiting enable	0	0, 1, 2	no
	+PMH=m	Modem on hold enable	0	0, 1	no
	+PMHT=m	Modem on hold timer	0	0 - 13	no
	+PMHR	Initiate modem on hold	none	0 - 13	no
	+PIG=m	PCM upstream ignore	0	0, 1	no
	+PMHF	V.92 modem on hold hook flash	none		no
	+PQC=m	V.92 phase 1 and phase 2 control	0	0, 1, 2, 3	no
	+PSS=m	Use short sequence	2	0, 1, 2	no

a. See the +MS=m description on Table 3-4 of the *MD566X Programmer's Guide* for a full command description of parameter ranges. For Data mode, the factory default setting is AT+MS=V90, 1, 0, 0 to send at speeds of 33,600 bps or below and receive at speeds of 53,333 bps and below.

\* Value saved in NVRAM. \*\*Command not preceded by an "AT".



Table 2-2. 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	Transmit break	none	0–9	no
*	\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	yes
	In connect state, transmits break to remote (if in Reliable mode):				
	\K0, 2, 4	Enters Command mode, no break sent			
	\K1	Destructive/expedited			
	\K3	Nondestructive/expedited			
	\K5	Nondestructive/nonexpedited			
	In command state, transmits break to remote (if in Reliable mode):				
	\K0, 1	Destructive/expedited			
	\K2, 3	Nondestructive/expedited			
	\K4, 5	Nondestructive/nonexpedited			
	In connect state, receives break at modem port (if in Direct mode):				
	\K0, 2, 4	Immediately sends break and enters command state			
	\K1, 3, 5	Immediately sends the break through			
	In connect state, receives break at modem port and sends to serial port:				
	\K0, 1	Destructive/expedited			

**Table 2-2. V.44 / V.42 / V.42 bis MNP\* Command Summary (Continued)**

Note	Command	Function	Default	Range	Reported by &Vn
	\K2, 3	Nondestructive/expedited			
	\K4, 5	Nondestructive/nonexpedited			
*	\Nn	Set operating mode	3	0–4	yes
	\N0, \N1	Selects Buffer (Normal) mode with speed buffering			
	\N2	Selects MNP Reliable mode			
	\N3	Selects V.42 Auto-reliable mode			
	\N4	Selects V.42 Reliable mode			
	\O	Originate reliable link	none	–	no
*	\Qn	Set serial port flow control	3	0–3	yes
	\Q0	Disables flow control			
	\Q1	XON/XOFF software flow control			
	\Q2	Unidirectional hardware flow control			
	\Q3	Bidirectional hardware flow control			
*	\T0	Disables inactivity timer	0	0–90	yes
	\U	Accept reliable link	none	–	no
*	\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			
	\Y	Switch to Reliable mode	none	–	no
	\Z	Switch to Normal mode	none	–	no
*	-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	yes
	+DS44=m	V.44 data compression	3,0,0, 471,942, 140,140, 1884, 3768	See note <sup>a</sup>	no

a. See the +DS44=m description in Table 3-4 for a full command description of parameter ranges.



\* Value saved in NVRAM.



**Table 2-3. 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
+FREv?	Identifies product version number	none	–	no

**Table 2-4. Fax Class 1 Command Summary**

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

**Table 2-5. IS-101 Voice Command Summary**

Command	Function	Default	Range	Reported by &Vn
+FCLASS=8	Voice mode selection	0	0, 1, 8	no
+FLO=n	Flow Control Select	1	0–2	no
+VBT=m	Buffer threshold setting	192, 320	192, 320	no
+VCID=n	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=n	Speakerphone microphone gain	128	121–131	no
+VGR=n	Receive gain selection	128	121–131	no
+VGS=n	Speakerphone speaker gain	128	121-131	no

**Table 2-5. IS-101 Voice Command Summary (Continued)**

+VGT=n	Volume selection	128	121–131	no
+VIP	Initialize parameter	–	–	no
+VIT=n	DTE/DCE inactivity timer	0	0–255	no
+VLS=n	Relay/speaker control	0	0–16	no
+VNH=n	Automatic hang-up control	0	0–2	no
+VRA=n	Ringback-goes-away timer	50	0–50	no
+VRN=n	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=n	Speakerphone on/off control	0	0, 1	no
#VSPS=n	Speakerphone type selection	1	0, 1	no
+VTD=n	Beep tone duration timer	100	5–255	no
+VTS=m	DTMF and tone generation	none	See note	no
+VTX	Play mode	none	–	no

**NOTE:** See the complete command description in the *MD566X Programmer's Guide* for range information.

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

**Table 2-6. 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
<DEL>	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 2-7. 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
<DEL>	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)
f	66	Data answer detected (2225 Hz)
R	52	Incoming ring
% '(,.)	25, 26, 27, 28, 29	Manufacturer-specified

**Table 2-8. 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
L	Redial last number

**Note:** The manufacturing-only S-registers **S91** and **S92** are listed in the Manufacturing-Only Commands in Table 2-13 on page 23.

\* Value saved in NVRAM.

**Table 2-9. 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
	S16	Modem test options	0	–	–	no
*	S18	Modem test timer	0	0–255	second	yes
*	S21	Bit-mapped options	48	–	–	no

**Table 2-9. S-Register Summary (Continued)**

Note	Register	Function	Default	Range	Units	Reported by &Vn
*	S22	Bit-mapped options	118	–	–	no
*	S23	Bit-mapped options	none	–	–	no
*	S25	Detect DTR change	5	0–255	0.01 second	yes
*	S27	Bit-mapped options	64	–	–	no
*	S30	Disconnect inactivity timer	0	0–255	minute	yes
*	S31	Bit-mapped options	49	–	–	no
*	S33	Sleep mode timer	10	0–90	second	yes
*	S37	Maximum line speed attempted	0	0–35	–	yes

**Note:** The manufacturing-only S-registers **S91** and **S92** are listed in the Manufacturing-Only Commands in Table 2-13 on page 23.

\* Value saved in NVRAM.

**Table 2-10. V.90/V.92 Mode DCE-to-ISP Response Codes**

Verbose Code	Numeric Code
CONNECT 33333	33
CONNECT 37333	34
CONNECT 41333	35
CONNECT 42667	36
CONNECT 44000	37
CONNECT 45333	38
CONNECT 46667	39
CONNECT 48000	42
CONNECT 49333	43
CONNECT 50667	53
CONNECT 52000	54
CONNECT 53333	55
CONNECT 54666	56
CONNECT 56000	57
CONNECT ( <i>DTE protocol</i> ) / <i>data compression</i> / TX:( <i>DCE transmit data rate</i> ) / RX:( <i>DCE receive data rate</i> )	See Note following Table 2-12 on page 23

**Table 2-11. V.34 Mode DCE-to-DCE Response Codes**

Verbose Code	Numeric Code
CONNECT 2400	10
CONNECT 4800	11
CONNECT 7200	24
CONNECT 9600	12
CONNECT 12000	25
CONNECT 14400	13
CONNECT 16800	59
CONNECT 19200	14
CONNECT 21600	61
CONNECT 24000	62
CONNECT 26400	63
CONNECT 28800	64
CONNECT 31200	65
CONNECT 33600	66
CONNECT ( <i>DTE protocol</i> ) / <i>data compression</i> / TX:( <i>DCE transmit data rate</i> ) / RX:( <i>DCE receive data rate</i> )	See Note following Table 2-12 on page 23

**Table 2-12. DTE-to-DCE Data Rate Response Codes**

Verbose Code	Numeric Code
OK	0
CONNECT	1
RING	2
NO CARRIER	3
ERROR	4
NO DIAL TONE	6
BUSY	7
NO ANSWER	8
CONNECT 1200	5
CONNECT 2400	10
CONNECT 4800	11
CONNECT 9600	12
CONNECT 19200	14
CONNECT 38400	28
CONNECT 57600	18
CONNECT 115200	31
CONNECT ( <i>DTE data rate</i> ) / ( <i>modulation</i> ) / ( <i>error correction</i> ) / ( <i>data compression</i> ) / TX:( <i>DCE transmit data rate</i> ) / RX:( <i>DCE receive data rate</i> )	See Note

**Note:** The **W3** AT command reports the special verbose code listed, which is used to evaluate the modem connection. The **W0–W2** AT commands report all other ‘CONNECT’ messages.

When the modem is configured for text responses using **V1**, the **W3** verbose response provides information about the DTE data rate, connection modulation, error correction protocol, data compression, and modem-to-modem data rate. When the modem is configured for **W3** and numeric responses using **V0**, the modem responds as if it were set up for **W0**.

**Table 2-13. Manufacturing-Only Command Summary <sup>a</sup>**

Note	Command	Function	Default	Range
*	*NCnn	Country Select	0	–
	!P=m	Set plug-and-play board serial number	none	0–255, 0–255, 0–255, 0–255
*	S91	Select transmit level (-dBm)	10	0–15
*	S92	DTMF transmit level (-dBm)	10	0–15
	#VGP0=n	Read/write to general-purpose pins 0–7	See note	–
	#VGP1=n	Read/write to general-purpose pins 8–15	See note	–
	#VGP2=n	Read/write to general-purpose pins 16–23	See note	–
	%TTnn	Tone test	00	–

a. These commands are meant to be used by the board manufacturer and not in generic applications software for end users.

\* Value saved in NVRAM.

**Note:** Default values for **#VGP0–2 =n** are dependent on board design.

### 3. BASIC DATA MODE AT COMMANDS

The 56K FastPath chipsets implement:

- Standard TIES-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 MD566X executes the AT commands for error correction (MNP 2-4, V.42) and data compression (MNP 5, V.42 bis) described in Table 4-2 on page 66, 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>
No Echo, Numeric (E0, V0)	AT<CR>	0<CR>
	ATS0?<CR>	000<CR><LF>0<CR>

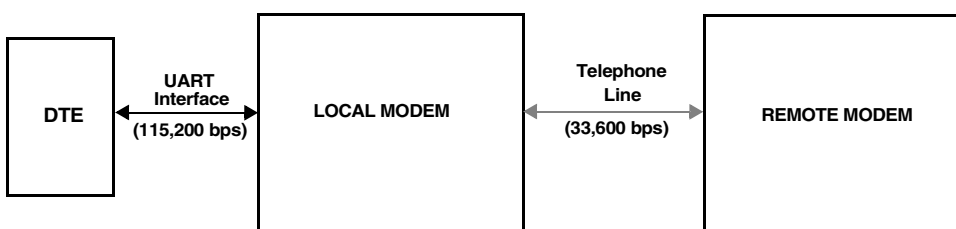


```

No Echo, Text (E0, V1)      AT<CR>          <CR><LF>OK<CR><LF>
                             AT$0?<CR>      <CR><LF>000<CR><LF><CR><LF>OK
                             <CR><LF>
    
```

Configure the DCE to use different response codes using the **ATWn** command (see page 49). The setting for the **ATXn** command (page 50) 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.

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 3-1. Example of a Remote Connection**

The modem then sends the “CONNECT” messages for the following three **Wn** commands:

1. ATW0  
CONNECT 115200
2. ATW2  
CONNECT 33600
3. ATW3  
CONNECT 115200/V34/LAPM/V42B/TX=33600/RX=33600

### 3.3 Modem Reset and NVRAM Commands [DS=n, 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=n** 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:

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

### 3.4 Modem Identification Commands [**In, +FMI?, +FMR?, +FMM?, +GMI?, +GMM?, +GMR?, +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 3-1 lists the commands used to obtain product information (all identification commands are usable in data, fax, or voice mode).

**Table 3-1. Product Identification Information**

Product Information	AT Commands			
	ATIn Command	Data Mode	Class 1 Fax Mode	Pre-FastPath™ Intel Modems
Modem Manufacturer	ATI4/ATI7	AT+GMI?	AT+FMI?	AT+FMFR?
Model Number	ATI3	AT+GMM?	AT+FMM?	AT+FMDL?
Revision Number	ATI1	AT+GMR?	AT+FMR?	AT+FREV?

Example:

ATI1 Causes the modem to send the modem's firmware version to the DTE.

CD08.55-612 (10/19/99) PARALLEL-SPEAKERPHONE 05-DSP PATCH.001.55

Firmware version that is the modem's response to the command.

### 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=n** 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):

- 1) 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**.
- 2) 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:

ATDT9,444-5555 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. 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 “+”.
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. V.90 or V.92 is the default data mode depending on the firmware version. For non-V.90 connections the chipsets fall back to V.34 mode. The modem defaults to whatever mode is issued by the **+MS=m** command (see page 56). The supported modulation types are listed in Table 3-2 on page 33. This table includes all modulation types and the data rates for transmitting and receiving. 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 53,333bps. 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 MD566X supports 3 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 3-4 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 redial. 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 the modem-on-hold flow charts.

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 ad 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 3-4 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, e-mail 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.

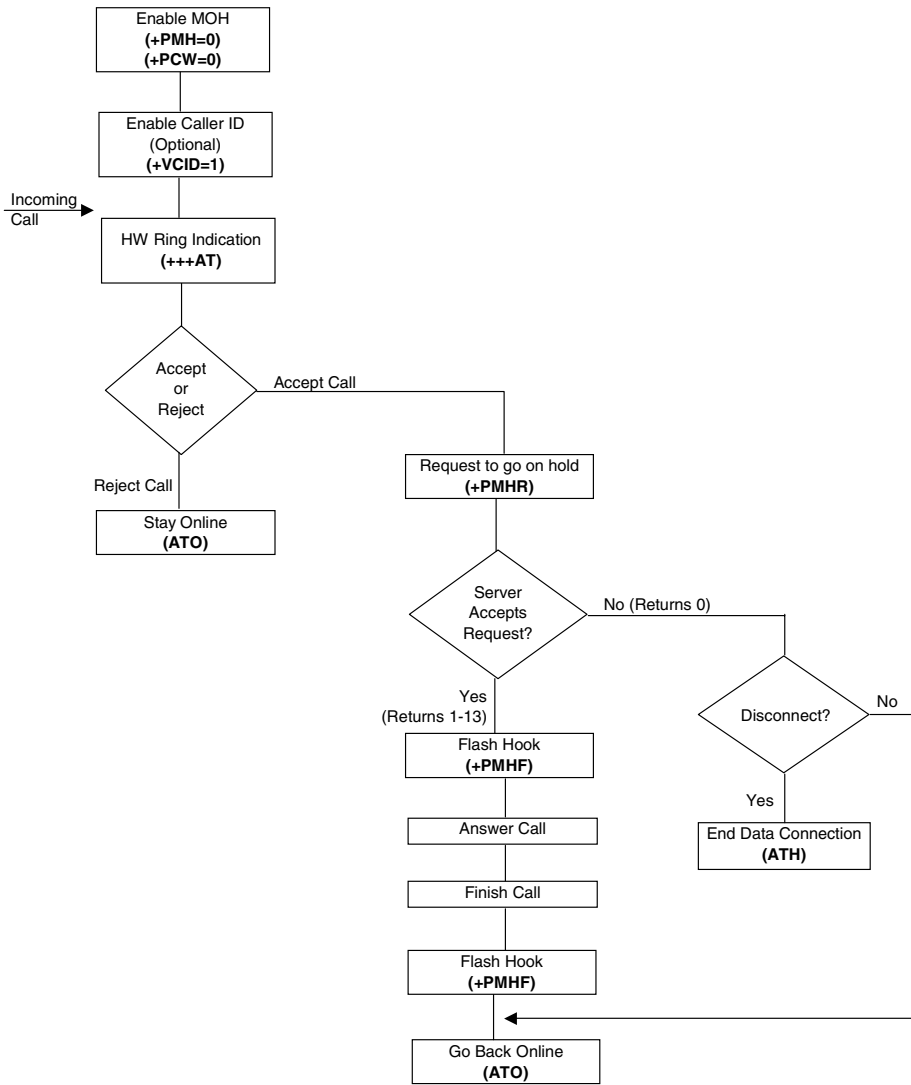
Several V.34 modes are available (see Table 3-2). These provide different speeds. For example, V34B offers a modem-to-modem data rate of 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps. For V.42, MNP, and Buffer (Normal) modes, the modem provides speed buffering (see Chapter 4 starting on page 63), which



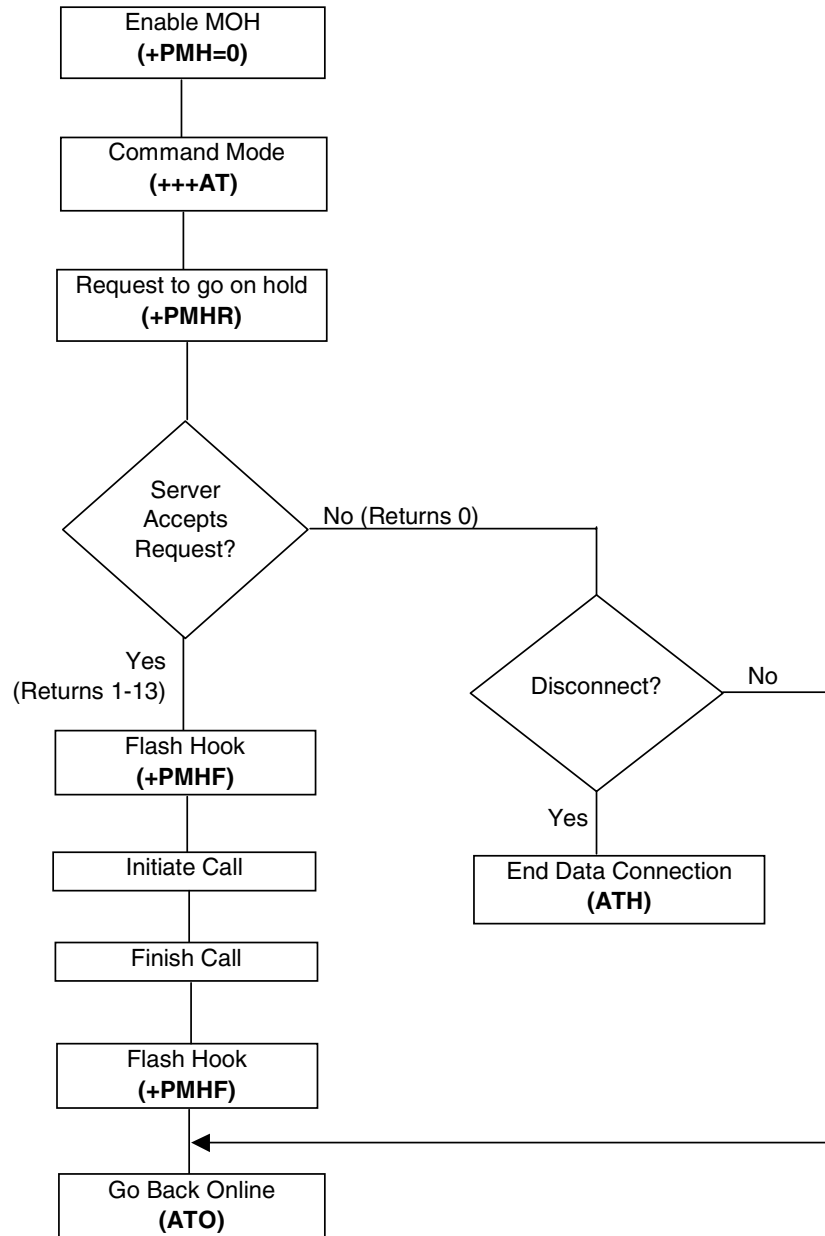
allows the DTE-to-modem data rate to be different from the modem-to-modem data rate. Users can take advantage of this feature by setting the DTE-to-modem rate to a high speed like 115,200 bps and letting the modem negotiate the best line rate.

The MD566X 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. Note that the transmitter speed and receiver speeds typically are different for most V.34 connections over the PSTN.

Modem-on-Hold: Incoming Voice Call in Data Mode



**Modem-on-Hold: Initiating a Voice Call in Data Mode**





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 AT commands **Bn**, **Nn**, and **+MS=m** and S-register **S37** define which modem-to-modem data rates are supported by the modem. The following table shows the supported modulation types. Each modulation supports one or more data rates.

**Table 3-2. Supported Modulation Types**

<carrier >	Description
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, and 28,800 bps
V34B	V.34 extended 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
V34S	V.34 symmetrical-only connections: 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, and 28,800 bps
V34BS	V.34 extended symmetrical 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 bps 56K V92 asymmetrical connection (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, 56,000 bps

The allowable connection modulations and data rates are determined by the **+MS=m** command, which uses four parameters: <carrier>, <automode>, <min rate>, and <max rate>.

The **+MS=m <carrier>** parameter defines the top modulation rate.

The **<automode>** parameter determines whether the modem connection is allowed to fall down to a lower modulation rate if the connection can not be made at a specified modulation or if the modem connection can only take place at the specified modulation. Setting <automode> to 1 allows the modem to connect at a slower <carrier> type than that specified. Setting <automode> to 0 allows the connection to use only the specified <carrier> type.

The **<min rate>** parameter defines the lowest data rate at which a modem connection can take place. Setting <min rate> to 0 has one of two meanings depending on the <automode> setting. When both **<automode>** and <min rate> are set to 0, then the lowest data rate at which the connection can take place is the lowest data rate specified by the **<carrier>** parameter. If **<automode>** is set to 1 and <min rate> is set to 0, then the lowest data rate is 300 bps.

The **<max rate>** parameter defines the highest data rate at which a modem connection can take place. If the <max rate> is set to 0, the modem uses the DTE data rate or a slower **<carrier>** data rate as the highest permitted connection data rate. This highest-permitted data rate means the modem attempts to connect at this data rate but may connect at a slower rate because of line impairment. If <max rate> and **<automode>** are set to 0 and the DTE data rate is below the lowest data rate supported by the modulation rate, then the modem's connection attempts always fail, and the modem reports a "NO CARRIER" message.

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 for two reasons. First, when the modem receives the **+MS=m** command, the modem does not check for conflicts of valid parameter information. Secondly, some of the same configuration information is provided by two other commands: **Nn** and **S37**. The command issued last takes precedence.

**+MS = <carrier >, <automode>, <min rate>, <max rate>**



The **Nn** command specifies whether the modem should attempt to establish a connection using a single modulation type or allow the connection to fall to a lower modulation type. **Nn** performs the same function as the **+MS=m <automode>** parameter. Whatever command is issued last configures the modem for any following connections. Thus, upon receiving the **+MS=m** command, the modem changes the value for **Nn**.

When configured to **N0**, the modem only attempts a connection at the **<carrier>** rate specified by **S37**, **+MS=m**, and **Bn**. If the remote modem does not support any of the **<carrier>** data rates, the modem does not achieve a connection and responds back with a "NO CARRIER" message.

When configured to **N1**, the modem attempts to connect to the remote modem at the highest speed, as defined by **S37**, **+MS=m**, and **Bn**. Since not all modems support (or are configured for) the same modem-to-modem data rates, the modems may connect at a lower speed.

S-register **S37** specifies the maximum data rate that can be attempted during a modem connection. If **S37** is set to '0', then the modem looks at the DTE rate to determine the maximum connection data rate. If the DTE data rate doesn't match one of the <carrier> data rates, then the modem uses the next-fastest data rate.

The **+MS** command sets the modulation speeds in the MD566X chipsets; however, to set the modulation to either V.22 or Bell 212, the **B0** or **B1** command also must be sent. To set the modulation type to ITU-T V.22, send the **B0** command; to set the modulation type to Bell 212, send **B1**. These commands can be entered before or after the **+MS** command. For example, to set the modulation to ITU-T V.22:

```
+MS = V22, 1, 1200, 1200; B0
```

It is important to remember that the ordering of commands is important in configuring the modem. For example, if the DTE 9600 bps data rate and the AT commands are issued in the following sequence, different connection rates result:

- |   |  |
|---|--|
| <p>1. AT<b>S37</b> = 0<br/>         AT<b>+MS</b> = V32B, 1, 0, 14400<br/>         ATDT1234<br/>         CONNECT 14400</p> | <p>2. AT<b>+MS</b> = V32B, 1, 0, 14400<br/>         AT<b>S37</b> = 0<br/>         ATDT1234<br/>         CONNECT 9600</p> |
|---|--|

Table 3-3 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 modulations, 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 3-3 shows examples of the resulting connection rate when non-default values are used.

**Table 3-3. Resulting DCE-to-DCE Connection Rates with Non-Default Values**

Originating Modem	Answering Modem	Resulting Connection Speed
+MS = V34, 1, 0, 0; the UART data rate = 115,200 bps	+MS = V32, 1, 0, 9600; 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, 28,800, 28,800; UART data rate = 115,200 bps	+MS = V32B, 1, 0, 9600; B1 and UART data rate = 14,400 bps	No connection: the originating modem is configured to attempt only a 28,800 bps connection, but the answering modem is configured to attempt a maximum data rate of 9600 bps.
N0, +MS = V32, 1, 0, 9600; S37 = 0; and UART data rate = 7200 bps	+MS = V34, 1, 0, 0; UART data rate = 9600 bps	7200 bps: the originating modem is configured to attempt connection at 7200 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) and local analog loopback self-test (see Section 3.9.2) for testing modem-to-modem and DTE-to-modem communication 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.

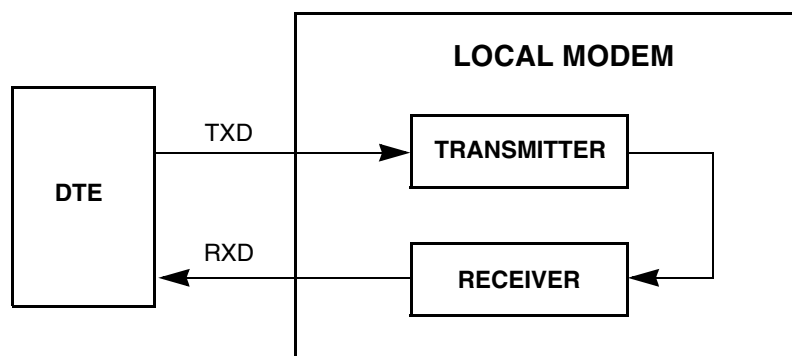


Figure 3-2. Local Analog Loopback Test

#### Local Modem (or Test Modem)

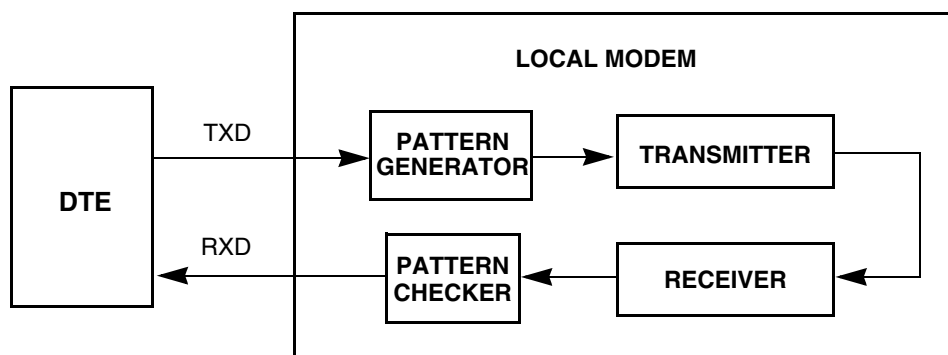
<code>AT&amp;F &amp;W&lt;CR&gt;</code>	Returns the modem to the factory defaults.
<code>AT S18 = 0 &amp;T1</code>	Causes the modem to run local analog loopback without self-test.
<code>CONNECT 115200</code>	Modem response code indicates that analog loopback is enabled with a DTE speed of 115200.
<code>This is a test.</code>	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 3-3. 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
OK	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
000	loopback, sends an error count to the DTE, and enters

OK

command mode.

### 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 56K FastPath 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:

- 1) *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).
  - a) 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.
  - b) 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.

- 2) 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.
- 3) Any character except an "A" or "a" is received from the DTE. The modem disables the EPD timer and changes back to data mode.

### 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: <gt 1><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
```

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.

**Table 3-4. Data Mode Command Descriptions**

**Note:** \*\* denotes the factory-default setting.

Command	Default	Description
<b>A/</b>	<b>none</b>	<b>Repeat Last Command:</b> This command re-executes the last AT command string stored in the command buffer. <i>A/</i> is the only command not preceded by AT and ended by a carriage return.  Sending any character (such as a carriage return) after <i>A/</i> 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.
<b>A</b>	<b>none</b>	<b>Answer Command:</b> 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.

Table 3-4. Data Mode Command Descriptions (Continued)

		<b>Select ITU-T or Bell*:</b> This command selects the ITU-T or Bell configuration for the modem.	
<b>Bn</b>	<b>1</b>	n = 0	Selects ITU-T V.22 when the modem is at 1200 bps and ITU-T V.21 when the modem is at 300 bps.
		n = 1**	Selects Bell 212A when the modem is at 1200 bps and Bell 103J when the modem is at 300 bps.
		n = 2	Selects ITU-T V.23 modulation connections only (that is, the modem does not connect for any other speed or modulation). The originating modem transmits at 75 bps (and receives at 1200 bps), and the answering modem transmits at 1200 bps (and receives at 75 bps).
		n = 3	Selects ITU-T V.23 modulation connections only (that is, the modem does not connect for any other speed or modulation). The originating modem transmits at 1200 bps (and receives at 75 bps), and the answering modem transmits at 75 bps (and receives at 1200 bps).
		<b>Carrier Control Option:</b> This command is reserved for selecting between controlled carrier or constant carrier modes. This modem supports only constant carrier mode.	
<b>Cn</b>	<b>1</b>	n = 0	Transmit carrier always off (returns an ERROR message)
		n = 1**	Normal transmit carrier (constant carrier)

**Table 3-4. Data Mode Command Descriptions (Continued)**

		<p><b>Dial Command:</b> 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 <b>AT&amp;Zn=x</b> command.</p> <p>T                Tone Dial—configures the modem to use DTMF tones to dial a telephone number.</p>
<b>D</b>	<b>none</b>	<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, <b>S6</b>, 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>,</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 <b>S8</b>.</p> <p>!</p> <p>                  Flash Hook—causes the modem to go on-hook for 0.75 seconds.</p> <p>@</p> <p>                  Wait for Quiet Answer—causes the modem to wait for specified amount of time (S-register <b>S7</b>) followed by 5 seconds of silence before processing the next dial modifier.</p> <p>;</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>&lt;space&gt; - ( ) 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>
<b>Programmer's Guide</b>		<p><b>Intel Confidential</b></p> <p>L                Redials last number.</p>

**Table 3-4. Data Mode Command Descriptions (Continued)**

<b>En</b>	<b>1</b>	<p><b>Command Mode Echo:</b> 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 n = 1**    Echo enabled</p>
<b>Fn</b>	<b>1</b>	<p><b>Online Echo:</b> Usually this command selects whether the modem echoes data back to the host during online data mode. This chipset does not support online data mode echo.</p> <p>n = 0      Echo enabled (returns an error message) n = 1**    Echo disabled</p>
<b>Hn</b>	<b>0</b>	<p><b>Switch Hook Control:</b> 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) n = 1      Pick up telephone line (go off-hook)</p>

**Table 3-4. Data Mode Command Descriptions (Continued)**

		<b>Identification/Checksum Option:</b> This command causes the modem to send product code and hardware setup information to the DTE.
	n = 0**	Reports product code
	n = 1	Reports firmware version
	n = 2	Verifies ROM checksum
	n = 3	Reports chipset name
	n = 4	Modem Manufacturer
	n = 5	Reports the following hardware configuration: programmed host interface (HOST I/F), program memory (P Mem), data memory (D Mem), and DSP code location (see example at the end of the <b>In</b> description).
	n = 6	Country Code
	n = 7	Modem Manufacturer
	n = 8	Modem firmware features
	Bit 0	00 = Serial, 01 = Parallel
	Bit 1	10 = PCMCIA, 11 = USB
	Bit 4	Voice: 0 = disabled, 1 = enabled
	Bit 5	V.80: 0 = disabled, 1 = enabled
	Bit 8	International Homologation: 0 = disabled, 1 = enabled
	Bit 9	0 = V.90 Autodetect, 1 = V.90 only
<b>In</b>	<b>0</b>	Bit 12 0 = 400 Series DSP, 1 = 800 Series DSP
		Bit 13 Program Space: 0 = Internal, 1 = External
		Bit 14 0 = patched, 1 = patchless
		Bit 2, 3, 6, 7, 10, 11 and 15 Reserved
	n = 9	Reserved
	n = 10	Modem board configuration
	Bit 0	0 = Telephone Emulation mode not supported 1 = Telephone Emulation mode supported
	Bit 1	0 = Digital speakerphone not supported 1 = Digital speakerphone supported
	Bit 2	0 = Reserved 1 = Reserved
	Bit 3	0 = No Caller ID 1 = Caller ID hardware on board
	Bit 4	0 = Reserved 1 = Reserved
	Bit 5	0 = No plug and play 1 = Plug and play supported by board
	Bit 6	0 = Microcontroller firmware in EPROM 1 = Microcontroller firmware in FLASH
	Bit 7	Reserved

Table 3-4. Data Mode Command Descriptions (Continued)

		Identification/Checksum Option: (cont.)	
In (cont.)	0	n = 11	Modem board configuration
		Bit 0	0 = Modem only board 1 = Modem and sound card board
		Bit 1	0 = No microphone jack 1 = Microphone jack on board
		Bit 2	0 = No external speaker 1 = External speaker on board
		Bit 3	0 = No local telephone off-hook detection on board 1 = Local telephone off-hook detection on board
		Bit 4	0 = No earphone support on board 1 = Earphone support on board
		Bit 5-7	Reserved
		n = 12	Reserved
		n = 13	Reserved
		n = 14	SAFE device
		n = 20	Line status information
		n = 21	Reserved
		n = 22	Reserved
		n = 23	Reserved
		n = 24	Reserved
n = 25	Reserved		
Examples:			
<pre> ATI1 CD08.55-612 (10/19/99) PARALLEL-SPEAKERPHONE05-DSPPATCH:001.55 OK </pre>			
<pre> ATI2 ROM TEST OK </pre>			
<pre> ATI3 MD56xx OK </pre>			
<pre> ATI5 Full V.92 upgradeable (Note: V.92 version only) Present, 32k DSP RAM.000 HOST I/F: Parallel P Mem: 016 Bit 001 W.S. D Mem: 008 Bit 001 W.S. DSP Code location = External RAM </pre>			

**Table 3-4. Data Mode Command Descriptions (Continued)**

		<b>Speaker Volume Control:</b> This command selects the modem's speaker volume.	
<b>Ln</b>	<b>2</b>	n = 0	Low speaker volume
		n = 1**	Low speaker volume
		n = 2	Medium speaker volume
		n = 3	High speaker volume
		<b>Speaker Control:</b> This command specifies when the speaker is turned on and off.	
<b>Mn</b>	<b>1</b>	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
		<b>Select Data Rate Handshake:</b> This command specifies whether the resulting modem-to-modem modulation can be different from the modulation specified in the +MS=m <carrier> parameter.	
<b>Nn</b>	<b>1</b>	n = 0	When originating or answering, connect only at the data rates specified by the modulation.
		n = 1**	When originating or answering, begin handshaking at the modulation data rate. If the remote modem does not support the specified modulation data rate, fall down in data rate or modulation to the highest compatible data rate.
		<b>Go Online:</b> This command causes the modem to return back to online data mode from online command mode.	
<b>On</b>	<b>0</b>	n = 0**	Returns the modem to data mode
		n = 1	Begins an equalizer retrain sequence, then returns to data mode
<b>P</b>	<b>none</b>	<b>Select Pulse Dialing:</b> This command configures the modem to use pulse dialing next time the modem dials a telephone number.	
		<b>Result Code Display Control:</b> This command selects whether the modem sends result codes to the DTE.	
<b>Qn</b>	<b>0</b>	n = 0**	Result codes enabled
		n = 1	Result codes disabled
<b>Sn</b>	<b>none</b>	Select an S-Register: This command selects the current S-register.	
		n = 0–37	

Table 3-4. Data Mode Command Descriptions (Continued)

<b>Sn=x</b>	<b>none</b>	<p><b>Write to an S-Register:</b> This command writes a decimal number “x” to S-register “n”.</p> <p>n = 0–37 x = 0–255</p>
<b>Sn?</b>	<b>none</b>	<p><b>Read an S-Register:</b> This command is used to read a decimal number from S-register “n”.</p> <p>n = 0–37</p>
<b>T</b>	<b>none</b>	<p><b>Select Tone Dialing:</b> This command configures the modem to use DTMF tones the next time the modem dials a telephone number (touch tone dialing).</p>
<b>Vn</b>	<b>1</b>	<p><b>Result Code Form:</b> This command selects whether modem response codes are in numeric or verbose form.</p> <p>n = 0            Numeric form n = 1**        Verbose (text) form</p>



**Table 3-4. Data Mode Command Descriptions (Continued)**

		<b>Response Code Data Rate:</b> This command selects whether the modem sends the DTE independent modem connection result codes for speed, error control protocol, or data compression.
	n = 0**	CONNECT result code reports DTE speed.
	n = 2	CONNECT result code reports DCE speed.
	n = 3	CONNECT result code reports DTE data rate, modulation mode, error correction, data compression, DCE transmitter speed and DCE receiver speed when the mode is configured for verbose <b>V1</b> (text) response codes. For numeric responses <b>V0</b> , the modem responds with the <b>W0</b> numeric response codes. The verbose response codes use the following format: <i>CONNECT (DTE data rate)/(modulation)/(error correction)/(data compression) / TX=(DCE transmit data rate) / RX=(DTE receive data rate)</i> Modulation types include: V21, V22, V22B, V23C, V32, V32B, V34, V.90 and V.92 Error correction types include: NONE, LAPM, MNP Data compression types include: NONE, V42B, MNP5 For example: <pre>CONNECT 115200/V34/LAPM/V42B/TX=28800/RX=28000</pre>
<b>Wn</b>	<b>0</b>	
	n = 4	CONNECT result code reports DCE protocol, data compression, and DCE data rate when the mode is configured for verbose <b>V1</b> (text) response codes). For numeric responses <b>V0</b> , the modem responds with the <b>W0</b> numeric response codes. The verbose response codes use the following format: <i>(DCE protocol)</i> <i>(data compression)</i> <i>(line speed)</i> Error correction types include: NONE, LAPM, MNP Data compression types include: NONE, V42B, MNP5 For example: <pre>PROTOCOL: LAPM COMPRESSION: V42B CONNECT 33,600</pre>

Table 3-4. Data Mode Command Descriptions (Continued)

			<p><b>Result Code Type/Call Progress:</b> This command determines which modem result codes are enabled. Additionally, this command specifies whether busy and dial tone detection are enabled or disabled.</p>
<b>Xn</b>	<b>4</b>	<p>n = 0      Result codes 0–4 enabled. Busy and dial tone detect disabled.</p> <p>n = 1      Result codes 0–5, 10 and above enabled. Busy and dial tone detect disabled.</p> <p>n = 2      Result codes 0–6, 10 and above enabled. Busy detect disabled and dial tone detect enabled.</p> <p>n = 3      Result codes 0–5, 7, 10 and above enabled. Busy detect enabled and dial tone detect disabled.</p> <p>n = 4**    Result codes 0–7, 10 and above enabled. Busy and dial tone detect enabled.</p>	
			<p><b>Long Space Disconnect:</b> 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>
<b>Yn</b>	<b>0</b>	<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 <b>ATH0</b> command, the modem sends at least 4 seconds of silence before hanging up.</p>	
			<p><b>Reset Modem/Recall Stored Profile:</b> 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>
<b>Zn</b>	<b>0</b>	<p>n = 0**    Resets the modem and recalls user profile 0</p> <p>n = 1      Resets the modem and recalls user profile 1</p>	
			<p><b>DCD (Data Carrier Detect) Option:</b> This command controls how the modem functions in relation to the DCD or RLSD signal.</p>
<b>&amp;Cn</b>	<b>1</b>	<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>	

**Table 3-4. Data Mode Command Descriptions (Continued)**

		<p><b>DTR (Data Terminal Ready) Option:</b> 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 not send an “OK” message to indicate it has performed the requested function.</p>	
<b>&amp;Dn</b>	<b>2</b>	<p>n = 0      In asynchronous mode (<b>&amp;Q0</b>), 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>	
<b>&amp;F</b>	<b>none</b>	<p><b>Load Factory Defaults:</b> This command loads command defaults and S-register factory defaults into the active configuration and configures the modem for data mode.</p>	
		<p><b>Guard Tone Option:</b> 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>	
<b>&amp;Gn</b>	<b>0</b>	<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>	
		<p><b>Select Serial Port Flow Control:</b> 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>	
<b>&amp;Kn</b>	<b>3</b>	<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>	
		<p><b>Select Communication Mode:</b> This command controls whether the modem operates in asynchronous or synchronous mode. This modem only supports asynchronous mode. This command is the same as &amp;Q0.</p>	
<b>&amp;M0</b>	<b>0</b>	<p>n = 0**    Asynchronous normal. The modem operates asynchronously in both command and online modes.</p>	

Table 3-4. Data Mode Command Descriptions (Continued)

			<b>Dial Pulse Ratio:</b> This command determines the make/break (that is, off-hook/on-hook) ratio during pulse dialing.
<b>&amp;Pn</b>	<b>0</b>	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.
			<b>Select Communication Mode:</b> This command controls whether the modem is operating in asynchronous or synchronous mode. This modem only supports asynchronous mode. This command is the same as &M0.
<b>&amp;Q0</b>	<b>0</b>	n = 0**	Asynchronous normal. The modem operates asynchronously in both command and online modes.
			<b>DSR (Data Set Ready) Option:</b> This command controls how the modem treats the DSR signal.
<b>&amp;Sn</b>	<b>0</b>	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.
			<b>Data Mode Self-Test Command:</b> This command is used in data mode (except V.90 and V.92 modes) to initiate and terminate loopback tests for testing modem-to-modem and DTE-to-modem data communication integrity.
<b>&amp;Tn</b>	<b>0</b>	n = 0**	Terminates test in progress
		n = 1	Local analog loopback
		n = 8	Local analog loopback with self-test
			<b>Disable Trellis Coding:</b> This command selects whether the modem transmits or receives modulated 9600 bps carrier with QAM or Trellis encoding for V.32.
<b>&amp;Un</b>	<b>0</b>	n = 0**	Enabled (Trellis modulation with QAM modulation as a fallback)
		n = 1	Disabled (QAM modulation only)

**Table 3-4. Data Mode Command Descriptions (Continued)**

<b>&amp;Vn</b>	<b>0</b>	<p><b>View Active Configuration and Stored Profiles:</b> 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 &amp;V0 displays the active profile and the stored profile 0; &amp;V1 displays the active profile and the stored profile 1. The information in the active profile is stored into the user profiles with the &amp;Wn command. &amp;W0 stores the active profile into the stored profile 0; &amp;W1, the stored profile 1.</p> <p>n = 0**          Stored profile 0 n = 1             Stored profile 1</p> <p><b>AT&amp;V0</b></p> <p><b>ACTIVE PROFILE:</b></p> <p>B1 E1 L2 M1 N1 P Q0 V1 W3 X4 Y0 &amp;C1 &amp;D2 &amp;G0 &amp;J0 &amp;P0 &amp;Q0 &amp;S0 &amp;U0 &amp;Y0 %A013 %C1 %E1 %G1 \A3 \C0 \G0 \J0 \K5 \N3 \Q3 \T000 \X0 -C1 -J1 "H3 "0032 S00:001 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 S30:000 S33:010 S37:000</p> <p><b>STORED PROFILE 0:</b></p> <p>B1 E1 L2 M1 N1 P Q0 V1 W3 X4 Y0 &amp;C1 &amp;D2 &amp;G0 &amp;J0 &amp;P0 &amp;Q0 &amp;S0 &amp;U0 %A013 %C1 %E1 %G1 \A3 \C0 \G0 \J0 \K5 \N3 \Q3 \T000 \X0 -C1 -J1 "H3 "0032 S00:001 S02:043 S06:002 S07:060 S08:002 S09:006 S10:014 S11:070 S12:050 S18:000 S25:005 S30:000 S33:000 S37:000</p> <p><b>TELEPHONE NUMBERS:</b></p> <p>&amp;Z0= 12345 &amp;Z1= 44444444 &amp;Z2= 12345 &amp;Z3= 11234567890</p> <p>OK</p>
		<b>&amp;Wn</b>

Table 3-4. Data Mode Command Descriptions (Continued)

<b>&amp;Yn</b>	<b>0</b>	<p><b>Select Stored Profile on Power-up:</b> This command selects the particular stored user profile from the NVRAM to be loaded into the active profile upon modem power-up.</p> <p>n = 0**      Select profile 0 n = 1      Select profile 1</p>
<b>&amp;Zn=x</b>	<b>none</b>	<p><b>Store Telephone Number:</b> 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=n command. Use the &amp;V command to see the stored telephone number.</p> <p>n = 0–3 x = 0–9 A B C D # * T P R W @ , ! ;</p>
<b>%En</b>	<b>1</b>	<p><b>Auto-Retrain Control:</b> 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.</p> <p>n = 0      Disabled n = 1**    Enabled</p>
<b>%Gn</b>	<b>1</b>	<p><b>Rate Renegotiation:</b> 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.</p> <p>n = 0      Disabled n = 1**    Enabled</p>

**Table 3-4. Data Mode Command Descriptions (Continued)**

			<p><b>Generate Data Modem Calling Tone:</b> 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.</p>
<b>-Cn</b>	<b>0</b>	<p>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</p>	
			<p><b>Identify Modem Manufacturer:</b> This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to AT+FM-FR? and AT+FMI?.</p>
<b>+GMI?</b>	<b>none</b>	<p>AT+GMI?  Intel Corporation  OK</p>	
			<p><b>Identify Product Model:</b> This command causes the DCE to report the modem chipset name. This command is identical to AT+FMDL? and AT+FMM? commands.</p>
<b>+GMM?</b>	<b>none</b>	<p>AT+GMM?  MD56xx  OK</p>	
			<p><b>Identify Product Revision:</b> This command causes the DCE to report the modem chipset revision level. This command is identical to AT+FREV? and AT+FMR?.</p>
<b>+GMR?</b>	<b>none</b>	<p>AT+GMR?  CD08.55-612 (10/19/99) PARALLEL-SPEAKERPHONE 05  OK</p>	

Table 3-4. Data Mode Command Descriptions (Continued)

**Modulation Selection:** This command sets the type of modulation used and the send and receive speeds. Settings for **Bn**, **+MS=m**, **Nn** and **S37** determine the allowable modem connections. **Nn** performs the same function as the **+MS=m <auto-mode>** parameter. **S37** performs the same function as the **+MS=m <max rate>** parameter.

Modems using MD566X chipsets can be configured by the **+MS=m** command to support only asymmetrical or symmetrical connections. The transmit and receive speeds are the same in symmetrical connections and different in asymmetrical connections. The type of connection is set by the **<carrier>** parameter. The chipsets default to the ITU-T V.90 or V.92 mode depending on firmware version. If the connection is non-V.90/V.92 the chipsets fall back to V.34 mode. Note that the transmitter speed and receiver speeds typically are different for most V.34 connections over the PSTN.

The **+MS** command sets the modulation speeds in the V.34 chipsets; however, **B0** also must be sent to set the modulation to V.22. Sending **B1** sets the modulation to Bell 212. These commands can be typed before or after the **+MS** command. For example, to set the modulation to ITU-T V.22:

```
+MS = V22, 1, 1200, 1200; B0
```

To check the settings for the **+MS** command, type **AT+MS?**

```
m = <carrier>, <automode>, <min rate>, <max rate>
```

**+MS=m**      see "m"

Defaults: m = V90, 1, 0, 0

**<carrier >** This eight-digit string parameter specifies the type of modulation used. Approved codes are shown in the following table. The modem can switch automatically between some types.

<carrier>	Description
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, and 28,800 bps
V34S	V.34 symmetrical-only connections: 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800 bps
V34B	V.34 extended 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
V34BS	V.34 extended symmetrical 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



**Table 3-4. Data Mode Command Descriptions (Continued)**

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<b>Modulation Selection: (cont.)</b>									
V90	<p>56-kbps V.90 asymmetrical connections (transmit): 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200 bps, and 33,600 bps</p> <p>56-kbps 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</p>								
V92	<p>56-kbps 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 bps</p> <p>56-kbps 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</p>								
<b>+MS=m</b> (cont.)	<p><b>see "m"</b></p> <p><b>&lt;automode&gt;</b> When enabled, this parameter allows the modem to negotiate modulation speeds automatically (if an automatic value is defined for that particular modulation). This feature is also controlled by the <b>Nn</b> AT command. The automode setting is based on which command, <b>Nn</b> or <b>+MS=m</b>, was issued last.</p> <p>Range: &lt;automode&gt; = 0, 1 Default: &lt;automode&gt; = 1</p> <table border="0" style="margin-left: 20px;"> <tr> <td style="padding-right: 20px;">&lt;automode&gt; = 0</td> <td>Disabled</td> </tr> <tr> <td>&lt;automode&gt; = 1</td> <td>Enabled</td> </tr> </table> <p><b>&lt;min rate&gt;</b> This parameter specifies the lowest data transfer rate at which the modem may establish a carrier signal connection.</p> <p>Range: &lt;min rate&gt; = 0, 300, 1200, 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.</p> <p>Default: &lt;min rate&gt; = 0</p> <table border="0" style="margin-left: 20px;"> <tr> <td style="padding-right: 20px;">&lt;min rate&gt; = 0</td> <td>                     Minimum allowed data rate                      - &lt;automode&gt; = 1                      Lowest data rate = 300 bps                      - &lt;automode&gt; = 0                      Lowest data rate = (Lowest modulation data rate)                 </td> </tr> <tr> <td>&lt;min rate&gt; ≠ 0</td> <td>Lowest permitted connection rate</td> </tr> </table> <p><b>&lt;max rate&gt;</b> This parameter sets the highest speed at which the modem may establish a connection. This feature is also controlled by the <b>S37</b> S-register. The &lt;max rate&gt; setting is based on which command, <b>S37</b> or <b>+MS=m</b>, was issued last.</p>	<automode> = 0	Disabled	<automode> = 1	Enabled	<min rate> = 0	Minimum allowed data rate - <automode> = 1 Lowest data rate = 300 bps - <automode> = 0 Lowest data rate = (Lowest modulation data rate)	<min rate> ≠ 0	Lowest permitted connection rate
<automode> = 0	Disabled								
<automode> = 1	Enabled								
<min rate> = 0	Minimum allowed data rate - <automode> = 1 Lowest data rate = 300 bps - <automode> = 0 Lowest data rate = (Lowest modulation data rate)								
<min rate> ≠ 0	Lowest permitted connection rate								

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Table 3-4. Data Mode Command Descriptions (Continued)

		<b>Modulation Selection: (cont.)</b>	
		Range: <max rate> = 0, 300, 1200, 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, 33,333, 33,600, 37,333, 41,333, 42,666, 44,000, 45,333, 46,666, 48,800, 49,333, 50,666, 52,000, 53,333, 54,666 <sup>a</sup> , and 56,000 <sup>a</sup> bps.	
		Default: <max rate> = 0	
		<max rate> = 0	Maximum allowed data rate: - If the maximum modulation data rate is less than or equal to the DTE data rate, then the highest data rate is the highest modulation data rate. - If the maximum modulation data rate is greater than the DTE data rate, then the highest data rate is the modulation data rate equal to or just below the DTE data rate.
		<max rate> ≠ 0	Highest permitted data rate
<b>+MS=m</b> (cont.)	see "m"	<b>Examples (DTE data rate = 115,200 bps)</b>	<b>Speed Range</b>
		+MS = V32, 1, 0, 0 +MS = V32, 0, 0, 0 +MS = V32B, 1, 9600, 14400 +MS = V34, 1, 0, 0 +MS = V34, 1, 2400, 28800 +MS = V34, 1, 9600, 28800 +MS = V34, 1, 28800, 28800 +MS = V34, 0, 19200, 26400 +MS = V90, 1, 0, 50666	300–9600 4800–9600 9600–14400 2400–28800 2400–28800 9600–28800 28800 only 19200–26400 4800–50666
		<b>Examples (DTE data rate = 2400 bps)</b>	<b>Speed Range</b>
		+MS = V32, 0, 0, 0 +MS = V32B, 1, 9600, 14400 +MS = V34, 1, 0, 0 +MS = V34, 1, 2400, 28800 +MS = V34, 1, 9600, 28800 +MS = V34, 1, 28800, 28800 +MS = V34, 0, 0, 0 +MS = V34, 0, 19200, 26400 +MS = V90, 1, 0, 50666	NO CARRIER 9600–14400 2400–2400 2400–28800 9600–28800 28800 only 2400 only 9200–26400 4800–50666

**Table 3-4. Data Mode Command Descriptions (Continued)**

		<b>Call Waiting Enable:</b> This command controls the action to be taken upon detection of call waiting in a V.92 DCS.	
<b>+PCW=m</b>	<b>0</b>	m = 0	Toggle V.24 Circuit 125 and collect Caller ID if enabled by +VCID
		m = 1	Hang up
		m = 2	Ignore V.92 call waiting
		<b>Modem on Hold Enable:</b> This command controls whether or not modem on hold procedures are enabled during V.92 operation.	
<b>+PMH=m</b>	<b>0</b>	m = 0	Enables V.92 modem on hold
		m = 1	Disables V.92 modem on hold
		<b>Modem on Hold Timer:</b> 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-Timeout.	
<b>+PMHT=m</b>	<b>none</b>	m = 0	Deny V.92 Modem-on-hold Request
		m = 1	Grant MOH with 10 second timeout
		m = 2	Grant MOH with 20 second timeout
		m = 3	Grant MOH with 30 second timeout
		m = 4	Grant MOH with 40 second timeout
		m = 5	Grant MOH with 1 minute timeout
		m = 6	Grant MOH with 2 minute timeout
		m = 7	Grant MOH with 3 minute timeout
		m = 8	Grant MOH with 4 minute timeout
		m = 9	Grant MOH with 6 minute timeout
		m = 10	Grant MOH with 8 minute timeout
		m = 11	Grant MOH with 12 minute timeout
		m = 12	Grant MOH with 16 minute timeout
		m = 13	Grant MOH with indefinite timeout

Table 3-4. Data Mode Command Descriptions (Continued)

		<p><b>Initiate Modem on Hold:</b> 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: &lt;value&gt; where &lt;value&gt; 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.</p>
		<p>m = 0 V.92 Modem on Hold Request Denied or not available</p> <p>m = 1 MOH with 10 second timeout Granted</p> <p>m = 2 MOH with 20 second timeout Granted</p> <p>m = 3 MOH with 30 second timeout Granted</p> <p>m = 4 MOH with 40 second timeout Granted</p> <p>m = 5 MOH with 1 minute timeout Granted</p> <p>m = 6 MOH with 2 minute timeout Granted</p> <p>m = 7 MOH with 3 minute timeout Granted</p> <p>m = 8 MOH with 4 minute timeout Granted</p> <p>m = 9 MOH with 6 minute timeout Granted</p> <p>m = 10 MOH with 8 minute timeout Granted</p> <p>m = 11 MOH with 12 minute timeout Granted</p> <p>m = 12 MOH with 16 minute timeout Granted</p> <p>m = 13 MOH with indefinite timeout Granted</p> <p>Implementation of this parameter is mandatory if V.92 is implemented in the DCE.</p>
		<p><b>PCM Upstream Ignore:</b> This command controls the use of PCM upstream in a V.92 DCE.</p>
		<p>m = 0 Enable PCM upstream</p> <p>m = 1 Disable PCM upstream</p>
		<p><b>V.92 Modem on Hold Hook Flash:</b> 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.</p>
		<p><b>V.92 Phase 1 and Phase 2 Control:</b> This control 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>m = 0 Enable Short Phase 1 and Short Phase 2</p> <p>m = 1 Enable Short Phase 1</p> <p>m = 2 Enable Short Phase 2</p> <p>m = 3 Disable short Phase 1 and Short Phase 2</p>

**Table 3-4. Data Mode Command Descriptions (Continued)**

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		<b>Use Short Sequence:</b> 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.	
<b>+PSS=m</b>	<b>2</b>	m = 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.
		m = 1	Forces the use of the short startup procedures on the next and subsequent connections if they are enabled by the +PQC command.
		m = 2	Forces the use of the full startup procedures on the next and subsequent connections independent of the setting of the +PQC command.

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a. Current download speeds are limited to 53,333 bps due to FCC rules that restrict modem power output.



***Notes***

## 4. ERROR CORRECTION AND DATA COMPRESSION

The MD566X chipsets support two types of data mode error correction (MNP<sup>®</sup> 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.42bis 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 4-2 V.42 bis data compression requires V.42 (LAPM only). MNP 5 requires MNP 2-4.

The MD566X chipsets support four operating modes: buffer (normal), MNP reliable, V.42 auto-reliable, and V.42 reliable. These four modes are selected by the \Nn command. 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). The modem-to-modem data rates can be set to 300, 1200, 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. Each operating mode is explained in more detail in the following tables.

When V.80 mode (synchronous access mode) for videoconferencing becomes available in the future, the +ES=m commands for data correction/compression will supersede the \Nn commands. Control reverts to the \Nn command upon exiting V.80 mode.

### Operating Modes

Mode	Features
Buffer (Normal) \N0 or \N1	No error correction/data compression, but speed buffering is supported.
MNP Reliable \N2	MNP 2–5 connection only. If an MNP connection cannot be established, the modem hangs up.
V.42 Auto-Reliable \N3	V.42/V.42 bis with fallback to MNP 2–5 or normal mode.
V.42 Reliable \N4	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 4-1 lists connection types corresponding to \Nn settings.

**Table 4-1. Resulting \Nn Connection Types**

\Nn Settings (Originate Modem)	\Nn Settings (Answer Modem)			
	\N0 or \N1 (Buffer)	\N2 (MNP Reliable)	\N3 (V.42 Auto- reliable)	\N4 (V.42 Reliable)
\N0 or \N1 (Buffer)	Buffer (normal) mode	Modem hangs up	Buffer (normal) mode	Modem hangs up
\N2 (MNP Reliable)	Modem hangs up	MNP 2-5	MNP 2-5	MNP 2-5
\N3 (V.42 Auto-reliable)	Buffer (normal) mode	MNP 2-5	V.42/V.42 bis	V.42/V.42 bis
\N4 (V.42 Reliable)	Modem hangs up	MNP 2-5	V.42/V.42 bis	V.42/V.42 bis

**NOTES:**

- 1) MNP 5 requires the modem to be configured for %C1.
- 2) V.42 bis requires the modem to be configured for "H3.
- 3) 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, "H3 %C1	&F \N3	or\N3
MNP2-4 or V.42:		
V.42 bis with fallback to V.42/MNP2-4: %C0 "H3 -J1	&F \N4 %C0	or\N4
V.42 bis only: -J0 "H3	&F \N4 -J0	or\N4
V.42 only: -J0 "H0	&F \N4 -J0 "H0	or\N4
MNP5 with fallback to MNP2-4: %C1	&F \N2	or\N2
MNP2-4 only: %C0	&F \N2 %C0	or\N2

**Table 4-2. V.44 / V.42 / V.42 bis and MNP Data Mode Command Descriptions**

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

Command	Default	Description
<b>%An</b>	<b>13</b>	<p><b>Set Auto-Reliable Fallback Character:</b> In auto-reliable mode (<b>\N3</b>) with auto-reliable fallback character enabled (<b>\C2</b>), 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.</p> <p>n = 0–127 (ASCII character)</p>
<b>%Cn</b>	<b>1</b>	<p><b>MNP 5 Data Compression Control:</b> 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%.</p> <p>n = 0, 1</p> <p>n = 0           No compression</p> <p>n = 1*         MNP Class 5 compression</p>
<b>\An</b>	<b>3</b>	<p><b>MNP Block Size:</b> 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>n = 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>
<b>\Bn</b>	<b>none</b>	<p><b>Transmit Break:</b> This command causes the modem to send a break (attention signal) to the remote modem for a duration specified by 'n'. When n = 0, the default break length is used.</p> <p>n = 0–9 (units of 100 ms)</p>

**Table 4-2. V.44 / V.42 / V.42 bis and MNP Data Mode Command Descriptions**

\Cn	0	<p><b>Set Auto-Reliable Buffer</b> (requires a license from Microcom®): In auto-reliable mode (\N3), 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>
		n = 0–2
		n = 0* Does not buffer data.
		n = 1 Reserved.
		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.
\Gn	0	<p><b>Set Modem Port Flow Control:</b> In buffer (normal) mode (either \N0 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>
		n = 0, 1
		n = 0* Disables port flow control
		n = 1 Sets port flow control to XON/XOFF
\Jn	0	<p><b>bps Rate Adjust Control:</b> 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>
		n = 0, 1
		n = 0* Turns off feature
		n = 1 Turns on feature

Table 4-2. V.44 / V.42 / V.42 bis and MNP Data Mode Command Descriptions

		<b>Set Break Control:</b> Defines what action the modem takes when a break (attention signal) is sent or received, as described below.	
		n = 0–5	
		<i>In connect state, transmits break to remote (if in reliable mode):</i>	
		n = 0, 2, 4	Enter command state, but does not send a break
		n = 1	Destructive/expedited
		n = 3	Nondestructive/expedited
		n = 5*	Nondestructive/non-expedited
		<i>In command state, transmits break to remote (if in reliable mode):</i>	
\Kn	5	n = 0, 1	Destructive/expedited
		n = 2, 3	Nondestructive/expedited
		n = 4, 5*	Nondestructive/non-expedited
		<i>In connect state, receives break at serial port (if in direct mode):</i>	
		n = 0, 2, 4	Immediately sends break and enters command state
		n = 1, 3, 5*	Immediately sends break through
		<i>In connect state, receives break at modem port and sends to serial port:</i>	
		n = 0, 1	Destructive/expedited
		n = 2, 3	Nondestructive/expedited
		n = 4, 5*	Nondestructive/non-expedited
		<b>Set Operating Mode:</b> Determines the type of connection attempted by the modem.	
		n = 0–4	
		n = 0, 1	Buffer (Normal) Mode — no data compression or error correction, but uses speed buffering.
		n = 2	MNP Reliable Mode — the modem attempts to negotiate an MNP error-correction ‘reliable’ link, hanging up if it fails.
\Nn	3	n = 3*	V.42 Auto-Reliable Mode — if V.42 detection is enabled (-Jn), a LAPM or MNP link can be detected and negotiated; otherwise, only LAPM is attempted. If configured for -J0 and a protocol connection is not made, the modem hangs up. If configured for -J1 and a protocol connection is not made, the modem falls back to speed buffering mode.
		n = 4	V.42 Reliable Mode — the modem attempts to negotiate LAPM error correction, hanging up if it fails.
\O	none	<b>Originate Reliable Link:</b> In buffer (normal) mode (\N0 or \N1), the modem attempts to originate an MNP link, regardless of whether the modem originated or answered the telephone call (physical connection). The remote modem must answer the MNP link request for the link to be established (refer to the \U command that follows).	

**Table 4-2. V.44 / V.42 / V.42 bis and MNP Data Mode Command Descriptions**

\Qn	3	<p><b>Set Serial Port Flow Control:</b> This command specifies the DTE-to-modem flow control. Software flow control uses the XOFF (13h) command to stop and the XON (11h) characters to start data transmission, both to and from the DTE. Unidirectional hardware flow control uses the CTS control line to stop or start data from the DTE only, while bidirectional hardware flow control also uses the RTS control to stop or start data from the modem.</p> <p>n = 0–3</p> <p>n = 0            Disables flow control</p> <p>n = 1            XON/XOFF software flow control</p> <p>n = 2            Unidirectional hardware flow control — CTS</p> <p>n = 3*          Bidirectional hardware flow control — RTS/CTS</p>
\Tn	0	<p><b>Set Inactivity Timer:</b> 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>n = 0–90        Length in minutes</p> <p>n = 0*          Disables inactivity timer</p>
\U	none	<p><b>Accept Auto-Reliable Link:</b> In buffer (normal) mode (<b>\N0</b> or <b>\N1</b>), the modem attempts to answer an MNP link request, regardless of whether the modem originated or answered the telephone call (physical connection). The remote modem must originate the MNP link request for the link to be established (refer to the preceding <b>\O</b> command).</p>
\Xn	0	<p><b>Set XON/XOFF Pass-Through:</b> If software flow control is enabled (<b>\Q1</b>), 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 (<b>\G1</b>) 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>n = 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>
\Y	none	<p><b>Switch to Reliable Mode:</b> In buffer (normal) mode (<b>\N0</b> or <b>\N1</b>), the modem attempts to originate or answer an MNP link request, depending on whether the modem originated or answered the physical connection, respectively. The remote modem must attempt to answer/originate the MNP link for the link to be established.</p>
\Z	none	<p><b>Switch to Buffer Mode:</b> During an MNP link, the modem disconnects the link (exit error correction/data compression) and changes to buffer mode without disconnecting the modem-to-modem connection.</p>

**Table 4-2. V.44 / V.42 / V.42 bis and MNP Data Mode Command Descriptions**

-Jn	1	<p><b>Set V.42 Detect Phase:</b> In V.42 modes (<b>V.42bis</b>, <b>V.42tertiary</b>), 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>n = 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><b>V.42 bis Compression Control:</b> 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>n = 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><b>V.42 bis String Length:</b> 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>n = 6–250      Number of characters</p> <p>n = 32*        Usual number of characters</p>

**Table 4-2. V.44 / V.42 / V.42 bis and MNP Data Mode Command Descriptions**

**V.44 Data Compression:** This command controls the V.44 data compression function if provided in the DCE. It accepts the following subparameters:

**m=[<direction>[,<compression\_negotiation>[,<capability>[,<max\_codewords\_tx>[,<max\_codewords\_rx>[,<max\_string\_tx>[,<max\_string\_rx>[,<max\_history\_tx>[,<max\_history\_rx>]]]]]]]]]]]**

**<direction>**, which specifies the desired direction(s) of operation of the data compression function; from the DTE point of view;

**<compression\_negotiation>**, which specifies whether or not the DCE should continue to operate if the desired result is not obtained;

**<capability>**, which specifies the use of stream method, packet method, multi-packet method;

**<max\_codewords\_tx>**, which specifies the maximum number of codewords which should be negotiated in the transmit direction;

**<max\_codewords\_rx>**, which specifies the maximum number of codewords which should be negotiated in the receive direction;

**<max\_string\_tx>**, which specifies the maximum string length to be negotiated in the transmit direction;

**<max\_string\_rx>**, which specifies the maximum string length to be negotiated in the receive direction;

**<max\_history\_tx>**, which specifies the maximum size of the history buffer to be negotiated in the transmit direction;

**<max\_history\_rx>**, which specifies the maximum size of the history buffer to be negotiated in the receive direction.

**<direction>: (Default = 3)**

- m = 0 Negotiated ... no compression
- m = 1 Transmit only
- m = 2 Receive only
- m = 3 Both directions, accept and direction

**<compression negotiation>: (Default = 0)**

- m = 0 Do not disconnect if REC. V.44 is not negotiated by the remote DCE as specified in <direction>. Always set to 0.

**<capability>: (Default = 0)**

- m = 0 Stream method
- m = 1 Packet method
- m = 2 Multi-packet method

**<max\_codewords\_tx>: (Default = 471)** 256 to 65536

**<max\_codewords\_rx>: (Default = 942)** 256 to 65536

**<max\_string\_tx>: (Default = 140)** 32 to 255

**<max\_string\_rx>: (Default = 140)** 32 to 255

**<max\_history\_tx>: (Default = 1884)** ≥ 512

**<max\_history\_rx>: (Default = 3768)** ≥ 512

+DS44=m  
3,0,0,471,  
972,140,  
140,1884,  
3768

## 5. FAX CLASS 1 AT COMMANDS

The 56K FastPath family implements 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 MD566X-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 5-1; all other fax AT commands are provided in Table 5-3 on page 76. This programmer's guide should be used with the *Class 1 Fax Application Note* and the specifications for EIA/TIA-578, ITU-T T.30, and T.4. The *Intel Class 1 Fax Application Note* shows several examples of how to use the fax AT commands and how to originate and answer a fax call.

### 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 5-1. Fax Identity Command Descriptions**

Command	Default	Description
<b>+FMFR?/+FMI?</b>	none	<p><b>Identifies Modem Manufacturer:</b> This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to <b>AT+GMI?</b>.</p> <p>AT+FMFR? Intel Corporation</p> <p>OK</p> <p><i>Note:</i> The DTE manufacturer name can be changed with the firmware configuration utility.</p>
<b>+FMDL?/+FMM?</b>	none	<p><b>Identifies Product Model:</b> This command causes the DCE to report the modem chipset name. This command is identical to AT13 and AT+GMM?.</p> <p>AT+FMDL? MD56xx</p> <p>OK</p> <p>The modem responds with 'MD566X' for all chipsets that support V.42/MNP protocols.</p>



**Table 5-1. Fax Identity Command Descriptions**

		<b>Identifies Product Version Number:</b> This command causes the DCE to report the modem chipset revision level. This command is identical to <b>ATi1</b> and <b>AT+GMR?</b> .
<b>+FREV?/+FMR?</b>	<b>none</b>	AT+FREV? CD08.55-612 (10/19/99) PARALLEL-SPEAKERPHONE 05
		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 5-2.

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 $10 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 5-2. <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).

Flag	Flag	Address Field	Control Field	Facsimile Control Field	Facsimile Information Field	Frame Checking Sequence (FCS)	Flag
------	------	---------------	---------------	-------------------------	-----------------------------	-------------------------------	------

**Figure 5-1. 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.

Address Field	Control Field	Facsimile Control Field	Facsimile Information Field
---------------	---------------	-------------------------	-----------------------------

**Figure 5-2. CLASS 1 DTE-Generated HDLC Frame Information (AT+FTH=<mod>)**

Address Field	Control Field	Facsimile Control Field	Facsimile Information Field	Frame Checking Sequence (FCS)
---------------	---------------	-------------------------	-----------------------------	-------------------------------

**Figure 5-3. 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

**Table 5-3. Fax Mode Command Descriptions**

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

Command	Default	Description
		<b>Fax Mode Selection:</b> 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 <b>+FCLASS</b> , are valid only in fax mode.
<b>+FCLASS=1</b>	<b>0</b>	<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>n = 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>
<b>+FRH=n</b>	<b>none</b>	<p><b>Receive HDLC Data:</b> The <b>+FRH=&lt;mod&gt;</b> command causes the modem to receive HDLC-framed data using the modulation mode selected in &lt;mod&gt;. 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 &lt;DLE&gt;&lt;ETX&gt; 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>

**Table 5-3. Fax Mode Command Descriptions (Continued)**

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

Command	Default	Description
		<p><b>Receive HDLC Data:</b> <i>(cont.)</i></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 <b>+FRH=&lt;mod&gt;</b> 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: &lt;mod&gt; = 3</p> <p>Refer to Table 5-2 on page 74.</p>
<b>+FRH=n</b> <i>(cont.)</i>		
		<p><b>Receive Data:</b> The <b>+FRM=&lt;mod&gt;</b> command causes the modem to enter receive mode using the modulation scheme specified in &lt;mod&gt;. &lt;mod&gt; may have the values shown in Table 5-2 on page 74.</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 &lt;DLE&gt;&lt;ETX&gt;.</p> <p>Upon loss of carrier, the modem returns to command state and sends a "NO CARRIER" result code to the DTE.</p> <p><i>Note:</i> If the modem is on-hook, then the modem always returns an 'ERROR' message to the DTE after receiving the <b>+FRM=&lt;mod&gt;</b> command.</p> <p>Range: &lt;mod&gt; = 24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146</p> <p>Refer to Table 5-2 on page 74.</p>
<b>+FRM=n</b>	<b>none</b>	
		<p><b>Wait for Silence:</b> The <b>+FRS=&lt;TIME&gt;</b> 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 &lt;TIME&gt; 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: &lt;TIME&gt; = 1–255 (10 ms)</p>
<b>+FRS=n</b>	<b>none</b>	

Table 5-3. Fax Mode Command Descriptions (Continued)

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

Command	Default	Description
<b>+FTH=n</b>	<b>none</b>	<p><b>Transmit HDLC Data:</b> The <b>+FTH=&lt;mod&gt;</b> command causes the modem to transmit data framed in HDLC protocol using the modulation mode selected. &lt;mod&gt; may have the values shown in Table 5-2 on page 74.</p> <p>After receiving the <b>+FTH</b> 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 <b>+FTH</b> command upon detecting &lt;DLE&gt;&lt;ETX&gt; 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"> <li>• The DTE sends additional data. The modem then transmits another frame.</li> <li>• The DTE sends only &lt;DLE&gt;&lt;ETX&gt; (a null frame). The modem then turns off the transmit carrier and send the “OK” result code to the DTE.</li> <li>• 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.</li> </ul> <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><i>Note:</i> If the modem is on-hook, it always returns an “ERROR” message to the DTE after receiving the <b>+FTH=&lt;mod&gt;</b> command.</p> <p>Range: &lt;mod&gt; = 3</p> <p>Refer to Table 5-2 on page 74.</p>

**Table 5-3. Fax Mode Command Descriptions (Continued)**

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

Command	Default	Description
<b>+FTM=n</b>	<b>none</b>	<p><b>Transmit Data:</b> The <b>+FTM = &lt;mod&gt;</b> command causes the modem to transmit data using the modulation selected in &lt;mod&gt;.</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 &lt;DLE&gt;&lt;ETX&gt; 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><i>Note:</i> 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><i>Note:</i> If the modem is on-hook, the modem always returns an “ERROR” message to the DTE after receiving the +FTM = &lt;mod&gt; command. Range: &lt;mod&gt; = 24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146</p> <p>Refer to Table 5-2 on page 74.</p>
<b>+FTS=n</b>	<b>none</b>	<p><b>Stop Transmission and Pause:</b> The <b>+FTS=&lt;TIME&gt;</b> 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 &lt;TIME&gt; is in 10-ms intervals.</p> <p>Range: &lt;TIME&gt; = 0–255 (in 10-ms intervals)</p>

## 6. IS-101 VOICE MODE AT COMMANDS

The 56K FastPath chipsets implement a voice mode AT command set that allows a DTE to record and play back voice messages. In addition to this programmer's guide, the Intel *IS-101 Voice Application Note*, shows a number of ways to use these AT commands. 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 6-1 on page 82). When multiple commands are placed on a line, a semicolon (;) must be placed after each voice (and fax) command.

See Table 2-6 and Table 2-7 on page 19 for voice character pairs (DTE-to-DCE and DCE-to-DTE).

**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:

<b>+V&lt;command&gt;?</b>	Read current setting
<b>+V&lt;command&gt; = ?</b>	Read permissible settings
<b>+V&lt;command&gt; = &lt;parameter&gt;</b>	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=n** 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=n**). 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 (\$10 \$03)
any data ... <DLE><DLE>	single \$10 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

DTMF detection information is handled differently than other detection information. IS-101 specifies that more than one <DLE><DTMF CHAR> character pair may be sent for a single DTMF tone burst. As such, the modem sends delimiter <DLE> character pairs to indicate the end of a tone burst. When a DTMF tone is detected in playback or command mode, the modem sends <DLE><DEL> to indicate the end of a burst. For example, from a single burst of DTMF 5 tones, the following reports are possible:

Playback and voice command modes:

```
<DLE><5><DLE><DEL>
```

When a DTMF tone is detected in the record mode, the modem sends <DLE></> to indicate the beginning of a tone burst. The modem may then send one or more <DLE><DTMF CHAR> character pairs followed by <DLE><DEL>, which signifies the end of the tone. For example, from a single burst of DTMF 5 tones, the following reports are possible:

Record mode only:

```
[voice data]<DLE></><DLE><5>[voice data]<DLE><DEL>[voice data]
[voice data]<DLE></><DLE><5>[voice data]<DLE><5>[voice data]
[voice data]<DLE><DEL>[voice data]
```

## 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=n** to n=1 or n=5 depending on the value for **Mn**.

To answer a call, use the **AT+VLS=n** 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=n**). Additionally, voice messages may be played through the modem/computer speaker. The FastPath 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 6-1. Voice Mode Command Descriptions

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

Command	Default	Description
<b>+FCLASS=8</b>	<b>0</b>	<b>Voice Mode Selection:</b> This command enables or disables voice mode. All voice mode commands (except for <b>+FCLASS=n</b> ) are valid only in voice mode.
		n = 0, 1, 8
		n = 0*      Data mode
		n = 1      Class 1 fax mode
<b>+FLO=n</b>	<b>1</b>	<b>Flow Control Select:</b> 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 <DC1> character (11h); XOFF is the ASCII <DC3> character (13h). The DCE may provide ITU-T's V.24 CTS (circuit 106) and RTS (circuit 133) for flow control.
		n = 0, 1, 2
		n = 0      Disables XON/XOFF and CTS/RTS flow control
		n = 1*      Enables XON/XOFF flow control in either direction
	n = 2      The DTE uses ITU-T's RTS to control flow to the modem; the modem uses ITU-T CTS to control flow to the DTE.	

**Table 6-1. Voice Mode Command Descriptions (Continued)**

<b>+VBT=m</b>	see "m"	<p><b>Buffer Threshold Setting:</b> This command specifies the flow control assert and deassert points inside the DCE's internal transmit buffer. The internal buffer is 512 bytes. The <b>+VBT=m</b> parameters are fixed in firmware and cannot be changed.</p> <p><b>m = &lt;deassert&gt;, &lt;assert&gt;</b>          Defaults: &lt;deassert&gt; = 192, &lt;assert&gt; = 320</p> <p><b>&lt;assert&gt;:</b> 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 &lt;assert&gt; parameter. So that no data is lost before the modem stops the flow of data, the &lt;assert&gt; parameter allows more data to enter the buffer until it reaches the larger number in its range.</p> <p>Range: &lt;assert&gt; = 192</p> <p><b>&lt;deassert&gt;:</b> This parameter starts data transfer from the DTE after the number of bytes in the transmit buffer falls below the &lt;deassert&gt; value.</p> <p>Range: &lt;deassert&gt; = 320</p>
<b>+VCID=n</b>	0	<p><b>Caller ID Selection:</b> 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>n = 0–2</p> <p>n = 0*      Disables Caller ID</p> <p>n = 1      Enables Caller ID with formatted presentation to the DTE. The modem presents the data items in a &lt;Tag&gt;&lt;Value&gt; pair format. The expected pairs are data, time, caller code (phone number), and name.</p> <p>n = 2      Enables Caller ID with unformatted presentation to the DTE. The modem presents the entire packet of information, excluding the leading U's, in ASCII-printable hex numbers.</p> <p><i>Note:</i> If <b>S0=1</b> (auto-answer mode) and Caller ID is enabled in data modem mode, then the modem answers only after the second ring signal.</p>

Table 6-1. Voice Mode Command Descriptions (Continued)

---

<b>+VDR=m</b>	see "m"	<p><b>Distinctive Ring Selection:</b> 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><b>m=&lt;enable&gt;, &lt;report&gt;</b> Defaults = 0, 0</p> <p><b>&lt;enable&gt; Ring Reporting:</b> The DCE reports the length of the ring period.</p> <p>Range: &lt;enable&gt; = 0–255 (enables/disables distinctive ring reporting in the form DROF=&lt;number in units of 0.1 seconds&gt;&lt;CR&gt;&lt;LF&gt;)</p> <p><b>&lt;report&gt; Time Ring Reporting:</b> The DCE reports the silence period's length. The DCE may produce a RING event code after the DRON message if enabled by the &lt;report&gt; parameter. The &lt;report&gt; 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: &lt;report&gt; = 0–255 (reporting type in the form DROF=&lt;number in units of 0.1 seconds&gt;)</p> <table border="0" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: left; padding-right: 20px;">&lt;enable&gt;</th> <th style="text-align: left; padding-right: 20px;">&lt;report&gt;</th> <th style="text-align: left;">Function</th> </tr> </thead> <tbody> <tr> <td style="padding-right: 20px;">0</td> <td style="padding-right: 20px;">–</td> <td>Distinctive ring disabled</td> </tr> <tr> <td style="padding-right: 20px;">1</td> <td style="padding-right: 20px;">0</td> <td>The modem reports DROF and DRON messages but does not report RING messages</td> </tr> <tr> <td style="padding-right: 20px;">1</td> <td style="padding-right: 20px;">non-0</td> <td>The modem reports DROF, DRON and RING messages</td> </tr> <tr> <td style="padding-right: 20px;">2–255</td> <td style="padding-right: 20px;">–</td> <td>Reserved</td> </tr> </tbody> </table> <p>Regardless of its setting, the <b>+VDR</b> command can be disabled by the <b>+VEM</b> 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															

---

<b>+VEM=m</b>	see "m"	<p><b>Event Reporting and Masking:</b> 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.</p> <p><b>m = &lt;mask&gt;</b> Defaults = "C", BB860980, BFE63883, BB863EE0</p>
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**Table 6-1. Voice Mode Command Descriptions (Continued)**

Event Reporting and Masking: <i>(cont.)</i>					
Hex Digit Location	Event Number (Bit Number)	Event Description	DCE Voice Mode(s)		
+VEM=m <i>(cont.)</i>	see "m"	1	0	Caller ID report	Command
			1	Reserved	
			2	Distinctive ringing	All
			3 *	RING	All
			4 *	DTMF received	All
			5 *	Receive buffer overrun	Receive
			6 *	Fax calling (for example, 1100 Hz)	All
			7	Data calling (for example, 1300 Hz)	All
			8	Local phone on/off hook	All
			9 *	Presumed hang-up (SILENCE) timeout	Receive
			10 *	Presumed end of message (QUIET) timeout	Receive and command
			11	Reserved	
			12	Reserved	
			13	Loop current interruption	All
			14	Loop current polarity reversal	All
			15	Reserved	
			16	Reserved	
			17	Reserved	
			18 *	Ringback/remote ring	All
			19 *	BUSY reorder/fast busy	Receive and Command
			20 *	DIALTONE	Receive and Command
			21	Reserved	
			22	Reserved	
			23*	Transmit buffer under-run	Transmit
			24	Extension phone on/off hook	All
			25 *	Fax or data answer (for example, 2100 Hz)	Command
			26	Data answer (for example, 2225 Hz)	Command
			27	Reserved	
			28	Reserved	
			29	Reserved	
			30	Reserved	
			31	Reserved	
			32	Reserved	
			33	Reserved	
			34	Reserved	
	35	Reserved			

**NOTES:**

- 1) Items marked with an asterisk (\*) meet IS-101 Class C specifications.
- 2) All: Playback, Record, and Command modes.
- 3) Reserved: Reserved event number that should be set to zero.

**Table 6-1. Voice Mode Command Descriptions (Continued)**
**Event Reporting and Masking: (cont.)**
**Example 1. Viewing Supported Events:**

To determine what events are supported by the modem, send 'AT+VEM=?'.

```
AT+VEM=?
`C' ← Feature Class
DB860980 ← Playback mode events
OFEE0883 ← Record mode events
BB863EE0 ← Command mode events
OK
```

**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.

**+VEM=m**  
(cont.)

see "m"

```
AT+VEM=BB863EE0
```

**Example 3. Reading the Event Mask Settings:**

To read the settings for each event, type:

```
AT+VEM?
BB863EE0
OK
```

**Example 4. Understanding the +VEM Hexadecimal Code:**

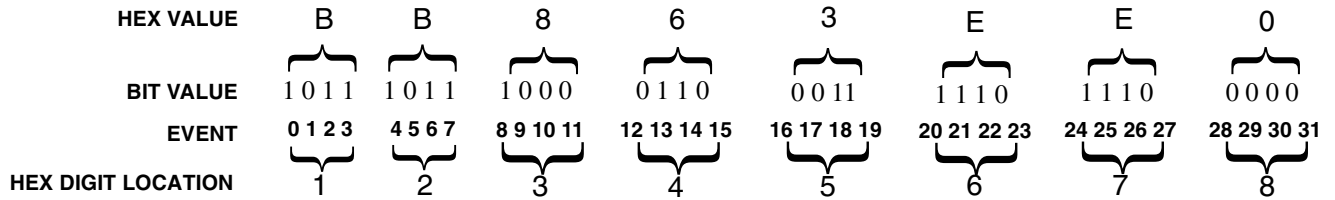
The following illustration shows how the hexadecimal eight-digit code (BB863EE0) is derived from the bit setting for each event:

HEX DIGIT LOCATION : 1 2 3 4 5 6 7 8

EIGHT-DIGIT HEX CODE: B B 8 6 3 E E 0

**Table 6-1. Voice Mode Command Descriptions (Continued)**

The following example shows how to read the string.



<b>+VGM=n</b>	<b>128</b>	<p><b>Speakerphone Microphone Gain:</b> This command sets the speakerphone’s microphone gain.</p> <p>n = 121–131</p> <p>n = 128*      Nominal value</p>
<b>+VGR=n</b>	<b>128</b>	<p><b>Receive Gain Selection:</b> 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.</p> <p>n = 121-131</p> <p>n = 128*      Nominal recording level</p>
<b>+VGS=n</b>	<b>128</b>	<p><b>Speakerphone Speaker Gain:</b> This command sets the speakerphone’s speaker gain.</p> <p>n = 121-131</p> <p>Default: n = 128*</p> <p>n = 121      Gain smaller than normal</p> <p>n = 131      Gain larger than normal</p>
<b>+VGT=n</b>	<b>128</b>	<p><b>Volume Selection:</b> 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>n = 121-131</p> <p>n = 128*      Nominal transmit level</p>

Table 6-1. Voice Mode Command Descriptions (Continued)

<b>+VIP</b>	<b>none</b>	<p><b>Initialize Parameter:</b> 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>
<b>+VIT=n</b>	<b>0</b>	<p><b>DTE / DCE Inactivity Timer:</b> 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 &lt;DLE&gt;&lt;NUL&gt; string) to the modem re-initializes this timer.</p> <p>n =0–255 (units of 1.0 second)</p> <p>n = 0*      Disables inactivity timer</p> <p>n ≠ 0      Inactivity timer active</p>



**Table 6-1. Voice Mode Command Descriptions (Continued)**

**Relay/Playback Control:** This command controls the four  $\mu$ P 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.

+VLS=n      0

Table 6-1. Voice Mode Command Descriptions (Continued)

Relay/Playback Control: (cont.)			
Voice I/O Primitive Codes			
	Primitive Code	Description	
<b>+VLS=n</b> (cont.)	0	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)
<p><i>Note:</i> For speakerphone applications, see <b>ATI10</b>, <b>+VSP</b>, and “Speakerphone AT Command Requirements” in the Voice Application Note for more details.</p>			
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.			
<b>+VNH=n</b>	0	n = 0–2	
		n = 0*	The modem retains automatic hang-ups as normal in data and fax modes
		n = 1	The modem disables automatic hang-ups usually found in non-voice modes
		n = 2	The modem disables all automatic hang-ups usually found in non-voice modes except a ‘logical’ hang-up

**Table 6-1. Voice Mode Command Descriptions (Continued)**

<b>+VRA=n</b>	<b>50</b>	<p><b>Ringback-Goes-Away Timer:</b> 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 &lt;DLE&gt;&lt;O&gt; 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.</p> <p>n = 0–50 (in 100-ms increments)  n = 0           The DCE returns the ‘OK’ code immediately after ringback.  n = 50*       (50 = 5.0 seconds)*</p>
<b>+VRN=n</b>	<b>10</b>	<p><b>Ringback-Never-Appeared Timer:</b> 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.</p> <p>n = 0–255 (in 1-second increments)  n = 0           The DCE immediately returns the OK result code after dialing  n = 10*       (10 = 10 seconds)*</p>

Table 6-1. Voice Mode Command Descriptions (Continued)

	<p><b>Record Mode:</b> This command causes the modem to enter record mode to record voice messages.</p> <p>Upon receiving the <b>AT+VRX</b> 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 &lt;DLE&gt;-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 &lt;DLE&gt;&lt;NUL&gt; 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 &lt;DLE&gt; 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 &lt;DLE&gt;&lt;ESC&gt; 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, &lt;DLE&gt;&lt;ETX&gt;, 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 &lt;DLE&gt;&lt;!&gt; to the modem while in record mode. Upon seeing &lt;DLE&gt;&lt;!&gt;, the modem terminates record mode, clears the modem's internal record buffer, and issues a &lt;DLE&gt;&lt;ETX&gt; to the DTE followed by an 'OK' message.</p> <p>The modem may immediately abort record mode if it receives either an <b>AT+VIT=n</b> time-out or a DTR toggle. If +VIT≠0 and the modem has not received any data or a &lt;DLE&gt;&lt;NUL&gt; 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 <b>&amp;Dn</b> setting. If configured for <b>&amp;D2</b> or <b>&amp;D3</b>, the modem immediately aborts record mode, hangs up the line, and changes to data mode (+FCLASS=0).</p> <p><i>Note:</i> The voice sampling rate and sampling mode must be the same values as used during record mode.</p>
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**Table 6-1. Voice Mode Command Descriptions (Continued)**

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<p><b>+VSD=m</b></p>	<p>see 'm'</p>	<p><b>Silence Detection (Quiet and Silence):</b> This command allows the DTE to set two parameters: <b>&lt;sds&gt;</b> reports the sensitivity for silence detection, and <b>&lt;sdi&gt;</b> reports the length of silence required for the DCE to report silence when receiving voice.</p> <p>The <b>&lt;DLE&gt;&lt;s&gt;</b> silence timer starts immediately after entering record mode. The modem stops using the <b>&lt;DLE&gt;&lt;s&gt;</b> timer and starts using the <b>&lt;DLE&gt;&lt;q&gt;</b> timer if:</p> <ul style="list-style-type: none"> <li>• the <b>&lt;DLE&gt;&lt;s&gt;</b> silence timer has timed out and a <b>&lt;DLE&gt;&lt;s&gt;</b> code has been sent to the DTE, or</li> <li>• if noise or voice energy has been detected above the silence detection threshold (as defined by <b>&lt;sds&gt;</b>).</li> </ul> <p><b>m = &lt;sds&gt;, &lt;sdi&gt;</b>            Defaults: m = 128, 50</p> <p><b>&lt;sds&gt; Silence Sensitivity:</b> If the received analog signal stays below this specified level for a user-specified time delay, the modem sends <b>&lt;DLE&gt;&lt;q&gt;</b> to the DTE. The modem sends only one <b>&lt;DLE&gt;&lt;q&gt;</b> to the DTE each time record mode <b>+VRX</b> is entered.</p> <p style="margin-left: 40px;"><b>&lt;sds&gt; = 121–131</b>            n = 128*      Nominal level</p> <p><b>&lt;sdi&gt; Length of Silence:</b> This parameter sets the period of silence that must elapse before the DCE reports silence (as detected by “Quiet” or “Silence”).</p> <p style="margin-left: 40px;"><b>&lt;sdi&gt; = 0–255 (units of 0.1 second)</b>            n = 0            Silence detection disabled            n = 50*        Silence detection enabled</p>
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Table 6-1. Voice Mode Command Descriptions (Continued)

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		<p><b>Compression Method Selection:</b> 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><b>m= &lt;cml&gt;, &lt;vsr&gt;, &lt;scs&gt;, &lt;sel&gt;</b>  Defaults: m = 140, 8000, 0, 0</p> <p><b>&lt;cml&gt; Compression Method:</b> This parameter selects a voice compression method. The DTE can obtain the label and a string constant identifier by using the <b>+VSM?</b> command.</p> <p>Range: &lt;cml&gt; = 0–2, 128, 129, 132, 140, 141  Default: &lt;cml&gt; = 140</p> <p>&lt;cml&gt; = 0    LIN1: 8-bit Linear PCM (pulse code modulation) sampling using twos-complement signed numbers</p> <p>&lt;cml&gt; = 1    LIN2: 16-bit Linear PCM sampling using unsigned numbers</p> <p>&lt;cml&gt; = 2    AD4: 4-bit Adaptive differential pulse code modulation</p> <p>&lt;cml&gt; = 128    LIN1: 8-bit Linear PCM (pulse code modulation) sampling using twos-complement signed numbers</p> <p>&lt;cml&gt; = 129    LIN2: 16-bit Linear PCM sampling using unsigned numbers</p> <p>&lt;cml&gt; = 132    AD4: 4-bit Adaptive differential pulse code modulation</p> <p>&lt;cml&gt; = 140*    CL1: 8-bit Intel A-law</p> <p>&lt;cml&gt; = 141    AD3: 3-bit Adaptive differential pulse code modulation</p>												
<b>+VSM=m</b>	<b>manufacturer-specified</b>													
		<p><b>&lt;vsr&gt; Sampling Rate:</b> 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 <b>+VSM=?</b> command to obtain supported sampling rates.</p> <p>Range: &lt;vsr&gt; = 4800, 7200, 8000, and 11025 samples/second  Default: &lt;vsr&gt; = 8000*</p> <table border="0"> <thead> <tr> <th style="text-align: left;"><b>&lt;vsr&gt; (samples/second)</b></th> <th style="text-align: left;"><b>Comments</b></th> </tr> </thead> <tbody> <tr> <td>4800</td> <td>Default used by previous legacy modems</td> </tr> <tr> <td>7200</td> <td></td> </tr> <tr> <td>8000</td> <td>Used by some bulletin boards</td> </tr> <tr> <td>9600</td> <td></td> </tr> <tr> <td>11025</td> <td>Used by many Windows* .WAV files</td> </tr> </tbody> </table>	<b>&lt;vsr&gt; (samples/second)</b>	<b>Comments</b>	4800	Default used by previous legacy modems	7200		8000	Used by some bulletin boards	9600		11025	Used by many Windows* .WAV files
<b>&lt;vsr&gt; (samples/second)</b>	<b>Comments</b>													
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7200														
8000	Used by some bulletin boards													
9600														
11025	Used by many Windows* .WAV files													
		<p><b>&lt;scs&gt; Silence Sensitivity:</b> 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 <b>&lt;sel&gt;</b> parameter. When transmitting voice, a non-zero value of this parameter informs the DCE that the data stream was recorded with silence compression.</p>												

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**Table 6-1. Voice Mode Command Descriptions (Continued)**

**Compression Method Selection:** *(cont.)*

**Transmission:** Range: n = 0

n = 0\* Disabled

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.

**Reception:** Range: n = 0

n = 0\* Disables DCE silence compression

n = increments of 1 Raises noise detection threshold

**<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.

	<b>&lt;cml&gt; Compression</b>	<b>&lt;vsr&gt; Sampling Rate</b>	<b>Serial Data Rate (bps)</b>	<b>UART Data Rate (bps)</b>	<b>Hard Disk (Bytes/sec.)</b>	<b>Note</b>	
<b>+VSM=m (cont.)</b>	<b>manufac- turer- specified</b>	<b>&lt;cml&gt; = CL1*</b>	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
		<b>&lt;cml&gt; = AD3</b>	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	
		<b>&lt;cml&gt; = AD4</b>	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	
		<b>&lt;cml&gt; = LIN1</b>	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
<b>&lt;cml&gt; = LIN2</b>	4800	96,000	115,200	9600	1		

**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 **AT15** 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.

Table 6-1. Voice Mode Command Descriptions (Continued)

<b>+VSP=n</b>	<b>0</b>	<p><b>Speakerphone On/Off Control:</b> 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 <b>AT+VLS=n</b> command. Typically, this means setting the off-hook relay driver, speaker, and microphone inputs with <b>AT+VLS=7</b>.</p> <p>After enabling the speakerphone mode (<b>+VSP=1</b>), 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.</p> <p>n = 0, 1  n = 0*      Speakerphone mode disabled  n = 1      Speakerphone mode enabled</p>
<b>#VSPS=n</b>	<b>1</b>	<p><b>Speakerphone Type Selection:</b> This command determines which speakerphone type is used when the modem receives a <b>+VSP=n</b> command. This allows the application software to select whether telephone emulation or digital speakerphone is used for <b>+VSP=n</b>. 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>n = 0, 1  n = 0      Telephone Emulation Mode speakerphone  n = 1*      Digital speakerphone</p>
<b>+VTD=n</b>	<b>100</b>	<p><b>Beep Tone Duration Timer:</b> This command sets the default duration of all DTMF tones.</p> <p>n = 5–255 (units of 0.01 seconds)  Default: n = 100  n = 100*      Default value (1 second)</p>



**Table 6-1. Voice Mode Command Descriptions (Continued)**

<b>+VTS=m</b>	<b>none</b>	<p><b>DTMF and Tone Generation:</b> This command causes the modem to generate DTMF tones or pulse tones in voice mode. The &lt;DLE&gt;&lt;!&gt; 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 <b>+VTS</b> sent without a parameter assumes the default value, which is a null string. The DTE may use the &lt;DLE&gt;&lt;NUL&gt;-shielded code to refresh the timer.</p> <p><b>m=&lt;string&gt;</b> The &lt;string&gt; is made up of a list of &lt;freq&gt; and &lt;duration&gt; parameters. &lt;freq&gt; is in units of Hz, and &lt;duration&gt; 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>
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Table 6-1. Voice Mode Command Descriptions (Continued)

<b>DTMF and Tone Generation: (cont.)</b>	
<b>+VTS=m</b> (cont.)	<p><b>1)</b> 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:</p> <pre>AT+VTS=&lt;DTMF or !&gt;</pre> <p>For example, to send a DTMF 1 tone, issue <code>AT+VTS=1</code> to the modem.</p> <p><b>2)</b> 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:</p> <pre>AT+VTS=[&lt;first tone freq 1&gt;, &lt;second tone freq 2&gt;, &lt;duration&gt;]</pre> <p>If the duration is not specified in the <code>&lt;duration&gt;</code> parameter, the modem sends tones for the duration specified by the <code>+VTD=n</code> command.</p> <p><b>a)</b> Single tones can be sent in brackets using the following format:</p> <pre>AT+VTS=[&lt;first tone freq 1&gt;]</pre> <p style="text-align: center;">or</p> <pre>AT+VTS=[&lt;first tone freq 1&gt;, &lt;space&gt;, &lt;duration&gt;]</pre> <p>For example: <code>AT+VTS=[3000]</code> This sends a single tone of 3000 Hz with a default duration specified by <code>+VTD=n</code>.</p> <p>For example: <code>AT+VTS=[3000,,50]</code> This sends a single tone of 3000 Hz with a duration of 500 ms (50 x 0.01 second).</p> <p><b>b)</b> Dual tones may be sent using the following format:</p> <pre>AT+VTS=[&lt;first tone freq 1&gt;,&lt;second tone freq 2&gt;]</pre> <p style="text-align: center;">or</p> <pre>AT+VTS=[&lt;first tone freq 1&gt;,&lt;second tone freq 2&gt;, &lt;duration&gt;]</pre> <p>For example: <code>AT+VTS=[3000,3300]</code> This sends a dual tone of 3000 Hz and 3300 Hz with the default duration set by the <code>+VTD=n</code> command.</p> <p>For example: <code>AT+VTS=[3000,3300,50]</code> This sends a dual tone of 3000 Hz and 3300 Hz with a duration of 500 ms (50 x 0.01 second).</p>

**Table 6-1. Voice Mode Command Descriptions (Continued)**

<b>DTMF and Tone Generation: (cont.)</b>		
		<p><b>c)</b> This command can be used to send a period of silence in a tone string. Use the following format:</p> <pre>AT+VTS=[ , , &lt;duration&gt;] AT+VTS=[ ]</pre> <p>For example: AT+VTS=[ , , 50] This sends a 500-ms period of silence.</p> <p><b>3)</b> Single DTMF tones or hookflashes are sent enclosed in braces “{}”. A duration must be included, as the duration set in <b>+VTD=n</b> does not apply.</p> <p>Use the following format:</p> <pre>AT+VTS={ &lt;DTMF or !&gt; , &lt;duration&gt; }</pre> <p>For example: AT+VTS={ 2 , 30 } This command sends DTMF tone 2 with a duration of 300 ms.</p> <p>For example: AT+VTS={ ! , 50 } This command sends a hook flash with a duration of 500 ms.</p>
<b>+VTS=m</b> (cont.)	<b>none</b>	<p>Send multiple DTMF signals and tones by combining elements in a given <b>+VTS=m</b> command string. For example:</p> <pre>AT+VTS={ ! , 30 } , 1 , 2 , [ 1000 , 1300 , 50 ] , ! , { * , 6 } , [ 1000 ] , 9</pre> <p>This command line programs the following events:</p> <ol style="list-style-type: none"> <li>1. Hook-flash with a duration of 300 ms.</li> <li>2. Send DTMF 1 for the duration specified by <b>+VTD</b> command.</li> <li>3. Send DTMF 2 for the duration specified by <b>+VTD</b> command.</li> <li>4. Send tone pair 1000 Hz and 1300 Hz for a duration of 500 ms.</li> <li>5. Hook-flash with a duration specified by <b>+VTD</b> command.</li> <li>6. Send DTMF * for a duration of 60 ms.</li> <li>7. Send tone 1000 Hz for a duration specified by the <b>+VTD</b> command.</li> <li>8. Send DTMF 9 for the duration specified by <b>+VTD</b> command.</li> </ol> <p>For example:</p> <pre>AT+VTS=1 , [ , , 50 ] , 2 , [ ] , 9</pre> <p>This command line programs the following events:</p> <ol style="list-style-type: none"> <li>1. Send DTMF 1 for the duration specified by <b>+VTD</b> command.</li> <li>2. Play silence for a duration of 500 ms.</li> <li>3. Send DTMF 2 for the duration specified by <b>+VTD</b> command.</li> <li>4. Play silence for a duration specified by <b>+VTD</b> command.</li> <li>5. Send DTMF 9 for the duration specified by <b>+VTD</b> command.</li> </ol>

**Table 6-1. Voice Mode Command Descriptions (Continued)**

	<p><b>Play Mode:</b> This command causes the modem to start voice transmission (play-back mode) and play back a previously recorded voice message.</p> <p>Upon receiving the <b>AT+VTX</b> command, the modem responds to the DTE with a “CONNECT” message at the current DTE-to-modem rate. It is important that the UART’s 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 <b>AT+FLO=n</b>. 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><b>+VTX</b>                      <b>none</b></p> <p>Playing mode is terminated when the data is exhausted and the modem receives the two terminating characters &lt;DLE&gt;&lt;ETX&gt; from the DTE. Upon detecting &lt;DLE&gt;&lt;ETX&gt;, 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 &lt;DLE&gt;&lt;CAN&gt;&lt;DLE&gt;&lt;ETX&gt;. The modem aborts playback mode immediately in two other situations: during a <b>AT+VIT=n</b> 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 &lt;DLE&gt;&lt;NUL&gt; 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 <b>&amp;Dn</b> setting. If configured for <b>&amp;D2</b> or <b>&amp;D3</b>, then the modem immediately aborts playback mode, hangs up the line, and switches to data mode (+FCLASS=0).</p> <p><i>Note:</i> The voice sampling rate and sampling mode must be the same values used during record mode.</p>
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## 7. S-REGISTERS

The MD566X 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 7-1. S-Register Command Descriptions**

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

Command	Default	Description
<b>S0</b>	<b>0</b>	<p><b>Number of Rings to Auto-Answer On:</b> 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>n = 0            Auto-answer mode disabled  n = 1-255        Auto-answer mode enabled</p> <p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>1) If Caller ID is enabled (<b>+VCID=<math>n</math></b>), then the modem only answers after the second ring even if S0=1.</li> <li>2) Setting n &gt; 2 causes the modem to answer on the <math>n^{\text{th}}</math> ring signal.</li> </ol>
<b>S1</b>	<b>0</b>	<p><b>Ring Count:</b> 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  Default: 0 rings</p>
<b>S2</b>	<b>43</b>	<p><b>Escape Character:</b> 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  Default: 43 (“+”)</p>

Table 7-1. S-Register Command Descriptions (Continued)

S3	13	<p><b>Carriage Return Character:</b> S3 specifies the AT command string terminator and modem response code terminator. The factory default is a &lt;CR&gt; or carriage return (ASCII decimal 13).</p> <p>Range: 0–127 Default: 13 (Carriage Return)</p>
S4	10	<p><b>Line Feed Character:</b> S4 specifies the line feed character, which is used for verbose (text) modem result codes.</p> <p>Range: 0-127 Default: 10 (line feed)</p>
S5	8	<p><b>Backspace Character:</b> 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.</p> <p>Range: 0–32, 127 Default: 8 (BS)</p>
S6	2	<p><b>Wait Before Blind Dialing:</b> 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 <b>X0</b>, <b>X1</b>, and <b>X3</b> (that is, blind-dialing types of result codes). Result code types <b>X2</b> and <b>X4</b> enable dial-tone detection and ignore the contents of S6.</p> <p>Range: 2–255 seconds Default: 2 seconds</p>
S7	60	<p><b>Wait for Carrier/Dial Tone:</b> 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.</p> <p>S7 also specifies the time duration for the '@' (wait for quiet answer) dial modifier.</p> <p>Range: 1–255 seconds Default: 60 seconds</p>
S8	2	<p><b>Pause Time for Dial Modifier:</b> 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.</p> <p>Range: 0–255 seconds Default: 2 seconds</p>

**Table 7-1. S-Register Command Descriptions (Continued)**

<b>S9</b>	<b>6</b>	<p><b>Carrier Detect Recovery Time:</b> 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.</p> <p>Range: 1–255 (1/10 of a second) Default: 6 (equals 0.6 seconds)</p>
<b>S10</b>	<b>14</b>	<p><b>Lost Carrier Hang Up Delay:</b> For modes V.34, V.90 and V.92, the modem retries the connection for S10 plus some base time before hanging up. The base time is 20 seconds in V.34 and 45 seconds in V.90 and V.92.</p> <p>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.</p> <p>In V.34, V.90 and V.92 modes, the modem automatically retries the connection for 45 seconds when S10 = 1–254.</p> <p>For all modes, the modem does not disconnect upon loss of the remote modem carrier if S10 is 255.</p> <p>Range: 0–255 (1/10 of a second) Default: 14 (equals 1.4 seconds)</p>
<b>S11</b>	<b>70</b>	<p><b>DTMF Dialing Speed:</b> S11 specifies the duration of dual-tone multi-frequency (DTMF) dialing. This register is not used for pulse dialing.</p> <p>Range: 50-255 ms Default: 70 ms</p>
<b>S12</b>	<b>50</b>	<p><b>Guard Time:</b> 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) Default: 50 (equals 1 second)</p>

Table 7-1. S-Register Command Descriptions (Continued)

		<b>Bit-Mapped Options:</b> S14 is a read-only register that indicates AT command settings.	
<b>S14</b>	<b>138</b>	Bit 0	Reserved
		Bit 1	0 <b>E0</b> is selected 1* <b>E1</b> is selected
		Bit 2	0* <b>Q0</b> is selected 1 <b>Q1</b> is selected
		Bit 3	0 <b>V0</b> is selected 1* <b>V1</b> is selected
		Bit 4	Reserved
		Bit 5	0* T (tone) dial is selected 1 P (pulse) dial is selected
		Bit 6	Reserved
		Bit 7	0 Answer 1* Originate
<b>S16</b>	<b>0</b>	Bit 0	0* Local analog loopback disabled 1 Local analog loopback enabled ( <b>&amp;T1</b> )
		Bit 1	Reserved
		Bit 2–5	Reserved
		Bit 6	0* Analog loopback with self-test disabled 1 Analog loopback with self-test enabled ( <b>&amp;T8</b> )
		Bit 7	0* Reserved 1 Reserved
<b>S18</b>	<b>0</b>	Range: 0–255 seconds Default: 0 seconds	



**Table 7-1. S-Register Command Descriptions (Continued)**

		<b>Bit-Mapped Options:</b> S21 is a read-only register that indicates AT command settings.		
<b>S21</b>	<b>48</b>	Bit 0	Reserved	
		Bit 1	Reserved	
		Bit 2	Reserved	
		Bits 4-3	00	<b>&amp;D0</b> is selected
			01	<b>&amp;D1</b> is selected
			10*	<b>&amp;D2</b> is selected
			11	<b>&amp;D3</b> is selected
		Bit 5	0	<b>&amp;C0</b> is selected
			1*	<b>&amp;C1</b> is selected
		Bit 6	0*	<b>&amp;S0</b> is selected
1	<b>&amp;S1</b> is selected			
Bit 7	0*	<b>Y0</b> is selected		
	1	<b>Y1</b> is selected		
		<b>Bit-Mapped Options:</b> S22 is a read-only register that indicates AT command settings.		
<b>S22</b>	<b>118</b>	Bits 1-0	00	<b>L0</b> is selected
			01	<b>L1</b> is selected
			10*	<b>L2</b> is selected
			11	<b>L3</b> is selected
		Bits 3-2	00	<b>M0</b> is selected
			01*	<b>M1</b> is selected
			10	<b>M2</b> is selected
			11	<b>M3</b> is selected
		Bits 6-4	000	<b>X0</b> is selected
			001	Reserved
			010	Reserved
			011	Reserved
			100	<b>X1</b> is selected
			101	<b>X2</b> is selected
			110	<b>X3</b> is selected
			111*	<b>X4</b> is selected
		Bit 7	0*	<b>&amp;P0</b> is selected
1	<b>&amp;P1</b> is selected			

Table 7-1. S-Register Command Descriptions (Continued)

			<b>Bit-Mapped Options:</b> S23 is a read-only register that indicates AT command settings.	
<b>S23</b>	<b>none</b>	Bit 0		Reserved
		Bits 3-1	000	0-300 bps communications rate
			001	1200 bps
			010	2400 bps
			011	4800 bps
			100	Reserved
			101	9600 bps
			110	19,200 bps
			111	≥38.4 bps
		Bit 5,4	00	Even parity/space parity
			01	No parity
			10	Odd parity/mark
			11	Reserved
		Bit 7,6	00	<b>&amp;G0</b> is selected
	01	<b>&amp;G1</b> is selected		
	10	<b>&amp;G2</b> is selected		
	11	Reserved		
<b>S25</b>	<b>5</b>	<b>Detect DTR Change:</b> 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 <b>&amp;Dn</b> command. A change in DTR that persists for a shorter time than the value specified in S25 is ignored by the modem (see the <b>&amp;Dn</b> command).		
		Range: 0–255 (1/100 of a second)		
			<b>Bit-Mapped Options:</b> S27 is a read-only register that indicates AT command settings.	
<b>S27</b>	<b>64</b>	Bits 3,1,0	000*	<b>&amp;Q0</b> is selected
			001	Reserved
			010	Reserved
			011	Reserved
			100	Reserved
			101	Not used
			110	Not used
			111	Not used
		Bits 2, 4, 5		Reserved
		Bits 7,6	00	<b>B0</b> is selected
			01*	<b>B1</b> is selected
			10	<b>B2</b> is selected
			11	<b>B3</b> is selected

**Table 7-1. S-Register Command Descriptions (Continued)**

<b>S30</b>	<b>0</b>	<p><b>Disconnect Inactivity Timer:</b> 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, <b>S30</b> is ignored (that is, the modem does <i>not</i> automatically hang up the line after a given time delay).</p> <p>Range: n = 0–255 minutes</p> <p>n = 0            Disabled</p>		
		<p><b>Bit-Mapped Options:</b> S31 is a read-only register that indicates AT command settings.</p>		
<b>S31</b>	<b>49</b>	Bit 0	0	<b>N0</b> is selected
			1*	<b>N1</b> is selected
		Bit 1	0*	<b>&amp;U0</b> is selected
			1	<b>&amp;U1</b> is selected
		Bit 2		Reserved
		Bit 3	0*	<b>-C0</b> is selected
			1	<b>-C1</b> is selected
		Bit 4	0	<b>%E0</b> is selected
			1*	<b>%E1</b> is selected
		Bit 5	0	<b>%G0</b> is selected
	1*	<b>%G1</b> is selected		
Bit 6, 7		Reserved		

Table 7-1. S-Register Command Descriptions (Continued)

S33	10	<p><b>Sleep Mode Timer:</b> S33 determines when the modem enters sleep or power-down mode. When enabled (S33 <math>\neq</math> 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> <ol style="list-style-type: none"> <li>1) No internal processing is being performed;</li> <li>2) No activity occurs between the host and the modem within a specified time period;</li> <li>3) The modem is off-line.</li> </ol> <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>
S37	0	<p><b>Maximum Line Speed Attempted:</b> This S-register selects the maximum line speed allowable (that is, the modem attempts to connect at this speed or falls back to a lower speed). Settings for Bn, +MS=m, Nn, and S37 determine the allowable modem connections. S37 provides the same information as the +MS=m <i>&lt;max rate&gt;</i> parameter. Changing the +MS=m <i>&lt;max rate&gt;</i> parameter automatically changes the value of S37. For example, setting +MS=m <i>&lt;max rate&gt;</i> to 0 sets S37 to 0. Note that S37 has no effect during V.32 bis retraining/rate negotiation.</p>

**Table 7-1. S-Register Command Descriptions (Continued)**

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Maximum Line Speed Attempted: (cont.)		
		n = 0–35
		n = 0*      DTE rate
		n = 1      Reserved
		n = 2      Reserved
		n = 3      300
		n = 4      Reserved
		n = 5      1200
		n = 6      2400
		n = 7      4800
		n = 8      7200
		n = 9      9600
		n = 10     12,000
		n = 11     14,400
		n = 12     16,800
		n = 13     19,200
		n = 14     21,600
		n = 15     24,000
<b>S37</b>	<b>0</b>	n = 16     26,400
		n = 17     28,800
		n = 18     31,200
		n = 19     33,600
		n = 20     36,000
		n = 21     33,333
		n = 22     37,333
		n = 23     41,333
		n = 24     42,666
		n = 25     44,000
		n = 26     45,333
		n = 27     46,666
		n = 28     48,000
		n = 29     49,333
		n = 30     50,666
		n = 31     52,000
		n = 32     53,333
		n = 33     54,666 <sup>a</sup>
		n = 34     56,000 <sup>a</sup>
		n = 35     57,333 <sup>a</sup>

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- a. Current download speeds are limited to 53,333 bps due to FCC rules that restrict modem power output.

## 8. CALLER ID

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 <MESG> <=> <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 8-1. 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.
MESG	MESG = <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 MESG 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
```



## 9. MANUFACTURING-ONLY COMMANDS

The following commands are provided for manufacturing and testing purposes only. These commands should not be included in end-user literature.

**Caution:** Serious damage to the controller may occur if these commands are implemented incorrectly.

The test commands **AT+FTTn** and **AT+FRTn** allow the modem manufacturer to test the fax transmit and receive modes during manufacturing testing.

The MD566X chipsets include three commands (**#VGPO=n**, **AT#VGP1=n**, and **AT#VGP2=n**) that may be used by modem manufacturers to provide additional or unique features. These commands should **not** be used by general-purpose software packages.

**Table 9-1. Manufacturing-Only Command Descriptions**

Command	Default	Description																										
		<p><b>Country Select:</b> This command is for international use. It sets the country-specific parameters, including S-register settings. The command checks whether an entered country code matches one of the codes stored in EPROM. If so, the entered code is stored in NVRAM. This code is loaded from NVRAM upon power-up or soft reset. The default value is used if no NVRAM is installed or if the NVRAM failed the self-test during reset.</p> <p>In the case of virgin NVRAM, the country code is not initialized, and the country code '0' will be loaded as a default. This may cause an anomaly such as dial tone detection. The <b>AT*NCn;&amp;W</b> (n=0 to 9) command is required to avoid this anomaly from power-up. The commands <b>AT&amp;F</b> and <b>ATZ</b> do not change the country code after the country is selected by the <b>AT*NCn;&amp;W</b> command. The command <b>ATI6</b> shows the specific country where that modem operates. The command <b>AT*NCn</b> followed by <b>AT&amp;W</b> has the same effect as the <b>AT*NCn;&amp;W</b> command.</p>																										
<b>*NCnn</b>	<b>0</b>	<table> <tr><td>n = 0*</td><td>United States</td></tr> <tr><td>n = 1</td><td>Japan</td></tr> <tr><td>n = 2</td><td>United Kingdom</td></tr> <tr><td>n = 3</td><td>Germany</td></tr> <tr><td>n = 4</td><td>Sweden</td></tr> <tr><td>n = 5</td><td>Denmark</td></tr> <tr><td>n = 6</td><td>Finland</td></tr> <tr><td>n = 7</td><td>Norway</td></tr> <tr><td>n = 8</td><td>Austria</td></tr> <tr><td>n = 9</td><td>CTR21</td></tr> <tr><td>n = 10</td><td>Russia</td></tr> <tr><td>n = 11</td><td>Australia</td></tr> <tr><td>n = 12</td><td>Malaysia</td></tr> </table>	n = 0*	United States	n = 1	Japan	n = 2	United Kingdom	n = 3	Germany	n = 4	Sweden	n = 5	Denmark	n = 6	Finland	n = 7	Norway	n = 8	Austria	n = 9	CTR21	n = 10	Russia	n = 11	Australia	n = 12	Malaysia
n = 0*	United States																											
n = 1	Japan																											
n = 2	United Kingdom																											
n = 3	Germany																											
n = 4	Sweden																											
n = 5	Denmark																											
n = 6	Finland																											
n = 7	Norway																											
n = 8	Austria																											
n = 9	CTR21																											
n = 10	Russia																											
n = 11	Australia																											
n = 12	Malaysia																											

Table 9-1. Manufacturing-Only Command Descriptions (Continued)

!P=m	none	<p><b>Set Plug-and-Play Board Serial Number:</b> This command sets the serial number for the plug-and-play board using four fields (or bytes) of eight bits each.</p> <p><i>m = Byte 3, Byte 2, Byte 1, Byte 0</i></p> <p>Byte = 0–255</p> <p>m = (0–255), (0–255), (0–255), (0–255)</p> <p>For example:</p> <p style="padding-left: 40px;">!P = 250, 0, 125, 1</p>
S91	10	<p><b>Data Transmit Level:</b> This S-register sets the modem's transmit level for the data mode. This value is stored in the NVRAM but is not displayed by the <b>&amp;Vn</b> command. The reset commands <b>&amp;F</b> and <b>Zn</b> have no effect on S91.</p> <p>Since the function of S91 relates to modem hardware, this command should <b>only</b> be used by the modem manufacturer and <b>never</b> used by a software developer or end user.</p> <p>In some countries, the end user is not allowed to change the transmit level. In these countries, the country PTT checks to make sure that the end user can not change the transmit level.</p> <p>Range: 0 to 15 (-15 dBm) Default: 10* (-10 dBm)</p>
S92	10	<p><b>Fax Transmit Level:</b> This S-register sets the modem's transmit level for the fax mode. This value is stored in the NVRAM but is not displayed by the <b>&amp;V</b> command. The reset commands <b>&amp;F</b> and <b>Zn</b> have no effect on S92.</p> <p>Since the function of S92 relates to modem hardware, this command should <b>only</b> be used by the modem manufacturer and <b>never</b> used by a software developer or end user.</p> <p>In some countries, the end user is not allowed to change the transmit level. In these countries, the country PTT checks to make sure that the end user can not change the transmit level.</p> <p>Range: 0 to 15 (-15 dBm) Default: 10* (-10 dBm)</p>

**Table 9-1. Manufacturing-Only Command Descriptions (Continued)**

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**Tone Test Command:** This command outputs the corresponding tones for testing DTMF, ALB and FAX.

**Tone Test:**

\$TTnn	00	<p>n = 00 DTMF digit 0 {941, 1336}</p> <p>n = 01 DTMF digit 1 {697, 1209}</p> <p>n = 02 DTMF digit 2 {697, 1336}</p> <p>n = 03 DTMF digit 3 {697, 1477}</p> <p>n = 04 DTMF digit 4 {770, 1209}</p> <p>n = 05 DTMF digit 5 {770, 1336}</p> <p>n = 06 DTMF digit 6 {770, 1477}</p> <p>n = 07 DTMF digit 7 {852, 1209}</p> <p>n = 08 DTMF digit 8 {852, 1336}</p> <p>n = 09 DTMF digit 9 {852, 1477}</p> <p>n = 0A DTMF digit * {941, 1209}</p> <p>n = 0B DTMF digit # {941, 1477}</p> <p>n = 0C DTMF digit A {697, 1633}</p> <p>n = 0D DTMF digit B {770, 1633}</p> <p>n = 0E DTMF digit C {852, 1633}</p> <p>n = 0F DTMF digit D {941, 1633}</p> <p>n = 10 V.21 chn 1 mark (orig), 980 Hz</p> <p>n = 11 V.21 chn 2 mark, 1650 Hz</p> <p>n = 12 V.23 backward chnl mark, 390 Hz</p> <p>n = 13 V.23 forward chnl mark, 1300 Hz</p> <p>n = 19 V.21 channel 1 space, 1180 Hz</p> <p>n = 1A V.21 channel 2 space, 1850 Hz</p> <p>n = 1B V.23 backward channel space, 450 Hz</p> <p>n = 1C V.23 forward channel space, 2100 Hz</p> <p>n = 30 silence</p> <p>n = 31 V.25 Answer Tone, 2100 Hz</p> <p>n = 32 Guard Tone (Data/Fax answer mode), 1800 Hz</p> <p>n = 33 V.25 Calling Tone, 1300 Hz</p> <p>n = 34 FAX Calling Tone, 1100 Hz</p> <p>n = 35 Data Answer Tone (Bell mode), 2225 Hz</p> <p>n = 36 Guard Tone (Data/FAX answer mode), 550 Hz</p>
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Table 9-1. Manufacturing-Only Command Descriptions (Continued)

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<b>Tone Test Command, Continued:</b>	
<b>Analog Loopback (ALB) Test:</b>	
	n = 15 V.22 ALB, originate
	n = 16 V.22 bis ALB, originate
	n = 17 V.22 ALB, answer
	n = 18 V.22 bis ALB, answer
	n = 20 V.32 ALB, 9600, originate
	n = 21 V.32 bis ALB, answer
	n = 60 V.34 ALB, 2400bps
	n = 61 V.34 ALB, 4800bps
	n = 62 V.34 ALB, 7200bps
	n = 63 V.34 ALB, 9600bps
	n = 64 V.34 ALB, 12000bps
	n = 65 V.34 ALB, 14400bps
	n = 66 V.34 ALB, 16800bps
	n = 67 V.34 ALB, 19200bps
	n = 68 V.34 ALB, 21600bps
	n = 69 V.34 ALB, 24000bps
<b>\$TTnn</b>	<b>00</b>
	n = 6a V.34 ALB, 26400bps
	n = 6b V.34 ALB, 28800bps
	n = 6c V.34 ALB, 31200bps
	n = 6d V.34 ALB, 33600bps
<b>FAX Test:</b>	
	n = 40 FAX configure V.27, 300bps
	n = 41 FAX configure V.27, 2400bps
	n = 42 FAX configure V.27, 4800bps
	n = 43 FAX configure V.29, 7200bps
	n = 44 FAX configure V.29, 9600bps
	n = 45 FAX configure V.17, 7200bps long train
	n = 46 FAX configure V.17, 7200bps short train
	n = 47 FAX configure V.17, 9600bps long train
	n = 48 FAX configure V.17, 9600bps short train
	n = 49 FAX configure V.17, 12000bps long train
	n = 4a FAX configure V.17, 12000bps short train
	n = 4b FAX configure V.17, 14400bps long train
	n = 4c FAX configure V.17, 14400bps short train

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**Table 9-1. Manufacturing-Only Command Descriptions (Continued)**

**Read/Write General-Purpose Pins:** These commands allow the DTE to set the modem signal level at the general-purpose input-output pins (GPIO0-GPIO23) to  $V_{CC}$  or ground. The **AT#VGP0-2?** commands allow the DTE to read the signals applied at these pins.

	<b>Command</b>	<b>Bit</b>	<b>Pins</b>
<b>#VGP0=n</b> <b>#VGP1=n</b> <b>See Note 1</b> <b>#VGP2=n</b>	#VGP0	0	Read/write general-purpose pin 0
		1	Read/write general-purpose pin 1
		2	Read/write general-purpose pin 2
		3	Read/write general-purpose pin 3
		4	Read/write general-purpose pin 4
		5	Read/write general-purpose pin 5
		6	Read/write general-purpose pin 6
		7	Read/write general-purpose pin 7
	#VGP1	0	Read/write general-purpose pin 8
		1	Read/write general-purpose pin 9
		2	Read/write general-purpose pin 10
		3	Read/write general-purpose pin 11
		4	Read/write general-purpose pin 12
		5	Read/write general-purpose pin 13
		6	Read/write general-purpose pin 14
		7	Read/write general-purpose pin 15
	#VGP2	0	Read/write general-purpose pin 16
		1	Read/write general-purpose pin 17
		2	Read/write general-purpose pin 18
		3	Read/write general-purpose pin 19
		4	Read/write general-purpose pin 20
		5	Read/write general-purpose pin 21
		6	Read/write general-purpose pin 22
		7	Read/write general-purpose pin 23

**NOTES:**

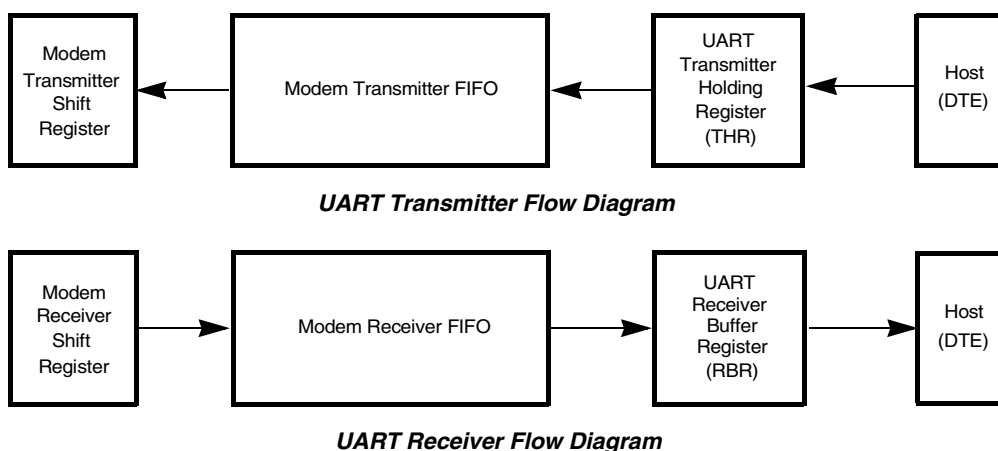
- 1) Default values for #VGP0–#VGP2 are dependent on board design.
- 2) These commands should not be used in general-purpose application software.



## 10. PARALLEL HOST INTERFACE 16C450/16C550A UART

The parallel host interface of the MD566X 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 10-1. 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.

Table 10-1. 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.



## 10.1 UART Register Definitions

### 10.1.1 Scratch Register (SCR)



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

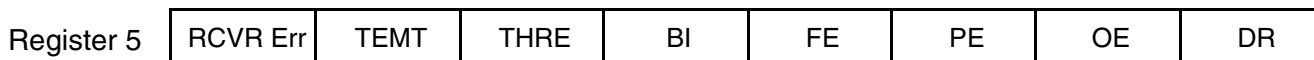
### 10.1.2 Modem Status Register (MSR)



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  $\mu$ P HINT pin whenever MSR bits 3:0 are set to ‘1’.

Bit 7	<b>Data Carrier Detect (DCD)</b> —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	<b>Ring Indicate (RI)</b> —This bit indicates when a ring signal has been detected.
Bit 5	<b>Data Set Ready (DSR)</b> —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	<b>Clear To Send (CTS)</b> —When this bit is set to “1”, it indicates to the DTE that the modem is ready to receive data.
Bit 3	<b>Delta Data Carrier Detect (DDCDD)</b> —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	<b>Trailing Edge of Ring Indicator (TERI)</b> —This bit is set to “1” after the RI signal goes from a high to low state.
Bit 1	<b>Delta Data Set Ready (DDSR)</b> —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	<b>Delta Clear to Send (DCTS)</b> —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.

### 10.1.3 Line Status Register (LSR)



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	<b>Error in RCVR FIFO</b> —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	<b>TEMT (Transmitter Empty)</b> —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	<b>THRE (Transmitter Holding Register Empty)</b> —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	<b>BI (Break Interrupt)</b> —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	<b>FE (Framing Error)</b> —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 resynchronize 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	<b>PE (Parity Error)</b> —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	<b>OE (Overrun Error)</b> —Not supported.
Bit 0	<b>Data Ready</b> —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.

#### 10.1.4 Modem Control Register (MCR)

Register 4	0	0	0	Loop	Out 2	Out 1	RTS	DTR
------------	---	---	---	------	-------	-------	-----	-----

This register controls the DTE-DCE UART interface.

Bit 7:5	<b>Not used</b> —These bits are permanently set to “0”.
Bit 4	<p><b>Loop Bit</b>—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).</p> <p>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.</p> <p>Unlike a real 16C450 UART, the modem signals OUT1*, OUT2*, RTS*, and DTR* are not looped back to the MSR register.</p>
Bit 3	<b>Out 2</b> —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	<b>Out 1</b> —This read/write bit is not used for any specific functions.
Bit 1	<b>RTS (Request to Send)</b> —This bit when set to “1”, indicates that the DTE is ready to send data to the modem.
Bit 0	<b>DTR (Data Terminal Ready)</b> —When set to “1”, this bit indicates that the DTE is read to establish a communication link.

### 10.1.5 Line Control Register (LCR)

Register 3	DLAB	SBRK	SPAR	EPS	PEN	STB	WLS1	WLS0
------------	------	------	------	-----	-----	-----	------	------

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	<b>Divisor Latch Access Bit (DLAB)</b> – 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	<p><b>SBRK (Set Break)</b>—This bit is used to send a long-space disconnect message to the remote modem. The procedure is as follows:</p> <ol style="list-style-type: none"> <li>1)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.</li> <li>2)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).</li> <li>3)To return to normal transmission mode, wait for the TEMT to be equal to “1”, then reset the SBRK bit.</li> </ol>
Bit 5	<b>SPAR (Stick Parity)</b> —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	<b>EPS (Even Parity Select)</b> —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	<p><b>PEN (Parity Enable)</b>—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.</p> <p><b>NOTE:</b> 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.</p>

Bit 2	<b>Number of Stop Bits (STB)</b> – 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	<b>Word Length Select Bits (WLS1 and WLS0)</b> – These two bits specify the data character word length of the transmitted and received data. The supported word lengths are provided below.		
	<b>Bit 1</b>	<b>Bit 0</b>	<b>Word Length</b>
	0	0	5 bits
	0	1	6 bits
	1	0	7 bits
	1	1	8 bits

### 10.1.6 FIFO Control Register (FCR)

Register 2  
(write-only)

RCVR Trig.	RCVR Trig.	Reserved	Reserved	DMA	XFIFOR	RFIFOR	FIFOE
------------	------------	----------	----------	-----	--------	--------	-------

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.

Bits 7:6	<b>MSB and LSB (RCVR Trigger Bits)</b> –FCR bits 7 and 6 are used to set the trigger level for the RCVR FIFO interrupt.		
	<b>Bit 7</b>	<b>Bit 6</b>	<b>RCVR FIFO Trigger Level (Bytes)</b>
	0	0	01
	0	1	04
	1	0	08
	1	1	14
Bits 5:3	<b>Reserved</b> –Bits 5, 4, and 3 are reserved for future enhancements.		
Bit 2	<b>XFIFOR (XMIT FIFO Reset)</b> –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	<b>RFIFOR (RCVR FIFO Reset)</b> –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	<b>FIFOE (FIFO Enable)</b> –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.		

### 10.1.7 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 10-2. 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	<b>FIFOs Enable Bits</b> —These two bits are set whenever FCR0 = 1.
Bits 5	<b>Not used</b> —This bit is permanently set to “0”.
Bit 4	<b>Reserved</b>
Bit 3	<b>Interrupt ID Bit 2</b> —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	<b>Interrupt ID Bits ID0 and ID1</b> —These two bits are used to identify the highest-priority interrupt as shown in Table 10-2.

Bit 0	<b>Interrupt Pending</b> —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).
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### 10.1.8 Interrupt Enable Register (IER)

Register 1 (DLAB = 0)	0	0	0	0	MSIE	RLSIE	THREIE	RDAIE
--------------------------	---	---	---	---	------	-------	--------	-------

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  $\mu$ 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	<b>Not used</b> —These bits are permanently set to “0”.
Bit 3	<b>MSIE (Modem Status Interrupt Enabled)</b> —when set to “1”, this bit enables the modem status interrupt.
Bit 2	<b>RLSIE (Receiver Line Status Interrupt Enabled)</b> —when set to “1”, this bit enables the receiver line status interrupt.
Bit 1	<b>THREIE (Transmitter Holding Register Empty Interrupt Enabled)</b> —when set to “1”, this bit enables the Transmitter Holding register empty interrupt.
Bit 0	<b>RDAIE (Received Data Available Interrupt Enabled)</b> —when set to “1” Programmer’s Guide, this bit enables the received data available interrupt.

### 10.1.9 Transmitter Holding Register (THR)

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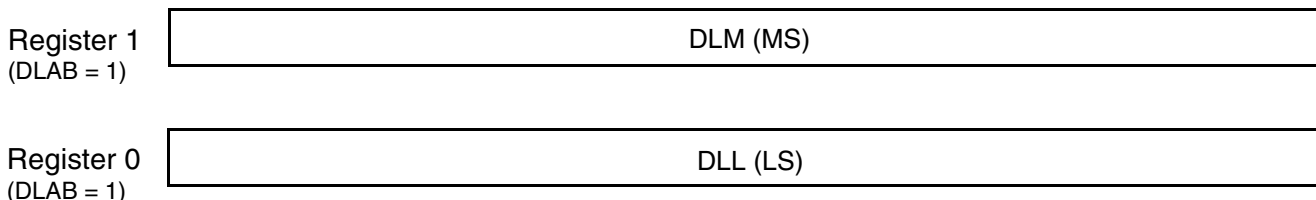
The THR (Transmitter Holding register) is a write-only register used for sending data and AT commands to the modem.

### 10.1.10 Receiver Buffer Register (RBR)

Register 0 (DLAB = 0)	RBR
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The RBR (Receiver Buffer register) is a read-only register used for receiving data and AT command responses from the modem.

### 10.1.11 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 10-3. 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

## 10.2 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.

### 10.2.1 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.

### 10.2.2 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





