56K Controllerless Modem FastPath™ Programmer's Guide

Modem Telephony Applications Engineering
Cirrus Logic Inc.

Scope and Applicability

This Programmer's Guide presents information about the CL-MD562X data/fax/voice chipsets.

Related Cirrus Logic Documents

- *CL-MD562X Data Book*
- AN-MD29 *IS-101 Voice Applications*
- AN-MD3 *Class 1 Fax*

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Appendixes

1. INTRODUCTION

The *CL-MD562X Programmer's Guide* describes the software interface of Cirrus Logic's controllerless modem FastPath™ two- or three-chip solutions. The controllerless modem chipsets eliminate the need for a dedicated modem controller by using the processing power of the host controller. This 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 Cirrus Logic publications: the *CL-MD562X Data Book*, the *IS-101 Voice Application Note* (AN-MD29), and the *Class 1 Fax Application Note* (AN-MD3). Please note that supported AT commands are firmware revision-dependent. The CL-MD562X chipsets feature a firmware configuration utility that allows the manufacturer to change many of the factory default values. For more information on this utility, please contact one of the Cirrus Logic sales offices listed on the back of this document.

Like the earlier solutions from Cirrus Logic, the controllerless modem family of products support a variety of applications without the need of additional firmware development. The CL-MD562X solutions described in Table 1-1 are currently available except as noted.

Table 1-1. Controllerless Modem Chipset Descriptions

Chipsets	Number of Devices	Features
CL-MD5620T/ CL-MD3420T	2	The CL-MD5620T sends data at 33.6 kbps and receives data at up to 56 kbps. The CL-MD3420T sends and receives data at 33.6 kbps. Both chipset types send and receive fax at 14.4 kbps. The chipsets also include telephone answering machine functions, telephone emulation, and support for Caller ID. Future upgrade option of ITU-V.80 videoconferencing.
CL-MD5622T/ CL-MD3422T	3	Same features as the CL-MD5620T/CL-MD3420T, plus full-duplex Speaker-phone mode with internal echo cancellation and an extra SAFE.

1.1 Controllerless Modem Driver Overview

When the controllerless modem chipsets are used with Microsoft® Windows applications, the traditional UART and serial port emulations are replaced by the proprietary CLM Port driver (see Figure 1-1 on page 6). Instead of transferring commands to UART virtual registers, then to a serial port, the CLM Port Driver sends commands directly to the Windows virtual machine driver VCOMM.VxD. This low-level communication driver supports the Win16 and Win32 Communication APIs.

When the controllerless chipsets are used with MS-DOS® applications, however, a UART emulation is required. Cirrus Logic provides an additional driver called CLM_DBS.VxD, which includes a UART emulation. Please refer to Section 10.1 on page 84 for an explanation of the CL-MD562X UART emulation. The CLM_DBS.VxD driver interacts directly with the VCOMM.VxD driver using the Win16 and Win32 Communication APIs.

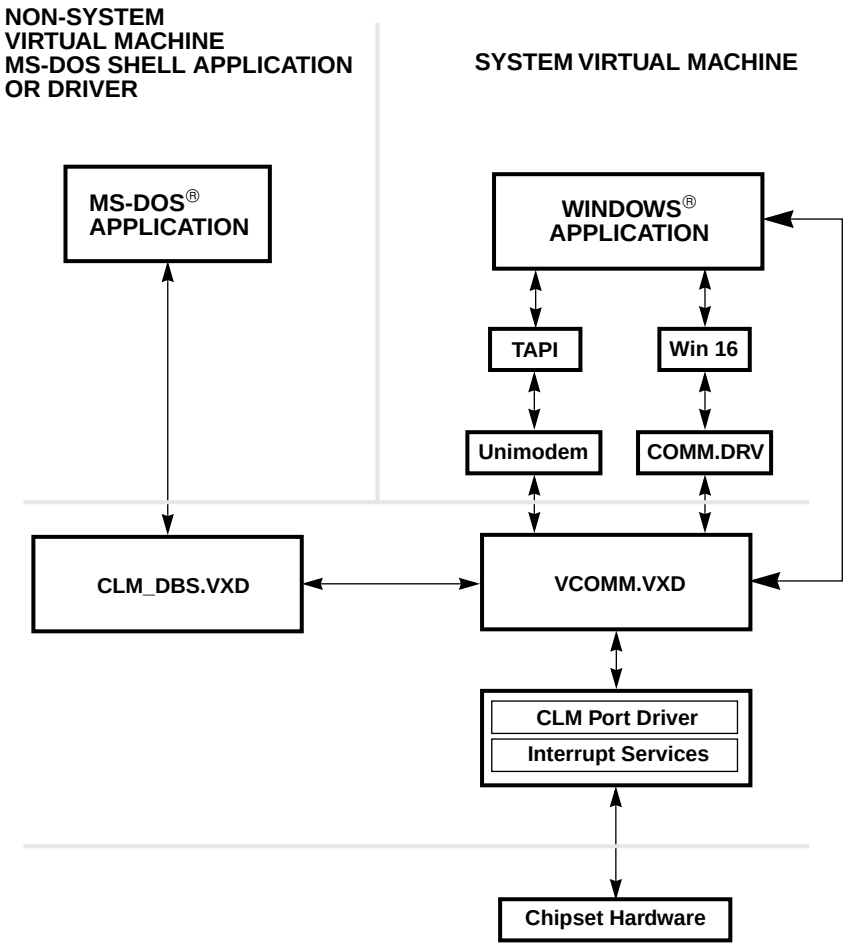

Figure 1-1. Controllerless Modem Drivers

1.2 V.90, x2™, and V.34 Data Modes

The CL-MD342X (V.34 mode) chipsets send and receive at 33.6 kbps in data mode. The CL-MD562X chipsets default to the ITU-T V.90 data transmission mode and fall back to the x2 Technology from 3Com® if the ISP does not support V.90 mode. The V.90 and x2 modes allow receive data rates of up to 57,333 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 and x2 modes fall back to V.34 mode in both the transmit and receive directions. Both chipset families implement all data rates and modulation schemes for ITU-T (International Telecommunications Union-Telecommunications) standards V.34, V.32 bis, V.32, V.22 bis, V.22, V.21, Bell 212A, and Bell 103.

1.3 Modem Connection Overview

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

The modem defaults to the command state. In the command state, the DTE (host) communicates to the modem through AT commands and S-registers. AT commands are character strings that help guide modem operation. S-registers are internal modem registers that the DTE can access. The S-registers contain modem status and configuration information. Many of the AT commands indirectly affect the contents of the S-registers. The CL-MD562X's AT command set and S-registers are divided into the following modes: Group 3 fax, data, V.42/MNP, voice, and an optional VoiceView mode. See Chapter 2 on page 9 for command table summaries. Note that supported AT commands are firmware revision-dependent (that is, not all commands are supported by all modem models or all firmware revisions).

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

A command line can include one or more AT commands that can or can not be separated by a space. AT commands can be either upper- or lower-case characters, but all characters for a given command must use the same case. A command line can include one or more AT commands. The commands can be separated by a space, if desired, but no punctuation is needed except for extended commands. Extended commands begin with a '+' such as fax, voice, and V.25 commands. In a multiple-command line, extended AT commands must be separated from following commands by a semicolon (;). 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 can be repeated by typing A/ without using a carriage return. Each command line can include up to 80 characters and spaces.

Examples of AT command strings:

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

The modem provides status information to the DTE in the form of response codes. These response codes can be expressed in text or numeric form. The supported response codes are provided in Table 2-10 on page 18.

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). The DTE rate can effect connect rate as well as throughput. The DTW should be at least the minimum rate shown in Table 1-2 to support the desired mode. Using a DTE rate of 115,200 or the highest rate possible will ensure the highest connect rate and throughput, especially when compression is used.

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 and x2)	33,333–115,200	
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
Fax	300–14,400	

Table 1-4. DCE-to-ISP Data Rates for x2 and V.90 Modes

Mode	Data Rate (bps)	Affected Data
Data (x2) transmit	4800–31,200	ISP-to-modem data rate
Data (x2) receive	33,333–57,333	
Data (V.90) transmit	4800–33,600	
Data (V.90) receive	28,000–56,000	

Each command can 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 that 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 fully described 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]	A/	Repeat last command	none	–	no
	A	Answer	none	–	no
	Cn	Carrier control option	1	0, 1	no
	C0	Transmit carrier always off			
	C1	Normal transmit carrier			
	D	Dial command	none	–	no
[b]	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	0–7, 10–11, 14, 20–23	no
	I0	Reports product code			
	I1	Reports modem chip firmware version			
	I2	Verifies ROM checksum			
	I3	Reports chipset name			
	I4	Reserved			
	I5	Reserved for modem chip hardware configuration			
	I6	Country code			
	I7	Version of board manufacturer firmware			
	I8	Features of modem firmware			
	I10	Modem board configuration — bits set by board manufacturer			
	I11	Modem board configuration — bits set by board manufacturer			
	I14	SAFE device			
	I20	Cirrus Logic silicon version			
	I21	Cirrus Logic firmware version			
	I22	Cirrus Logic manufacturer name			

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

Note	Command	Function	Default	Range	Reported by &Vn
	I23	Cirrus Logic product model			
b	Ln	Speaker volume control	2	0–3	yes
	L0	Low speaker volume			
	L1	Low speaker volume			
	L2	Medium speaker volume			
	L3	High speaker volume			
b	Mn	Speaker control	1	0–3	yes
	M0	Speaker always off			
	M1	Speaker on until carrier present			
	M2	Speaker always on			
	M3	Speaker off during dialing; speaker on until carrier present			
	On	Go online	0	0, 1, 3	no
	O0	Returns modem to Data mode			
	O1	Retrains equalizer and then returns to Data mode			
	O3	Renegotiates rate and then returns to Data mode			
b	P	Select pulse dialing	none	–	yes
b	Qn	Result code display control	0	0, 1	yes
	Q0	Enables result codes			
	Q1	Disables result codes			
	Sn	Select an S-register	none	0–33	no
	Sn=x	Write to an S-register	none	n=0–33 x=0–255	no
	Sn?	Read from an S-register	none	0–33	no
b	T	Select tone dialing	none	–	no
b	Vn	Result code form	1	0, 1	yes
	V0	Choose numeric form			
	V1	Choose text form			
b	Wn	Response code data rate	0	0–4	yes
	W0	Reports DTE speed response codes			
	W1	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			

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

Note	Command	Function	Default	Range	Reported by &Vn
b	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			
b	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			
b	&Cn	DCD (data carrier detect) option	1	0, 1	yes
	&C0	Ignores remote modem status; DCD always on			
	&C1	DCD set according to remote modem status			
	&Dn	DTR (data terminal ready) option	2	0–3	yes
	&D0	In Async mode, modem ignores DTR			
	&D1	Modem switches from data mode to command mode when an on-to-off transition of DTR occurs			
	&D2	When DTR switches off, the modem goes on-hook and disables Auto-answer mode; when DTR switches on, auto-answer is enabled			
	&D3	Turning off DTR re-initializes the modem and resets values except UART registers			
	&F	Load factory defaults	none	–	no
b	&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			

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

Note	Command	Function	Default	Range	Reported by &Vn
	&K3	Bidirectional hardware flow control			
	&K4	XON/XOFF software flow control			
b	&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			
b	&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	no
	&T0	Terminates test in progress			
	&T1	Initiates local analog loopback			
b	&Un	Disable Trellis coding	0	0, 1	yes
	&U0	Enables Trellis coding with QAM as fall-back			
	&U1	QAM modulation only			
	&Vn	View active and stored profiles	0	0, 1, 3	no
	&V0	View active profile and stored profile 0			
	&V1	View active profile and stored profile 1			
	&Wn	Stored active profile	0	0, 1	no
	&W0	Store in user profile 0			
	&W1	Store in user profile 1			
b	&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
b	%En	Auto-retrain control	1	0, 1	yes
	%E0	Disables auto-retrain			
	%E1	Enables auto-retrain			
b	%Gn	Rate renegotiation	1	0, 1	yes
	%G0	Disabled			
	%G1	Enabled			
b	-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			

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

Note	Command	Function	Default	Range	Reported by &Vn
	+A8E=m	V.8 and V.8 bis operation controls	1,1,C1,0,0	c	no
b	+DS=m	Controls V.42 bis data compression	3,0,2048,6	c	yes
	+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, 0, 0 (CL-MD562X only) V34, 1, 0, 0, 0, 0 (CL-MD342X only)	[c]	no

[a] Command not preceded by an 'AT'.

[b] Value saved in NVRAM.

[c] For Data mode, the factory default setting is AT+MS=V90, 1, 0, 0, 0, 0 to send at speeds of 33,600 bps or below and receive at speeds of 53,333 bps or less. For V.34 mode and below, AT+MS=V34, 1, 0, 0, 0, 0.

Table 2-2. V.42 / V.42 bis MNP® Command Summary

Note	Command	Function	Default	Range	Reported by &Vn
[a]	%An	Set auto-reliable fallback character	13	0–127	yes
a	%Cn	MNP 5 data compression control	1	0, 1	yes
	%C0	No compression			
	%C1	Enables MNP5 data compression			
a	\An	MNP block size	3	0–3	yes
	\A0	Maximum 64 characters			
	\A1	Maximum 128 characters			
	\A2	Maximum 192 characters			
	\A3	Maximum 256 characters			
a	\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			
a	\Gn	Set modem port flow control	0	0, 1	yes
	\G0	Disables port flow control			
	\G1	Sets port flow control to XON/XOFF			
a	\Jn	bps rate adjust control	0	0, 1	yes
	\J0	Disables rate adjust			
	\J1	Enables rate adjust			
a	\T0	Disables inactivity timer	0	0–90	yes

Table 2-2. V.42 / V.42 bis MNP® Command Summary *(cont.)*

Note	Command	Function	Default	Range	Reported by &Vn
a	\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			
a	-Jn	Set V.42 detect phase	1	0, 1	yes
	-J0	Disables the V.42 detect phase			
	-J1	Enables the V.42 detect phase			
a	“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
	+ES=m	Error control selection	3,0,2	See note	no

[a] 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
+VGT=n	Volume selection	128	121–131	no
+VIP	Initialize parameter	–	–	no
+VIT=n	DTE/DCE inactivity timer	0	0–255	no
+VLS=n	Hardware type control	0	0–15	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		no
+VSM=m	Compression method selection	140, 8000, 0, 0		no
+VSP=n	Speakerphone on/off control	0	0, 1	no

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

Command	Function	Default	Range	Reported by &Vn
#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		no
+VTX	Play mode	none	–	no

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

Table 2-7. Voice DTE←DCE Character Pairs *(cont.)*

Response	Hex Code	Function
H	48	Local phone goes off hook
s	73	Presumed hang-up silence time-out
q	71	Presumed end-of-message quiet time-out
I	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

Table 2-9. S-Register Summary

Note	Register	Function	Default	Range	Units	Reported by &Vn
[a]	S0	No. of rings to auto-answer on	0	0–255	ring	yes
	S1	Ring count	0	0–255	ring	yes
a	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
a	S6	Wait before dialing	2	2–255	second	yes
a	S7	Wait for carrier	60	1–255	second	yes
a	S8	Pause time for dial modifier	2	0–255	second	yes
a	S9	Carrier recovery time	6	1–255	0.1 second	yes
a	S10	Lost carrier hang up delay	14	1–255	0.1 second	yes
a	S11	DTMF dialing speed	70	50–255	ms	yes
a	S12	Guard Time	50	0–255	(0.02 second)	yes
a	S14	Bit-mapped options	138	–	–	no
	S16	Modem test options	0	–	–	no
a	S18	Modem test timer	0	0–255	second	yes
a	S21	Bit-mapped options	48	–	–	no
a	S22	Bit-mapped options	118	–	–	no
a	S23	Bit-mapped options	31	–	–	no
a	S25	Detect DTR change	5	0–255	0.01 second	yes
a	S30	Disconnect inactivity timer	0	0–255	minute	yes
a	S31	Bit-mapped options	49	–	–	no
a	S33	Sleep mode timer	10	0–90	second	yes

[a] Value saved in NVRAM.

NOTE: The manufacturing-only S-registers **S91** and **S92** are listed in Table 2-9 on page 18.

Table 2-10. DTE-Modem Data Rate Response Codes

Numeric Code	Text Code
0	OK
1	CONNECT
2	RING
3	NO CARRIER
4	ERROR
5	CONNECT 1200
6	NO DIALTONE
7	BUSY
8	NO ANSWER

Table 2-10. DTE-Modem Data Rate Response Codes *(cont.)*

Numeric Code	Text Code
9	CONNECT 600
10	CONNECT 2400
11	CONNECT 4800
12	CONNECT 9600
13	CONNECT 14400
14	CONNECT 19200
18	CONNECT 57600
22	CONNECT 1200/75
23	CONNECT 75/1200
24	CONNECT 7200
25	CONNECT 12000
28	CONNECT 38400
31	CONNECT 115200
32	FCERROR
33	CONNECT 33333
34	CONNECT 37333
35	CONNECT 41333
36	CONNECT 42666
37	CONNECT 44000
38	CONNECT 45333
39	CONNECT 46666
42	CONNECT 48000
43	CONNECT 49333
45	RINGBACK
53	CONNECT 50666
54	CONNECT 52000
55	CONNECT 53333
56	CONNECT 54666
57	CONNECT 56000
58	CONNECT 57333
59	CONNECT 16800
60	CONNECT 21600
62	CONNECT 24000
63	CONNECT 26400
64	CONNECT 28800
65	CONNECT 31200
66	CONNECT 33600
67	COMPRESSION: V.42BIS
68	COMPRESSION: MNP5

Table 2-10. DTE-Modem Data Rate Response Codes *(cont.)*

Numeric Code	Text Code
69	COMPRESSION: NONE
70	PROTOCOL: NONE
74	PROTOCOL: V80 SAM
77	PROTOCOL: LAP-M
80	PROTOCOL: MNP
81	PROTOCOL: MNP 2
82	PROTOCOL: MNP 3
83	PROTOCOL: MNP 2,4
84	PROTOCOL: MNP 3,4
98	CPON=
99	CPOF=
100	DRON=
101	DROF=
See Note	CONNECT (*DTE data rate*) /(*modulation*)/*(error correction)/(data compression)* / TX:(*DCE transmit data rate*) / RX:(*DCE receive data rate*)

NOTE: The **W3** AT command reports the special text code listed, which is used to evaluate the modem connection. The **W0**, **W1**, **W2**, and **W4** AT commands report all other 'CONNECT' messages. When the modem is configured for text responses **V1**, the **W3** text 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 **V0**, the modem responds as if it were set up for **W0**.

Table 2-11. Manufacturing-Only Command Summary [a]

Note	Command	Function	Default	Range
[b]	*NCnn	Country Select	0	–
b	S91	Select data transmit level	–10	9–16
b	S92	Select DTMF fax transmit level	–10	0–15
	#VGP0=n	Read/write to general-purpose pins 0–7	[c]	–
	#VGP1=n	Read/write to general-purpose pins 8–15	c	–

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

[b] Value saved in NVRAM.

[c] Default values for **#VGP0–1 =n** are dependent on board design.

3. BASIC DATA MODE AT COMMANDS

The 56K FastPath chipsets implement:

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

In data mode, the AT commands configure the DCE (modem) to establish a connection with a remote data modem. In data mode, the CL-MD562X chipsets execute the AT commands for error correction (MNP 2-4, V.42) and data compression (MNP 5, V.42 bis) described in Table 4-3 on page 47, 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> ATS0?<CR>	AT<CR>0<CR> ATS0?<CR>000<CR><LF>0<CR>
Echo, Text (E1, V1)	AT<CR> ATS0?<CR>	AT<CR><CR><LF> OK<CR><LF> ATS0?<CR><CR><LF>000<CR><LF><CR> <LF>OK<CR><LF>
No Echo, Numeric E0, V0)	AT<CR> ATS0?<CR>	0<CR> 000<CR><LF>0<CR>
No Echo, Text (E0, V1)	AT<CR> ATS0?<CR>	<CR><LF>OK<CR><LF> <CR><LF>000<CR><LF><CR><LF>OK <CR><LF>

Configure the DCE to use different response codes using the **ATWn** command (see the table on page 35). The setting for the **ATXn** command (page 35) 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.

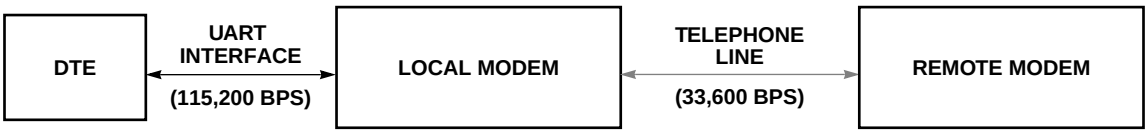

Figure 3-1. Example of a Remote Connection

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/LAP-M/V42BIS/TX=33600/RX=33600

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

On power-up, the DCE defaults to the configuration specified in NVRAM. The DCE can then be configured. 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:

`ATZ`	Resets, then configures the modem to NVRAM user profile 0.
`AT&F S0=1 &W1 &Y1`	**&F** configures the modem for factory defaults.

S0=1 configures the modem to answer after one ring.

&W1 saves the active configuration to user profile 1.

&Y1 configures the modem to use NVRAM user profile 1 as the power-up defaults.

`AT&Z2 = 9, (408)555-5555` Stores a telephone number into the NVRAM as phone number 2, which can be redialed later using **ATDS=2**.

3.4 Modem Identification Command

In, +FMI?, +FMR?, +FMM?, +GMI?, +GMM?, +GMR?, +FMFR?, +FMDL?, +FREV?

The modem provides product identification AT commands that help determine the 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™ Cirrus Logic Modems**
Modem Manufacturer	N/A	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.

`CD02.07-MM02.02` Firmware version. 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: (assume factory defaults)

`ATDT 9,555-5555`	Automatically dials the telephone number with DTMF tones. After dialing a '9', the comma (,) causes the modem to pause[a] 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.

[a] The default pause time for the United States is 2 seconds. Other countries will have other default times.

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 on page 28. To re-enter the online data mode, use the **ATOn** command.

Example:

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

3.7 Hanging Up

Hn, S10, Zn, &D2

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

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

3.8 Modem-to-Modem Connection Data Rates

The data rates differ for each data mode selected. The CL-MD342X chipsets operate using the V.34 mode. For the CL-MD562X chipsets, V.90 is the default data mode. This falls back automatically to the x2 Technology mode from 3Com in connections with ISPs not supporting the V.90 mode. For non-ISP connections, the chipsets fall back to V.34 mode. The modem defaults to whatever mode is issued by the **+MS=m** command (see the supported modulation types on Table 3-2).

The supported modulation types are listed in Table 3-2 and includes all modulation types and the data rates for transmitting and receiving. While the V.90 and x2 modes can achieve receive speeds at up to 57,333 bps, speeds over 53,333 bps are currently prohibited due to FCC rules that restrict modem power output. In other types of connections, the chipset receives at V.34 mode rates.

Two V.34 modes are available. These provide different speeds. For example, V34S offers a modem-to-modem data rate of 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps. For V.42, MNP, and Buffer (Normal) modes, the modem provides speed buffering (see Chapter 4), 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 allow the modem to negotiate the maximum line rate.

The CL-MD562X 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 x2 mode connections are always asymmetrical. V.34 mode connections can be either symmetrical or asymmetrical. The +MS command uses six parameters for asymmetrical modes and four parameters for symmetrical modes. Note that the transmitter and receiver speeds are typically different for most V.34 connections over the PSTN.

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

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

The **+MS=m** command defines which modem-to-modem data rates are supported by the modem. Table 3-2 shows the supported modulation types. Each modulation supports one or more data rates.

Table 3-2. Supported Modulation Types

<carrier >	Description
Bell103	300 bps
Bell212A	1200 bps
V21	V.21 300 bps
V22	V.22 1200 bps
V22B	V.22 bis 1200 and 2400 bps
V23C	V.23, with constant carrier; 1200 bps forward and 75 bps reverse
V32	V.32 4800 and 9600 bps
V32B	V.32 bis 7200, 9600, 12,000, and 14,400 bps
V34	V.34 asymmetrical connections: 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps
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, 31,200, and 33,600 bps
X2	56K x2 asymmetrical connections (transmit): 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, and 28,800, and 31,200 bps 56K x2 asymmetrical connections (receive): 33,333, 37,333, 41,333, 42,667, 44,000, 45,333, 46,667, 48,000, 49,333, 50,667, 52,000, 53,333, 54,666, 56,000, and 57,333 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, 30,667, 32,000, 33,333, 34,667, 36,000, 37,333, 38,667, 40,000, 41,333, 42,667, 44,000, 45,333, 46,667, 48,000, 49,333, 50,667, 52,000 53,333, 54,667, and 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> for symmetrical modes. An additional two parameters, <min rx rate> and <max rx rate>, are used for asymmetrical connections such as x2 or V34. If these additional parameters are sent in a symmetrical connection, they cause an error.

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 cannot 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 occur. 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 occur 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 occur. 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 can connect at a slower rate because of line impairment. If <max rate> and <auto-mode> 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. When the modem receives the **+MS=m** command, the modem does not check for conflicts of valid parameter information.

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 can be lower than the speeds defined in this table.

For V.90, x2, and V.34 modulation, the modem can receive data at a different data rate than the transmit data rate. All other modulation types, besides V.23 and V.34, use the same data rate for the transmitter and receiver. Use **ATW3** to see the modem's actual receive and transmit data rates (the modem must be configured for **ATV1** text response codes). Table 3-3 shows examples of the resulting connection rate when non-default values are used.

Table 3-3. Resulting Modem-to-Modem 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, 33,600, 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 33,600 bps connection, but the answering modem is configured to attempt a maximum data rate of 9600 bps.
N0, +MS = V32, 1, 7200, 9600; and UART data rate = 7200 bps	+MS = V34, 1, 0, 0; UART data rate = 9600 bps	9600 bps: the originating modem is configured to attempt connection at between 7200 to 9600 bps. 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 '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 on page 28) and local analog loopback self-test (see Section 3.9 on page 27) for testing modem-to-modem and DTE-to-modem communication integrity in all modes except V.90 and x2. 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 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.

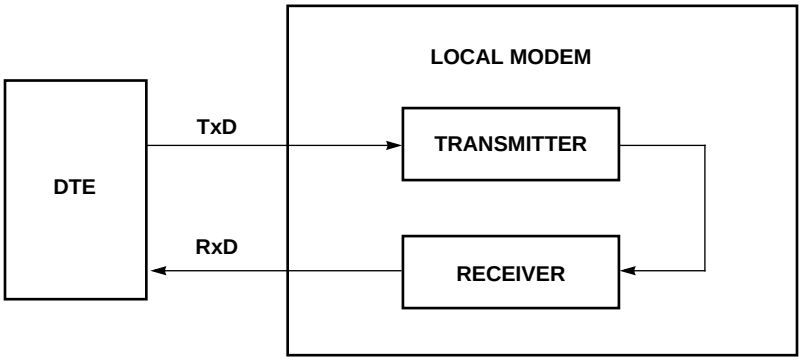

Figure 3-2. Local Analog Loopback Test

Local Modem (or Test Modem)

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

3.10 AT Escape Sequences

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

Cirrus Logic also makes the Hayes® Escape Sequence available to customers (see the following statement regarding licensing requirements).

> Licensing Requirements for Hayes Escape Sequence
>
> The Cirrus Logic 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.
>
> Cirrus Logic 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, 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.

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 can cause the modem to incorrectly decide that an incoming AT string is invalid. The ignored 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 is typically a '+' character. The following is an example of the TIES:

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 repeat. The character immediately preceding the first character of the three-character sequence ***cannot*** be the same as the escape character. Therefore, '+++ AT<CR>' is valid, but '++++ AT<CR>' is not.

3.10.2 Hayes® Escape Sequence

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

The escape character is determined by the value stored in S-register **S2** and is typically a '+' character. Guard times are silence times when the DTE does not send any data to the modem. Guard times ensure that the modem does not falsely detect an escape sequence if three consecutive escape characters are received from the DTE. The preceding and following guard times are defined in S-register **S12**. Typically, these guard times are one 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 one 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
```

Table 3-4. Data Mode Command Descriptions[a]

Command	Default	Description
A/	**none**	**Repeat Last Command:** This command re-executes the last AT command string stored in the command buffer. A/ is the only command not preceded by AT and ended by a carriage return. Sending any character (such as a carriage return) after A/ and before a modem response is sent to the DTE causes the modem to abort the remainder of the command string in the modem internal command buffer.
A	**none**	**Answer Command:** This command causes the modem to immediately go off-hook and initiate an answer mode handshake without waiting for an incoming ring signal. This command is useful for manually answering a call or establishing a back-to-back connection with an originate-mode modem.
Cn	**1**	**Carrier Control Option:** This command is reserved for selecting between controlled carrier or constant carrier modes. This modem supports only constant carrier mode. n = 0 — Transmit carrier always off (returns an ERROR message) n = 1* — Normal transmit carrier (constant carrier)
D	**none**	**Dial Command:** This command causes the modem to immediately go off-hook as an originating modem and dial a telephone number with corresponding dial modifiers. Dial modifiers are parameters that define how the modem should dial the telephone number. Dial Modifiers 0–9 — Dialing Digits A, B, C, D, *, # — Tone Dial Characters P — Pulse Dial—configures the modem to use pulse dialing to dial a telephone number. 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. S = n — Dial NVRAM Telephone Number—causes the modem to dial a telephone number previously stored in the NVRAM with the **AT&Zn=x** command. T — Tone Dial—configures the modem to use DTMF tones to dial a telephone number W — Wait for Dial Tone—causes the modem to look for dial tone for a specified amount of time. If dial tone or the amount of time specified by the S-register, **S6**, times out, the modem processes the next command in the dial string. If a busy signal is detected, the modem responds to the DTE with a busy response code and then goes into off-line command mode. , — Pause—causes the modem to pause or delay implementing the next parameter in the dial string by the time specified in S-register **S8**. ! — Flash Hook—causes the modem to go on-hook for 0.5 seconds.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
D *(cont.)*		**Dial Command** *(cont.)* @ — Wait for Quiet Answer—causes the modem to wait for specified amount of time (S-register **S7**) followed by 5 seconds of silence before processing the next dial modifier. ; — Return to Idle State—causes the modem to enter online command mode without initiating a data modem handshake (used for phone directory auto-dialers). <space> - ( ) — Ignored by Modem—these four characters are ignored by the modem. Spaces also can be included in the dial string to separate area codes and numbers.
En	**1**	**Command Mode Echo:** This command selects whether the modem echoes AT commands back to the host in either online or off-line command mode. n = 0 — Echo disabled n = 1* — Echo enabled
Hn	**0**	**Switch Hook Control:** This command controls the telephone line relay (OHREL*) and causes the modem to either hang up or pick up the telephone line. n = 0* — Hang up telephone line (go on-hook) n = 1 — Pick up telephone line (go off-hook)
In	**0**	**Identification/Checksum Option:** This command causes the modem to send product code and hardware setup information to the DTE. n = 0* — Report product code n = 1 — Modem chip firmware version # n = 2 — Verifies ROM checksum n = 3 — Reports chipset name n = 4 — Reserved n = 5 — Reserved for modem chip hardware configuration n = 6 — Country code n = 7 — Version of board manufacturer firmware n = 8 — Modem firmware features Bit 0 — 0 = No VoiceView, 1 = VoiceView supported Bit 1 — 0 = No DSVD, 1 = DSVD supported Bits 2-7 — Reserved n = 10 — Modem board configuration—Bits set by board manufacturer 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

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description

In *(cont.)*		**Identification/Checksum Option** *(cont.)*
		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
		n = 11 Modem board configuration—Bits set by board manufacturer:
		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.
		1 = Local telephone off-hook detection on board.
		Bit 4 0 = No earphone support.
		1 = Earphone support on board.
		Bit 5-7 Reserved
		n = 14 SAFE device.
		n = 20 Cirrus Logic silicon version.
		n = 21 Cirrus Logic firmware version.
		n = 22 Cirrus Logic manufacturer name.
		n = 23 Cirrus Logic product model.
		
		Examples:
		`ATI1`
		`CD04.08 - MM03.XX`
		`OK`
		
		`ATI2`
		`OK`
		
		`ATI3`
		`CL-MD562X`
		`OK`
		
		`ATI5`
		`HOST I/F: Parallel`
		`P Mem: 016 Bit 001 W.S.`
		`D Mem: 008 Bit 001 W.S.`
		`DSP Code location = External RAM`

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
Ln	**2**	**Speaker Volume Control:** This command selects the modem's speaker volume. n = 0 Low speaker volume. n = 1 Low speaker volume. n = 2* Medium speaker volume. n = 3 High speaker volume.
Mn	**1**	**Speaker Control:** This command specifies when the speaker is turned on and off. n = 0 Speaker always off. n = 1* Speaker on until carrier present. n = 2 Speaker always on. n = 3 Speaker off during dialing, and on until carrier.
On	**0**	**Go Online:** This command causes the modem to return to online data mode from online command mode. n = 0* Returns the modem to data mode. n = 1 Begins an equalizer retrain sequence; returns to data mode. n = 3 Renegotiates rate; returns to data mode.
P	**none**	**Select Pulse Dialing:** This command configures the modem to use pulse dialing the next time the modem dials a telephone number.
Qn	**0**	**Result Code Display Control:** This command selects whether the modem sends result codes to the DTE. n = 0* Result codes enabled. n = 1 Result codes disabled.
Sn	**none**	**Select an S-Register:** This command selects the current S-register. n = 0–37
Sn=x	**none**	**Write to an S-Register:** This command writes a decimal number 'x' to S-register 'n'. n = 0–37 x = 0–255
Sn?	**none**	**Read an S-Register:** This command is used to read a decimal number from S-register 'n'. n = 0–37
T	**none**	**Select Tone Dialing:** This command configures the modem to use DTMF tones the next time the modem dials a telephone number (touch tone dialing).
Vn	**1**	**Result Code Form:** This command selects whether modem response codes are in numeric or text form. n = 0 Numeric form. n = 1* Text form.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description

Wn	**0**	**Response Code Data Rate:** 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 text **V1** response codes. For numeric responses **V0,** the modem responds with the **W0** numeric response code. The text response codes use the following format:
		CONNECT (*DTE data rate*) /(*modulation*)/*(error correction)/(data compression)* / TX=(*DCE transmit data rate*) / RX=(*DCE receive data rate*)
		Modulation types include: V21, V22, V22B, V23C, V32, V32B, V34, and x2.
		Error correction types include: NONE, LAP-M, MNP.
		Data compression types include: NONE, V42BIS, MNP5.
		For example:
		`CONNECT 115200/V34/LAP-M/V42BIS/TX=28800/ RX=28000`
		n = 4 CONNECT result code reports DCE protocol, data compression, and DCE data rate when the mode is configured for text **V1** response codes. For numeric responses **V0**, the modem responds with the **W0** numeric response code. The text response codes use the following format:
		(DCE protocol)
		(data compression)
		(line speed)
		Error correction types include: NONE, LAP-M, MNP
		Data compression types include: NONE, V42BIS, MNP5
		For example:
		`PROTOCOL: LAP-M`
		`COMPRESSION: V42BIS`
		`CONNECT 33,600`

Xn	**4**	**Result Code Type/Call Progress:** This command determines which modem result codes are enabled. Additionally, this command specifies whether busy and dial tone detection are enabled or disabled. n = 0 Result codes 0–4 enabled. Busy and dial tone detect disabled. n = 1 Result codes 0–5, 10 and above enabled. Busy and dial tone detect disabled. n = 2 Result codes 0–6, 10 and above enabled. Busy detect disabled and dial tone detect enabled. n = 3 Result codes 0–5, 7, 10 and above enabled. Busy detect enabled and dial tone detect disabled. n = 4* Result codes 0–7, 10 and above enabled. Busy and dial tone detect enabled.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
Yn	**0**	**Long Space Disconnect:** This command determines whether the modem disconnects after receiving 1.6 seconds of silence and whether the modem sends a period of silence to the remote modem before disconnecting. n = 0* Disables long space disconnect. n = 1 Enables long space disconnect. The modem disconnects after receiving 1.6 seconds of silence from the remote modem. Additionally, after receiving an **ATH0** command, the modem sends at least 4 seconds of silence before hanging up.
Zn	**0**	**Reset Modem/Recall Stored Profile:** This command causes the modem to go on-hook (hang-up), perform a warm reset, and load user-configuration profile 'n' (previously stored in the NVRAM) into the active profile. The **Zn** command must be the last command in command string, as all subsequent commands are ignored. n = 0* Resets the modem and recalls user profile 0. n = 1 Resets the modem and recalls user profile 1.
&Cn	**1**	**DCD (Data Carrier Detect) Option:** This command controls how the modem functions in relation to the DCD or RLSD signal. n = 0 State of carrier from remote modem is ignored. DCD is always on. n = 1* State of carrier from remote modem is tracked. DCD reflects the state of the received carrier.
&Dn	**2**	**DTR (Data Terminal Ready) Option:** This command controls how the modem responds to DTR. After toggling DTR, the host should wait 200 ms before modifying the UART registers or sending a new command to the modem. This is done because the modem does *not* send an 'OK' message to indicate it has performed the requested function. n = 0 In asynchronous mode (**&Q0**), the modem ignores DTR. n = 1 The modem switches from data mode to command mode when an on-to-off transition of DTR occurs. 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. 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.
&F	**none**	**Load Factory Defaults:** This command loads command defaults and S-register factory defaults into the active configuration and configures the modem for data mode.
&Gn	**0**	**Guard Tone Option:** This command controls whether the modem sends out guard tones while connected to a remote modem (for ITU-T V.22 BIS [1200 bps] and V.22 BIS [2400 bps] connections only). Guard tones can 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. n = 0* Guard tone disabled. n = 1 550-Hz guard tone enabled. n = 2 1800-Hz guard tone enabled.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
&Kn	**3**	**Select Serial Port Flow Control:** This command specifies the DTE-to-modem flow control. Software flow control uses the characters XOFF (13h) and XON (11h) to stop and start data transmission, respectively, both to and from the DTE. Bidirectional hardware flow control uses RTS/CTS to stop and start data from the modem. n = 0 Disables flow control. n = 3* Bidirectional hardware flow control — RTS/CTS. n = 4 XON/XOFF software flow control.
&M0	**0**	**Select Communication Mode:** This command controls whether the modem operates in asynchronous or synchronous mode. This modem only supports asynchronous mode. This command is the same as **&Q0**. n = 0* Asynchronous normal. The modem operates asynchronously in both command and online modes.
&Pn	**0**	**Dial Pulse Ratio:** This command determines the make/break (that is, off-hook/on-hook) ratio during pulse dialing. 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.
&Q0	**0**	**Select Communication Mode:** 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**. n = 0* Asynchronous normal. The modem operates asynchronously in both command and online modes.
&Sn	**0**	**DSR (Data Set Ready) Option:** This command controls how the modem treats the DSR signal. 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.
&Tn	**0**	**Data Mode Self-Test Command:** This command is used in data mode (except x2 and V.90 connections) to initiate and terminate loopback tests for testing modem-to-modem and DTE-to-modem data communication integrity. n = 0* Terminates test in progress. n = 1 Local analog loopback. n = 8 Local analog loopback with self-test.
&Un	**0**	**Disable Trellis Coding:** This command selects whether the modem transmits or receives modulated 9600 bps carrier with QAM or Trellis encoding for V.32. n = 0* Enabled (Trellis modulation with QAM modulation as a fallback). n = 1 Disabled (QAM modulation only).

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description

&Vn	**0**	**View Active Configuration and Stored Profiles:** This command causes the modem to display the command and S-register information contained in the active user profile and in one of two stored profiles.The command **&V0** displays the active profile and the stored profile 0; **&V1** displays the active profile and the stored profile 1. The information in the active profile is stored into the user profiles with the **&Wn** command. **&W0** stores the active profile into the stored profile 0; **&W1**, the stored profile 1.
		n = 0* Stored profile 0.
		n = 1 Stored profile 1.
		AT&V0
		Active profile:
		`E1 L2 M1 P Q0 V1 W3 X4 Y0 &C1 &D2 &G0 &P0 &Q0 &S0 &U0 &Y0`
		`%A013 %C1 %E1 %G1 \A3 \C0 \G0 \J0 \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`
		Stored profile 0:
		`E1 L2 M1 P Q0 V1 W3 X4 Y0 &C1 &D2 &G0 &P0 &Q0 &S0 &U0`
		`%A013 %C1 %E1 %G1 \A3 \C0 \G0 \J0 \T000 \X0 -C1 -J1 "H3 "O032`
		`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`
		Telephone numbers:
		`&Z0= 12345`
		`&Z1= 4444444`
		`&Z2= 12345`
		`&Z3= 11234567890`
		`OK`

&Wn	**0**	**Store Active Profile:** This command causes the modem to store a subset of the active profile command and S-register configurations into the NVRAM user profile ‘n’. n = 0* Store in user profile 0. n = 1 Store in user profile 1.
&Yn	**0**	**Select Stored Profile on Power-up:** This command selects the particular stored user profile from the NVRAM to be loaded into the active profile upon modem power-up. n = 0* Select profile 0. n = 1 Select profile 1.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

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

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+A8E=m	**see 'm'**	**V.8 and V.8 bis Operation Controls:** This command configures V.8 and V.8 BIS operation. The default settings of this command supports V.80 mode. If issued when the DCE is on-hook, this command is a compound parameter used to precondition V.8 and V.8 bis originating and answering operation. It is not supported as an action command while the DCE is off-hook. If enabled, V.8 negotiation does not preclude simultaneous implementation of other means of negotiation (for example, V.8 bis, V.18, and V.32 bis Annex A). For the **+A8E** default values, the signal indicators are not generated by the DCE. When the parameters <v8o>=6 and <v8a>=5, the **+A8I**, **+A8C**, **+A8A**, **+A8J**, and **+A8M** indications are sent from the DTE, but the **+A8M** command is not used because the DCE controls the V.8 section. ***m = <v8o>, <v8a>, <v8cf>, <v8b>,<cfrange>, <protrange>*** Default: 1, 1, C1, 0, , **<v8o>** V.8 origination selection. Range <v8o>: 0, 1, 6 Default: 1 n = 0 Disable V.8 origination negotiation. n = 1* DCE-controlled V.8 origination negotiation. n = 6 DCE-controlled V.8 origination negotiation, enable indications only. **<v8a>** V.8 answer selection. Range <v8a>: 0, 1, 5 Default: 1 n = 0 Disable V.8 answer negotiation. n = 1* DCE-controlled V.8 answer negotiation. n = 5 DCE-controlled V.8 answer negotiation, enable indications only. **<v8cf>** V.8 call function Range <v8cf>: 0x21, 0xC1 Default: 0x21 n = 0x21* Sets the V.8 call function to indicate H.324. n = 0xC1 Sets the V.8 call function to indicate standard data mode. **V.8 and V.8 bis Operation Controls:** *(cont.)* **<v8b>** V.8 bis control Range <v8b>: 0 Default: 0 n = 0* Disable V.8 bis negotiation. **<cfrange>** Not supported. **<protrange>** Not supported.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+A8E=m *(cont.)*		**V.8 and V.8 bis Operation Controls** *(cont.)* Indication — Definition +A8A:1 — Indicates V.8 ANSam has been detected. This indication is only sent to the DTE if +A8E<v8o>=6 and operating in Originate mode. +A8A:2 — Indicates V.25 answer tone (2100 Hz) has been detected. This indication is only sent to the DTE if +A8E<v8o>=6 and operating in Originate mode. +A8I:<v8cf> — Indicates the detection of a V.8 CI-signal and the recovered call function only if +A8E<v8a>=5 and operating in answer mode. +A8M:<CM> — Indicates the hexadecimal-coded CM signal only if +A8E<v8a>=5 and operating in answer mode. +A8M:<JM> — Indicates the hexadecimal-coded JM signal only if +A8E<v8o>=6 and operating in Originate mode. +A8J:[0,1] — Indicates the modem is transmitting the V.8 termination signal. +A8J:1 indicates transmission or detection of CJ signal. +A8J:0 indicates timeout while waiting for a CJ signal.
+DS=m	**see 'm'**	**Data Compression:** This command sets multiple parameters for the control of data compression. ***m = <direction>, <compression negotiation>, <max dict>, <max string>*** Default: m = 3, 0, 2048, 6 **<direction>** — Specifies the direction of the data compression as seen by the DTE. Range: <direction> = 0–3 Default: <direction> = 3 <direction> = 0 — Negotiated; no compression. <direction> = 1 — Transmit only. <direction> = 2 — Receive only. <direction> = 3* — Both directions; accept any direction. **<compression negotiation>** — Specifies whether the modem should stay connected or disconnect based on the desired result. Range: <compression negotiation> = 0, 1 Default: <compression negotiation> = 0 <compression negotiation> = 0* — Do not disconnect. <compression negotiation> = 1 — Disconnect. **<max dictionary>** — Specifies the maximum number of dictionary entries that should be negotiated. Range: <max dictionary> = 512 to 65535 Default: <max dictionary> = 2048 **<max string>** — Specifies the maximum string length to be negotiated. Range: <max string> = 6–250 Default: <max string> = 6

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+GMI?	**none**	**Identify Modem Manufacturer:** This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to the **AT+FMFR?** and **AT+FMI?** commands AT+GMI? CIRRUS LOGIC OK The modem manufacturer's name can be changed using the firmware configuration utility.
+GMM?	**none**	**Identify Product Model:** This command causes the DCE to report the modem chipset name. This command is identical to the **AT+FMDL?** and **AT+FMM?** commands. AT+GMM? CL-MD56XX OK The modem product model can be changed using the firmware configuration utility.
+GMR?	**none**	**Identify Product RevisioN:** This command causes the DCE to report the modem chipset revision level. This command is identical to the **AT+FREV?** and **AT+FMR? commands**. AT+GMR? CD04.08–540K Parallel-SP04 OK The modem product model can be changed using the firmware configuration utility.
+MS=m	**see 'm'**	**Modulation Selection:** This command sets the type of modulation used and the send and receive speeds. Settings for **+MS=m** determine the allowable modem connections. Modems using CL-MD562X 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 CL-MD342X chipsets use data modes up to and including V.34. The CL-MD562X chipsets default to the ITU-T V.90 asymmetrical mode and fall back to x2 mode if an ISP (internet service provider) does not provide V.90 mode. If the connection is non-ISP, the chipsets fall back to V.34 mode. Note that the transmitter speed and receiver speeds are typically different for most V.34 connections over the PSTN. +MS uses six parameters for asymmetric modes such as x2 and V34. Only the first four parameters can be sent for symmetric modes, or an error occurs. To check the settings for the +MS command, type AT+MS? *m = <carrier>, <automode>, <min rate>, <max rate>, <min rx rate>, <max rx rate>* Default: m = V90, 1, 0, 0, 0, 0 (CL-MD562X only) m = V34, 1, 0, 0, 0, 0 (CL-MD342X only)

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+MS=m *(cont.)*		**Modulation Selection** *(cont.)*

<carrier > Specifies the type of modulation used. Approved codes are shown as follows. The modem can automatically switch between some types.

<carrier>	Description
Bell103	300 bps
Bell212A	1200 bps
V21	V.21 300 bps
V22	V.22 1200 bps
V22B	V.22 bis 1200 and 2400 bps
V23C	V.23, with constant carrier; 1200 bps forward and 75 bps reverse
V32	V.32 4800 and 9600 bps
V32B	V.32 bis 7200, 9600, 12,000, and 14,400 bps
V34	V.34 asymmetrical connections: 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps
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, 31,200, and 33,600 bps

x256-kbps x2 asymmetrical connections (transmit): 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, and 31,200 bps

56-kbps x2 asymmetrical connections (receive): 33,333, 37,333, 41,333, 42,667, 44,000, 45,333, 46,667, 48,000, 49,333, 50,667, 52,000, 53,333, 54,666, 56,000, and 57,333 bps

V9056-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, and 33,600 bps

56-kbps V.90 asymmetrical connections (receive): 28,000, 29,333, 30,667, 32,000, 33,333, 34,667, 36,000, 37,333, 38,667, 40,000, 41,333, 42,667, 44,000, 45,333, 46,667, 48,000, 49,333, 50,667, 52,000, 53,333, 54,667, and 56,000 bps

<automode> When enabled, this parameter allows the modem to negotiate modulation speeds automatically (if an automatic value is defined for that particular modulation).

Range: <automode> = 0, 1

Default: <automode> = 1
<automode> = 0 Disabled.
<automode> = 1Enabled.

<min rate> This parameter specifies the lowest data transfer rate at which the modem can establish a carrier signal connection.

Range: <min 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, and 33,600 bps.

Default: <min rate> = 0

<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.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+MS=m *(cont.)*		**Modulation Selection:** *(cont.)* **<max rate>** This parameter sets the highest speed at which the modem can establish a connection. 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, and 33,600 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. **<min rx rate>** This parameter specifies the lowest data transfer rate at which the modem can receive data. Range: <min rx rate> = 0, 300, 1200, 2400, 4800, 7200, 9600, 12,200, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps. Default: <min rx rate> = 0 <min rx rate> = 0 — Minimum allowed data receive rate. • <automode> = 1. Lowest data receive rate = 300 bps. • <automode> = 0. Lowest data receive rate = (Lowest modulation data rate). <min rx rate> ≠ 0 — Lowest permitted receive rate. **<max rx rate>** This parameter sets the highest speed at which the modem can receive data. Range: <max rx rate> = 0, 300, 1200, 2400, 4800, 7200, 9600, 12,200, 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, 56,000, and 57,333 bps. Default: <max rx rate> = 0 <max rx rate> = 0 — Maximum allowed data receive rate: • If the maximum receive data rate is less than or equal to the DTE data rate, then the highest data rate is the highest receive data rate. • If the maximum receive data rate is greater than the DTE data receive rate, then the highest data rate is the modulation data rate equal to or just below the DTE data receive rate. <max rx rate> ≠ 0 — Highest permitted data receive rate.

Table 3-4. Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description	
+MS=m *(cont.)*		**Modulation Selection**: *(cont.)*	
		Examples (DTE data rate = 115,200 bps)	**Speed Range**
		+MS = V32, 1, 0, 0	300–9600
		+MS = V32, 0, 0, 0	4800–9600
		+MS = V32B, 1, 9600, 14400	9600–14400
		+MS = V34, 1, 0, 0	300–28800
		+MS = V34, 1, 300, 28800	300–28800
		+MS = V34, 1, 9600, 33600	9600–33600
		+MS = V34, 1, 28800, 33600	28800-33600
		+MS = V34, 0, 19200, 26400	19200–26400
		+MS = X2, 1, 0, 0, 48000, 52000	TX: 300-31200 RX: 48000-52000
		+MS = V90, 1, 0, 0, 49333, 50666	TX: 300-33600 RX: 49333-50666
		Examples (DTE data rate = 2400 bps)	**Speed Range**
		+MS = V32, 0, 0, 0	NO CARRIER
		+MS = V32B, 1, 9600, 14400	9600–14400
		+MS = V34, 1, 0, 0	300–2400
		+MS = V34, 1, 300, 28800	300–28800
		+MS = V34, 1, 9600, 28800	9600–28800
		+MS = V34, 1, 28800, 28800	28800 only
		+MS = V34, 0, 0, 0	2400 only
		+MS = V34, 0, 19200, 26400	19200–26400
		+MS = X2, 1, 0, 0, 48000, 52000	TX: 300-2400 RX: 48000-52000
		+MS = V90, 1, 0, 0, 49333, 50666	TX: 300-31200 RX: 49333-50666

[a]An asterisk (*) denotes the factory-default setting.

4. ERROR CORRECTION AND DATA COMPRESSION

The 56K FastPath chipsets support two types of data mode error correction, MNP®2–4 and V.42 bis, and data compression, MNP5 and V.42 bis. V.42 error correction uses LAP-M as the primary error-control protocol, and MNP2-4 as the alternative. V.42 bis data compression requires V.42 (LAP-M only). MNP5 requires MNP2–4.

The CL-MD562X chipsets support four operating modes: buffer (normal), MNP reliable, V.42 Auto-reliable, and V.42 Reliable. These chipsets allow the DCE to communicate with remote modems that can or can not support error correction and data compression. Speed buffering, which is used for all operating modes, allows the DTE-to-modem data rate to be different from the modem-to-modem data rate. This is accomplished by using transmitter and receiver buffers in the modem. Thus, the DTE-to-modem data rate can be set for 2400 bps when the modem-to-modem data rate is 300 bps without causing any data errors. In all data modes, the DTE-to-modem data rate can be set for any valid speed between 300 bps to 115,200 bps (that is, the modem autobauds up to 115,200 bps). See Table 1-2 on page 8 for all DTE-to-DTE data rates. The modem-to-modem data rates are listed in Table 1-3 on page 8. See Table 1-4 on page 8 for the modem-to-ISP data rates. Each operating mode is explained in more detail in the following tables.

Table 4-1. Operating Modes

Mode	Features
Buffer (Normal) **+ES=1, 0, 1**	No error correction/data compression, but speed buffering is supported.
MNP Reliable **+ES=4, 4, 6**	MNP2–4, 5 connection only. If an MNP connection cannot be established, the modem hangs up.
V.42 Auto-reliable **+ES=3, 0, 2**	V.42/V.42 bis with fallback to MNP2–4, 5 or normal mode.
V.42 Reliable **+ES=3, 2, 4**	V.42, V.42 bis or MNP2–4, 5 only connection. If a V.42/V.42 bis/MNP2–4, 5 connection cannot be established, the modem hangs up.

Table 4-2 lists connection types corresponding to **+ES** settings.

Table 4-2. Resulting +ES Connection Types *(see page 47 for table notes)*

+ES Settings (Originate Modem)	+ES Settings (Answer Modem)			
	+ES=1, 0, 1 (Buffer)	**+ES=4, 4, 6 (MNP Reliable)**	**+ES=3, 0, 2 (V.42 Auto-reliable)**	**+ES=3, 2, 4 (V.42 Reliable)**
+ES=1, 0, 1 (Buffer)	Buffer (normal) mode	Modem hangs up	Buffer (normal) mode	Modem hangs up
+ES=4, 4, 6 (MNP Reliable)	Modem hangs up	MNP2–4, 5	MNP2–4, 5	MNP2–4, 5
+ES=3, 0, 2 (V.42 Auto-reliable)	Buffer (normal) mode	MNP2–4, 5	V.42/V.42 bis	V.42/V.42 bis
+ES=3, 2, 4 (V.42 Reliable)	Modem hangs up	MNP2–4, 5	V.42/V.42 bis	V.42/V.42 bis

NOTES:

1) MNP5 requires the modem to be configured for **%C1**.
2) V.42 bis requires the modem to be configured for **"H3**.
3) Refer to the **\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, MNP2–4 or V.42:	&F +ES=3,0,2	*or*	+ES=3,0,2 "H3 %C1
V.42 bis with fallback to V.42/MNP2–4:	&F +ES=3,2,4 %C0	*or*	+ES=3,2,4 %C0 "H3 -J1
V.42 bis only:	&F +ES=3,2,4 -J0	*or*	+ES=3,2,4 -J0 "H3
V.42 only:	&F +ES=3,2,4 -J0 "H0	*or*	+ES=3,2,4 -J0 "H0
MNP5 with fallback to MNP2–4:	&F +ES=4,4,6	*or*	+ES=4,4,6 %C1
MNP2–4 only:	&F +ES=4,4,6 %C0	*or*	+ES=4,4,6 %C0

Table 4-3. V.42 and MNP® Data Mode Command Descriptions[a]

Command	Default	Description
%An	**13**	**Set Auto-Reliable Fallback Character:** In Auto-reliable mode (**+ES=3,0,2**) with auto-reliable fallback character enabled (**\C2**), receipt of the fallback character from the line during the V.42 detection phase causes the modem to switch to buffer (normal) mode. This allows a remote user with a non-V.42 modem to immediately connect with a V.42 modem. A space or carriage return is usually chosen for the fallback character. n = 0–127 (ASCII character.)
%Cn	**1**	**MNP 5 Data Compression Control:** This command controls whether the data sent during the MNP frames is compressed using the MNP Class 5 compression standard. MNP 5 data compression can improve throughput by as much as 150%. n = 0, 1 n = 0 No compression. n = 1* MNP Class 5 compression.
\An	**3**	**MNP Block Size:** This command specifies the maximum number of data bytes in an MNP data frame. A smaller frame size can improve throughput on high-impairment (noisy) telephone lines. n = 0–3 n = 0 Maximum 64 characters. n = 1 Maximum 128 characters. n = 2 Maximum 192 characters. n = 3* Maximum 256 characters.

Table 4-3. V.42 and MNP® Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
\Cn	**0**	**Set Auto-Reliable Buffer:** (requires a license from Microcom®) In Auto-reliable mode (**+ES=3,0,2**), this command determines the fallback method and enables data buffering. The settings for this command are used by the modem during the V.42 detection phase. 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 the serial port. This feature allows non-V.42 modems to immediately connect to a V.42 modem without data loss.
\Gn	**0**	**Set Modem Port Flow Control:** In Buffer (normal) mode (either **+ES=1,0,1** or after fallback), this command enables modem-to-modem flow control using XOFF (13h) to stop and XON (11h) to start transmission between modems. n = 0, 1 n = 0* Disables port flow control. n = 1 Sets port flow control to XON/XOFF.
\Jn	**0**	**bps Rate Adjust Control:** If this command is enabled, the serial port speed automatically changes to the modem-connection speed. This forces the user to change the DTE-to-modem bps rate, if needed. If the command is disabled, the serial port speed is independent of the connection speed, which allows much greater throughput when using error correction and data compression. n = 0, 1 n = 0* Feature enabled. n = 1 Feature disabled.
\Tn	**0**	**Set Inactivity Timer:** During a Buffer (normal) or Reliable mode connection, if no data is sent or received within the inactivity time period, the link is disconnected. The default, '0', disables this feature. n = 0–90 Sets length in minutes. n = 0* Disables inactivity timer.
\Xn	**0**	**Set XON/XOFF Pass-Through:** If software flow control is enabled (**\Q1**), this command defines whether the XON (11h) and XOFF (13h) characters received from the DTE are sent to the remote modem. In addition, if the modem port flow control is enabled (**\G1**) in Normal mode, the command specifies whether the XON and XOFF characters received from the remote modem are sent to the DTE. In both cases, the flow control operation is not affected. n = 0, 1 n = 0* Processes flow control characters. n = 1 Processes flow control characters and passes them through to the local or remote for processing.
-Jn	**1**	**Set V.42 Detect Phase:** In V.42 modes (**+ES=3,0,2** and **+ES=3,2,4**), this command specifies whether the modem detects V.42, MNP, or no error-correcting protocols from the remote modem and changes to the appropriate mode. Otherwise, only V.42 is attempted. n = 0, 1 n = 0 Disables the V.42 detect phase. n = 1* Enables the V.42 detect phase.

Table 4-3. V.42 and MNP® Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
“Hn	**3**	**V.42 bis Compression Control:** This command specifies whether the data in the LAP-M 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. n = 0–3 n = 0 Disables V.42 bis. n = 1 Enables V.42 bis only when transmitting data. n = 2 Enables V.42 bis only when receiving data. n = 3* Enables V.42 bis for both transmitting and receiving data.
“On	**32**	**V.42 bis String Length:** This command specifies the maximum number of characters that can be compressed into one V.42 bis code word. The default value of 32 optimizes throughput for most file types. n = 6–250 Number of characters. n = 32* Usual number of characters.
+ES=m	**see ‘m’**	**Error Control Selection:** The **+ES=m** command controls the operation of the V.42 error detection and correction protocol in the DCE. Once a connection has been established between the DCE and DTE, the **<orig_rqst>** subparameter can put the interface into synchronous access mode. In the default settings, synchronous access mode is disabled. To change modes, send another **+ES** command. +ES=1,0,1 Buffered mode. +ES=4,4,6 MNP Reliable mode +ES=3,0,2* V.42 Auto-Reliable mode. +ES=3,2,4 V.42 Reliable mode. +ES=2,3,5 LAPM Reliable mode. +ES=6, ,8 Synchronous Access mode. ***m = <orig_rqst>, <orig_fbk>, <ans_fbk>*** Default: m = 3, 0, 2 **<orig_rqst>** Specifies the initial requested mode of operation when the DCE is the originator. If <orig_rqst>=6, the modem ignores the **<orig_fbk>** setting. Range <orig_rqst>: 1–4, 6 Default: 3 n = 0 Reserved. n = 1 Initiate call with Buffer mode only. n = 2 Initiate V.42 without detection phase. If V.80 mode is in use, this is a request to disable V.42 detection phase. n = 3* Initiate V.42 with detection phase. n = 4 Initiate alternate protocol. n = 6 Initiate synchronous access mode when connection is completed and when in data state.

Table 4-3. V.42 and MNP® Data Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+ES=m *(cont.)*	**see 'm'**	**Error Control Selection**: *(cont.)* **<orig_fbk>** Specifies the acceptable fallback mode of operation when the DCE is the originator. This setting is ignored if <orig_rqst>=6. Range <orig_fbk>: 0–2, 4 Default: 0 n = 0* Error control optional (either LAP-M or alternative acceptable). If error control is not established, maintain the DTE-DCE data rate and use the V.14 Buffer mode with flow control during non-error control operation. n = 1 Error control optional (either LAP-M or alternative acceptable). If error control is not established, change the DTE-DCE data rate to match the line rate and use Direct mode. n = 2 Error control required (either LAP-M or alternative acceptable). If error control is not established, disconnect. n = 3 Reserved. n = 4 Error control required (only alternative protocol acceptable). If error control is not established, disconnect. **<ans_fbk>** Specifies the acceptable fallback mode of operation when the DCE is the answerer. Range <ans_fbk>: 1, 2, 4–6, 8 Default: 2 n = 0 Direct mode. n = 1 Error control disabled, use Buffer mode. n = 2* Error control optional (either LAP-M or alternative acceptable). If error control is not established, maintain the DTE-DCE data rate and use local buffering and flow control during non-error control operation. n = 3 Reserved. n = 4 Error control is required (either LAP-M or alternative is acceptable). If error control is not established, disconnect. n = 5 Error control required (only LAP-M acceptable). If error control is not established, disconnect. n = 6 Error control required (only the alternative protocol is acceptable). If error control is not established, disconnect. n = 8 Initiate synchronous access mode when the connection is complete and data state is entered.

[a]An asterisk (*) denotes the factory-default setting.

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 CL-MD562X–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 55. 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 Cirrus Logic *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
+FMFR?/+FMI?	**none**	**Identifies Modem Manufacturer:** This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to **AT+GMI?**. AT+FMFR? CIRRUS LOGIC OK The DTE manufacturer name can be changed with the firmware configuration utility.
+FMDL?/+FMM?	**none**	**Identifies Product Model:** This command causes the DCE to report the modem chipset name. This command is identical to ATI3 and AT+GMM?. AT+FMDL? CL-MD56XX OK The modem responds with 'CL-MD562X' for all chipsets that support V.42/MNP protocols.
+FREV?/+FMR?	**none**	**Identifies Product Version Number:** This command causes the DCE to report the modem chipset revision level. This command is identical to **ATI1** and **AT+GMR?**. AT+FREV? CD04.08-540K Parallel-SP04 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 can 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 on page 53.

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

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

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

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

Table 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 shown in Figure 5-1. When sending the HDLC data, the modem automatically generates the flags and the frame checking sequence (Frame Check Sum). All the other fields are transmitted to or received from the DTE (that is, these fields are under the control of the DTE).

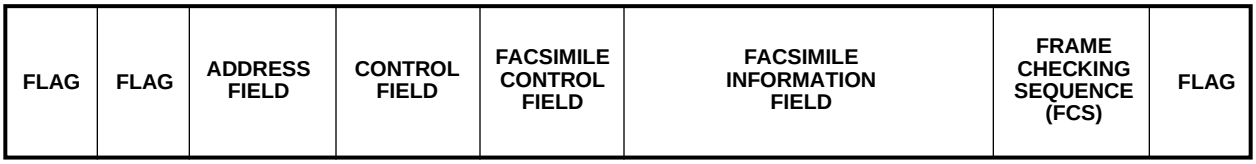

Figure 5-1. T.30 HDLC Frame Format

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.

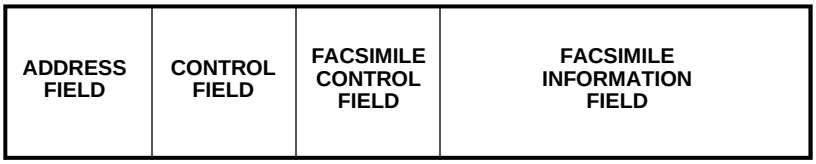

Figure 5-2. CLASS 1 DTE-Generated HDLC Frame Information (AT+FTH=<mod>)

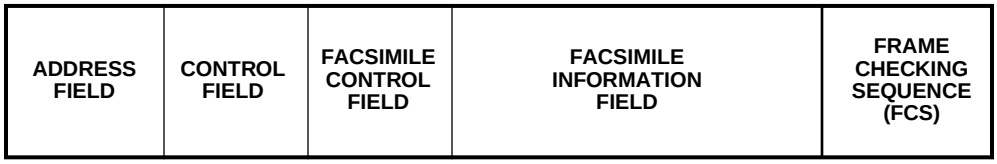

Figure 5-3. CLASS 1 DTE Reception of HDLC Frame Information (AT+FRH=<mod>)

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. A 'T' can be added to the string for DTMF tone dialing, or a 'P' can be added for pulse dialing. Unlike the data modem mode, auto-answering is not supported by the modem while in fax mode. It is recommended that S-register **S0** be set to '0' (that is, use 'ATA') whenever the modem is expected to receive a fax call.

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

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

1) It places the modem off-hook.

2) It causes the modem to transmit the answer tone.

3) It causes the modem to act as if it received an **AT+FTH=3** command from the DTE.

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

Data All.
Voice +FCLASS, +VDR, +VNH, +VIP, and +VCID.

Table 5-3. Fax Mode Command Descriptions[a]

Command	Default	Description
+FCLASS=1	**0**	**Fax Mode Selection:** This command is used to select a fax class, indicate current fax class mode setting, and indicate supported fax classes. All fax mode commands, except for **+FCLASS**, are valid only in fax mode. +FCLASS? Indicates current fax class selection. +FCLASS = ? Indicates supported fax classes. +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. n = 0, 1, 8 n = 0* Configures DCE for data modem operation. n = 1 Configures DCE for fax Class 1 modem operation. n = 8 Configures DCE for IS-101 voice mode.
+FRH=n	**none**	**Receive HDLC Data:** The **+FRH=<mod>** command causes the modem to receive HDLC-framed data using the modulation mode selected in <mod>. The modem then delivers the next-received frame to the DTE. 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. 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. After the FCS bytes are transferred, the modem marks the end of the frame with <DLE><ETX> and reports the status of the frame reception to the DTE. If the frame was received correctly (FCS is correct), the modem returns an '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. After sending the status result code, the modem is ready to accept new commands from the DTE. 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. After sending the result code indicating that frame reception is complete, the modem continues to receive and buffer the data in the selected mode. If the DTE issues another **+FRH=<mod>** command, the modem returns another 'CONNECT' result code and continues with HDLC reception. If the DTE issues any command that changes modulation, the DCE stops the receive process. The DCE then discards any buffered data and processes the command. Range: <mod> = 3 Refer to Table 5-2 on page 53.

Table 5-3. Fax Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+FRM=n	**none**	**Receive Data:** The **+FRM=<mod>** command causes the modem to enter Receive mode using the modulation scheme specified in <mod>. <mod> can have the values shown in Table 5-2 on page 53. 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. After receiving the selected carrier, the modem transfers all received data patterns to the DTE as consecutive start-stop framed bytes, including leading marking conditions or flags. The modem marks the end of the data stream with <DLE><ETX>. Upon loss of carrier, the modem returns to the command state and sends a 'NO CARRIER' result code to the DTE. If the modem is on-hook, then the modem always returns an 'ERROR' message to the DTE after receiving the **+FRM=<mod>** command. Range: <mod> = 24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146 Refer to Table 5-2 on page 53.
+FRS=n	**none**	**Wait for Silence:** The **+FRS=<TIME>** command causes the modem to send an 'OK' result code to the DTE when silence has been detected on the line for the amount of time specified. The value <TIME> is in 10-ms intervals. The command terminates when the required amount of silence has been detected on the line or the DTE sends the modem another character that is discarded. In either event, the DTE returns the 'OK' result code. Range: <TIME> = 1–255 (10 ms)
+FTH=n	**none**	**Transmit HDLC Data:** The **+FTH=<mod>** command causes the modem to transmit data framed in HDLC protocol using the modulation mode selected. <mod> can have the values shown in Table 5-2 on page 53. After receiving the **+FTH** command, the modem sends a 'CONNECT' result code to the DTE. The modem then transmits signal converter training (if required) followed by flags until the first byte of data is sent by the DTE. The modem terminates the **+FTH** command upon detecting <DLE><ETX> characters in the data stream. When the buffer is empty, the modem computes and appends the FCS 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 transmit. 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 the 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: • The DTE sends additional data. The modem then transmits another frame. • The DTE sends only <DLE><ETX> (a null frame). The modem then turns off the transmit carrier and sends the 'OK' result code to the DTE. • If the DTE transmits no additional data within 5 seconds from when the modem reported the 'CONNECT' result code, the modem turns off the transmit carrier mode, returns to command mode, and sends the 'ERROR' result code to the DTE. 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. If the modem is on-hook, it always returns an 'ERROR' message to the DTE after receiving the +FTH=<mod> command. Range: <mod> = 3 Refer to Table 5-2 on page 53.

Table 5-3. Fax Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+FTM=n	**none**	**Transmit Data:** The **+FTM = <mod>** command causes the modem to transmit data using the modulation selected in <mod>. The modem returns a 'CONNECT' result code and transmits the proper training sequence in the selected mode, followed by constant '1' bits until data is received from the DTE. The modem terminates this command upon detecting <DLE><ETX> characters in the data stream. 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 the command state, and returns an 'ERROR' result code to the modem. Hex $00 replication does *not* provide the required timing needed for generating the TCF frame (1.5 seconds of 0s'). 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 the command state, and sends the 'OK' result code to the DTE. If the modem is on-hook, the modem always returns an 'ERROR' message to the DTE after receiving the +FTM = <mod> command. Range: <mod> = 24, 48, 72, 73, 74, 96, 97, 98, 121, 122, 145, 146 Refer to Table 5-2 on page 53.
+FTS=n	**none**	**Stop Transmission and Pause:** The **+FTS=<TIME>** command causes the modem to stop all transmissions. The modem waits for the specified amount of time, then sends an 'OK' result code to the DTE. The value <TIME> is in 10-ms intervals. Range: <TIME> = 0–255 (in 10-ms intervals)

[a] An asterisk (*) denotes the factory default setting.

6. IS-101 VOICE MODE AT COMMANDS

The 56K FastPath chipsets implement a voice mode AT command set that allows the DTE to record and play-back voice messages. In addition to this programmer's guide, the Cirrus Logic publication AN-MD29, *IS-101 Voice Applications*, 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 has a detailed description of each command (see Table 6-1 on page 59). 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 16 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 can be used as follows:

```
+V<command>?                    Read current setting

+V<command> = ?                 Read permissible settings

+V<command> = <parameter>       Set parameter
```

For example, **AT+FCLASS?** determines whether the modem is configured for data (or fax) mode or voice mode. **AT+FCLASS=?** determines which data/fax/voice modes are supported by the modem. **AT+FCLASS=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 $10h in data stream

any data ... <DLE><X>           <X> is a special character,
delete both <DLE> and <X> from the data stream
```

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

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

6.1 DTMF Detection Reporting

DTMF detection information is reported by the modem to the DTE by a <DLE> shielded command as outlined in Section 6.5 of the ITU V.253 specification. When the DTMF burst is detected in Voice mode, the modem sends to the DTE a <DLE></> followed by a sequence of <DLE><tone value> characters every 70 ms until the burst is no longer detected by the DCE. Then a <DLE><-> is inserted to indicate the end of the determination interval.

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

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

6.2 Relay Control

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

```
ATDT <telephone number>
```

If the modem was not already off-hook, then this command automatically configures the value for **AT+VLS=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 occurs 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 can be used to control the local telephone or handset when implementing local playback/record mode (**AT+VLS=n**). Additionally, voice messages can 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 can 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[a]

Command	Default	Description
+FCLASS=8	**0**	**Voice Mode Selection:** This command enables or disables voice mode. All voice mode commands (except for **+FCLASS=n**) are valid only in voice mode. n = 0, 1, 8 n = 0* Data mode. n = 1 Class 1 fax mode. n = 8 Voice mode enabled.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+FLO=n	**1**	**Flow Control Select:** This command allows the DTE to identify and select the types of flow control used. DCEs using the IS-101 standard must support in-band XON/XOFF flow control. XON is the ASCII <DC1> character (11h); XOFF is the ASCII <DC3> character (13h). The DCE can 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.
+VBT=m	**see 'm'**	**Buffer Threshold Setting:** This command specifies the flow control assert and deassert points inside the DCE's internal transmit buffer. The internal buffer is 512 bytes. The **+VBT=m** parameters are fixed in firmware and cannot be changed. ***m = <deassert>, <assert>*** Default: <deassert> = 192, <assert> = 320 **<assert>:** This parameter stops data transfer from the DTE when the number of bytes in the buffer reaches the lower number of the range specified by the <assert> parameter. So that no data is lost before the modem stops the flow of data, the <assert> parameter allows more data to enter the buffer until it reaches the larger number in its range. Range: <assert> = 192 **<deassert>:** This parameter starts data transfer from the DTE after the number of bytes in the transmit buffer falls below the <deassert> value. Range: <deassert> = 320
+VCID=n	**0**	**Caller ID Selection:** This command controls the reporting and presentation of data in the ICLID (Incoming Call Line ID) data format used by the Caller ID services in the United States and Canada. At a minimum, the data sent to the DCE includes the date, time, and the caller's telephone number. Caller ID information is sent to the DTE during the first and second ring signals when the modem is in voice, data, or fax mode. n = 0–2 n = 0* Disables Caller ID. n = 1 Enables Caller ID with formatted presentation to the DTE. The modem presents the data items in a <Tag><Value> pair format. The expected pairs are data, time, caller code (phone number), and name. 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. **NOTE:** If **S0=1** (auto-answer mode) and Caller ID are enabled in data modem mode, then the modem answers only after the second ring signal.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VDR=m	**see 'm'**	**Distinctive Ring Selection:** This command contains two parameters. The first selects whether the modem reports distinctive ring cadence information. The second parameter controls the timing of the RING event code report. ***m=<enable>, <report>*** Defaults = 0, 0 ***<enable>* Ring Reporting**: The DCE reports the length of the ring period. Range: <enable> = 0–255 (enables/disables distinctive ring reporting in the form DROF=<number in units of 0.1 seconds><CR><LF>) ***<report>* Time Ring Reporting**: The DCE reports the silence period's length. The DCE can produce a RING event code after the DRON message if enabled by the <report> parameter. The <report> parameter should be set to a value larger than the expected off-times within a single pattern so the RING even reports are issued only during the off-times between the complex patterns. Range: <report> = 0–255 (reporting type in the form DROF=<number in units of 0.1 seconds>)

<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

Regardless of its setting, the **+VDR** command can be disabled by the **+VEM** command.

+VEM=m	**see 'm'**	**Event Reporting and Masking:** This command selects which detection events are supported in voice mode. Each event is represented by a single bit of a four-digit hex number (see the following table). Setting an event number bit to '0' means that event is not reported. Setting a bit to '1' indicates that a detected event is reported. While the event settings affect all modes (that is, playback, record, and command), not just voice command mode, the mask can be changed each time the mode is changed. Not all events are supported in each mode. See the following table for supported events. This modem supports more features than an IS-101 Class C-compliant modem. (Class C is the highest IS-101 compliant modem, and Class A is the lowest.) See the following examples for more information. ***m = <mask>*** Defaults = 'C', BB860980, BFE63883, BB863EE0

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VEM=m *(cont.)*	**see 'm'**	**Event Reporting and Masking**: *(cont.)*

Hex Digit Location	Event Number (Bit Number)	Event Description	DCE Voice Mode(s)
1	0	Caller ID report	Command
	1	Reserved	
	2	Distinctive ringing	All
	3 *	RING	All
2	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
3	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	
4	12	Reserved	
	13	Loop current interruption	All
	14	Loop current polarity reversal	All
	15	Reserved	
5	16	Reserved	
	17	Reserved	
	18 *	Ringback/remote ring	All
	19 *	BUSY reorder/fast busy	Receive and Command
6	20 *	DIALTONE	Receive and Command
	21	Reserved	
	22	Reserved	
	23*	Transmit buffer under-run	Transmit
7	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	
8	28	Reserved	
	29	Reserved	
	30	Reserved	
	31	Reserved	
	32	Reserved	
	33	Reserved	
	34	Reserved	
	35	Reserved	

Items marked with an asterisk (*) meet IS-101 Class C specifications.

All: Playback, Record, and Command modes.

Reserved: Reserved event number should be set to '0'.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description

+VEM=m *(cont.)*	**see 'm'**	**Event Reporting and Masking**: *(cont.)*
		Example 1. Viewing Supported Events
		To determine the events 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.
		`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 illustrates how the hexadecimal eight-digit code BB863EE0 is derived from the bit setting for each event:
		HEX DIGIT LOCATION: 1 2 3 4 5 6 7 8
		EIGHT-DIGIT HEX CODE: B B 8 6 3 E E 0
		The following example shows how to read the string.

+VGM=n	**128**	**Speakerphone Microphone Gain:** This command sets the speakerphone's microphone gain. n = 121–131 n = 128* Nominal value.

HEX VALUE	**B**	**B**	**8**	**6**	**3**	**E**	**E**	**0**
BIT VALUE	**1 0 1 1**	**1 0 1 1**	**1 0 0 0**	**0 1 1 0**	**0 0 1 1**	**1 1 1 0**	**1 1 1 0**	**0 0 0 0**
EVENT	**0 1 2 3**	**4 5 6 7**	**8 9 10 11**	**12 13 14 15**	**16 17 18 19**	**20 21 22 23**	**24 25 26 27**	**28 29 30 31**
HEX DIGIT LOCATION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

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

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VLS=n	**0**	**Relay/Playback Control:** This command controls the four µP relay drivers and controls hardware paths for voice playback/record transmit and receive.

Preassigned Voice I/O Labels

<label>	Primitive Code	Description
0	None	DCE on-hook. Local phone connected to Telco.
1	T	DCE off-hook. DCE connected to Telco. Local phone provided with power to detect the hook condition.
2	L	DCE on-hook. Local phone connected to DCE.
3	LT	DCE off-hook. Local phone connected to Telco. DCE connected to Telco. (Not implemented. Return error.)
4	S	Internal speaker connected to DCE. DCE on-hook. Local phone connected to Telco.
5	ST	Internal speaker connected to Telco. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
6	M	Internal microphone connected to DCE. DCE on-hook. Local phone connected to Telco.
7	MST	Internal microphone and internal speaker connected to Telco. Squelching active. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
8	S1	External speaker connected to DCE. DCE on-hook. Local phone connected to Telco. (Implemented as 4. Speaker jack determines.)
9	S1T	External speaker connected to Telco. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 5. Speaker jack determines.)
10	MS1T	Internal microphone and external speaker connected to Telco. Squelching active. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 7. Speaker jack determines.)
11	M1	External microphone connected to DCE. DCE on-hook. Local phone connected to Telco. (Implemented as 6. Mic jack determines.)
12	M1ST	External microphone and internal speaker connected to Telco. Squelching active. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 7. Mic jack determines.)
13	M1S1T	External microphone and external speaker connected to Telco. Squelching active. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition. (Implemented as 7.)
14	H	Handset or headset connected to DCE. DCE on-hook. Local phone connected to Telco.
15	HT	Handset or headset connected to Telco. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.
16	HT	Handset or headset connected to Telco with microphone muted. DCE off-hook. DCE connected to Telco. Local phone provided with power to detect hook condition.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VLS=n *(cont.)*	**0**	**Relay/Playback Control**: *(cont.)* ***Voice I/O Primitive Codes*** **Primitive Code** — **Description** L — Local phone. T — Telco line. M0 — Internal microphone. M1 — External microphone. S0 — Internal speaker (requires squelch on any microphone activity). S1 — External speaker (requires squelch on any microphone activity). H0 — External microphone and speaker combination (handset or headset). For speakerphone applications, see **ATI10**, **+VSP**, and "Speakerphone AT Command Requirements" in the Application Note AN-MD29, *'ISO Voice Applications*' for more details.
+VNH=n	**0**	**Automatic Hang-Up Control:** This command changes the way the modem responds to hang-up commands after it switches from Voice mode to Fax or Data modes. 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.
+VRA=n	**50**	**Ringback-Goes-Away Timer:** After originating a call in Voice mode, this command selects the length of time the DCE waits between ringbacks before the DCE assumes the remote party has gone off-hook. After dialing a phone number and detecting a ringback, the modem sends <DLE><0> to the DTE if another ringback is not detected within this timer value. This indicates that the remote telephone has been picked up (that is, gone off-hook). The ringback-goes-away timer is reset every time a new ringback is detected. n = 0–50 (in 100-ms increments) n = 0 The DCE returns the 'OK' code immediately after ringback. n = 50* (50 = 5.0 seconds).
+VRN=n	**10**	**Ringback-Never-Appeared Timer:** This command sets the length of time the DCE waits for ringback when originating a call in Voice mode. This can 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. n = 0–255 (in 1-second increments) n = 0 The DCE immediately returns the OK result code after dialing. n = 10* (10 = 10 seconds).
+VRX	**none**	**Record Mode:** This command causes the modem to enter Record mode to record voice messages. Upon receiving the **AT+VRX** command, the modem responds to the DTE with a 'CONNECT' message at the current DTE-to-modem rate. The UART DTE-to-modem rate must 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 can be lost or garbled during playback of the message. After sending the 'CONNECT' message, the modem then sends digitized voice data that is <DLE>-shielded to the DTE.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VRX *(cont.)*		**Record Mode** *(cont.)* The modem buffers the data to ensure steady voice delivery even though the voice data can be transferred to the DTE in bursts. The DTE can use the <DLE><NUL> shielded code as a no-operation command to refresh the inactivity timer. During Voice Receive mode, the modem informs the DTE about pertinent events that can prompt the DTE to terminate the voice receive state. The DCE sends <DLE> codes for detection of signals such as busy tone, dial tone, DTMF tone, and codes for 'Presumed End of Message' or 'Presumed Hang-up.' Record mode is terminated whenever the modem issues a <DLE><ESC> command or provides a DTE/DCE inactivity timer time out. Upon detecting the terminating character, the modem stops sampling the analog data. The modem then terminates Record mode by sending the remaining voice data stored in its internal buffer, <DLE><ETX> and sending an 'OK' message to the DTE. In some situations, the application software can want to abort Record mode and immediately performs a new function without first reading all the recorded voice data from the modem's internal buffer (for example, after detecting fax calling tone). This is accomplished by sending <DLE><!> to the modem while in Record mode. Upon seeing <DLE><!>, the modem terminates Record mode, clears the modem's internal record buffer, and issues a <DLE><ETX> to the DTE followed by an 'OK' message. The modem can immediately abort record mode if it receives either an **AT+VIT=n** time-out or a DTR toggle. If **+VIT≠0** and the modem has not received any data or a <DLE><NUL> code before the **+VIT** timer times out, then the modem immediately aborts record mode. The modem then hangs up the line and changes to data mode (**+FCLASS=0**). If the UART DTR signal is toggled on-off-on, then the modem follows the **&Dn** setting. If configured for **&D2** or **&D3**, the modem immediately aborts Record mode, hangs up the line, and changes to Data mode (**+FCLASS=0**). **IMPORTANT:** The voice sampling rate and sampling mode must be the same values used during Record mode.
+VSD=m	**see 'm'**	**Silence Detection (Quiet and Silence):** This command allows the DTE to set two parameters: **<sds>** reports the sensitivity for silence detection, and **<sdi>** reports the length of silence required for the DCE to report silence when receiving voice. The <DLE><s> silence timer starts immediately after entering Record mode. The modem stops using the <DLE><s> timer and starts using the <DLE><q> timer if: the <DLE><s> silence timer has timed out and a <DLE><s> code has been sent to the DTE, or if noise or voice energy has been detected above the silence detection threshold (as defined by <sds>). ***m = <sds>, <sdi>*** Default: m = 128, 50 **<sds> Silence Sensitivity:** If the received analog signal stays below this specified level for a user-specified time delay, the modem sends <DLE><q> to the DTE. The modem sends only one <DLE><q> to the DTE each time Record mode **+VRX** is entered. <sds> = 121–131 n = 128* Nominal level. **<sdi> Length of Silence:** This parameter sets the period of silence that must elapse before the DCE reports silence (as detected by 'Quiet' or 'Silence'). <sdi> = 0–255 (units of 0.1 second) n = 0 Silence detection disabled. n = 50* Silence detection enabled.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VSM=m	**manufacturer-specified**	**Compression Method Selection:** This command contains four parameters that specify the voice compression method, voice sampling rate, silence compression sensitivity, and the degree of silence expansion. The DCE can support different capabilities for each compression method. ***m= <cml>, <vsr>, <scs>, <sel>*** Default: m = 140, 8000, 0, 0 **<cml> Compression Method:** This parameter selects a voice compression method. The DTE can obtain the label and a string constant identifier by using the **+VSM?** command. Range: <cml> = 0–2, 128, 129, 132, 140, 141 Default: <cml> = 140 <cml> = 0 LIN1: 8-bit linear PCM (pulse code modulation) sampling using two's complement signed numbers. <cml> = 1 LIN2: 16-bit Linear PCM sampling using unsigned numbers. <cml> = 2 AD4: 4-bit Adaptive differential pulse code modulation. <cml> = 128 LIN1: 8-bit Linear PCM (pulse code modulation) sampling using twos-complement signed numbers. <cml> = 129 LIN2: 16-bit Linear PCM sampling using unsigned numbers. <cml> = 132 AD4: 4-bit Adaptive differential pulse code modulation. <cml> = 140* CL1: 8-bit Cirrus A-law. <cml> = 141 AD3: 3-bit Adaptive differential pulse code modulation. **<vsr> Sampling Rate:** This parameter selects the DCE voice sampling/digitizing rate for the voice signal. The supported sampling rates are dependent on the compression schemes used. Use the **+VSM=?** command to obtain supported sampling rates. Range: <vsr> = 4800, 7200, 8000, and 11025 samples/second Default: <vsr> = 8000*

<vsr> (samples/second)	**Comments**
4800	Default used by previous Cirrus Logic modems.
7200	
8000	Used by some BBS.
9600	
11025	Used by many Windows®.WAV files.

<scs> Silence Sensitivity: The function of this parameter depends on whether the DTE is transmitting or receiving in voice mode. The DTE can modify the silence expansion using the **<sel>** parameter. When transmitting voice, a non-zero value of this parameter informs the DCE that the data stream was recorded with silence compression.
Transmission:

Range: n = 0

n = 0* Disabled.
When receiving voice, this parameter changes the level of noise that the DCE considers silence. A higher 'n' number raises the threshold of noise detection.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VSM=m *(cont.)*	**manufacturer specified**	**Compression Method Selection** *(cont.)*

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.

<cml> Compression	<vsr> Sampling Rate	Serial Data Rate (bps)	UART Data Rate (bps)	Hard Disk (Bytes/sec.)	Note
<cml> = CL1*	4800	48,000	57,600	4800	
	7200	72,000	115,200	7200	1
	8000	80,000	115,200	8000	1
	9600	96,000	115,200	9600	1
	11025	110,250	115,200	11,025	1
<cml> = AD3	4800	18,000	19,200	1800	
	7200	27,000	38,400	2700	
	8000	30,000	38,400	3000	
	9600	36,000	38,400	3600	
	11025	41,344	57,600	4135	
<cml> = AD4	4800	24,000	38,400	2400	
	7200	36,000	38,400	3600	
	8000	40,000	57,600	4800	
	9600	48,000	57,600	4800	
	11025	55,125	57,600	5513	
<cml> = LIN1	4800	48,000	57,600	4800	
	7200	72,000	115,200	7200	1
	8000	80,000	115,200	8000	1
	9600	96,000	115,200	9600	1
	11,025	110,250	115,200	11,025	1
<cml> = LIN2	4800	96,000	115,200	9600	1

Because of the high UART data rates, these compression/sample rates can not be applicable to serial host interface (that is, serial box modem) designs (see **ATI5** to determine if the modem is using the serial host interface). For parallel and PC Card host interfaces, the modem ignores the UART data rate.
DTMF detection is provided for all sample rates.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VSP=n	**0**	**Speakerphone On/Off Control:** This command turns on the speakerphone function. This feature provides full-duplex speakerphone capabilities with internal adaptive echo cancellers. This command takes the received voice signal and loops it back to the analog transmit pins. The host must configure the relays and microphone interface as necessary using the **AT+VLS=n** command. Typically, this means setting the off-hook relay driver, speaker, and microphone inputs with **AT+VLS=13**. After enabling Speakerphone mode (**+VSP=1**), the modem remains in Voice Command mode and provides information about local off-hook detection, DTMF detection, and tone detection — if supported by the modem board. n = 0, 1 n = 0* Speakerphone mode disabled. n = 1 Speakerphone mode enabled.
#VSPS=n	**1**	**Speakerphone Type Selection:** This command determines which speakerphone type is used when the modem receives a **+VSP=n** command. This allows the application software to select whether telephone emulation or digital speakerphone is used for **+VSP=n**. 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'. n = 0, 1 n = 0* Telephone Emulation mode speakerphone. n = 1* Digital speakerphone.
+VTD=n	**100**	**Beep Tone Duration Timer:** This command sets the default duration of all DTMF tones. n = 5–255 (units of 0.01 seconds) Default: n = 100 n = 100* Default value (1 second).
+VTS=m	**none**	**DTMF and Tone Generation:** This command causes the modem to generate DTMF tones or pulse tones in Voice mode. The <DLE><!> code aborts the playback of tones, sends the 'OK' result code, and returns the modem to the voice command state. The DTE/DCE inactivity timer is in place during tone production. The command **+VTS** sent without a parameter assumes the default value, which is a null string. The DTE can use the <DLE><NUL>-shielded code to refresh the timer. ***m=<string>*** The <string> is made up of a list of <freq> and <duration> parameters. <freq> is in units of Hz, and <duration> is in units of 0.01 seconds. 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 value of zero. The following list explains each element and how it can be used. **1)** Single ASCII character in the set, 0-9, #, *, ! and A-D, which is interpreted as a single DTMF tone. DTMF tones are sent as a single element expressed in the form: AT+VTS=<DTMF or !> For example, to send a DTMF 1 tone, issue **AT+VTS=1** to the modem.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VTS=m *(cont.)*	**none**	**DTMF and Tone Generation:** *(cont.)*

2) String drawn from the first set but not including a flash hook code '!' and enclosed in brackets '[ ]',which can produce a single or dual tone. The string includes three parameters, which set the frequency of two non-standard DTMF or single tones and a common duration for both. The quantity in brackets consists of a three-element list that is expressed in the following format:

```
AT+VTS=[<first tone freq 1>, <second tone freq 2>,
<duration>]
```

If the duration is not specified in the <duration> parameter, the modem sends tones for the duration specified by the **+VTD=n** command.

a) Single tones can be sent in brackets using the following format:

```
AT+VTS=[<first tone freq 1>]
```

or

```
AT+VTS=[<first tone freq 1>, <space>, <duration>]
```

For example:

`AT+VTS=[3000]`	Sends a single tone of 3000 Hz with a default duration specified by **+VTD=n**.
`AT+VTS=[3000,,50]`	Sends a single tone of 3000 Hz with a duration of 500 ms (50 x 0.01 second).

b) Dual tones can be sent using the following format:

```
AT+VTS=[<first tone freq 1>,<second tone freq 2>]
```

or

```
AT+VTS=[<first tone freq 1>,<second tone freq 2>,
<duration>]
```

For example:

`AT+VTS=[3000,3300]`	Sends a dual tone of 3000 Hz and 3300 Hz with the default duration set by the **+VTD=n** command.
`AT+VTS=[3000,3300,50]`	Sends a dual tone of 3000 Hz and 3300 Hz with a duration of 500 ms (50 x 0.01 second).

c) This command can be used to send a period of silence in a tone string. Use the following format:

```
AT+VTS=[ , ,<duration>]
```

```
AT+VTS=[ ]
```

For example:

`AT+VTS=[ , ,50]`	Sends a 500-ms period of silence.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description

+VTS=m *(cont.)*	**none**	**DTMF and Tone Generation:** *(cont.)*
		
		3) Single DTMF tones or hook-flashes are sent enclosed in braces "{ }". A duration must be included, as the duration set in **+VTD=n** does not apply.
		Use the following format:
		
		`AT+VTS={<DTMF or !>,<duration>}`
		
		For example:
		`AT+VTS={2,30}` Sends DTMF tone 2 with a duration of 300 ms.
		
		`AT+VTS={!,50}` Sends a hook flash with a duration of 500 ms.
		
		Send multiple DTMF signals and tones by combining elements in a given **+VTS=m** command string.
		For example:
		
		`AT+VTS={!,30}, 1, 2, [1000,1300,50], !, {*,6}, [1000], 9`
		
		This command line programs the following events:
		1. Hook-flash with a duration of 300 ms.
		2. Send DTMF 1 for the duration specified by **+VTD** command.
		3. Send DTMF 2 for the duration specified by **+VTD** command.
		4. Send tone pair 1000 Hz and 1300 Hz for a duration of 500 ms.
		5. Hook-flash with a duration specified by **+VTD** command.
		6. Send DTMF * for a duration of 60 ms.
		7. Send tone 1000 Hz for a duration specified by the **+VTD** command.
		8. Send DTMF 9 for the duration specified by **+VTD** command.
		For example:
		
		`AT+VTS=1, [, ,50], 2, [ ], 9`
		
		This command line programs the following events:
		1. Send DTMF 1 for the duration specified by **+VTD** command.
		2. Play silence for a duration of 500 ms.
		3. Send DTMF 2 for the duration specified by **+VTD** command.
		4. Play silence for a duration specified by **+VTD** command.
		5. Send DTMF 9 for the duration specified by **+VTD** command.

Table 6-1. Voice Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+VTX	**none**	**Play Mode:** This command causes the modem to start voice transmission (Playback mode) and playback a previously recorded voice message. Upon receiving the **AT+VTX** command, the modem responds to the DTE with a 'CONNECT' message at the current DTE-to-modem rate. It is important that the 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 can be lost or the playback message garbled. After receiving the 'CONNECT' message, the DTE then sends the voice file to the modem. To ensure that data is not overwritten, the modem provides both hardware or software flow control with **AT+FLO=n**. The modem also buffers the data to ensure steady voice delivery, even though the voice data can be transferred from the DTE in bursts. Playback mode is terminated when the data is exhausted and the modem receives the two terminating characters <DLE><ETX> from the DTE. Upon detecting <DLE><ETX>, the modem issues an 'OK' result code. After the modem's internal buffer is empty, it returns to Command mode. To abort Playback mode immediately without waiting for the modem to empty its internal buffer, send <DLE><CAN><DLE><ETX>.The modem immediately aborts Playback mode in two other situations: during a **AT+VIT=n** time-out or a DTR toggle. The modem immediately aborts Playback mode if +VIT≠0 and the modem has not received any data or if the modem receives a <DLE><NUL> code before the **+VIT** times out. The modem then hangs up the line and switches to data mode (**+FCLASS=0**). If the UART DTR signal is toggled on-off-on, then the modem follows the **&Dn** setting. If configured for **&D2** or **&D3**, then the modem immediately aborts Playback mode, hangs up the line, and switches to Data mode (**+FCLASS=0**). **IMPORTANT:** The voice sampling rate and sampling mode must be the same values used during Record mode.

[a]An asterisk (*) denotes the factory-default setting

7. S-REGISTERS

The 56K FastPath 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 **ATSn=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 **ATSn?** 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 can cause the modem to act improperly (that is, even though the contents of a read-only S-register can be changed using the **ATSn=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[a]

Command	Default	Description
S0	**0**	**Number of Rings to Auto-Answer On:** Assigning S0 a value from 1 to 255 configures the modem for Auto Answer mode. The modem automatically goes off-hook and initiates a Data mode-Answer mode handshake after detecting the specified number of rings. This S-register is meant for Data Modem mode only and should be set to '0' for Fax and Voice modes. Range: 0–255 rings n = 0 Auto-Answer mode disabled. n = 1-255 Auto-Answer mode enabled. **NOTES:** 1) If Caller ID is enabled (**+VCID=n**), then the modem only answers after the second ring even if S0=1. 2) Setting n > 2 causes the modem to answer on the n^{th} ring signal.
S1	**0**	**Ring Count:** Reports the number of ring signals detected by the modem. This register is cleared to zero if no new ring signals are detected within an 8-second time interval. Range: 0–255 rings Default: 0 rings
S2	**43**	**Escape Character:** Specifies an ASCII value for the Hayes or TIES escape character. The factory default is '+' or ASCII decimal 43. The escape character can range between 0–127. Any value over 127 disables the escape sequence. Range: 0–127 Default: 43 ('+')
S3	**13**	**Carriage Return Character:** Specifies the AT command string terminator and modem response code terminator. The factory default is a <CR> or carriage return (ASCII decimal 13). Range: 0–127 Default: 43 ('+')
S4	**10**	**Line Feed Character:** Specifies the line feed character, used for verbose (text) modem result codes. Range: 0-127 Default: 10 (line feed)

Table 7-1. S-Register Command Descriptions[a] *(cont.)*

Command	Default	Description
S5	**8**	**Backspace Character:** Specifies the backspace character used to delete the last-entered character. After receiving a backspace character, the modem sends three characters to the DTE: a backspace character, a space character, and then another backspace character. Range: 0–32, 127 Default: 8 (BS)
S6	**2**	**Wait Before Blind Dialing:** Specifies the amount of time that must elapse after the modem goes off-hook and starts dialing the first telephone number. The modem waits for at least 2 seconds before dialing the first number, even if S6 is set for a value less than 2. S6 is only used for result code type commands **X0**, **X1**, and **X3** (that is, blind-dialing type result codes). Result code types **X2** and **X4** enable dial-tone detection and ignore the contents of S6. Range: 2–255 seconds Default: 2 seconds
S7	**60**	**Wait for Carrier/Dial Tone:** Specifies the length of time that the modem waits to detect the remote modem carrier after dialing the telephone number. If the remote modem carrier is not detected within the S7 time limit, the modem hangs up and sends a 'NO CARRIER' response code to the DTE. If the remote modem carrier is detected, the modem goes into online Data mode and sends a 'CONNECT' message to the DTE. S7 also specifies the time duration for the '@' (wait for quiet answer) dial modifier. Range: 1–255 seconds Default: 60 seconds
S8	**2**	**Pause Time for Dial Modifier:** Specifies the length of time that the modem pauses during the dialing process each time the ',' dial modifier is detected in the dialing string. Range: 0–255 seconds Default: 2 seconds
S9	**6**	**Carrier Detect Recovery Time:** Specifies how long the remote modem carrier must be present on the telephone line before the modem detects it and turns on DCD. The greater the time duration, the less likely that a false carrier detection occurs due to noise on the telephone line. Range: 1–255 (1/10 of a second) Default: 6 (equals 0.6 seconds)
S10	**14**	**Lost Carrier Hang Up Delay:** For modes V.32 bis and below, S10 specifies the length of time the modem waits before hanging up after the loss of the remote modem carrier. This delay allows for the temporary loss of the remote modem carrier without causing the local modem to hang up. In V.34, x2, and V.90 modes, the modem retries the connection for the time specified in S10 (plus the mode-specific base time) before hanging up. In V.34 mode, the base time is 20 seconds. In x2 and V.90 modes, the base time is 45 seconds. For all modes, the modem does not disconnect upon loss of the remote modem carrier if S10 is 255. Range: 0–255 (1/10 of a second) Default: 14 (equals 1.4 seconds plus base time)
S11	**70**	**DTMF Dialing Speed:** Specifies the duration of dual-tone multi-frequency (DTMF) dialing. This register is not used for pulse dialing. Range: 50-255 ms Default: 70 ms

Table 7-1. S-Register Command Descriptions[a] *(cont.)*

Command	Default	Description
S12	**50**	**Guard Time:** Specifies guard and detect times used for the Hayes and TIES escape sequences. 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. 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. Range: 0–255 (1/50 of a second) Default: 50 (equals 1 second)
S14	**138**	**Bit-Mapped Options:** A read-only register indicating AT command settings. Bit 0 — Reserved Bit 1 — 0 **E0** is selected; 1* **E1** is selected Bit 2 — 0* **Q0** is selected; 1 **Q1** is selected Bit 3 — 0 **V0** is selected; 1* **V1** 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
S16	**0**	**Modem Test Options:** Indicates the test in progress. Bit 0 — 0* Local analog loopback disabled; 1 (**&T1**) Local analog loopback enabled Bit 1 — Reserved Bit 2–5 — Reserved Bit 6 — Reserved Bit 7 — Reserved
S18	**0**	**Modem Test Timer:** Specifies the length of time that the modem conducts a Data mode (except for x2 and V.90 modes) loopback test using the **&Tn** command. After timing out, the modem returns to Command mode. Setting S18 to '0' disables the modem test timer; the loopback test must be terminated by issuing the appropriate escape sequence followed by an **AT&T0** or **ATH**. Range: 0–255 seconds Default: 0 seconds

Table 7-1. S-Register Command Descriptions[a] *(cont.)*

Command	Default	Description		
S21	**48**	**Bit-Mapped Options:** A read-only register indicating AT command settings.		
		Bit 0		Reserved
		Bit 1		Reserved
		Bit 2		Reserved
		Bits 4-3	00	**&D0** is selected
			01	**&D1** is selected
			10*	**&D2** is selected
			11	**&D3** is selected
		Bit 5	0	**&C0** is selected
			1*	**&C1** is selected
		Bit 6	0*	**&S0** is selected
			1	**&S1** is selected
		Bit 7	0*	**Y0** is selected
			1	**Y1** is selected
S22	**118**	**Bit-Mapped Options:** A read-only register indicating AT command settings.		
		Bits 1-0	00	**L0** is selected
			01	**L1** is selected
			10*	**L2** is selected
			11	**L3** is selected
		Bits 3-2	00	**M0** is selected
			01*	**M1** is selected
			10	**M2** is selected
			11	**M3** is selected
		Bits 6-4	000	**X0** is selected
			001	Reserved
			010	Reserved
			011	Reserved
			100	**X1** is selected
			101	**X2** is selected
			110	**X3** is selected
			111*	**X4** is selected
		Bit 7	0*	**&P0** is selected
			1	**&P1** is selected
S23	**none**	**Bit-Mapped Options:** A read-only register indicating AT command settings.		
		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
			01	No parity
			10	Odd parity
			11	Reserved
		Bit 7,6	00	**&G0** is selected
			01	**&G1** is selected
			10	**&G2** is selected
			11	Reserved

Table 7-1. S-Register Command Descriptions[a] *(cont.)*

Command	Default	Description
S25	**5**	**Detect DTR Change:** Defines the minimum amount of time that DTR has to remain off (that is, on-off-on transitions) before the modem performs the function specified by **&Dn** command. A change in DTR that persists for a shorter time than the value specified in S25 is ignored by the modem (see the **&Dn** command). Range: 0–255 (1/100 of a second)
S30	0	**Disconnect Inactivity Timer:** Sets the length of time (in minutes) that the modem stays online/off-hook before disconnecting when no data is being transmitted or received. In Data and Fax modes, any data transmitted or received between the DTE-DCE interface resets the timer. In all other modes (except Telephone-Emulation mode), any data transmitted resets the timer. In Telephone-Emulation mode, S30 is ignored (that is, the modem does *not* automatically hang up the line after a given time delay). Range: n = 0–255 minutes n = 0 Disabled.
S31	**49**	**Bit-Mapped Options:** A read-only register that indicates AT command settings. Bit 0 Reserved Bit 1 0* **&U0** is selected 1 **&U1** is selected Bit 2 Reserved Bit 3 0* **-C0** is selected 1 **-C1** is selected Bit 4 0 **%E0** is selected 1* **%E1** is selected Bit 5 0 **%G0** is selected 1* **%G1** is selected Bit 6, 7 Reserved
S33	10	**Sleep Mode Timer:** Determines when the modem enters sleep or power-down mode. When enabled (S33 ≠ 0), the controller enters sleep mode whenever the modem has been inactive for the user-programmed time delay (S33). The modem is considered to be in an inactive state when: • No internal processing is being performed; • No activity occurs between the host and the modem within a specified time period; • The modem is off-line. The modem exits sleep mode whenever the host reads or writes to the modem or when a ring signal is detected. Sleep mode is disabled by setting S33 to '0'. Range: 0–90 seconds

[a]An asterisk (*) denotes the factory-default setting

8. CALLER ID

This section describes Caller ID for the United States. Caller ID is a service that lets the called party view the telephone number of the caller before the call is answered. The information transmitted to the called party through 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 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) or MDM (multiple data message). 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 can 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, P indicates that the calling number information is not available since the originating caller has requested private service, and 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: Formatted form reporting (**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
MESG = 060342424231
RING
RING
```

Example 2: Unsolicited response (**AT+VCID=1**) form of Voice mode (**+FCLASS=8**), which includes Voice, Command, Playback, and Record modes.

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

Example 3: Formatted form reporting illustrates when the DCE does not recognize the tag of the packet (Data or Fax Command mode).

```
RING

MESG = 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: Unformatted form reporting (Data or Fax Command mode).

```
RING

MESG = 0412303332313133430353931343535313233343 5

RING

RING
```

9. MANUFACTURING-ONLY COMMANDS

The following commands are provided for manufacturing and test purposes only. Do not include these commands in end-user literature.

CAUTION: Serious damage to the controller can occur if these commands are incorrectly implemented.

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

The FastPath chipsets include two commands, **#VGPO=n and AT#VGP1=n**, that can 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
***NCnn**	**0**	**Country Select**: For international use, this command sets the country-specific parameters, including S-register settings. The command checks that the entered country code matches one of the codes stored on 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, '0', is used if no NVRAM is installed or if the NVRAM failed the self-test during reset. On blank NVRAM, the default, '0', is loaded and the country code is not initialized. This can cause errors, such as dial tone detection. Set the **AT*NCn;&W** (n=0 to 9) command at power-up. Do not use **AT&F** and **ATZ** after setting, as they have no affect on the country code. **ATI6** stores the country code. **AT*NCn** followed by **AT&W** is the same as the **AT*NCn;&W** command. n = 0* USA = United States n = 1 JPN = Japan n = 2 GBR = United Kingdom n = 3 GR = Germany n = 4 SWE = Sweden n = 5 DNK= Denmark n = 6 FIN = Finland n = 7 NOR = Norway n = 8 AUT = Austria n = 9 CHE = Switzerland
S91	**10**	**Select Data Transmit Level:** Sets the modem transmit level for the Data mode. This value is stored in the NVRAM, but not displayed by the **&Vn** command. The reset commands **&F** and **Zn** have no effect on S91. Since the function of S91 relates to modem hardware, this command should *only* be used by the modem manufacturer and *never* used by a software developer or end user. In some countries, the end user is not permitted to change the transmit level. In these countries, the country PTT ensures the end user cannot change the transmit level. Range: 9 to 16 (-16 dBm) Default: 10* (-10 dBm)

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

Command	Default	Description
S92	**10**	**Select Fax Transmit Level:** Sets the modem's transmit level for the Fax mode. This value is stored in the NVRAM, but not displayed by the **&V** command. The reset commands **&F** and **Zn** have no effect on S92. Since the function of S92 relates to modem hardware, this command should *only* be used by the modem manufacturer and *never* used by a software developer or end user. In some countries, the end user is not permitted to change the transmit level. In these countries, the country PTT ensures the end user cannot change the transmit level. Range: 0 to 15 (-15 dBm) Default: 10* (-10 dBm)
#VGP0=n **#VGP1=n**	**See Note 1**	**Read/Write General-Purpose Pins:** These commands allow the DTE to set the modem signal level at the GPIO[23:0} pins to V_{CC} or ground. The **AT#VGP0–2?** commands allow the DTE to read the signals applied at these pins.

Command	Bit	Pins
#VGP0	0	Read/write GPIO 0
	1	Read/write GPIO 1
	2	Read/write GPIO 2
	3	Read/write GPIO 3
	4	Read/write GPIO 4
	5	Read/write GPIO 5
	6	Read/write GPIO 6
	7	Read/write GPIO 7
#VGP1	0	Read/write GPIO 8
	1	Read/write GPIO 9
	2	Read/write GPIO 10
	3	Read/write GPIO 11
	4	Read/write GPIO 12
	5	Read/write GPIO 13
	6	Read/write GPIO 14
	7	Read/write GPIO 15

NOTES:

1) Default values for #VGP0–#VGP1 are dependent on board design.
2) These commands should not be used in general-purpose application software.

10. PARALLEL HOST INTERFACE 16C450/16C550A UART

10.1 UART Emulation in the Controllerless Modem

When controllerless modems are used with Windows applications, the communication driver architecture eliminates the need for a UART emulation (see Section 1.1 on page 5). However, MS-DOS applications used with controllerless modems still require UART emulation. Cirrus Logic provides the CLM_DBS.VXD driver, including this UART emulation and also directly interacts with the Windows VCOMM.VxD driver (see Figure 10-1).

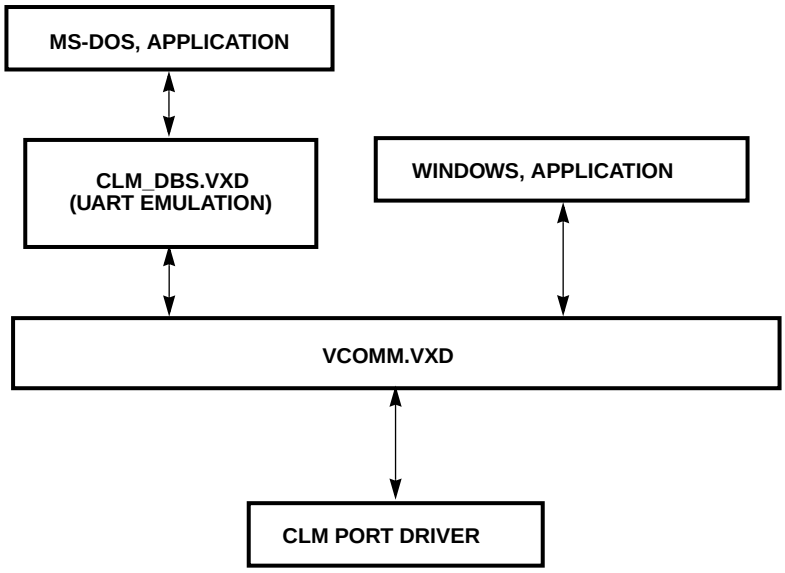

Figure 10-1. UART Emulation in CLM_DBS.VxD

CLM_DBS emulates the critical functionality of the 16550 UART. Because all the functionality of a hardware UART is not meaningful to a software emulation, some internal characteristics can not be implemented. For reference to a traditional hardware based solution, see Appendix B, “16C450/16C550A UART DESCRIPTION”

The parallel host interface of the FastPath family emulates the electrical and register functions of a 16550A and 16C450 UART. On 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 one byte at a time. In 16C550A emulation mode, the modem provides two 16-byte FIFO buffers, one each for the transmitter and receiver. Up to 16 bytes of data can be sent to or received from the modem for each data interrupt, instead of only a single byte as in 16C450 mode. Figure 10-2 on page 85 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.

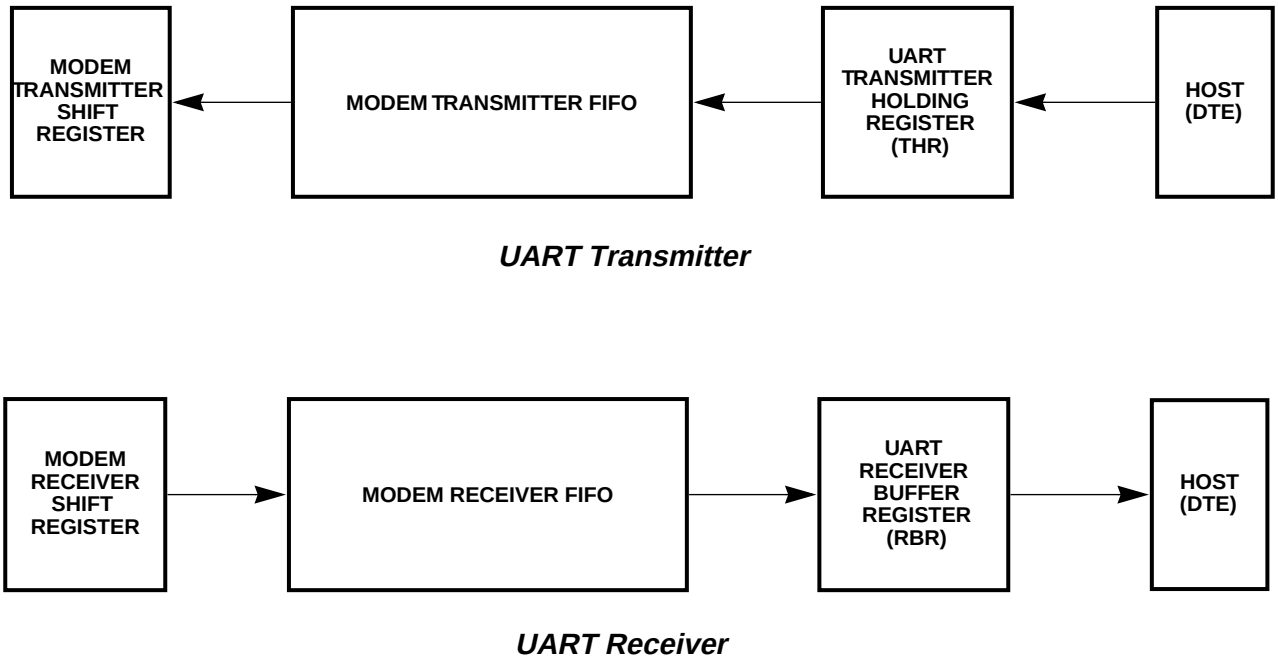

Figure 10-2. FIFO Buffers for Transmitter and Receiver

Register addresses are divided into two types: single-register access and multiple-register access. Most 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) can access two or more internal registers.

UART register address 2 writes FIFO control information into FCR (FIFO Control register) and reads IIR (Interrupt Identity register).

UART register address 1 reads and writes data to IER (Interrupt Enable register – when DLAB = 0) and MS DLM (Divisor Latch register – when DLAB = 1).

UART register address 0 reads data from RBR (Receiver Buffer register – when DLAB = 0), writes data to THR (Transmitter Holding register – when DLAB = 0), and reads and writes to LS DLL (Divisor Latch register – when DLAB = 1).

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 (SCR)	Scratch register (SCR)							
6	Modem Status (MSR)	Data Carrier Detect (DCD)	Ring Indicator (RI)	Data Set Ready (DSR)	Clear to Send (CTS)	Delta Data Carrier Detect (DDCD)	Trailing Edge of Ring Indicator (TERI)	Delta Data Set Ready (DDSR)	Delta Clear to Send (DCTS)
5	Line Status (LSR)	Error in Rx FIFO[a]	Transmitter Empty (TEMT)	Transmitter Holding Empty (THRE)	Break Interrupt (BI)	Framing Error (FE)	Parity Error (PE)	Overrun Error (OE)	Data Ready (DR)
04	Modem Control (MCR)	0	0	0	Loop	Out 2	Out 1	Request to Send (RTS)	Data Terminal Ready (DTR)
3	Line Control (LCR)	Divisor Latch Access (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 write only (FCR)	Rx Trigger (MSB)	Rx Trigger (LSB)	Reserved	Reserved	Reserved	Tx FIFO Reset (XFIFOR)	Rx FIFO Reset (RFIFOR)	FIFO Enable (FIFOE)
2	Interrupt Identity read only (IIR)	FIFOs Enabled[a]	FIFOs Enabled[a]	0	0	Interrupt ID bit 2[a]	Interrupt ID bit 1[a]	Interrupt ID bit 0[a]	'0' if interrupt pending
1 DLAB=0	Interrupt Enable (IER)	0	0	0	0	Modem Status Interrupt Enable (MSIE)	Receive Line Status Interrupt Enable (RLSIE)	Transmit Holding Empty Interrupt Enable (THREIE)	Received Data Available Interrupt Enable (RDAIE)
0 DLAB=0	Tx Holding write only (THR)	Transmit Holding register (THR) write only							
0 DLAB=0	Rx Buffer read only (RBR)	Receive 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)							

[a] These bits are always '0' in 16C450 mode

10.2 UART Register Definitions

Register 7: Scratch Register

Register Name: **SCR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
SCR							

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

Register 6: Modem Status Register

Register Name: **MSR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
DCD	RI	DSR	CTS	DDCD	TERI	DDSR	DCTS

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 (IER[3]), the modem generates an interrupt on the µP HINT pin whenever MSR bits [3:0] are set to '1'.

Bit	Description
7	**Data Carrier Detect (DCD)**: When this bit is set to '1', it indicates that the remote modem data carrier has been detected (refer to the **&C** command).
6	**Ring Indicate (RI)**: This bit indicates a ring signal has been detected.
5	**Data Set Ready (DSR)**: This bit indicates 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.
4	**Clear To Send (CTS)**: When this bit is set to '1', it indicates to the DTE that the modem is ready to receive data.
3	**Delta Data Carrier Detect (DDCD)**: When this bit is set to '1', it indicates that the DCD bit has changed its value since the DTE last read MSR.
2	**Trailing Edge of Ring Indicator (TERI)**: This bit is set to '1' after the RI signal goes from high to low.
1	**Delta Data Set Ready (DDSR)**: When this bit is set to '1', it indicates that the DSR bit has changed value since the DTE last read the MSR.
0	**Delta Clear to Send (DCTS)**: When this bit is set to '1', it indicates that the CTS bit has changed value since the DTE last read the MSR.

Register 5: Line Status Register

Register Name: **LSR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
Rx Err	TEMT	THRE	BI	FE	PE	OE	DR

This read-only register provides UART status information to the host. Bits 4:1 report error conditions and are reset to '0' during a host read of this register. When [4:1] are '1' and RLSIE is enabled, an interrupt is generated to the host.

Bits 0, 5, and 6 provide status information for sending and receiving data through the THR (Transmit Holding register) and the RBR. 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 FIFO.

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

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

Register 4: Modem Control Register

Register Name: **MCR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
0	0	0	Loop	Out 2	Out 1	RTS	DTR

This register controls the DTE-DCE UART interface.

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

Register 3: Link Control Register

Register Name: **LCR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
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 + the number of data character bits + parity + the number of stop bits).

Bit	Description
7	**DLAB (Divisor Latch Access Bit)**: This bit must be set to '1' to access the divisor latches of the baud rate generator during a read or write operation. UART registers 1 and 0 are used for the divisor latches. This bit must be set to '0' to access RBR, THR, or IER.
6	**SBRK (Set Break)**: This bit sends a long-space disconnect message to the remote modem. Use the following procedure: **1. After the THRE bit (LSRIS) is set to '1' by the DCE, before setting SBRK, the DTE needs to write ($00h) to the THR.** **2. The DTE sets SBRK after the next time THRE is set by the DCE (a long space is now being transmitted).** **3. To return to normal transmission mode, wait for TEMT to equal '1', then reset SBRK.**

Bit	Description *(cont.)*
Bit 5	**SPAR (Stick Parity):** When this bit is set to '1', stick parity is enabled. When configured for stick parity (SPAR = 1), even parity (EPS = 1), and parity enable (PEN = 1), 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', and the parity bit is transmitted and checked as a logic '1'.
Bit 4	**EPS (Even Parity Select):** When even parity select (LCR4) and parity enable (LCR3) are set to '1', an even number of logic 1's are transmitted or checked. When even parity select (LCR4) is a '0' and parity enable (LCR3) is a '1', an odd number of logic 1's are transmitted or checked.
Bit 3	**PEN (Parity Enable):** When this bit is set to '1', a parity bit is generated (transmitted data) or checked (receive data) between the last data character word bit and stop bit of the serial data. **NOTE**: The parity bit is used to produce an even or odd number of '1's when the data word bits and the parity bits are totaled.
Bit 2	**STB (Number of Stop Bits):** 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, 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, 1.5 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	**WLS1 and WLS0 (Word Length Select Bits):** These two bits specify the data character word length of the transmitted and received data, as shown. **bit 1** / **bit 0** / **Word Length (bits)** 0 / 0 / 5 0 / 1 / 6 1 / 0 / 7 1 / 1 / 8

Register 2: FIFO Control Register (write only)

Register Name: **FCR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
Rx Trigger	Rx Trigger	Reserved			XFIFOR	RFIFOR	FIFOE

This write-only register enables the Rx and Tx FIFOs, clears the FIFOs, sets the Rx FIFO trigger level, and selects the DMA signaling type.

Bits	Description
7:6	**Rx Trigger Bits:** FCR bits 7 and 6 are used to set the trigger level for the Rx FIFO interrupt. **Bit 7** / **Bit 6** / **Rx FIFO Trigger Level (Bytes)** 0 / 0 / 01 0 / 1 / 04 1 / 0 / 08 1 / 1 / 14
5:3	**Reserved**

Bits	Description *(cont.)*
Bit 2	**XFIFOR (Tx FIFO Reset):** When this bit is set to '1',all bytes in the Tx FIFO are cleared and the internal counter logic resets to '0'. The internal shift register is not cleared by the XFIFOR bit. This bit is automatically cleared by the modem.
Bit 1	**RFIFOR (Rx FIFO Reset):** When this bit set to '1', all bytes in the Rx FIFO are cleared and the internal counter logic resets to '0'. The internal shift register is not cleared by the RFIFOR bit. This bit is automatically cleared by the modem.
Bit 0	**FIFOE (FIFO Enable):** When this bit is set to '1', both FIFOs are enabled. This bit must be '1' when writing to any other FIFO bit. If FIFO is not set to '1', then the DTE cannot program any FIFO functions.

Register 2: Interrupt Identity Register (read only)

Register Name: **IIR**

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
FIFO EN	FIFO EN	0	VDMA	Int ID 2	Int ID 1	Int ID 0	Int Pending

This read-only register indicates when the Tx and Rx FIFOs are enabled and indicate the source of highest-priority pending interrupt to the DTE. The five levels of modem interrupt sources in order of priority are: receiver line status, received data ready, character timeout indication, THR 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 IIR, the modem records new interrupts but does not change the current indicator until the read process is complete.

Table 10-2. Interrupt Control Functions

FIFO Mode Only	Interrupt Identification Register			Interrupt Source and Reset Functions			
Bit 3 Int. ID 2	Bit 2 Int. ID1	Bit 1 Int. ID0	Bit 0 Int. Pen	Priority	Interrupt Type	Interrupt Source	Interrupt Reset Control
0	0	0	1	–	None	None	–
0	1	1	0	Highest	Receiver line status	OE, PE, FE, BI, or break interrupt	Read LSR
0	1	0	0	Second	Received data available	Receiver data available or trigger level reached	Read RBR or FIFO drops below trigger level
1	1	0	0	Second	Character timeout indication	No characters removed from or entered into the Rx FIFO during the last four character times; there is at least one character in Rx FIFO.	Read RBR
0	0	1	0	Third	THRE	THRE	Read IIR (if interrupt source) or write to THR
0	0	0	0	Fourth	Modem status	CTS, DSR, RI, or DCD	Read the MSR

Bit	Description
7:6	**FIFOs Enable Bits:** These two bits are set whenever FCR[0] = 1.
5	**Not used:** This bit is always '0'.
4	**Reserved**
3	**Interrupt ID Bit 2:** In 16C450 mode, this bit is always '0'. In FIFO mode, this bit and bit IIR[2] are set when a timeout interrupt is pending.
2:1	**Interrupt ID Bits ID0 and ID1:** These two bits identify the highest-priority interrupt, as shown in Table 10-2.
0	**Interrupt Pending:** This bit indicates when a modem interrupt is pending. When 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).

Register 1: Interrupt Enable Register

Register Name: **IER** (DLAB = 0)

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
0	0	0	0	MSIE	RLSIE	THREIE	RDAIE

This register enables up to five types of UART interrupts: receiver line status, received data available, character timeout indication (FIFO mode only), THRE, and modem status. Each enabled interrupt can individually cause a HINT. To cause a HINT, the interrupt enable bit and MCR[2] must be set to '1'.

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

Register 0: Transmitter Holding Register (write only)

Register Name: **THR** (DLAB = 0)

Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
THR							

THR is a write-only register for sending data and AT commands to the modem.

Register 0: Receiver Buffer Register (read only)							
Register Name: **RBR** (DLAB = 0)							
Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
RBR							

RBR is a read-only register for receiving data and AT command responses from the modem.

Register 1: Divisor Latch Register (msb)							
Register Name: **DLM** (DLAB = 1)							
Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
DLM (MS)							

Register 0: Divisor Latch Register (lsb)							
Register Name: **DLL** (DLAB = 1)							
Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
DLL (LS)							

The LS divisor latch (least-significant byte) and MS divisor latch (most-significant byte) are two read/write registers that set the modem data rate. The data rate is selected by loading each divisor latch with the appropriate hex value, as shown in Table 10-3. 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	Divisor Latch (Hex)	
	(Decimal)	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

10.3 16C550A UART FIFO Operation

The modem 16C550A UART FIFO works in both interrupt and polled operation. This section provides a description of each operation.

10.3.1 FIFO Interrupt Mode Operation

Both the modem Rx and Tx UART FIFOs can be set for interrupt mode operation. The Rx FIFO trigger level and character timeout interrupts have the same priority as the current received data available interrupt. The Tx FIFO empty interrupt has the same priority as the Transmitter Holding register empty interrupt. The following lists Information pertinent to using the these interrupts.

1) When both the Rx FIFO and the receiver interrupts are enabled (FCR[0] = 1, IER[0] = 1), the UART initiates receiver interrupts under the following conditions:

- **a)** The receive data available interrupt (IIR[3:0} = 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 (LSR[0]), is set as soon as a character transfers from the internal shift register to the Rx FIFO. DR is reset when the FIFO is empty.

2) When the Rx FIFO and receiver interrupts are enabled, the UART initiates a Rx FIFO timeout interrupt under the following conditions:

- **a)** At least one character is in the FIFO.
- **b)** The most recent serial character received was longer than four continuous character times ago.
- **c)** The most recent DTE read of the FIFO was longer than four continuous character times ago.

3) When a timeout interrupt has occurred and the DTE reads one character from the FIFO, the timeout interrupt is cleared and the timer reset.

4) The timeout timer is reset after a new character is received or after the DTE reads the Rx FIFO.

5) When the Tx FIFO and the transmitter interrupt are enabled (FCR[0] = 1, IER[1] = 1), the UART initiates Tx interrupts under the following conditions:

- **a)** The THR interrupt (IIR[3] = 02) occurs when the Tx FIFO is empty, and clears as soon as the THR is written to or the IIR is read. During servicing, the 1–16 character interrupt can be written to the Tx FIFO.

10.3.2 FIFO Polled Mode Operation

Both the modem Rx and Tx UART FIFOs can be set for polled mode operation. The UART FIFO is set for polled mode when FIFOE (FCR[0]) = 1 and the respective interrupt enable bit (IER[3:0]) = 0.

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

- LSR[7] indicates when any errors occur in the Rx FIFO.
- LSR[6] indicates when both the Tx FIFO and shift registers are empty.
- The THRE bit (LSR[5]) is set to ‘1’ whenever the Tx FIFO is empty.
- LSR[4:1] specify when BI, FE, PE, or OE occur.
- The DR bit (LSR[0]) is set to ‘1’ when at least one byte is in the Rx FIFO.

Unlike FIFO interrupt mode, FIFO polled mode does not support buffer trigger levels or timeout conditions.

Appendix A

V.80 MODE VIDEOCONFERENCING

The CL-MD562X chipset family supports the ITU-H.324 videoconferencing standards, allowing an asynchronous interface (PC) to transmit and receive a synchronous bitstream. This enables the PC to deliver and control videoconferencing data more efficiently than over a standard asynchronous modem. The V.80 mode offers in-band DCE control and a synchronous access mode with HDLC framing required for compliance with host-based H.324 videoconferencing application software. The CL-MD562X chipsets support both transparent and framed submodes of the V.80 synchronous access mode. The type of operation can switch between the two submodes using 8-bit in-band commands.

In synchronous access mode, the start-stop framed data octets from the V.24 standard's circuit 103 are stripped of the start and stop bits and concatenated for transmission to the remote DCE. The synchronous bitstream from the remote DCE is divided into octets and transmitted to the local DTE on the V.24 standard's circuit 104 with start and stop bits inserted.

Synchronous access mode supports 8-bit in-band commands, which send control-type commands in the data stream (for more information, see Section A.6.1 on page 99). The 8-bit commands provide a way to select and report synchronous modes and set flow-control thresholds, bit processing in the DCE, and signal converter operation after connection.

A.1 Framed Submode

Framed submode is the primary method for data exchange in H.324 videoconferencing. In framed submode, bit-oriented synchronous protocol framing is performed by the DCE. Framed submode creates an HDLC-based connection between DCEs. When transmitting in the framed submode, the DCE performs bit processing functions in support of several DCE-DCE protocols. Bit-oriented processing includes ISO 3309 procedures for flag transparency via zero insertion. When the DTE is receiving in framed submode, the DCE forwards the received octets to the DTE after first removing the zero-inserted bits, appending start- and stop-framing bits, and shielding certain octet values.

A.2 Transparent Submode

In transparent submode, no additional bit processing is done. The transparent submode bitstream is as specified by the DTE using **<EM>**-shielding procedures. All received bits are delivered to the DTE. Transparent submode supports completely host-based protocols. When data is transmitted in the transparent submode, the DCE strips the start and stop framing bits from the DTE-originated bitstream. The DCE translates the **<EM>**-shielded code, then transmits the resulting synchronous bit sequence on the line. If configured for mark-idle operation by the **+ESA** parameter, the DCE receiver immediately forwards receive data to the DTE.

A.3 Voice Call First Mode

The VCF (Voice Call First) mode enables the transition from a standard telephone call to an H.324 videoconferencing call in the same connection. The telephone is attached through the V.80-enabled modem or by a modem-initiated speakerphone call.

Before starting a VCF session, both parties must be in VCF mode. A VCF session is typically initiated by a caller placing a video-enabled PC in speakerphone mode, then placing a call using software with telephony and video features. When the voice session is established, either party can initiate VCF mode.

The videoconferencing application sends the command string. **ATX1D** or **ATX3D** for the modem to ignore dialtone; **AT-C2** enables the CI (Call Indicator) tone. This string tells the originating station to place the modem off-hook (**ATD**) in Blind-dial mode (**X1** and **X3**) or since dial tone is not present. After receiving an **ATD** command, the originating modem mutes the local audio and initiates a V.8 session by transmitting the CI tone. Transmission of CI initiates the handshake.

The answering modem must be set up to monitor the line (using **+A8E=6,5,21**) for the CI tone. After detection, the answering modem responds by sending **+A8I:21** to the DTE. The modem transmits answer tone and initiates a V.8 session only after the application changes the connection to Data mode (with the **+FCLASS=0** command) and an **ATA** command is received. The ability to execute a transition from a handset is dependent on the telephone interface circuit.

For information about setting up a videoconferencing system, please see the Cirrus Logic application note AN-MD52, *Videoconferencing*.

A.4 Video Call Mode

In Video Call mode videoconferencing, both parties must be in Video Call mode before a connection can be made. The two parties then establish a data link over a telephone network for audio and video transfer.

Software sets the originating and receiving modems in synchronous access mode (using the **+ES=6,,8** command). The originator dials (**ATDTXXX-XXX**) and waits for an answer tone. The remote modem sends an answer tone to begin V.8 negotiations only after receiving an **ATA** command or the number of rings equals the value stored in the **S0** register. The modem responds with 'CONNECT' upon a successful connection.

Table A-1. V.80 Default Command Summary

V.80 Modes	+FCLASS	+A8E	+ES	+ESA
Video First	0	, , 21	6, , 8	, 1
Voice Call First	8	6, 5, 21	6, , 8	, 1

A.5 Connection Procedure

The V.80 mode is inactive in the CL-MD562X default settings. The **+ES**, **+ESA**, and **+ITF** commands must be issued to activate V.80 mode. To see whether the V.80 mode has been enabled, issue the **AT+ES?** command. Before changing these commands, the modem must be placed in data mode (**FCLASS=0**). Choose the synchronous access mode (**+ES=6, ,8**). The **+ESA** command configures the type of synchronous connection. The **+A8E=m** command configures V.80 negotiation parameters.

The mode can be changed from transparent to framed submode using the 8-bit in-band command **<EM><flag>** and from framed to transparent submode using **<EM><mark>**. The DCE flushes its receive data buffer on every submode transition.

Table A-2. V.80 Videoconferencing Mode Command Summary

Command	Function	Default	Range	Reported by &Vn
FCLASS=0	Mode selection	0	0, 1, 8	no
+ESA=m	Synchronous Access mode configuration	0, 0, 1, , 0, 0, 126,	[a]	no
8-bit in-band controls: <EM><hex code>	In-band commands and indications for use in Synchronous Access mode only	none	[a]	no

[a] Refer to Table A-3 for parameter ranges.

Table A-3. V.80 Videoconferencing Mode Command Descriptions[a]

Command	Default	Description
+FCLASS=0	0	**Data Mode Selection:** This command enables or disables Data mode. n = 0, 1, 8 n = 0* Data mode. n = 1 Class 1 fax mode. n = 8 Voice mode enabled.
+ESA=m	**see 'm'**	**Synchronous Access Mode Configuration:** Once the modem is in Synchronous Access mode (using the **+ES** command), the **+ESA** command specifies how Synchronous Access mode operates. If Synchronous Access mode is implemented in the DCE, **<trans_idle>** and **<nrzi_en>** must be zero. *m = <trans_idle>, <framed_idle>, <framed_un_ov>, <hd_auto>, <crc_type>, <nrzi_en>, <syn1>, <syn2>* Default: 0, 0, 1, , 0, 0, 126, **<trans_idle>** Specifies the bit sequence transmitted by the DCE when a transmit data buffer underrun occurs (in Transparent submode). Range <trans_idle>: 0 Default: 0 n = 0* In Transparent submode, the DCE transmits an 8-bit SYN sequence on idle.

Table A-3. V.80 Videoconferencing Mode Command Descriptions[a] *(cont.)*

Command	Default	Description
+ESA=m *(cont.)*		**Synchronous Access Mode Configuration** *(cont.)* **<framed_idle>** Specifies the bit sequence transmitted by the DCE when a transmit data buffer underrun occurs immediately after a flag (in Framed submode). Range <framed_idle>: 0, 1 Default: 0 n = 0* In Framed submode, the DCE transmits HDLC flags on idle. n = 1 In Framed submode, the DCE transmits marks on idle. **<framed_un_ov>** Specifies the actions undertaken by the DCE when a transmit data underrun or overrun condition occurs immediately after a non-flag octet (in Framed submode). Range <framed_un_ov>: 0, 1 Default: 1 n = 0 In Framed submode, the DCE transmits an abort-on-underrun in the middle of a frame. n = 1* In Framed submode, the DCE transmits a flag-on-underrun in the middle of the frame and notifies the DTE of the underrun/overrun. **<hd_auto>** Not supported. **<crc_type>** Specifies the CRC polynomial used while operating in Framed submode. Range <crc_type>: 0 Default: 0 n = 0* CRC generation and checking disabled. **<nrzi_en>** Specifies whether NRZI (Non-Return to Zero Inverted) encoding is to be used by the DCE for transmit and receive data. Range <nrzi_en>: 0 Default: 0 n = 0* NZRI encoding/decoding disabled. **<syn1>** Specifies the octet values to be used while performing character-oriented framing. Range <syn1>: 0–255 Default: 126 n = 126* This command specifies the 8-bit transmit idle sequence to be used by the DCE in Transparent submode. **<syn2>**Not supported.

[a]An asterisk (*) denotes the factory-default setting.

A.6 In-Band Commands (<EM><hex code>)

In-band commands allow commands to be sent as part of the data stream in Synchronous Access mode. These commands consist of the escape sequence **<EM>** (19h) plus a hex code. In-band commands are executed as they are received in the data stream. If a data stream contained an in-band command to escape to the command state, the data preceding this command would be delivered before entering command mode, but any data after the command would be treated as AT commands and not delivered.

All Synchronous Access mode connections initially operate in Transparent submode. It is possible to dynamically switch between Transparent submode and Framed submode in the same session. The 8-bit command **<EM><mark>** initiates Transparent submode; the 8-bit command **<EM><flag>** initiates Framed submode.

A.6.1 8-Bit In-Band Commands

Choosing Synchronous Access mode with the **+ES=m** command enables the use of the 8-bit commands listed in Table A-4 and Table A-5. The 8-bit in-band commands are only used in Synchronous Access mode. They provide a means to select and report synchronous modes, bit processing in the DCE, and signal converter operation after connection. Some 8-bit control-type commands are specific to only one submode.

Some **<EM>** parameters refer to the DCE's data signaling rate. For example, the **<EM><rate>** command is followed by the parameters **<tx><rx>**, which specify the transmit and receive data signaling rate upon completion or a retraining or rate renegotiation. The values for these data signaling parameters is defined in Table A-6 on page 101. These values apply for parameters **<tx>** and **<rx>**.

Table A-4. 8-Bit In-Band Commands

Framed Submode	Transparent Submode	Command/ Indication Pair Symbol	Hex Code (h)	Circuit 103 Description Character Transparency	Circuit 104 Description Character Transparency
X	X	<EM><t1>	5C	Transmit one 19h pattern	Receive one 19h pattern
X	X	<EM><t2>	76	Transmit one 99h pattern	Receive one 99h pattern
X	X	<EM><t3>	A0	Transmit DC1	Receive DC1
X	X	<EM><t4>	A1	Transmit DC3	Receive DC3
X	X	<EM><t5>	5D	Transmit two 19h patterns	Receive two 19h patterns
X	X	<EM><t6>	77	Transmit two 99h patterns	Receive two 99h patterns
X	X	<EM><t7>	A2	Transmit two DC1 patterns	Receive two DC1 patterns
X	X	<EM><t8>	A3	Transmit two DC3 patterns	Receive two DC3 patterns
X	X	<EM><t9>	A4	Transmit 19h, 99h	Receive 19h, 99h
X	X	<EM><t10>	A5	Transmit 19h, DC1	Receive 19h, DC1
X	X	<EM><t11>	A6	Transmit 19h, DC3	Receive 19h, DC3
X	X	<EM><t12>	A7	Transmit 99h, 19h	Receive 99h, 19h

Table A-4. 8-Bit In-Band Commands *(cont.)*

Framed Sub-mode	Transparent Sub-mode	Command/ Indication Pair Symbol	Hex Code (h)	Circuit 103 Description Character Transparency	Circuit 104 Description Character Transparency
X	X	<EM><t13>	A8	Transmit 99h, DC1	Receive 99h, DC1
X	X	<EM><t14>	A9	Transmit 99h, DC3	Receive 99h, DC3
X	X	<EM><t15>	AA	Transmit DC1, 19h	Receive DC1, 19h
X	X	<EM><t16>	AB	Transmit DC1, 99h	Receive DC1, 99h
X	X	<EM><t17>	AC	Transmit DC1, DC3	Receive DC1, DC3
X	X	<EM><t18>	AD	Transmit DC3, 19h	Receive DC3, 19h
X	X	<EM><t19>	AE	Transmit DC3, 99h	Receive DC3, 99h
X	X	<EM><t20>	AF	Transmit DC3, DC1	Receive DC3, DC1
X (receive only)	X	<EM><mark>	B0	Begin Transparent submode	HDLC abort detected in Framed submode
X		<EM><flag>	B1	Transmit a flag; enter Framed submode if currently in Transparent submode. If enabled, proceed with FCS if this follows a non-flag octet sequence.	Non-flag-to-flag transition detected. Preceding data was a valid frame; FCS is valid if CRC checking was enabled.
X		<EM><err>	B2	Transmit abort	Non-flag-to-flag transition detected. The preceding data was not a valid frame.
X	X	<EM><hunt>	B3	Enter Hunt mode.	Not applicable.
X	X	<EM><under>	B4	Not applicable.	Transmit data underrun.
X	X	<EM><tover>	B5		Transmit data overrun.
X	X	<EM><rover>	B6		Receive data overrun.
X		<EM><resume>	B7	Resume after transmit underrun.	Not applicable.
X	X	<EM><bnum>	B8	Not applicable.	Octets <octnum0><octnum1> specify the number of octets in the transmit data buffer. Octets <octnum0><octnum1> specify the number of discarded octets.
X		<EM><unum>	B9		Octets <octnum0><octnum1> specify the number of discarded octets.

Table A-5. 8-Bit In-Band Commands

Framed Sub-mode	Transparent Sub-mode	Command/ Indication Pair Symbol	Hex Code (h)	**Circuit 103 Description** **Duplex Carrier Control**	**Circuit 104 Description** **Duplex Carrier Status**
X	X	<EM><eot>	BA	Terminate carrier, return to command state.	Loss of carrier detected, return to command state.
X	X	<EM><ecs>	BB	Go to online command state.	Not applicable.
X	X	<EM><rm>	BC	Request rate renegotiation (duplex).	Indicate rate renegotiation (duplex).
X	X	<EM><rtn>	BD	Request rate retrain (duplex).	Indicate rate retrain (duplex).
		<EM><rate>	BE	Octets <tx><rx> set maximum transmit and receive rates.	Retrain/renegotiate completed; following octets, <tx><rx>, indicate transmit and receive rates.

Table A-6. Command/Indication Bit Rates

Symbol	Hex Code (h)	Duplex or Primary Channel Data Signaling Rate (bps)
<p24>	21	2400
<p48>	22	4800
<p72>	23	7200
<p96>	24	9600
<p120>	25	12,000
<p144>	26	14,400
<p168>	27	16,800
<p192>	28	19,200
<p216>	29	21,600
<p240>	2A	24,000
<p264>	2B	26,400
<p288>	2C	28,800
<p312>	2D	31,200
<p336>	2E	33,600

Appendix B

16C450/16C550A UART DESCRIPTION

B.1 Controllerless Modem Overview

The CL-MD56XXT chipsets eliminate the need for a dedicated modem controller by using the processing power of the host controller. The CL-MD56XXT controllerless modems replace the traditional UART and serial port emulations with a proprietary CLM port driver. Instead of transferring commands to UART virtual registers and then to a serial port, the CLM port driver sends commands directly to the Windows virtual machine driver, VCOMM.VxD, the low-level communication driver that supports the Win16 and Win32 communication APIs (see Figure B-1).

For MS-DOS® applications , the chipsets provide an additional driver, CLM_DBS.VxD that includes the UART emulation required by MS-DOS. The CLM_DBS.VxD driver interacts directly with the VCOMM.VxD driver using the Win16 and Win32 communication APIs.

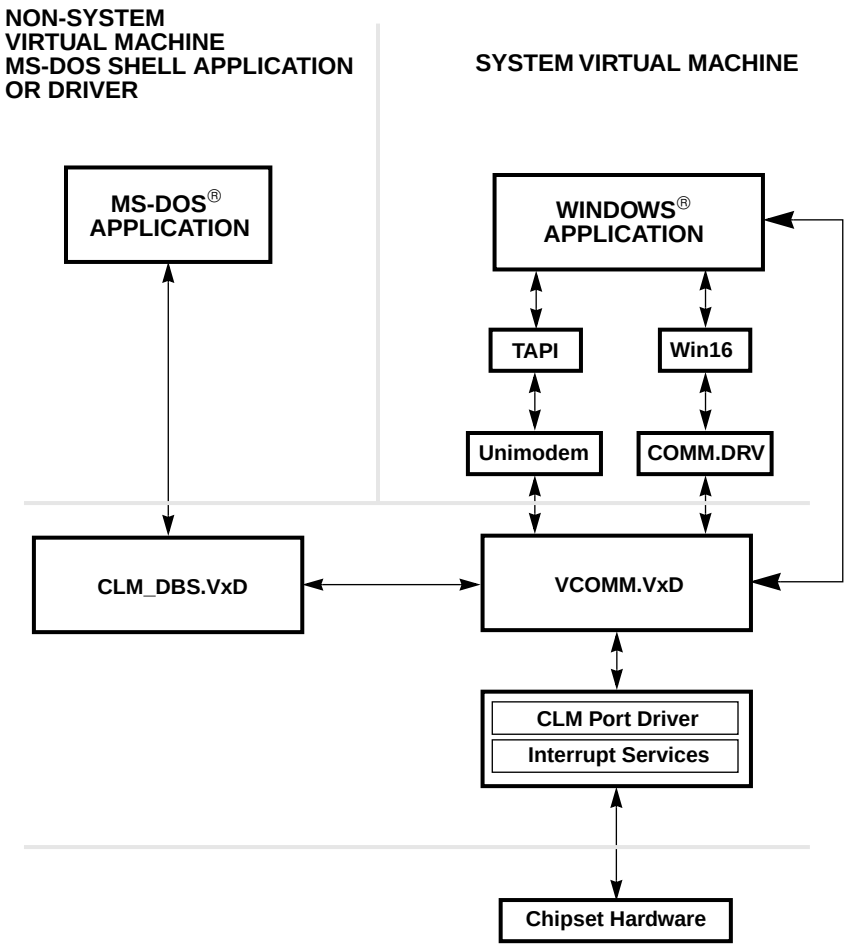

Figure B-1. Controllerless Modem Block Diagram

B.2 UART Emulation in the Controllerless Modem

In traditional modem designs, data passes from the modem (DCE) to the host computer (DTE) through a serial link. Data then passes over a serial link to a remote modem through a 16550-emulation UART.

With controllerless modems, MS-DOS applications still require UART emulation. The CLM_DBS.VxD includes UART emulation that interacts directly with the Windows VCOMM.VxD driver (see Figure B-2). Alternatively, Windows applications eliminate the need for UART emulation and pass data directly from the DTE to the CLM port driver, which then transfers it to the VCOMM.VxD driver.

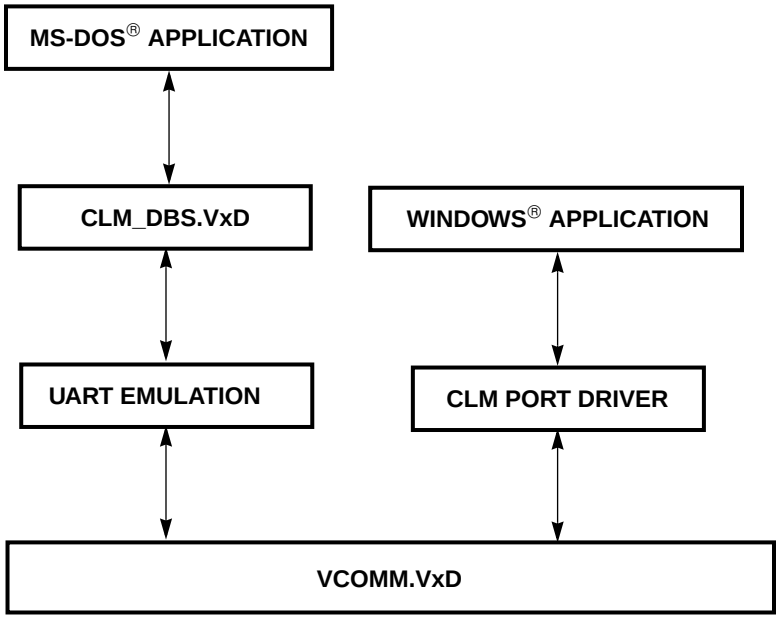

Figure B-2. UART Emulation in CLM_DBS.VxD

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