CIRRUS LOGIC®

CL-MD56XX

Preliminary Programmer's Guide

56K FastPath™ CL-MD56XX Programmer's Guide

PC Telephony Applications Engineering
Cirrus Logic Inc.

Scope and Applicability

This Programmer's Guide presents information about the CL-MD56XX data/fax/voice chipsets.

Related Cirrus Logic Documents

– CL-MD56XX Data Book

– IS-101 Voice Application Note

– Class 1 Fax Application Note

Version 0.7 **April 1997**

Notes

FOR CL-MD34XX CHIPSET USERS

For those users familiar with Cirrus Logic CL-MD34XX Programmer's Guide, v0.9, the CL-MD56XX Programmer's Guide, v 0.7, differs significantly in the following areas:

Table 1-1 on page 9: Part numbers for CL-MD56XX chipsets.

Table 2-1 on page 12: For Data mode commands, changed default on the **+MS** command to VX2, 1, 300, 0; **&Tn** commands for all modes except x2.

Table 2-13 on page 25: Added the S-register **S32**, x2 Mode Enable. Changed range for S-register **S37**.

Table 2-14 on page 26: Added response codes for x2 mode connections; deleted response codes for Fax and Data modes.

Section 3.8 on page 31: Added the x2™ Technology data modulation mode from U.S. Robotics®. The FCC limits transmission speeds for the x2 mode to 53,333 bps.

Section 3.9 on page 34: Loopback tests do not apply to the x2 mode.

AT COMMAND ADDENDUM

This section identifies AT commands that have not been implemented on the CL-MD56XX chipsets as of 4/11/97. These commands can be found in the CL-MD56XX Programmer's Guide, v0.7, on the indicated page numbers:

1) Basic Data Mode AT Commands, Table 2-1 on page 12:

&T3–&T7 (loopback tests)

2) V.42 / V.42 bis MNP® AT Commands, Table 2-2 on page 17:

\Bn (transmit break)

\C1 (sets 4-second auto-reliable buffer)

\Kn (sets break controls)

3) Fax Class 1, Table 2-4 on page 20:

+FAE

4) IS-101 Voice AT Commands, Table 2-5 on page 20:

#VCSD, (silence detection for voice command mode)

5) Voice DTE ← DCE Character Pairs, Table 2-7 on page 22:

ASCII characters: **I L P p % ‘ , ( )**

6) All Radish® VoiceView™ commands included in the CL-MD56XX Programmer's Guide are optional:

VoiceView® Commands, Table 2-9 on page 23
VoiceView® Response Codes, Table 2-10 on page 24
VoiceView® <DLE> Character Pairs, Table 2-11 on page 24

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CONVENTIONS

This section lists conventions used in this data book.

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

Abbreviations

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

Acronyms

Acronym	Definition
AC	alternating current
AT	'Attention' command prefix for Hayes AT® command set (for example, 'ATDT 123')
CMOS	complementary metal-oxide semiconductor
DC	direct current
DAA	data access arrangement
DRAM	dynamic random-access memory
DSVD	digital simultaneous voice and data
EPROM	electrically programmable read-only memory
FIFO	first in/first out
HDLC	high-level data link control
ISA	industry standard architecture
LSB	least-significant bit
MSB	most-significant bit
NVRAM	non-volatile random-access memory
PPP	point-to-point protocol
RAM	random-access memory
ROM	read-only memory
R/W	read/write
SDLC	synchronous data link control
SQFP	shrink quad flat pack
SRAM	static random-access memory
TTL	transistor-transistor logic
UART	universal asynchronous receiver transmitter
VQFP	very-tight-pitch quad flat pack

1. INTRODUCTION

The CL-MD56XX Programmer's Guide describes the software interface of Cirrus Logic's 56K FastPath™ three- or four-chip solution. The programmer's guide includes the AT command sets for data, fax, and voice and the 16C450/16C550A UART emulation. The programmer's guide should be used with the CL-MD56XX Data Book, the IS-101 Voice Application Note, and the Class 1 Fax Application Note. Please note that supported AT commands are firmware revision-dependent. The CL-MD56XX 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 56K FastPath family of products supports a variety of applications without the need of additional firmware development. Current CL-MD56XX solutions are described in Table 1-1.

Table 1-1. Cirrus Logic 56K FastPath™ Chipsets

Number of Devices	Chipset	Features
3	CL-MD5650	High-speed chipset that provides 33,600-bps Data mode and 14,400-bps Fax mode. It includes three built-in DTE interfaces — a parallel 16C450A/16C550-compatible ISA bus interface, a Windows® 95-compatible ISA bus plug-and-play interface, and a serial RS-232 interface. Voice features include IS-101 Voice mode and Radish® VoiceView™.
	CL-MD5651T	Same features as the CL-MD5650, except the chipset adds a built-in PC Card interface and uses DSP and SAFE chips that are 3.3 V instead of 5 V. The PC Card interface has 16C450/16C550-compatible registers. This chipset does not support parallel ISA bus and serial RS-232 host interfaces.
4	CL-MD5652	Same features as the CL-MD5650, plus full-duplex Speakerphone mode with internal echo cancellation and an extra SAFE.
	CL-MD5653T	Same features as the CL-MD5652, except the chipset adds a built-in PC Card interface and uses DSP and SAFE chips that are 3.3 V instead of 5 V. The PC Card interface has 16C450/16C550-compatible registers. This chipset does not support parallel ISA bus and serial RS-232 host interfaces.
4	CL-MD5662T	Same features as the CL-MD5652, except the chipset adds DSVD (digital simultaneous voice and data) and uses DSP and SAFE chips that are 3.3 V instead of 5 V.
	CL-MD5663T	Same features as the CL-MD5662T, except the chipset adds a built-in PC Card interface that has 16C450/16C550-compatible registers. This chipset does not support parallel ISA bus and serial RS-232 host interfaces.

1.1 x2 and V.34 Data Modes

The CL-MD56XX chipsets implement the U.S. Robotics® x2™ Technology data transmission mode. The x2 Technology allows 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, x2 mode achieves V.34 speeds in both the transmit and receive directions.

1.2 Modem Connection Overview

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

The modem defaults to the command state. In the command state, the DTE (host) communicates to the modem through AT commands and S-registers. AT commands are character strings that help guide modem operation. S-registers are internal modem registers that the DTE can access. The S-registers contain modem status and configuration information. Many of the AT commands indirectly affect the contents of the S-registers. The CL-MD56XX's AT command set and S-registers are divided into five categories: Group 3 fax, data, V.42/MNP, voice, and VoiceView. Table 2-1 on page 12 through Table 2-15 on page 27 provide summaries of all AT commands, and Table 2-13 on page 25 provides summaries of all S-registers. Note that supported AT commands are firmware revision-dependent (that is, not all commands are supported by all modem models or all firmware revisions).

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

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

Examples of AT command strings:

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

The modem provides status information to the DTE in the form of response codes. These response codes can be expressed in text or numeric form. The supported response codes are provided in Table 2-14 on page 26.

Examples of modem responses:

```
OK
ERROR
CONNECT 28800
0
```

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

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

The modem recognizes AT commands from the DTE at any valid data rate from 300 bps to 115,200 bps (that is, the modem autobauds up to 115,200 bps); however, the DTE should use the data rate specified for each mode (see the following table).

Data Rate for Each Mode

Mode	Data Rate (bps)	Affected Data
Data (V.34)	300–33,600	Modem-to-modem data rates
	300–115,200	DTE-to-modem data rates
Data (x2™ Technology) (transmit only)	4800–31,200	Modem-to-modem data rates
Data (x2™ Technology) (receive only)	33,333–57,333	Internet Service Provider-to-modem data rates
Data (x2™ Technology) (receive only)	300–115,200	DTE-to-modem data rates
Fax	19,200	AT commands and fax data transfers
Voice	19,200–115,200	AT commands, playback and record modes (varies according to compression type)

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

2. COMMAND SUMMARY

This section contains summary tables of all AT commands, S-registers, and manufacturing-only commands. A full description of these commands are found in other chapters of the Programmer's Guide. Use the following list to locate the correct table:

Table 2-1. Basic Data Mode AT Commands

Command	Function	Default	Range	Reported by &Vn
A/ **	Repeat last command	none	–	no
A	Answer	none	–	no
Bn *	Select ITU-T or Bell®	1	0–3	yes
B0	Selects ITU-T V.22 at 1200 bps and ITU-T V.21 at 300 bps			
B1	Selects Bell® 212A at 1200 bps and Bell® 103J at 300 bps			
B2	Selects ITU-T V.23 only. The originating modem transmits at 75 bps (and receives at 1200 bps); the answering modem receives at 75 bps (and transmits at 1200 bps)			
B3	Selects ITU-T V.23 only. The originating modem transmits at 1200 bps (and receives at 75 bps); the answering modem receives at 1200 bps (and transmits at 75 bps)			
Cn	Carrier control option	1	0, 1	no
C0	Transmit carrier always off			
C1	Normal transmit carrier			
D	Dial command	none	–	no
En *	Command mode echo	1	0, 1	yes

Table 2-1. Basic Data Mode AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
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	0–14, 20–24	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			
I23	Cirrus Logic product model			
Ln *	Speaker volume control	2	0–3	yes
L0	Low speaker volume			
L1	Low speaker volume			
L2	Medium speaker volume			
L3	High speaker volume			
Mn *	Speaker control	1	0–3	yes
M0	Speaker always off			
M1	Speaker on until carrier present			

Table 2-1. Basic Data Mode AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
M2	Speaker always on			
M3	Speaker off during dialing; speaker on until carrier present			
Nn *	Select data rate handshake	1	0, 1	yes
N0	Handshake only at DTE-to-modem data rate			
N1	Begins handshake at DTE-to-modem data rate and falls to highest compatible rate			
On	Go online	0	0, 1	no
O0	Returns modem to data mode			
O1	Retrains equalizer and then returns to data mode			
P *	Select pulse dialing	none	–	yes
Qn *	Result code display control	0	0, 1	yes
Q0	Enables result codes			
Q1	Disables result codes			
Sn	Select an S-register	none	0–37	no
Sn=x	Write to an S-register	none	n=0–37 x=0–255	no
Sn?	Read from an S-register	none	0–37	no
T *	Select tone dialing	none	–	no
Vn *	Result code form	1	0, 1	yes
V0	Choose numeric form			
V1	Choose verbose (text) form			
Wn *	Response code data rate	0	0–4	yes
W0	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.			
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			

Table 2-1. Basic Data Mode AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
X3	Enables result codes 0–5, 7, and 10 and above; enables busy detection and disables dial tone detection			
X4	Enables result codes 0–7 and 10 and above; enables busy and dial tone detection			
Yn *	Long space disconnect	0	0, 1	yes
Y0	Disables long space disconnect			
Y1	Enables long space disconnect			
Zn	Recall stored profile	0	0, 1	no
Z0	Resets modem and recalls user profile 0			
Z1	Resets modem and recalls user profile 1			
&Cn *	DCD (data carrier detect) option	1	0, 1	yes
&C0	Ignores remote modem status; DCD always on			
&C1	DCD set according to remote modem status			
&Dn	DTR (data terminal ready) option	2	0–3	yes
&D0	In async mode, modem ignores DTR			
&D1	Modem switches from data mode to command mode when an on-to-off transition of DTR occurs.			
&D2	When DTR switches off, the modem goes on-hook and disables auto-answer mode; when DTR switches on, auto-answer is enabled			
&D3	Turning off DTR re-initializes the modem and resets values except UART registers			
&F	Load factory defaults	none	–	no
&Gn *	Guard tone option (1200 bps and 2400 bps only)	0	0–2	yes
&G0	Disables guard tone			
&G1	Enables 550-Hz guard tone			
&G2	Enables 1800-Hz guard tone			
&Jn *	Auxiliary relay control	0	0, 1	yes
&J0	Auxiliary relay never operated			
&J1	Activates auxiliary relay when modem is off-hook			
&Kn	Select serial port flow control	3	0, 3, 4	yes
&K0	Disables flow control			
&K3	Bidirectional hardware flow control			
&K4	XON/XOFF software flow control			

Table 2-1. Basic Data Mode AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
&M0 *	Communication mode option—modem supports only async mode	0	0	no
&Pn *	Dial pulse ratio	0	0, 1	yes
&P0	Sets 10-pps pulse dial with 39% / 61% make-break			
&P1	Sets 10-pps pulse dial with 33% / 67% make-break			
&Q0 *	Communication mode option—modem supports only async mode	0	0	yes
&Sn *	DSR (data set ready) option	0	0, 1	yes
&S0	DSR is always active			
&S1	DSR active only during handshaking and when carrier is lost			
&Tn	Self-test commands (not x2 mode)	0	0–8	no
&T0	Terminates test in progress			
&T1	Initiates local analog loopback			
&T3	Initiates local digital loopback			
&T4	Grants RDL request from remote modem			
&T5	Denies RDL request from remote modem			
&T6	Initiates remote digital loopback			
&T7	Starts remote digital loopback with self-test			
&T8	Initiates local analog loopback with self-test			
&Un *	Disable Trellis coding	0	0, 1	yes
&U0	Enables Trellis coding with QAM as fallback			
&U1	QAM modulation only			
&Vn	View active and stored profiles	0	0, 1, 3	no
&V0	View stored profile 0			
&V1	View stored profile 1			
&V3	View relay and general-purpose input-output status			
&Wn	Stored active profile	0	0, 1	no
&W0	Store in user profile 0			
&W1	Store in user profile 1			
&Yn *	Select stored profile on power up	0	0, 1	yes
&Y0	Recall stored profile 0 on power-up			
&Y1	Recall stored profile 1 on power-up			

Table 2-1. Basic Data Mode AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
&Zn=x	Store telephone number (up to 30 digits) to location 'n' (0–3)	none	n = 0–3 x = 0–9 A B C D # * T P R W @ , ! ;	no
%En *	Auto-retrain control	1	0, 1	yes
%E0	Disables auto-retrain			
%E1	Enables auto-retrain			
%Gn *	Rate renegotiation	0	0, 1	yes
%G0	Disabled			
%G1	Enabled			
-Cn *	Generate data modem calling tone	1	0–2	yes
-C0	Calling tone disabled			
-C1	1300-Hz calling tone enabled			
-C2	V.8 calling tone and 1300-Hz calling tone			
+GMI?	Identify modem manufacturer	none	–	no
+GMM?	Identify product model	none	–	no
+GMR?	Identify product revision	none	–	no
+MS=m	Modulation selections	VX2, 1, 300, 0	See note †	no

† See full command description in the CL-MD56XX Programmer's Guide for parameter ranges. For data mode, the factory default setting is AT+MS=VX2, 1, 300, 0 to send at speeds of 31,200 bps and below and receive at speeds of 53,333 bps and below.

* Value saved in NVRAM.

** Command not preceded by an 'AT'.

Table 2-2. V.42 / V.42 bis MNP® AT Commands

Command	Function	Default	Range	Reported by &Vn
%An *	Set auto-reliable fallback character	13	0–127	yes
%Cn *	MNP 5 data compression control	1	0, 1	yes
%C0	No compression			
%C1	Enables MNP 5 data compression			
\An *	MNP block size	3	0–3	yes
\A0	Maximum 64 characters			
\A1	Maximum 128 characters			
\A2	Maximum 192 characters			
\A3	Maximum 256 characters			
\Bn *	Transmit break	none	0–9	no

Table 2-2. V.42 / V.42 bis MNP® AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
\Cn *	Set auto-reliable buffer	0	0–2	yes
\C0	No data buffering			
\C1	Four-second buffer until 200 characters in the buffer or detection of a SYN character			
\C2	No buffering. Connects non-V.42 modems to V.42 modem			
\Gn *	Set modem port flow control	0	0, 1	yes
\G0	Disables port flow control			
\G1	Sets port flow control to XON/XOFF			
\Jn *	bps rate adjust control	0	0, 1	yes
\J0	Disables rate adjust			
\J1	Enables rate adjust			
\Kn *	Set break control	5	0–5	yes
In connect state, transmits break to remote (if in reliable mode):				
\K0, 2, 4	Enters command mode, no break sent			
\K1	Destructive/expedited			
\K3	Nondestructive/expedited			
\K5	Nondestructive/nonexpedited			
In command state, transmits break to remote (if in reliable mode):				
\K0, 1	Destructive/expedited			
\K2, 3	Nondestructive/expedited			
\K4, 5	Nondestructive/nonexpedited			
In connect state, receives break at modem port (if in direct mode):				
\K0, 2, 4	Immediately sends break and enters command state			
\K1, 3, 5	Immediately sends the break through			
In connect state, receives break at modem port and sends to serial port:				
\K0, 1	Destructive/expedited			
\K2, 3	Nondestructive/expedited			
\K4, 5	Nondestructive/nonexpedited			
\Nn *	Set operating mode	3	0–4	yes
\N0, 1	Selects Buffer (Normal) mode with speed buffering			
\N2	Selects MNP reliable mode			
\N3	Selects V.42 auto-reliable mode			
\N4	Selects V.42 reliable mode			
\O	Originate reliable link	none	–	no

Table 2-2. V.42 / V.42 bis MNP® AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
\Qn *	Set serial port flow control	3	0–3	yes
\Q0	Disables flow control			
\Q1	XON/XOFF software flow control			
\Q2	Unidirectional hardware flow control			
\Q3	Bidirectional hardware flow control			
\T0 *	Disables inactivity timer	0	0–90	yes
\U	Accept reliable link	none	–	no
\Xn *	Set XON/XOFF pass-through	0	0, 1	yes
\X0	Processes flow control characters			
\X1	Processes flow control characters and passes to local or remote			
\Y	Switch to reliable mode	none	–	no
\Z	Switch to Normal mode	none	–	no
-Jn *	Set V.42 detect phase	1	0, 1	yes
-J0	Disables the V.42 detect phase			
-J1	Enables the V.42 detect phase			
"Hn *	V.42 bis compression control	3	0–3	yes
“H0	Disables V.42 bis			
“H1	Enables V.42 bis only when transmitting data			
“H2	Enables V.42 bis only when receiving data			
“H3	Enables V.42 bis for both transmitting and receiving data			
"On	V.42 bis string length	32	6–250	yes

* Value saved in NVRAM.

Table 2-3. Fax Identity Commands

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 AT Commands

Command	Function	Default	Range	Reported by &Vn
+FAE=n	Fax/data autorecognition	0	0, 1	no
+FCLASS=1	Mode selection	0	0, 1, 8, 80	yes
+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

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

Table 2-5. IS-101 Voice AT Commands

Command	Function	Default	Range	Reported by &Vn
+FCLASS=8	Voice mode selection	0	0, 1, 8, 80	yes
+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
#VCSD=n	Voice command mode silence detection	0	0, 1	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	Relay/speaker control	0	0–16	no
+VNH=n	Automatic hang-up control	0	0–2	no
+VRA=n	Ringback-goes-away timer	50	0–50	no
+VRN=n	Ringback-never-appeared timer	10	0–255	no
+VRX	Record mode	none	–	no
+VSD=m	Silence detection (quiet and silence)	128, 50	See note†	no
+VSM=m	Compression method selection	140, 8000, 0, 0	See note††	no

Table 2-5. IS-101 Voice AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
+VSP=n	Speakerphone on/off control	0	0, 1	no
#VSPS=n	Speakerphone type selection	manufacturer-specified	0, 1	no
+VTD=n	Beep tone duration timer	100	5–255	no
+VTS=m	DTMF and tone generation	none	See note †††	no
+VTX	Play mode	none	–	no

† See the **+VSD=m** command description on page 88 for a complete description.
†† See the **+VSM=m** command description on page 89 for a complete description.
††† See the **+VTS=m** command description on page 91 for a complete description.

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

Table 2-6. Voice DTE → DCE Character Pairs

Response	Hex Code	Function
<NUL>	00	Do nothing
<DLE>	10	Two contiguous <DLE><DLE> codes indicate a single <DLE> in the data stream
<SUB>	1A	<DLE><DLE> in data stream
<ETX>	03	End transmit data state
/	2F	Start of DTMF tone shielding
~	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
<FS>	1C	Concatenate transmit data streams
?	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
~	7E	DTMF transition to off
0–9	30–39	DTMF tones 0–9
A–D	41–44	DTMF tones A–D
*	2A	DTMF tone *
#	23	DTMF tone #
o	6F	Receive buffer overrun
c	63	1100-Hz fax calling tone
e	65	1300-Hz data calling tone
h	68	Local phone goes on hook
H	48	Local phone goes off hook
s	73	Presumed hang-up silence time-out
q	71	Presumed end-of-message quiet time-out
l	6C	Loop current interruption
L	4C	Loop current polarity reversal
r	72	Ringback
b	62	Busy/reorder/fast busy
d	64	Dial tone detected
u	75	Transmit buffer under-run
p	70	Line voltage increase (extension phone goes on-hook)
P	50	Line voltage decrease (extension phone goes off-hook)
a	61	Fax or data answer tone (2100 Hz)
f	66	Data answer detected (2225 Hz)
R	52	Incoming ring
% ' (,)	25, 26, 27, 28, 29	Manufacturer-specified

Table 2-8. V.80 Videoconferencing Mode Commands

Command	Function	Default	Range	Reported by &Vn
FCLASS=0	Mode selection	0	0, 1, 8, 80	yes
+A8E=m	V.8 and V.8 bis operation controls	1, 1, C1, 0, ,	See note†	no
+ES=m	Error control selection	3, 0, 2	See note††	no
+ESA=m	Synchronous access mode configuration	0, 0, 1, , 0, 0, 126,	See note†††	no
+ITF=m	Transmit flow control thresholds	320, 192, 0	See note††††	no
8-bit in-band controls: <EM><hex code>	In-band commands and indications for use in synchronous access mode only	none	See note†††††	no

† See page 97 for complete command descriptions.
†† See page 98 for complete command descriptions.
††† See page 100 for complete command descriptions.
†††† See page 101 for complete command descriptions.
††††† See page 102 for complete command descriptions.

Table 2-9. VoiceView™ Commands

Command	Default	Function
+FCLASS=80	0	Mode selection
+FLO=n	1	Flow control select
+FPR	4	Select DTE/DCE Interface Rate—turn on/off autobaud
-SAC	–	Accept data mode request
-SCD	–	Capabilities data
-SDA	–	Start modem data mode
-SDS	–	Disable switchhook status monitoring (required if DCE implements switchhook status monitoring and is used with a handset adapter)
-SER?	–	Error status (read only)
-SFX	–	Start fax data mode
-SIC	–	Reset capabilities to default setting
-SIP	–	Initialize VoiceView parameters
-SQR	–	Capabilities query response control
-SSP	–	VoiceView transmission speed
-SSQ	–	Start capabilities query
-SSR	–	Start sequence response control
-SVV	–	Start VoiceView data mode
+VGM=n	128	Speakerphone microphone gain
+VGS=n	128	Speakerphone speaker gain
+VLS=n	0	Analog source/destination selection
+VSP=n	0	Speakerphone on/off control

Table 2-10. VoiceView™ Response Codes

Response	Function
-SFA	Fax data mode start sequence event (mandatory only if fax data mode is supported)
-SMD	Modem data mode start sequence event (mandatory only if modem data mode is supported)
-SRA	Receive ADSI response event
-SRC:	Receive capabilities information event
-SRQ	Receive capabilities query event
-SSV	VoiceView data mode start sequence event
-STO	Talk-off event

Table 2-11. VoiceView™ <DLE> Character Pairs

Command	Function
<CAN>	Abort data transfer in progress
<EOT>	End of message marker, final message of transaction, no response accepted (ASCII 10h 04h)
<ESC>	End of message marker; the DCE immediately returns to voice mode (ASCII 10h 1Bh)
<ETB>	End of message marker, final response requested, after which the transaction terminates (ASCII 10h 17h)
<ETX>	End of message marker, continue transaction, response requested (ASCII 10h 03h)

Table 2-12. Dial Modifiers

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

Table 2-13. S-Register Summary

Register	Function	Default	Range	Units	Reported by &Vn
S0 *	No. of rings to auto-answer on	0	0–255	ring	yes
S1	Ring count	0	0–255	ring	yes
S2 *	Escape character	43	0–127	ASCII	yes
S3	Carriage return character	13	0–127	ASCII	yes
S4	Line feed character	10	0–127	ASCII	yes
S5	Backspace character	8	0–32, 127	ASCII	yes
S6 *	Wait before dialing	2	2–255	second	yes
S7 *	Wait for carrier	60	1–255	second	yes
S8 *	Pause time for dial modifier	2	0–255	second	yes
S9 *	Carrier recovery time	6	1–255	0.1 second	yes
S10 *	Lost carrier hang up delay	14	1–255	0.1 second	yes
S11 *	DTMF dialing speed	70	50–255	ms	yes
S12 *	Guard Time	50	0–255	(0.02 second)	yes
S14 *	Bit-mapped options	170	–	–	no
S16	Modem test options	0	–	–	no
S18 *	Modem test timer	0	0–255	second	yes
S21 *	Bit-mapped options	48	–	–	no
S22 *	Bit-mapped options	118	–	–	no
S23 *	Bit-mapped options	none	–	–	no
S25 *	Detect DTR change	5	0–255	0.01 second	yes
S27 *	Bit-mapped options	64	–	–	no
S30 *	Disconnect inactivity timer	0	0–255	minute	yes
S31 *	Bit-mapped options	none	–	–	no
S32 *	x2 mode enable	32	0–255	–	yes
S33 *	Sleep mode timer	10	0–90	second	yes
S37 *	Maximum line speed attempted	0	0–35	–	yes

*Value saved in NVRAM.

NOTE: The manufacturing only S-registers **S91** and **S92** are listed in Table 2-15 on page 27.

Table 2-14. DTE-Modem Data Rate Response Codes

Numeric Code	Verbose Code
0	OK
1	CONNECT
2	RING
3	NO CARRIER
4	ERROR
5	CONNECT 1200
6	NO DIAL TONE
7	BUSY
8	NO ANSWER
23	CONNECT 75/1200
22	CONNECT1200/75
10	CONNECT 2400
11	CONNECT 4800
24	CONNECT 7200
12	CONNECT 9600
25	CONNECT 12000
13	CONNECT 14400
59	CONNECT 16800
14	CONNECT 19200
61	CONNECT 21600
62	CONNECT 24000
63	CONNECT 26400
64	CONNECT 28800
65	CONNECT 31200
33	CONNECT 33333
66	CONNECT 33600
34	CONNECT 37333
28	CONNECT 38400
35	CONNECT 41333
36	CONNECT 42666
37	CONNECT 44000
38	CONNECT 45333
39	CONNECT 46666
42	CONNECT 48000
43	CONNECT 49333
53	CONNECT 50666
54	CONNECT 52000
55	CONNECT 53333
56	CONNECT 54666

Table 2-14. DTE-Modem Data Rate Response Codes (cont.)

Numeric Code	Verbose Code
57	CONNECT 56000
58	CONNECT 57333
18	CONNECT 57600
31	CONNECT 115200
45	RINGBACK
See Note	CONNECT (DTE data rate) /(modulation)/(error correction)/(data compression) / TX:(DCE transmit data rate) / RX:(DCE receive data rate)

NOTE: This verbose response code is used to evaluate the modem connection and is enabled by the **W3** AT command. All other 'CONNECT' messages are used for **W0–W2** AT commands. When the modem is configured for text responses **V1**, the **W3** verbose response codes provide 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 2-15. Manufacturing-Only Commands†

Command	Function	Default	Range
%L	Receive line signal level	none	–
*NCnn *	Country Select	0	–
!P=m	Set plug-and-play board serial number	none	0–255, 0–255, 0–255, 0–255
S91 *	Data transmit level	10	0–15
S92 *	Fax transmit level	10	0–15
-Tn	Generate continuous DTMF tones	7	6, 7
#VGP0=n	Read/write to general-purpose pins 0–7	See note	–
#VGP1=n	Read/write to general-purpose pins 8–15	See note	–
#VGP2=n	Read/write to general-purpose pins 16–23	See note	–

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

* Value saved in NVRAM.

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

3. BASIC DATA MODE AT COMMANDS

The 56K FastPath chipsets implement:

- Standard 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. A detailed description of each data command is provided in Table 3-4 starting on page 42. In data mode, the CL-MD56XX executes the AT commands for error correction (MNP 2-4, V.42) and data compression (MNP 5, V.42 bis) described in Table 4-2 starting on page 61, 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 page 47). The setting for the **ATXn** command (page 48) can affect which **ATWn** response codes are reported to the DCE. The **ATXn** command configures the modem call progress detection and reporting requirements during dialing (for example, dial tone and busy tone detection). The **ATQn** command selects whether the modem sends result codes to the DTE.

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

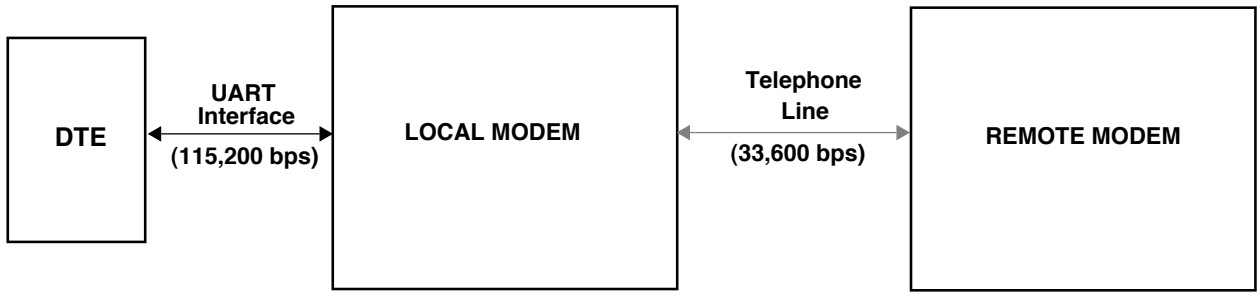


Figure 3-1. Example of a Remote Connection

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

1. `ATW0`

   `CONNECT 115200`

2. `ATW2`

   `CONNECT 33600`

3. `ATW3`

   `CONNECT 115200/V34/LAPM/V42B/TX=33600/RX=33600`

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

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

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

Examples:

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

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

&W1 saves the active configuration to user profile 1.

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

`AT&Z2 = T9, (408)444-5555` Stores a telephone number into the NVRAM as phone number 2, which can be re-dialed later using **ATDS=2**.

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

The modem provides product identification AT commands that help determine the modem's manufacturer, model number, and product revision. To provide flexibility with older software application programs, the modem supports several commands that can be used to request a single item of identification (such as a modem model number). Table 3-1 lists the commands used to obtain product information (all identification commands are useable in data, fax, or voice mode).

Table 3-1. Product Identification Information

Product Information	AT Commands			
	ATIn Command	Data Mode	Class 1 Fax Mode	Previous 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 that is the modem's response to the command.

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

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

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

1) The time period between the ring signals is greater than 8 seconds, which causes the **S1** counter to reset and thus never reach the value for **S0**.

2) Caller ID is enabled and **S0=1**, the modem answers on the second ring signal instead of the first ring signal. This happens because Caller ID puts a signal on the telephone line between the first and second ring signal.

Example:

`ATD T9,444-5555`	Automatically dials the telephone number with DTMF tones. After dialing a '9', the comma (,) causes the modem to pause two seconds before dialing the rest of the telephone number.
`modem 1: ATD;` `modem 2: ATA`	When establishing a manual-to-manual connection, the designated originating modem should receive the **ATD** command from its DTE just before the designated answering modem receives the **ATA** command from its DTE. It is important that the time between the **ATD** and **ATA** commands is less than 2 seconds.
`AT-C1DT 123`	Causes the modem to dial the telephone number 123 and immediately start sending a data calling tone. Calling tone can then be detected by the remote voice mail system. After detecting the calling tone, the remote system can change to data mode and start the data modem connection handshake.

3.6 Online Command Mode [Escape Codes, On]

After establishing a connection with a remote modem, the DTE sends the appropriate escape sequence to the DCE, which causes the DCE to enter the online command mode. The online command mode is used to send AT commands to the DCE while the DCE is still connected to the remote modem. The supported escape sequences are described in Section 3.10 on page 39. 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 1 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 the data mode selected. x2 is the default data mode. The x2 mode is enabled by the **S32** S-register. When x2 is disabled by S32, the modem defaults to whatever mode is issued by the **+MS=m** command (see the supported modulation types on Table 3-2 on page 32). If the x2 mode is disabled with **S32**, trying to set **+MS=m** to x2 mode will result in an error message.

For x2 mode, the modem-to-modem data rates (transmit only) are 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, and 31,200 bps. The x2 modem-to-modem receive rates (in connections with equipment-compatible Internet Service Providers only) are 33,333, 37,333, 41,333, 42,667, 44,000, 45,333, 46,667, 48,000, 49,333, 50,667, 52,000 and 53,333 bps. In other types of connections, the chipset receives at V.34

mode rates. While the x2 Technology can achieve receive speeds up to 57,333 bps, these are currently prohibited due to FCC rules that restrict modem power output.

In V.34 mode, the modem-to-modem data rate can be set to 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. For V.42, MNP, and Buffer (Normal) modes, the modem provides speed buffering (see Section 4 on page 57), which allows the DTE-to-modem data rate to be different from the modem-to-modem data rate. Users can take advantage of this feature by setting the DTE-to-modem rate to a high speed like 115,200 bps and letting the modem negotiate the best line rate.

The type of connection can be symmetrical or asymmetrical. In symmetrical connections, the modem transmits and receives at the same speed; in asymmetrical mode, these differ. V.34 mode connections can be either symmetrical or asymmetrical. x2 mode connections are always asymmetrical. The CL-MD56XX chipsets can be configured (by the **+MS=m** command) to support either asymmetrical or symmetrical connections. Note that the transmitter speed and receiver speeds typically are different for most V.34 connections over the PSTN.

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

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

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

Table 3-2. Supported Modulation Types

<carrier >	Description
V21	V.21 300 bps
V22	V.22 1200 bps
V22B	V.22 bis 1200 and 2400 bps
V23C	V.23, with constant carrier; 1200 bps forward and 300 bps reverse
V32	V.32 4800 and 9600 bps
V32B	V.32 bis 7200, 9600, 12,200, and 14,400 bps
V34	V.34 asymmetrical connections: 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
V34S	V.34 symmetrical-only connections: 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
V34B	V.34 extended asymmetrical connections: 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
V34BS	V.34 extended symmetrical connections: 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
VX2	56K 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 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 and 53,333 bps

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

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

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

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

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

If the **+MS=m** parameters contain conflicting information like "+MS=V34,1,14400,0" with a DTE data rate of 2400 bps, then the modem's connection attempts always fail, and the modem reports a "NO CARRIER" message. This happens for two reasons. First, when the modem receives the **+MS=m** command, the modem does not check for conflicts of valid parameter information. Secondly, some of the same configuration information is provided by two other commands: **Nn** and **S37**. The command issued last takes precedence.

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

same as **Nn** — same as **S37**

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

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

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

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

The **+MS** command sets the modulation speeds in the CL-MD56XX chipsets; however, to set the modulation to either V.22 or Bell 212, the **B0** or **B1** command also must be sent. To set the modulation type to ITU-T V.22, send the **B0** command; to set the modulation type to Bell 212, send **B1**. These commands can be entered before or after the **+MS** command. For example, to set the modulation to ITU-T V.22:

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

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

```
1. ATS37 = 0                          2. AT+MS = V32B, 1, 0, 14400
   AT+MS = V32B, 1, 0, 14400             ATS37 = 0
   ATDT1234                              ATDT1234
   CONNECT 14400                         CONNECT 9600
```

Table 3-3 on page 34 shows the resulting connection data rate when using non-default values. Because of impairments on the telephone line, the actual connection speeds may be lower than the speeds defined in this table.

For V.34 and x2 modulation, the modem may 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, 28,800, 28,800; UART data rate = 115,200 bps	+MS = V32B, 1, 0, 9600; B1 and UART data rate = 14,400 bps	No connection: the originating modem is configured to attempt only a 28,800 bps connection, but the answering modem is configured to attempt a maximum data rate of 9600 bps.
N0, +MS = V32, 1, 0, 9600; S37 = 0; and UART data rate = 7200 bps	+MS = V34, 1, 0,0; UART data rate = 9600 bps	7200 bps: the originating modem is configured to attempt connection at 7200 bps or below. The answering modem is configured to attempt a data rate of 9600 bps or below. The connection takes place at 7200 bps, the highest speed supported by both modems.

3.9 Diagnostic Testing [S18, &Tn]

The modem provides digital and analog loopback tests for testing modem-to-modem and DTE-to-modem communication integrity in all modes except x2. Communication integrity is checked by initiating a remote loopback test, then sending a known data string and comparing it to the received data. If the received data is the same as the transmitted data, it indicates the communication channel is working properly. If the received data is not the same as the transmitted data, it indicates that there may be a problem with the communication channel, local modem, remote modem, local DTE-to-modem interface, or remote DTE-to-modem interface. The loopback test modes provide a method for isolating the cause of failures.

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

Four types of loopback tests are supported: local analog loopback (page 35), local analog loopback with self-test (page 36), remote digital loopback (page 37), and remote digital loopback with self-test (page 38). Local analog loopback is used to check the DTE-to-modem communication integrity. Digital loopback initiated by the local modem allows the remote modem to check the modem-to-modem communication over the telephone line. Remote digital loopback is used by the local modem to check the modem-to-modem communication integrity over the telephone line. Remote digital loopback with self-test is initiated only by the remote modem and allows the remote DTE to check the modem-to-modem communication integrity over the telephone line. For remote digital loopback with self-test, the local DTE can only grant or deny a remote request for digital loopback.

After entering a 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, local analog and remote digital loopback each provide a self-test mode. 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. Each type of loopback test is illustrated in the following examples. Before starting a test, use **AT&F &W<CR>** to return the modem to factory defaults.

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. Before starting the test, use **AT&F &W<CR>** to return the modem to factory defaults.

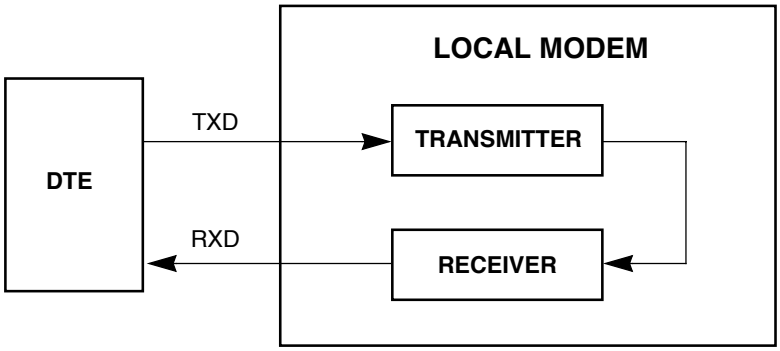


Figure 3-2. Local Analog Loopback Test

Local Modem (or Test Modem)

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

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

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

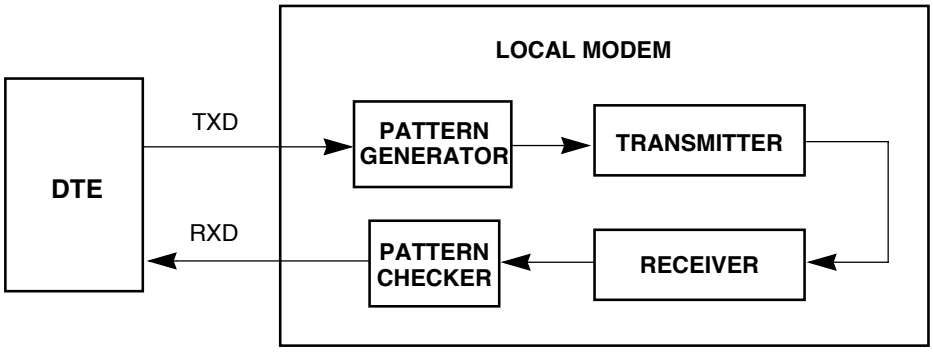


Figure 3-3. Local Analog Loopback with Self-Test

Local Modem (or Test Modem)

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

3.9.3 Remote Digital Loopback (RDL) [AT&T6]

This test is used by the local DTE to check modem-to-modem communication integrity over the telephone line. To use RDL, the remote modem must be previously configured to grant remote RDL (**AT&T4**). Before starting the test, use **AT&F &W<CR>** to return the modem to factory defaults.

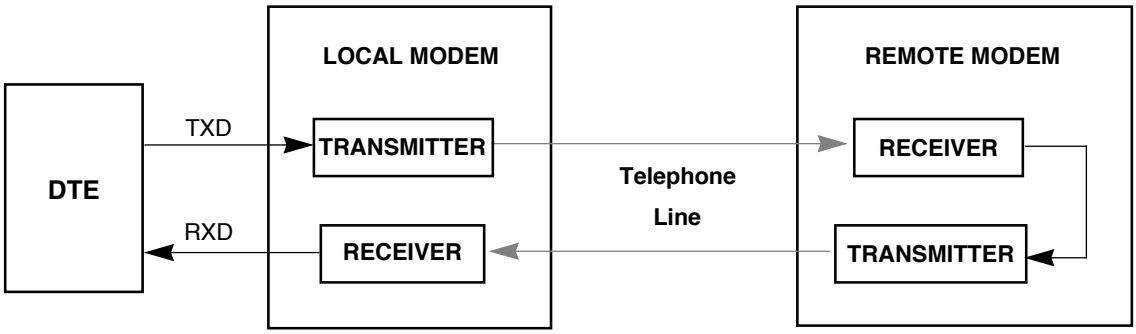


Figure 3-4. Remote Digital Loopback Test

Remote Modem

```
AT&T4                          Remote modem is now configured to grant RDL.
            OK
```

Local Modem (or Test Modem)

```
ATDT<remote phone number>      Establish a data mode connection with
            CONNECT            remote modem.

+++                            Go to online command mode.
            OK

AT&T6                          Initiate remote digital loopback.
            CONNECT

This is a test                 Test string that a user could type at the keyboard. If
                               received data is the same as the test string, then the
                               telephone line communication channel is working
                               properly.

+++                            Go to command mode.
            OK

AT&T0                          Terminate loopback test and remain connected to
            OK                 remote modem (local modem stays in online
                               command mode).

ATH                            Disconnect call.
            OK
```

3.9.4 Remote Digital Loopback (RDL) with Self-Test [AT&T7]

This test is used by the local DTE to check modem-to-modem communication integrity over the telephone line. Before starting the test, use **AT&F &W<CR>** to return the modem to factory defaults.

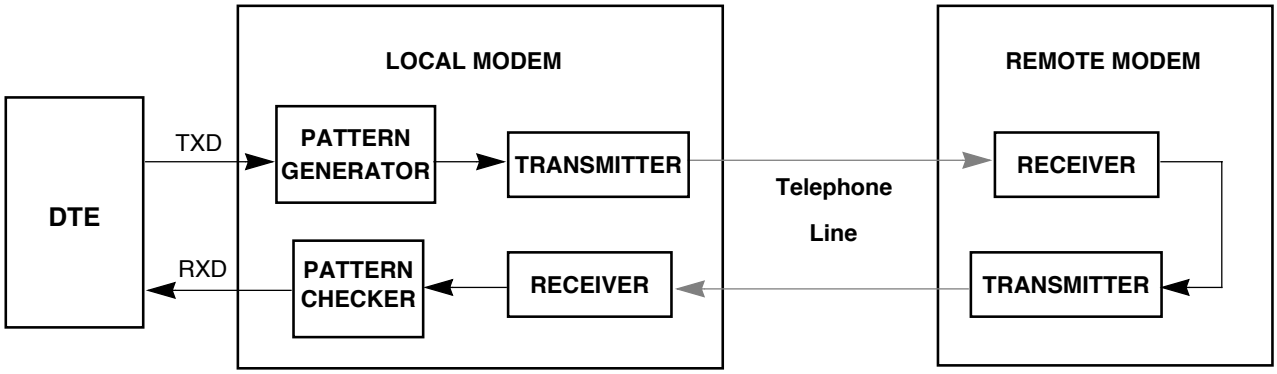


Figure 3-5. Remote Digital Loopback with Self-Test

Remote Modem

```
   AT&T4                        Remote modem is now configured to grant RDL.
                OK
```

Local Modem (or Test Modem)

```
1. AT S18=0                     Change to direct mode and set test timer to zero.
                OK
   ATDT<remote phone number>    Establish a data mode connection with remote modem.
                CONNECT
   +++                          Go to online command mode.
                OK
   AT&T7                        Initiate remote digital loopback with self-test.
                OK
   AT&T0                        After a user-selectable time, abort loopback test.The
                OK              local modem remains connected to remote modem (local
                                modem stays in online command mode).
   ATH                          Disconnect call.
                OK
2. AT S18=20                    Sets test timer to terminate loopback test after
                OK              20 seconds.
   ATDT<remote phone number>    Establish a data mode connection with remote modem.
                CONNECT
   +++                          Go to online command mode.
                OK
   AT&T7                        Initiate remote digital loopback with self-test.
                OK
```

```
AT                      Even though in a test mode, the modem responds to
        OK              new commands.
000                     After 20 seconds, the modem aborts the remote loopback,
        OK              sends an error count to the DTE and then enters online
                        command mode.
ATH                     Disconnect call.
        OK
```

3.10 AT Escape Sequences

The 56K family provides two industry-standard escape sequences, TIES (Time Independent Escape Sequence) and the Hayes® Escape Sequence.

The DTE sends the escape sequence to return the modem to command state while in the online data state (that is, connected to another modem) or in diagnostic mode (**&Tn** commands). Currently, most modems implement the Hayes Escape Sequence; but since its use may require a license from Hayes, TIES is provided as an alternative.

TIES/Hayes Escape Sequences

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 Hayes® Escape Sequence

The Hayes Escape Sequence, developed by Hayes Microcomputer Products, Inc., has been adopted by many modem manufacturers. The DTE implements the escape sequence by sending the modem an escape character three times, preceded and followed by guard times. Upon detecting the escape sequence, the modem sends an 'OK' response to the DTE. To re-enter the online data state, the DTE then sends the modem **ATO** followed by the contents of S-register **S3** (typically a <CR>).

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

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
```

3.10.2 Time-Independent Escape Sequence

TIES (Time-Independent Escape Sequence) 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 may cause the modem to incorrectly decide that an incoming AT string is invalid. The ignore characters are <LF>, <space>, and <CR> (<CR> is ignored only when **S3** is not equal to <CR>). Not all AT commands are supported during TIES command mode. The following is a list of supported commands:

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

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

Format: <char1><char2><char3><AT command><contents of S3>

char1 = char2 = char3 = escape character (S2)

Example:

DTE: +++ AT<CR>

DCE: OK

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

Table 3-4. Basic Data Mode AT Command Set Summary

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

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.
Bn	**1**	**Select ITU-T or Bell®:** This command selects the ITU-T or BELL configuration for the modem. n = 0 Selects ITU-T V.22 when the modem is at 1200 bps and ITU-T V.21 when the modem is at 300 bps. n = 1* Selects Bell® 212A when the modem is at 1200 bps and Bell® 103J when the modem is at 300 bps. n = 2 Selects ITU-T V.23 modulation connections only (that is, the modem does not connect for any other speed or modulation). The originating modem transmits at 75 bps (and receives at 1200 bps), and the answering modem transmits at 1200 bps (and receives at 75 bps). n = 3 Selects ITU-T V.23 modulation connections only (that is, the modem does not connect for any other speed or modulation). The originating modem transmits at 1200 bps (and receives at 75 bps), and the answering modem transmits at 75 bps (and receives at 1200 bps).
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.

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
D	**none**	**Dial Command:** (cont.)
		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 0.75 seconds.
		@ — 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 autodialers).
	<space> - ( )	Ignored by Modem—these four characters are ignored by the modem. Spaces also may be included in the dial string to separate area codes and numbers.
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
Fn	**1**	**Online Echo:** Usually this command selects whether the modem echoes data back to the host during online data mode. This chipset does not support online data mode echo. n = 0 Echo enabled (returns an error message) n = 1* Echo disabled

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
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 Reports the following hardware configuration: programmed host interface (HOST I/F), program memory (P Mem), data memory (D Mem), and DSP code location (see example at the end of the **In** description). n = 6 Country Code US= United States JP= Japan UK= United Kingdom GR= Germany FR= France IT= Italy NT= Netherlands n = 7 Board manufacturer firmware version # 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 = 9 Reserved n = 10 Modem board configuration—Bits set by board manufacturer Bit 2 Bit 1 Bit 0 0 0 0 = Telephone-Emulation Mode 1 0 0 = CL-MD56XX digital speakerphone (+VSP=n) 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

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description

In	**0**	**Identification/Checksum Option:** (cont.)
		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 on board; 1 = Local telephone off-hook detection on board
		Bit 4 — 0 = No local telephone on-hook detection on board; 1 = Local telephone on-hook detection on board
		Bit 4-7 — Reserved
		n = 12 — Reserved
		n = 13 — 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
		n = 24 — Reserved
		n = 25 — Reserved
		Examples:
		`ATI1`
		`CD04.08 - MM03.XX`
		`OK`
		`ATI2`
		`OK`
		`ATI3`
		`CL-MD56XX`
		`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`

3-4 Basic Data Mode AT Command Set Summary (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
Nn	**1**	**Select Data Rate Handshake:** This command specifies whether the resulting modem-to-modem modulation can be different from the modulation specified in the **+MS=m** <carrier> parameter. n = 0 When originating or answering, connect only at the data rates specified by the modulation. n = 1* When originating or answering, begin handshaking at the modulation data rate. If the remote modem does not support the specified modulation data rate, fall down in data rate or modulation to the highest compatible data rate.
On	**0**	**Go Online:** This command causes the modem to return back to online data mode from online command mode. n = 0* Returns the modem to data mode n = 1 Begins an equalizer retrain sequence, then returns to data mode
P	**none**	**Select Pulse Dialing:** This command configures the modem to use pulse dialing next time the modem dials a telephone number.
Qn	**0**	**Result Code Display Control:** This command selects whether the modem sends result codes to the DTE. n = 0* Result codes enabled n = 1 Result codes disabled
Sn	**none**	**Select an S-Register:** This command selects the current S-register. n = 0–37
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

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
T	**none**	**Select Tone Dialing:** This command configures the modem to use DTMF tones the next time the modem dials a telephone number (touch tone dialing).
Vn	**1**	**Result Code Form:** This command selects whether modem response codes are in numeric or verbose form. n = 0 Numeric form n = 1* Verbose (text) form

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 = 1 CONNECT result code reports DTE speed.
		n = 2 CONNECT result code reports DCE speed.
		n = 3 CONNECT result code reports DTE data rate, modulation mode, error correction, data compression, DCE transmitter speed and DCE receiver speed when the mode is configured for verbose **V1** (text) response codes. For numeric responses **V0,** the modem responds with the **W0** numeric response codes. The verbose response codes use the following format:
		CONNECT (DTE data rate) /(modulation)/(error correction)/(data compression) / TX=(DCE transmit data rate) / RX=(DTE receive data rate)
		Modulation types include: V21, V22, V22B, V23C, V32, V32B, V34, and x2
		Error correction types include: NONE, LAPM, MNP
		Data compression types include: NONE, V42B, MNP5
		For example:
		`CONNECT 115200/V34/LAPM/V42B/TX=28800/RX=28000`
		n = 4 CONNECT result code reports DTE protocol, data compression, and DTE data rate when the mode is configured for verbose **V1** (text response codes). For numeric responses **V0**, the modem responds with the **W0** numeric response codes. The verbose response codes use the following format:
		(DTE protocol)
		(data compression)
		(line speed)
		Error correction types include: NONE, LAPM, MNP
		Data compression types include: NONE, V42B, MNP5
		For example:
		`PROTOCOL: LAPM`
		`COMPRESSION: V42B`
		`CONNECT 33,600`

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
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.
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 it causers all subsequent commands to be 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.

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
&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 may be required in some countries but are not needed in the United States. Guard tones are sent by the answer modem to disable Central Office echo cancelers. n = 0* Guard tone disabled n = 1 550-Hz guard tone enabled n = 2 1800-Hz guard tone enabled
&Jn	**0**	**Auxiliary Relay Control:** This command controls whether the modem supports the A/A1 function. A/A1 is used only for RJ-12 and RJ-13 telephone connectors and not for RJ-11 telephone connectors. A and A1 are two pins on the RJ-13 connector that indicate when a modem/telephone is being used on a multi-line telephone system. To implement the A/A1 feature, the chipset provides an A/A1* relay driver. Typically, the A/A1* relay driver drives a normally open relay that connects the A and A1 signals from the RJ-13 telephone connector—pins 2 and 5, respectively. When enabled (**&J1**), the modem activates the A/A1* relay driver whenever it goes off-hook. Activating the A/A1* relay driver causes the normally open relay to close, shorting A and A1 together. **CAUTION:** The A/A1 function should never be used on an RJ-11 telephone jack, since most United States homes provide a second telephone signal on RJ-11 pins 2 and 5. Thus, it is recommended that &J0 always be used. n = 0 * Auxiliary relay is never operated. n = 1 A lead is connected to the A1 lead while the modem is off-hook.

3-4 Basic Data Mode AT Command Set Summary (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 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 = 4 Grants RDL request from remote modem n = 5 Denies RDL request from remote modem n = 6 Remote digital loopback n = 7 Remote digital loopback with self-test n = 8 Local analog loopback with self-test

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
&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. Range: n = 0–1 n = 0* Enabled (Trellis modulation with QAM modulation as a fallback) n = 1 Disabled (QAM modulation only)
&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 n = 3 Relay, general-purpose input/output status **AT&V0** **ACTIVE PROFILE:** B1 E1 L2 M1 N1 P Q0 V1 W3 X4 Y0 &C1 &D2 &G0 &J0 &P0 &Q0 &S0 &U0 &Y0 %A013 %C1 %E1 %G1 \A3 \C0 \G0 \J0 \K5 \N3 \Q3 \T000 \X0 -C1 -J1 "H3 "O032 S00:001 S01:000 S02:043 S03:013 S04:010 S05:008 S06:002 S07:060 S08:002 S09:006 S10:014 S11:070 S12:050 S18:000 S25:005 S30:000 S33:010 S37:000 **STORED PROFILE 0:** B1 E1 L2 M1 N1 P Q0 V1 W3 X4 Y0 &C1 &D2 &G0 &J0 &P0 &Q0 &S0 &U0 %A013 %C1 %E1 %G1 \A3 \C0 \G0 \J0 \K5 \N3 \Q3 \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 S37:000 **TELEPHONE NUMBERS:** &Z0= 12345 &Z1= T4444444 &Z2= T12345 &Z3= T11234567890 OK

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
&Wn	**0**	**Store Active Profile:** This command causes the modem to store a subset of the active profile command and S-register configurations into the NVRAM user profile 'n'. n = 0* Store in user profile 0 n = 1 Store in user profile 1
&Yn	**0**	**Select Stored Profile on Power-up:** This command selects the particular stored user profile from the NVRAM to be loaded into the active profile upon modem power-up. n = 0* Select profile 0 n = 1 Select profile 1
&Zn=x	**none**	**Store Telephone Number**: This command stores a telephone number up to 30 digits (including dial modifiers) in the NVRAM. To dial the stored telephone number, use the **ATDS=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 may affect data reliability. The value for 'n' is stored in the NVRAM. n = 0 Disabled n = 1* Enabled
%Gn	**0**	**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

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
-Cn	**1**	**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

+GMI?	**none**	**Identify Modem Manufacturer**: This command causes the DCE to send a message to the DTE indicating the DCE manufacturer. This command is identical to **AT+FMFR?** and **AT+FMI?**.
		`AT+GMI?`
		`CIRRUS LOGIC`
		`OK`
		NOTE: 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 **AT+FMDL?** and **AT+FMM?** commands.
		`AT+GMM?`
		`CL-MD56XX`
		`OK`
		NOTE: 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 **AT+FREV?** and **AT+FMR?**.
		`AT+GMR?`
		`CD 2.07–MM 02.02`
		`OK`
		NOTE: The modem product model can be changed using the firmware configuration utility.

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description

+MS=m **see 'm'**

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

V.34 modulation connections can be symmetrical or asymmetrical. In symmetrical connections, the transmit and receive speeds are the same; in asymmetrical, they are different. Modems using CL-MD56XX chipsets can be configured by the +MS=m command to support only asymmetrical or symmetrical connections. The factory default is for a 33,600-bps asymmetrical connection. Note that the transmitter speed and receiver speeds typically are different for most V.34 connections over the PSTN.

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

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

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

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

Defaults: m = VX2, 1, 300, 0

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

<carrier>	Description
V21	V.21 300 bps
V22	V.22 1200 bps
V22B	V.22 bis 1200 and 2400 bps
V23C	V.23, with constant carrier; 1200 bps forward and 300 bps reverse
V32	V.32 4800 and 9600 bps
V32B	V.32 bis 7200, 9600, 12,200, and 14,400 bps
V34	V.34 asymmetrical connections: 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
V34S	V.34 symmetrical-only connections: 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
V34B	V.34 extended asymmetrical connections: 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
V34BS	V.34 extended symmetrical connections: 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
VX2	56K 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 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 and 53,333 bps

3-4 Basic Data Mode AT Command Set Summary (cont.)

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

<automode> When enabled, this parameter allows the modem to negotiate modulation speeds automatically (if an automatic value is defined for that particular modulation). This feature is also controlled by the **Nn** AT command. The automode setting is based on which command, **Nn** or +MS=m, was issued last.

Range: <automode> = 0, 1

Default: <automode> = 1

<automode> = 0	Disabled
<automode> = 1	Enabled

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

Range: <min 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, 33,600, 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

<max rate> This parameter sets the highest speed at which the modem may establish a connection. This feature is also controlled by the **S37** S-register. The <max rate> setting is based on which command, **S37** or +MS=m, was issued last.

Range: <max 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 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

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

3-4 Basic Data Mode AT Command Set Summary (cont.)

Command	Default	Description
+MS=m		**Modulation Selection**: (cont.)
		Examples (DTE data rate = 115,200 bps): Speed
		+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, 28800 9600–28800
		+MS = V34, 1, 28800, 28800 28800 only
		+MS = V34, 0, 19200, 26400 19200–26400
		+MS = V32, 1, 0, 0 300–9600
		+MS = V32, 0, 0, 0 4800–9600
		+MS = VX2, 1, 0, 0
		Examples (DTE data rate = 2400 bps): Speed
		+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 = V32, 0, 0, 0 NO CARRIER

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 (MNP 5 and V.42 bis). V.42 error correction uses LAPM as the primary error-control protocol and uses MNP 2-4 as an alternative. V.42 bis data compression requires V.42 (LAPM only). MNP 5 requires MNP 2-4. The supported V.42 bis/MNP AT command set is listed below.

V.42 / V.42 bis MNP® AT Commands

Command	Function	Default	Range	Reported by &Vn
%An *	Set auto-reliable fallback character	13	0–127	yes
%Cn *	MNP 5 data compression control	1	0, 1	yes
%C0	No compression			
%C1	Enables MNP 5 data compression			
\An *	MNP block size	3	0–3	yes
\A0	Maximum 64 characters			
\A1	Maximum 128 characters			
\A2	Maximum 192 characters			
\A3	Maximum 256 characters			
\Bn *	Transmit break	none	0–9	no
\Cn *	Set auto-reliable buffer	0	0–2	yes
\C0	No data buffering			
\C1	Four-second buffer until 200 characters in the buffer or detection of a SYN character			
\C2	No buffering. Connects non-V.42 modems to V.42 modem			
\Gn *	Set modem port flow control	0	0, 1	yes
\G0	Disables port flow control			
\G1	Sets port flow control to XON/XOFF			
\Jn *	bps rate adjust control	0	0, 1	yes
\J0	Disables rate adjust			
\J1	Enables rate adjust			
\Kn *	Set break control	5	0–5	yes
In connect state, transmits break to remote (if in reliable mode):				
\K0, 2, 4	Enters command mode, no break sent			
\K1	Destructive/expedited			
\K3	Nondestructive/expedited			
\K5	Nondestructive/nonexpedited			
In command state, transmits break to remote (if in reliable mode):				
\K0, 1	Destructive/expedited			

V.42 / V.42 bis MNP® AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
\K2, 3	Nondestructive/expedited			
\K4, 5	Nondestructive/nonexpedited			
In connect state, receives break at modem port (if in direct mode):				
\K0, 2, 4	Immediately sends break and enters command state			
\K1, 3, 5	Immediately sends the break through			
In connect state, receives break at modem port and sends to serial port:				
\K0, 1	Destructive/expedited			
\K2, 3	Nondestructive/expedited			
\K4, 5	Nondestructive/nonexpedited			
\Nn *	Set operating mode	3	0–4	yes
\N0, 1	Selects buffer (normal) mode with speed buffering			
\N2	Selects MNP reliable mode			
\N3	Selects V.42 auto-reliable mode			
\N4	Selects V.42 reliable mode			
\O	Originate reliable link	none	–	no
\Qn *	Set serial port flow control	3	0–3	yes
\Q0	Disables flow control			
\Q1	XON/XOFF software flow control			
\Q2	Unidirectional hardware flow control			
\Q3	Bidirectional hardware flow control			
\T0 *	Disables inactivity timer	0	0–90	yes
\U	Accept reliable link	none	–	no
\Xn *	Set XON/XOFF pass-through	0	0, 1	yes
\X0	Processes flow control characters			
\X1	Processes flow control characters and passes to local or remote			
\Y	Switch to reliable mode	none	–	no
\Z	Switch to normal mode	none	–	no
-Jn *	Set V.42 detect phase	1	0, 1	yes
-J0	Disables the V.42 detect phase			
-J1	Enables the V.42 detect phase			
"Hn *	V.42 bis compression control	3	0–3	yes
“H0	Disables V.42 bis			
“H1	Enables V.42 bis only when transmitting data			
“H2	Enables V.42 bis only when receiving data			

V.42 / V.42 bis MNP® AT Commands (cont.)

Command	Function	Default	Range	Reported by &Vn
“H3	Enables V.42 bis for both transmitting and receiving data			
"On	V.42 bis string length	32	6–250	yes

* Value saved in NVRAM.

The CL-MD56XX chipsets support four operating modes: buffer (normal), MNP reliable, V.42 auto-reliable, and V.42 reliable. These four modes are selected by the **\Nn** command. They allow the DCE to communicate with remote modems that may or may not support error correction and data compression. Speed buffering, which is used for all operating modes, allows the DTE-to-modem data rate to be different from the modem-to-modem data rate. This is accomplished by using transmitter and receiver buffers in the modem. Thus, the DTE-to-modem data rate can be set for 2400 bps when the modem-to-modem data rate is 300 bps without causing any data errors. In all data modes, the DTE-to-modem data rate can be set for any valid speed between 300 bps to 115,200 bps (that is, the modem autobauds up to 115,200 bps). The modem-to-modem data rates can be set to 300, 1200, 2400, 4800, 7200, 9600, 12,200, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, and 33,600 bps. Each operating mode is explained in more detail in the following tables.

When in V.80 mode (synchronous access mode) for videoconferencing, the V.80-mode-only **+ES=m** commands for data correction/compression supersede the \Nn commands. See page 98 for a table comparing **+ES=m** and \N commands. Control reverts to the \Nn command upon exiting V.80 mode.

Operating Modes

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

Connection types corresponding to **\Nn** settings are provided in Table 4-1.

Table 4-1. Resulting \Nn Connection Types

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

NOTES:

1) MNP 5 requires the modem to be configured for **%C1**.
2) V.42 bis requires the modem to be configured for **"H3**.
3) Refer to **\Cn** and **%An** commands for more information about auto-reliable mode.

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

```
V.42 bis with fallback to MNP5,          &F \N3           or     \N3 "H3 %C1
MNP2-4 or V.42:
V.42 bis with fallback to V.42/MNP2-4:   &F \N4 %C0       or     \N4 %C0 "H3 -J1
V.42 bis only:                           &F \N4 -J0       or     \N4 -J0 "H3
V.42 only:                               &F \N4 -J0 "H0   or     \N4 -J0 "H0
MNP5 with fallback to MNP2-4:            &F \N2           or     \N2 %C1
MNP2-4 only:                             &F \N2 %C0       or     \N2 %C0
```

Table 4-2. V.42 and MNP Data Mode Command Summary

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

Command	Default	Description
%An	**13**	**Set Auto-Reliable Fallback Character:** In auto-reliable mode (**\N3**) with auto-reliable fallback character enabled (**\C2**), receipt of the fallback character from the line during the V.42 detection phase causes the modem to switch to buffer (normal) mode. This allows a remote user with a non-V.42 modem to connect immediately with a V.42 modem. A space or carriage return is usually chosen for the fallback character. n = 0–127 (ASCII character)
%Cn	**1**	**MNP 5 Data Compression Control:** This command controls whether the data sent during the MNP frames is compressed using MNP Class 5 compression standard. MNP 5 data compression can improve throughput by as much as 150%. 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 may 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
\Bn	**none**	**Transmit Break:** This command causes the modem to send a break (attention signal) to the remote modem for a duration specified by 'n'. When n = 0, the default break length is used. n = 0–9 (units of 100 ms)
\Cn	**0**	**Set Auto-Reliable Buffer (requires a license from Microcom®):** In auto-reliable mode (**\N3**), this command determines the fallback method and enables data buffering. The settings for this command are used by the modem during the V.42 detection phase. n = 0–2 n = 0* Does not buffer data. n = 1 Buffers data for four seconds or until 200 characters have been buffered or the SYN character is detected, then switches to reliable mode. If the buffer fills, data is passed to the serial port. n = 2 Does not buffer data. Switches to buffer (normal) mode upon receipt of auto-reliable fallback character and passes it to serial port. This feature allows non-V.42 modems to connect immediately to a V.42 modem without data loss.

4-2 V.42 and MNP Data Mode Command Summary (cont.)

Command	Default	Description
\Gn	**0**	**Set Modem Port Flow Control:** In buffer (normal) mode (either **\N0** or after fallback), this command enables modem-to-modem flow control using XOFF (13h) to stop and XON (11h) to start transmission between modems. 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* Turns off feature n = 1 Turns on feature
\Kn	**5**	**Set Break Control:** Defines what action the modem takes when a break (attention signal) is sent or received, as described below. n = 0–5 In connect state, transmits break to remote (if in reliable mode): n = 0, 2, 4 Enter command state, but does not send a break n = 1 Destructive/expedited n = 3 Nondestructive/expedited n = 5* Nondestructive/non-expedited In command state, transmits break to remote (if in reliable mode): n = 0, 1 Destructive/expedited n = 2, 3 Nondestructive/expedited n = 4, 5* Nondestructive/non-expedited In connect state, receives break at serial port (if in direct mode): n = 0, 2, 4 Immediately sends break and enters command state n = 1,3, 5* Immediately sends break through In connect state, receives break at modem port and sends to serial port: n = 0,1 Destructive/expedited n = 2, 3 Nondestructive/expedited n = 4, 5* Nondestructive/non-expedited

4-2 V.42 and MNP Data Mode Command Summary (cont.)

Command	Default	Description
\Nn	**3**	**Set Operating Mode:** Determines the type of connection attempted by the modem. n = 0–4 n = 0, 1 — Buffer (Normal) Mode — no data compression or error correction, but uses speed buffering. n = 2 — MNP Reliable Mode — the modem attempts to negotiate an MNP error-correction 'reliable' link, hanging up if it fails. n = 3* — V.42 Auto-Reliable Mode — if V.42 detection is enabled (**-Jn**), a LAPM or MNP link can be detected and negotiated; otherwise, only LAPM is attempted. If configured for **-J0** and a protocol connection is not made, the modem hangs up. If configured for **-J1** and a protocol connection is not made, the modem falls back to speed buffering mode. n = 4 — V.42 Reliable Mode — the modem attempts to negotiate LAPM error correction, hanging up if it fails.
\O	**none**	**Originate Reliable Link**: In buffer (normal) mode (**\N0** or **\N1**), the modem attempts to originate an MNP link, regardless of whether the modem originated or answered the telephone call (physical connection). The remote modem must answer the MNP link request for the link to be established (refer to the \U command that follows).
\Qn	**3**	**Set Serial Port Flow Control:** This command specifies the DTE-to-modem flow control. Software flow control uses the XOFF (13h) command to stop and the XON (11h) characters to start data transmission, both to and from the DTE. Unidirectional hardware flow control uses the CTS control line to stop or start data from the DTE only, while bidirectional hardware flow control also uses the RTS control to stop or start data from the modem. n = 0–3 n = 0 — Disables flow control n = 1 — XON/XOFF software flow control n = 2 — Unidirectional hardware flow control — CTS n = 3* — Bidirectional hardware flow control — RTS/CTS
\Tn	**0**	**Set Inactivity Timer:** During a buffer (normal) or reliable connection, if no data is sent or received within the inactivity time period, the link is disconnected. The default, '0', disables this feature. n = 0–90 — Length in minutes n = 0* — Disables inactivity timer
\U	**none**	**Accept Auto-Reliable Link**: In buffer (normal) mode (**\N0** or **\N1**), the modem attempts to answer an MNP link request, regardless of whether the modem originated or answered the telephone call (physical connection). The remote modem must originate the MNP link request for the link to be established (refer to the preceding \O command).

4-2 V.42 and MNP Data Mode Command Summary (cont.)

Command	Default	Description
\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, 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 so they can process the characters.
\Y	**none**	**Switch to Reliable Mode**: In buffer (normal) mode (**\N0** or **\N1**), the modem attempts to originate or answer an MNP link request, depending on whether the modem originated or answered the physical connection, respectively. The remote modem must attempt to answer/originate the MNP link for the link to be established.
\Z	**none**	**Switch to Buffer Mode**: During an MNP link, the modem disconnects the link (exit error correction/data compression) and changes to buffer mode without disconnecting the modem-to-modem connection.
-Jn	**1**	**Set V.42 Detect Phase:** In V.42 modes (**\N3**, **\N4**), 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
"Hn	**3**	**V.42 bis Compression Control:** This command specifies whether the data in the LAPM frames are compressed using V.42 bis data compression. This can improve throughput by as much as 400%. Compression can be negotiated to operate in one direction or both. 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

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-MD56XX–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 on page 66; all other fax AT commands are provided in Table 5-3 starting on page 70. 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.

Fax Identity Commands

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 revision	none	–	no
+FREV?	Identifies product revision	none	–	no

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

Table 5-1. Fax Identity Commands

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`
		NOTE: 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-MD56XX' 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?`
		`CD02.07-MM02.02`
		`OK`

5.2 Fax Class 1 Commands

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

Each command may be used as follows:

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

Fax Class 1 AT Commands

Command	Function	Default	Range	Reported by &Vn
+FAE=n	Fax/data autorecognition	0	0, 1	no
+FCLASS=1	Mode selection	0	0, 1, 8, 80	yes
+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

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 68.

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

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

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

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

Table 5-2. <mod> Selection Table

Value	Modulation	Speed (bps)
3	V.21 ch 2	300
24	V.27 ter	2400
48	V.27 ter	4800
72	V.29	7200
73	V.17	7200
74	V.17 with short train	7200
96	V.29	9600
97	V.17	9600
98	V.17 with short train	9600
121	V.17	12,200
122	V.17 with short train	12,200
145	V.17	14,400
146	V.17 with short train	14,400

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

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

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

Figure 5-1. T.30 HDLC Frame Format

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

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

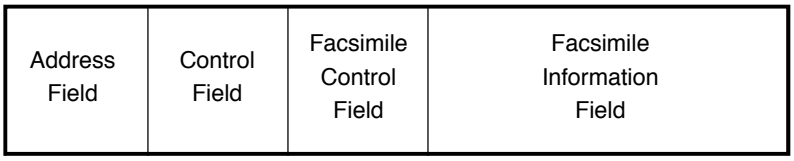


Figure 5-2. CLASS 1 DTE Generated HDLC Frame Information (AT+FTH=<mod>)

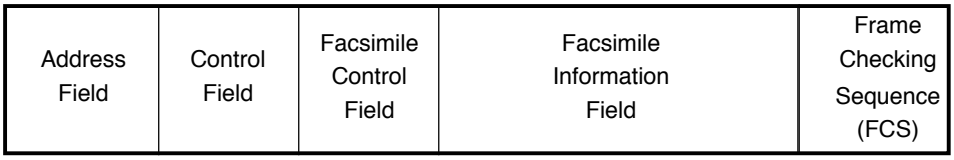


Figure 5-3. CLASS 1 DTE Reception of HDLC Frame Information (AT+FRH=<mod>)

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. Unlike the data modem mode, auto-answering is not supported by the modem while in fax mode. It is recommended that S-register **S0** be set to '0' (that is, use 'ATA') whenever the modem is expected to receive a fax call.

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

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

1) It places the modem off-hook.

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

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

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

Data: All
Voice: +FCLASS

Table 5-3. Fax Mode AT Command Set Summary

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

Command	Default	Description
+FAE=n	**0**	**Fax/Data Autorecognition**: This command allows the modem to determine automatically whether an incoming call is data or fax and to answer accordingly. When disabled, the modem answers as a fax modem only. n = 0* Disable data/fax auto-answer mode n = 1 Enable data/fax auto-answer mode
+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, 80 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 n = 80 Configures DCE for VoiceView operation
+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 a 'OK' result code. If the frame was received in error (FCS is not correct, carrier lost, or data lost due to data overflow), the DCE returns an 'ERROR' result code. The DTE should then discard this frame. After sending the status result code, the modem is ready to accept new commands from the DTE.

5-3 Fax Mode AT Command Set Summary (cont.)

Command	Default	Description
+FRH=n		**Receive HDLC Data**: (cont.) 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 68.
+FRM=n	**none**	**Receive Data**: The **+FRM=<mod>** command causes the modem to enter receive mode using the modulation scheme specified in <mod>. <mod> may have the values shown in Table 5-2 on page 68. 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 command state and sends a 'NO CARRIER' result code to the DTE. **NOTE:** 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.)
+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)

5-3 Fax Mode AT Command Set Summary (cont.)

Command	Default	Description
+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> may have the values shown in Table 5-2 on page 68. 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 (Frame Check Sequence) and a closing flag to the frame. The modem ensures that the minimum number of flags required by T.30 are sent before the data from the DTE begins to be transmitted. The modem checks the final frame bit in the control field of each frame; this is the fifth-received bit of the second byte of each frame. If the final frame bit is a '1', the modem ceases transmission after the frame is sent, returns to command state, and sends the 'OK' result code to the DTE. If the final frame bit is a '0', the modem sends another 'CONNECT' result code to the DTE after the current frame is sent. The modem continues to transmit flags until the DTE takes one of the following actions: • The DTE sends additional data. The modem then transmits another frame. • The DTE sends only <DLE><ETX> (a null frame). The modem then turns off the transmit carrier and send the 'OK' result code to the DTE. • If the DTE transmits no additional data within 5 seconds from when the modem reported the 'CONNECT' result code, the modem turns off the transmit carrier mode, returns to command mode, and sends the 'ERROR' result code to the DTE. 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. **NOTE:** 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 68.

5-3 Fax Mode AT Command Set Summary (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 command state, and returns an 'ERROR' result code to the modem. **NOTE:** Hex $00 replication does **not** provide the required timing needed for generating the TCF frame (1.5 seconds of '0's'). If the modem's transmit buffer empties and the last transmitted character was not a NULL, the modem turns off the transmit carrier, returns to command state, and sends the 'OK' result code to the DTE. **NOTE:** 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 68.
+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)

6. IS-101 VOICE MODE AT COMMANDS

The 56K FastPath chipsets implement a voice mode AT command set that allows a DTE to record and play back voice messages. In addition to this programmer's guide, the IS-101 Voice Application Note shows several ways to use these AT commands. This product is compatible with the EIA/TIA IS-101 voice command set. This section lists supported commands and a detailed description of each command (see Table 6-3 starting on page 79). When multiple commands are placed on a line, a semicolon (;) must be placed after each voice (and fax) command.

IS-101 Voice AT Commands

Command	Function	Default	Range	Reported by &Vn
+FCLASS=8	Voice mode selection	0	0, 1, 8, 80	yes
+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
#VCSD=n	Voice command mode silence detection	0	0, 1	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	Relay/speaker control	0	0–16	no
+VNH=n	Automatic hang-up control	0	0–2	no
+VRA=n	Ringback-goes-away timer	50	0–50	no
+VRN=n	Ringback-never-appeared timer	10	0–255	no
+VRX	Record mode	none	–	no
+VSD=m	Silence detection (quiet and silence)	128, 50	See note†	no
+VSM=m	Compression method selection	140, 8000, 0, 0	See note††	no
+VSP=n	Speakerphone on/off control	0	0, 1	no
#VSPS=n	Speakerphone type selection	manufacturer-specified	0, 1	no
+VTD=n	Beep tone duration timer	100	5–255	no
+VTS=m	DTMF and tone generation	none	See note †††	no
+VTX	Play mode	none	–	no

† See the **+VSD=m** command description on page 88 for a complete description.
†† See the **+VSM=m** command description on page 89 for a complete description.
††† See the **+VTS=m** command description on page 91 for a complete description.

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

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

Each command may be used as follows:

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

For example, **AT+FCLASS?** determines whether the modem is configured for data (or fax) mode or voice mode. **AT+FCLASS=?** determines which data/fax/voice modes are supported by the modem. **AT+FCLASS=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 (see Table 6-1 and Table 6-2 on page 76). Special characters in the data stream are used in the following way:

any data ... <DLE><ETX>	end of data stream ($10 $03)
any data ... <DLE><DLE>	single $10 in data stream
any data ... <DLE><X>	X is a special character (Table 6-2), delete both <DLE> and X from the data stream

Table 6-1. Voice DTE → DCE Character Pairs

ASCII Characters	Hex Code	Meaning	Notes
<NUL>	00	Do nothing	Playback and Record modes
<DLE>	10	Two contiguous <DLE><DLE> codes indicate a single <DLE> in the data stream	Playback and Record modes
<SUB>	1A	<DLE><DLE> in data stream	Playback and Record modes
<ETX>	03	End transmit data state	Playback mode only
/	2F	Start of DTMF tone shielding	Playback mode only
~	7F	DTMF transition to off	Playback mode only
u	75	Bump up the volume	Playback mode only
d	64	Bump down the volume	Playback mode only
<ESC>	1B	End receive data state	Record mode only
!	21	Receive data abort	Record mode only
<CAN>	18	Clear transmit buffer of voice data	Playback mode only
<FS>	1C	Concatenate transmit data streams	Playback mode only
?	3F	Transmit buffer space available query	Playback mode only

Table 6-2. Voice DTE ← DCE Character Pairs

ASCII Characters	Hex Code	Meaning	Notes
<DLE>	10	Single <DLE> character in the data stream	Record mode only
<SUB>	1A	<DLE><DLE> in data stream	Playback and Record modes
<ETX>	3	End of record mode data	Record mode only
X	58	Packet header for 'Complex Event Detection Report'	All modes
.	2E	Packet terminator for the 'Complex Event Detection Report'	All modes
/	2F	Start of DTMF tone shielding	Record mode only
~	7E	DTMF transition to off	All modes
0–9	30–39	DTMF tones 0–9	All modes
A–D	41–44	DTMF tones A–D	All modes
*	2A	DTMF tone *	All modes
#	23	DTMF tone #	All modes
o	6F	Receive buffer overrun	Record mode only
c	63	1100-Hz fax calling tone	All modes
e	65	1300-Hz data calling tone	All modes
h	68	Local phone goes on hook	See note
H	48	Local phone goes off hook	See note
s	73	Presumed hang-up silence time-out	Record mode only — 's' silence timer starts immediately after entering record mode. This character pair indicates that the remote user has hung up before leaving a voice message. Use **+VSD=m** to enable this feature.
q	71	Presumed end-of-message quiet time-out	Record mode only — 'q' silence timer starts after 's' timer interval is over or after the received signal is above silence threshold level. This character pair is used to indicate that the remote user has left a voice message and then hung up. Command mode only — the modem can be configured by the **#VCSD=n** command to report silence in the voice off-hook command mode. Use **+VSD=m** to enable this feature.
l	6C	Loop current interruption	All modes; See note
L	4C	Loop current polarity reversal	All modes; See note
r	72	Ringback	All modes
b	62	Busy/reorder/fast busy	Record and voice command modes only
d	64	Dial tone detected	Record and voice command modes
u	75	Transmit buffer under-run	Playback only

Table 6-2. Voice DTE ← DCE Character Pairs (cont.)

ASCII Characters	Hex Code	Meaning	Notes
p	70	Line voltage increase (extension phone goes on-hook)	All modes; See note
P	50	Line voltage decrease (extension phone goes off-hook)	All modes; See note
a	61	Fax or data answer tone (2100 Hz)	Voice command mode only
f	66	Data answer detected (2225 Hz)	Voice command mode only
R	52	Incoming ring	All modes; See note
% ‘ (,)	25, 26, 27, 28, 29	Manufacturer-specified	General-purpose input pin signal information; See note

NOTE: To include these features, the modem board must have the appropriate circuitry, and the modem firmware must be configured properly by the board manufacturer.

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

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

6.1 DTMF Detection

DTMF detection information is handled differently than other detection information. IS-101 specifies that more than one <DLE><DTMF CHAR> character pair may be sent for a single DTMF tone burst. As such, the modem sends delimiter <DLE> character pairs to indicate the end of a tone burst. When a DTMF tone is detected in playback or command mode, the modem sends <DLE><~> to indicate the end of a burst. For example, from a single burst of DTMF5 tones, the following reports are possible:

Playback and voice command modes:

<DLE><5><DLE><~>

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

Record mode only:

[voice data]<DLE></><DLE><5>[voice data]<DLE><~>[voice data]

[voice data]<DLE></><DLE><5>[voice data]<DLE><5>[voice data]<DLE><~>[voice data]

6.2 Relay Control

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

ATDT <telephone number>

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

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

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

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

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

Data: All

Fax: +FCLASS

Table 6-3. Voice Mode AT Command Set Summary

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

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, 80 n = 0* Data mode n = 1 Class 1 fax mode n = 8 Voice mode enabled n = 80 VoiceView mode enabled
+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 <DCI> character (11h); XOFF is the ASCII <DC3> character (13h). The DCE may provide ITU-T's V.24 CTS (circuit 106) and RTS (circuit 133) for flow control. n = 0, 1, 2 n = 0 Disables XON/XOFF and CTS/RTS flow control n = 1* Enables XON/XOFF flow control in either direction n = 2 The DTE uses ITU-T's RTS to control flow to the modem; the modem uses ITU-T CTS to control flow to the DTE.
+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>** Defaults: <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

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+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 is enabled in data modem mode, then the modem answers only after the second ring signal.
#VCSD=n	**0**	**Voice Command Mode Silence Detection**: This command causes the modem to look for silence on the telephone line while off-hook in voice command mode. After detecting silence for the specified time period (**AT+VSD=n**), the modem sends <DLE><q> to the DTE. n = 0, 1 n = 0* Silence detection disabled n = 1 Silence detection enabled
+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 may produce a RING event code after the DRON message if enabled by the <report> parameter. The <report> parameter should be set to a value larger than the expected off-times within a single pattern so the RING even reports are issued only during the off-times between the complex patterns. Range: <report> = 0–255 (reporting type in the form DROF=<number in units of 0.1 seconds>)

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description

+VDR=m

Distinctive Ring Selection: (cont.)

<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 — Default: **'C'** **BB860980** **BFE63883** **BB863EE0**

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

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+VEM=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
	4 *	DTMF received	All
2	5 *	Receive buffer overrun	Receive
	6 *	Fax calling (for example, 1100 Hz)	All
	7	Data calling (for example, 1300 Hz)	All
	8	Local phone on/off hook	All
	9 *	Presumed hang-up (SILENCE) time-out	Receive
3	10 *	Presumed end of message (QUIET) time-out	Receive and Command
	11	Reserved	
	12	Reserved	
	13	Loop current interruption	All
4	14	Loop current polarity reversal	All
	15	Reserved	
	16	Reserved	
	17	Reserved	
5	18 *	Ringback/remote ring	All
	19 *	BUSY Reorder/fast busy	Receive and Command
	20 *	DIALTONE	Receive and Command
	21	Reserved	
6	22	Reserved	All
	23 *	Transmit buffer under-run	Transmit
	24	Extension phone on/off hook	All
	25 *	Fax or data answer (for example, 2100 Hz)	Command
7	26	Data answer (for example, 2225 Hz)	Command
	27	Reserved	
	28	Reserved	
	29	Reserved	
8	30	Reserved	
	31	Reserved	
	32	Reserved	
	33	Reserved	
9	34	Reserved	
	35	Reserved	

NOTES:

1) * Marked items meet IS-101 Class C specifications.
2) All = playback, record, and command modes.
3) Reserved: Reserved event number that should be set to zero.

6-3 Voice Mode AT Command Set Summary (cont.)

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

Example 1. Viewing Supported Events:

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

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

Example 2. Setting the Event Mask:

To set the event mask, issue AT+VEM=m, where 'm' is eight hex digits. This command is issued only in command mode and is followed when changing between voice modes. That is, the modem uses the event mask previously set by the **+VEM=m** command when entering playback or record mode. The modem ignores any event bit set when that feature is not supported in that voice mode.

```
AT+VEM=BB863EE0
```

Example 3. Reading the Event Mask Settings:

To read the settings for each event, type:

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

Example 4. Understanding the +VEM Hexadecimal Code:

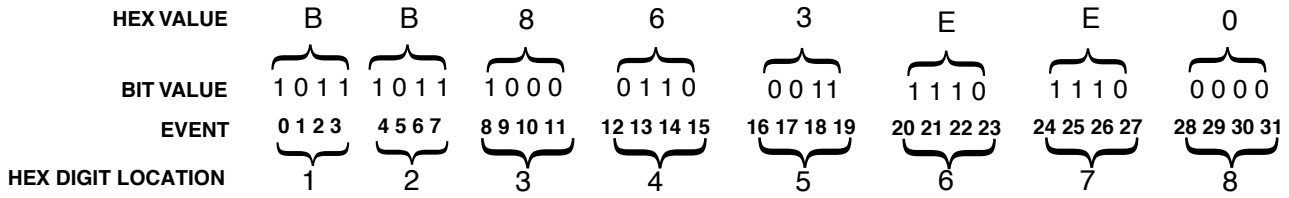
The following illustration shows how the hexadecimal eight-digit code (BB863EE0) is derived from the bit setting for each event:

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

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

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+VEM=m		**Event Reporting and Masking**: (cont.) 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
+VGR=n	**128**	**Receive Gain Selection**: This command sets the recording level for the modem's voice mode. A different recording level may be needed for each type of recording device. This includes telephone line, local handset, local telephone, or microphone. 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 may be needed for each type of playback device (telephone line, local handset, local telephone, or speaker). n = 121-131 n = 128* Nominal transmit level

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+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
+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.)

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+VLS=n	**0**	**Relay/Playback Control**: (cont.)

Preassigned Voice I/O Labels (cont.)

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.

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)

NOTE: For speakerphone applications, see **ATI10**, **+VSP**, and "Speakerphone AT Command Requirements" in the Voice Application Note 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

---

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+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. After dialing a phone number, the modem sends an 'Error' result code to the DTE if ringback is not detected before the timer value elapses. This may indicate one of several conditions: the remote telephone was picked up before the ringback tone was generated; the number is no longer in service; or the number was incomplete. This timer is disabled after detecting the first ringback. 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. It is important that the UART DTE-to-modem rate be equal or higher to the compression-scheme-required UART data rate (for example, CL1 at 4800 samples/second requires 57,600 bps). If the DTE-to-modem data rate is lower than the compression-scheme-required UART data rate, then data may be lost or may be garbled during playback of the message. After sending the 'CONNECT' message, the modem then sends digitized voice data that is <DLE>-shielded to the DTE. The modem buffers the data to ensure steady voice delivery even though the voice data may be transferred to the DTE in bursts. The DTE may use the <DLE><NUL> shielded code as a no-operation command to refresh the inactivity timer. During voice receive mode, the modem informs the DTE about pertinent events that may prompt the DTE to terminate the voice receive state. The DCE sends <DLE> codes for detection of signals such as busy tone, dial tone, DTMF tone, and codes for 'Presumed End of Message' or 'Presumed Hang-up.' Record mode is terminated whenever the modem issues a <DLE><ESC> command or provides a DTE/DCE inactivity timer time-out. Upon detecting the terminating character, the modem stops sampling the analog data. The modem then terminates record mode by sending the remaining voice data stored in its internal buffer, <DLE><ETX>, and an 'OK' message to the DTE. In some situations, the application software may want to abort record mode and immediately perform a new function without first reading all the recorded voice data from the

6-3 Voice Mode AT Command Set Summary (cont.)

Command	Default	Description
+VRX	**none**	**Record Mode**: (cont.) 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 may immediately abort record mode if it receives either an **AT+VIT=n** timeout 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). **NOTE:** The voice sampling rate and sampling mode must be the same values as 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><q> silence timer starts immediately after entering record mode. The modem stops using the <DLE><q> timer and starts using the <DLE><s> timer if: • the <DLE><q> silence timer has timed out and a <DLE><q> 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>** Defaults: 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

6-3 Voice Mode AT Command Set Summary (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>** Defaults: 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 twos-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> = 141AD3: 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 bulletin boards.
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

6-3 Voice Mode AT Command Set Summary (cont.)

Command **Default** **Description**

+VSM=m

Compression Method Selection: (cont.)

When receiving voice, this parameter changes the level of noise that the DCE treats as silence. A higher 'n' number raises the threshold of noise detection.

Reception: Range: n = 0

n = 0* Disables DCE silence compression
n =increments of 1 Raises noise detection threshold

<sel> Silence Expansion: This command enables the DTE to modify the amount of silence expansion. This parameter represents the maximum period of silence the DCE expands a period of silence compressed by the **<scs>** parameter. The DCE ignores the <sel> parameter if **<scs>** is zero.

<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

NOTES:

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

6-3 Voice Mode AT Command Set Summary (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=7**. After enabling the speakerphone mode (**+VSP=1**), the modem remains in voice command mode and provides information about local off-hook detection, DTMF detection, and tone detection — if supported by the modem board. n = 0, 1 n = 0* Speakerphone mode disabled n = 1 Speakerphone mode enabled
#VSPS=n	**0 or 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 may 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 the value of zero. The following list explains each element and how it can be used.

6-3 Voice Mode AT Command Set Summary (cont.)

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

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.

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] This sends a single tone of 3000 Hz with a default duration specified by **+VTD=n**.

For example: AT+VTS=[3000,,50]
This sends a single tone of 3000 Hz with a duration of 500 ms (50 x 0.01 second).

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

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

or

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

For example: AT+VTS=[3000,3300]
This sends a dual tone of 3000 Hz and 3300 Hz with the default duration set by the **+VTD=n** command.

For example: AT+VTS=[3000,3300,50]

This sends a dual tone of 3000 Hz and 3300 Hz with a duration of 500 ms (50 x 0.01 second).

6-3 Voice Mode AT Command Set Summary (cont.)

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

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]`
This sends a 500-ms period of silence.

3) Single DTMF tones or hookflashes 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}`
This command sends DTMF tone 2 with a duration of 300 ms.

For example: `AT+VTS={!,50}`
This command 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.

6-3 Voice Mode AT Command Set Summary (cont.)

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

7. V.80 MODE VIDEOCONFERENCING

7.1 Overview

All versions of the CL-MD56XX chipset family support the ITU-H.324 videoconferencing standards, which allow 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 that is required for compliance with host-based H.324 videoconferencing application software. The CL-MD56XX chipsets support both transparent and framed submodes of the V.80 synchronous access mode. The type of operation may be switched between the two submodes using 8-bit in-band commands.

In the 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.

The synchronous access mode supports 8-bit in-band commands, which send control-type commands in the data stream (for more information, see Section 7.6.1 on page 102). The 8-bit commands provide a means to select and report synchronous modes and to set flow control thresholds, bit processing in the DCE, and signal converter operation after connection.

7.2 Framed Submode

The 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 the 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.

7.3 Transparent Submode

In the 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. The 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.

7.4 Voice Call First

The CL-MD56XX chipsets implement VCF (Voice Call First). VCF operation enables the transition from a standard phone call to an H.324 videoconferencing call. This may be achieved from a standard telephone attached through the V.80-enabled modem or from a modem-initiated speakerphone call. In both cases, the parties have established a normal voice telephony connection that must be interrupted and transitioned to a videoconferencing link. This requires the modems to complete a start-up sequence and establish an H.324 link.

Typically, a VCF session is initiated by a party calling from a video-enabled PC on an H.324 videophone. From the PC in the speakerphone mode, the call is placed using the telephony application software and the video application software. When the voice session is established, both parties enable videoconferencing, with one party initiating the session.

The originating station must issue a command to place the modem off-hook (**ATD**), and the modem must be in a blind-dial mode (**X1**) since dial tone is not present. Transmission of CI initiates the handshake (**-C2** command).

The answering station must be ready to receive the CI signal (**+A8E** command with **<v8a>** set to 5). When CI is received, an **ATA** command prompts the modem to initiate the start-up sequence. The ability to execute a transition from a handset is dependent on the telephone interface circuit.

For more information about Voice Call First, please see Cirrus Logic's Videoconferencing Application Note.

7.5 Connection Procedure

Before videoconferencing can be achieved, the modem must be in data mode (**FCLASS=0**). V.80 mode is inactive in default settings. Activate V.80 mode using the **+ES=m** command by choosing the synchronous access mode (+ES=6, ,8). The **+ESA** command configures the type of synchronous connection. To see whether V.80 mode is enabled, issue the **AT+ES?** command. The **+A8E=m** command configures V.80 negotiation parameters, and the **+ITF=m** command sets flow control thresholds.

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 sub-mode transition.

Flow control is available to allow the DTE-DCE octet transfer rate to be matched to that of the line without buffer underrun or overrun.

V.80 Videoconferencing Mode Commands

Command	Function	Default	Range	Reported by &Vn
FCLASS=0	Mode selection	0	0, 1, 8, 80	yes
+A8E=m	V.8 and V.8 bis operation controls	1,1,C1,0, ,	See note†	no
+ES=m	Error control selection	3, 0, 2	See note††	no
+ESA=m	Synchronous access mode configuration	0, 0, 1, , 0, 0, 126,	See note†††	no
+ITF=m	Transmit flow control thresholds	320, 192, 0	See note††††	no
8-bit in-band controls: <EM><hex code>	In-band commands and indications for use in synchronous access mode only	none	See note†††††	no

† See page 97 for complete command descriptions.

†† See page 98 for complete command descriptions.

††† See page 100 for complete command descriptions.

†††† See page 101 for complete command descriptions.

††††† See page 102 for complete command descriptions.

Table 7-1. V.80 Videoconferencing Mode Summary

Command	Default	Description
+FCLASS=0	**0**	**Data Mode Selection**: This command enables or disables data mode. n = 0, 1, 8, 80 n = 0* Data mode n = 1 Class 1 fax mode n = 8 Voice mode enabled n = 80 VoiceView mode enabled
+A8E=m	**see 'm'**	**V.8 and V.8 bis Operation Controls:** This command configures V.8 and V.8 bis operation. If issued when the DCE is on-hook, this command is a compound parameter used to precondition V.8 and V.8 bis originating and answering operation. It is not supported as an action command while the DCE is off-hook. If enabled, V.8 negotiation does not preclude simultaneous implementation of other means of negotiation (for example, V.8 bis, V.18, and V.32 bis Annex A). For the +A8E default values, the signal indicators (see Table 7-2 on page 98) are not generated by the DCE. When the parameters <v8o>=6 and <v8a>=5, the **+A8I**, **+A8C**, **+A8A**, **+A8J**, and **+A8M** indications are sent from the DTE, but the **+A8M** command is not used because the DCE controls the V.8 section. **m = <v8o>, <v8a>, <v8cf>, <v8b>,<cfrange>, <protrange>** Defaults: 1, 1, C1, 0, , **<v8o>** V.8 origination selection. Range <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: 0xC1 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.

7-1 V.80 Videoconferencing Mode Summary (cont.)

Command	Default	Description
+A8E=m	**see 'm'**	**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 7-2. Indication Parameters

Indication	Definition
+A8A:1	Indicates V.8 ANSam has been detected. This indication is only sent to the DTE if +A8E<v8o>=6 and operating in originate mode.
+A8A:2	Indicates V.25 answer tone (2100 Hz) has been detected. This indication is only sent to the DTE if +A8E<v8o>=6 and operating in originate mode.
+A8I:<v8cf>	Indicates the detection of a V.8 CI-signal and the recovered call function (only if +A8E<v8a>=5 and operating in answer mode).
+A8M:<CM>	Indicates the hexadecimal-coded CM signal (only if +A8E<v8a>=5 and operating in answer mode)
+A8M:<JM>	Indicates the hexadecimal-coded JM signal (only if +A8E<v8o>=6 and operating in originate mode)
+A8J:[0,1]	Indicates the modem is transmitting the V.8 termination signal. +A8J:1 indicates transmission or detection of CJ while +A8J:0 indicates timeout while waiting for a CJ signal.

+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.

When +ES is issued, its error correction settings replace those of the **\Nn** error control selection commands (see the following table and Section 4 on page 57). When initiating V.80 (synchronous access) mode, the error correction default +ES setting of 3,0,2 is equivalent to the \N3 V.42 autoreliable mode. To switch out of the synchronous access mode, choose another mode using the **+ES** or **\N** commands.

+ES=1,0,1	\N0	Buffered mode
+ES=0,1,0	\N1	Direct mode
+ES=4,4,6	\N2	MNP reliable mode
+ES=3,0,2*	\N3	V.42 autoreliable mode
+ES=3,2,4	\N4	V.42 reliable mode
+ES=2,3,5	\N5	LAPM reliable mode
+ES=6, ,8	\N6	Synchronous access mode

7-1 V.80 Videoconferencing Mode Summary (cont.)

Command	Default	Description
+ES=m	**see 'm'**	**Error Control Selection**: (cont.)

m = <orig_rqst>, <orig_fbk>, <ans_fbk>
Defaults: 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>: 0–4, 6

Default: 3

n = 0	Direct mode
n = 1	Initiate call with buffered 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.

<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>: 0–4

Default: 0

n = 0*	Error control optional (either LAPM or alternative acceptable). If error control is not established, maintain the DTE-DCE data rate and use the V.14 buffered mode with flow control during non-error control operation.
n = 1	Error control optional (either LAPM or alternative acceptable). If error control is not established, change the DTE-DCE data rate to match the line rate and use direct mode.
n = 2	Error control required (either LAPM or alternative acceptable). If error control is not established, disconnect.
n = 3	Error control required (only LAPM acceptable). If error control is not established, disconnect.
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>: 0–6, 8

Default: 2

n = 0	Direct mode.
n = 1	Error control disabled, use buffered mode.

7-1 V.80 Videoconferencing Mode Summary (cont.)

Command	Default	Description
+ES=m	**see 'm'**	**<ans_fbk>**: (cont.) n = 2* Error control optional (either LAPM or alternative acceptable). If error control is not established, maintain the DTE-DCE data rate and use local buffering and flow control during non-error control operation. n = 3 Error control is optional (either LAPM or alternative acceptable). If error control is not established, change the DTE-DCE data rate to match the line rate and use the direct mode. n = 4 Error control is required (either LAPM or alternative is acceptable). If error control is not established, disconnect. n = 5 Error control required (only LAPM 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.
+ESA=m	**see 'm'**	**Synchronous Access Mode Configuration**: Once the modem has been placed in synchronous access mode using the **+ES** command, the +ESA command specifies how the 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>** Defaults: 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. **<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).

7-1 V.80 Videoconferencing Mode Summary (cont.)

Command	Default	Description
+ESA=m	**see 'm'**	**<framed_un_ov>**: (cont.) Range <framed_un_ov>: 0, 1 Default: 0 n = 0* In framed submode, the DCE transmits 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 an underrun or 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 and 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.
+ITF=m	**see 'm'**	**Transmit Flow Control Thresholds**: These commands allows the DTE to determine the input buffer size in the DCE for data on circuit 103 from the DTE, to control the thresholds used for flow control of such data, and to control how often the DCE reports to the DTE the number of octets in this buffer. The DTE can adjust its own thresholds for flow control of data on circuit 104 from the DCE. The <off_value>, <on_value>, and <report_period> are applicable in Synchronous access mode. The test and read forms of this command are supported. Periodic reporting of the status of the transmit buffer is not supported.

7-1 V.80 Videoconferencing Mode Summary (cont.)

Command	Default	Description
+ITF=m	**see 'm'**	**Transmit Flow Control Thresholds**: (cont.) **m = <off_value>, <on_value>, <report_period>** Defaults: 320, 192, 0 **<off_value>** Determines the threshold (in octets) above which the DCE generates a flow off signal. **<on_value>** Determines the threshold (in octets) below which the DCE generates a flow on signal. **<report_period>** Not supported.

7.6 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.

7.6.1 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 7-3 on page 103. 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 (see the checkmarks in the framed and transparent submode columns in Table 7-3).

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 7-4 on page 104. These values apply for parameters **<tx>**and **<rx>**.

Table 7-3. 8-Bit In-Band Commands

Framed Sub-mode	Trans-parent Sub-mode	Command/ Indication Pair Symbol	Hex Code (h)	Circuit 103 Description	Circuit 104 Description
				Character Transparency	**Character Transparency**
✔	✔	<EM><t1>	5C	Transmit one 19h pattern	Receive one 19h pattern
✔	✔	<EM><t2>	76	Transmit one 99h pattern	Receive one 99h pattern
✔	✔	<EM><t3>	A0	Transmit DC1	Receive DC1
✔	✔	<EM><t4>	A1	Transmit DC3	Receive DC3
✔	✔	<EM><t5>	5D	Transmit two 19h patterns	Receive two 19h patterns
✔	✔	<EM><t6>	77	Transmit two 99h patterns	Receive two 99h patterns
✔	✔	<EM><t7>	A2	Transmit two DC1 patterns	Receive two DC1 patterns
✔	✔	<EM><t8>	A3	Transmit two DC3 patterns	Receive two DC3 patterns
✔	✔	<EM><t9>	A4	Transmit 19h, 99h	Receive 19h, 99h
✔	✔	<EM><t10>	A5	Transmit 19h, DC1	Receive 19h, DC1
✔	✔	<EM><t11>	A6	Transmit 19h, DC3	Receive 19h, DC3
✔	✔	<EM><t12>	A7	Transmit 99h, 19h	Receive 99h, 19h
✔	✔	<EM><t13>	A8	Transmit 99h, DC1	Receive 99h, DC1
✔	✔	<EM><t14>	A9	Transmit 99h, DC3	Receive 99h, DC3
✔	✔	<EM><t15>	AA	Transmit DC1, 19h	Receive DC1, 19h
✔	✔	<EM><t16>	AB	Transmit DC1, 99h	Receive DC1, 99h
✔	✔	<EM><t17>	AC	Transmit DC1, DC3	Receive DC1, DC3
✔	✔	<EM><t18>	AD	Transmit DC3, 19h	Receive DC3, 19h
✔	✔	<EM><t19>	AE	Transmit DC3, 99h	Receive DC3, 99h
✔	✔	<EM><t20>	AF	Transmit DC3, DC1	Receive DC3, DC1
✔ (receive only)	✔	<EM><mark>	B0	Begin transparent submode	HDLC abort detected in framed submode
✔		<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.
✔		<EM><err>	B2	Transmit abort	Non-flag–to–flag transition detected. The preceding data was not a valid frame
✔	✔	<EM><under>	B4	Not applicable	Transmit data under-run
✔	✔	<EM><tover>	B5	Not applicable	Transmit data overrun

Table 7-3. 8-Bit In-Band Commands (cont.)

Framed Sub-mode	Trans-parent Sub-mode	Command/ Indication Pair Symbol	Hex Code (h)	Circuit 103 Description	Circuit 104 Description
✔	✔	<EM><rover>	B6	Not applicable	Receive data over-run
✔		<EM><resume>	B7	Resume after transmit under-run	Not applicable
✔	✔	<EM><bnum>	B8	Not applicable	The following octets, <octnum0><octnum1>, specify the number of octets in the transmit data buffer. The following octets, <octnum0><octnum1>, specifies the number of discarded octets.
✔		<EM><unum>	B9	Not applicable	The following octets, <octnum0><octnum1>, specify the number of discarded octets.
				Duplex Carrier Control	**Duplex Carrier Status**
✔	✔	<EM><eot>	BA	Terminate carrier, return to command state	Loss of carrier detected, return to command state
✔	✔	<EM><ecs>	BB	Go to online command state	Not applicable
✔	✔	<EM><rm>	BC	Request rate renegotiation (duplex)	Indicate rate renegotiation (duplex)
✔	✔	<EM><rtn>	BD	Request rate retrain (duplex)	Indicate rate retrain (duplex)
		<EM><rate>	BE	Following octets, <tx><rx>, set maximum transmit and receive rates	Retrain/renegotiate completed; following octets, <tx><rx>, indicate transmit and receive rates

Table 7-4. 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

Table 7-4. Command/Indication Bit Rates (cont.)

Symbol	Hex Code (h)	Duplex or Primary Channel Data Signaling Rate (bps)
<p336>	2F	33,600

8. RADISH® VOICEVIEW™

The 56K FastPath family offers an optional upgrade for Radish VoiceView. VoiceView allows the modem to switch back and forth between data and voice modes or voice conversations during the same telephone-line connection. This may be useful for calling remote stations. The remote modem sends a screen of data to the local modem, where it is displayed on the monitor. The remote unit simultaneously plays a voice message explaining the data on the monitor. Activate VoiceView by sending **AT+FCLASS=80** to the modem. The optional VoiceView commands and responses are listed in the following tables.

VoiceView™ Commands

Command	Default	Function
+FCLASS=8	0	Mode selection
+FLO=n	1	Flow control select
+FPR	4	Select DTE/DCE Interface Rate —turn on/off autobaud
-SAC	–	Accept data mode request
-SCD	–	Capabilities data
-SDA	–	Start modem data mode
-SDS	–	Disable switchhook status monitoring (required if DCE implements switchhook status monitoring and is used with a handset adapter)
-SER?	–	Error status (read only)
-SFX	–	Start fax data mode
-SIC	–	Reset capabilities to default setting
-SIP	–	Initialize VoiceView parameters
-SQR	–	Capabilities query response control
-SSP	–	VoiceView transmission speed
-SSQ	–	Start capabilities query
-SSR	–	Start sequence response control
-SVV	–	Start VoiceView data mode
+VGM=n	128	Speakerphone microphone gain
+VGS=n	128	Speakerphone speaker gain
+VLS=n	0	Analog source/destination selection
+VSP=n	0	Speakerphone on/off control

VoiceView ™ Response Codes

Response	Function
-SFA	Fax data mode start sequence event (mandatory only if fax data mode is supported)
-SMD	Modem data mode start sequence event (mandatory only if modem data mode is supported)
-SRA	Receive ADSI response event
-SRC:	Receive capabilities information event
-SRQ	Receive capabilities query event
-SSV	VoiceView data mode start sequence event
-STO	Talk-off event

VoiceView ™ <DLE> Character Pairs

Command	Function
<CAN>	Abort data transfer in progress
<EOT>	End of message marker, final message of transaction, no response accepted (ASCII 10h 04h)
<ESC>	End of message marker; the DCE immediately returns to voice mode (ASCII 10h 1Bh)
<ETB>	End of message marker, final response requested, after which the transaction terminates (ASCII 10h 17h)
<ETX>	End of message marker, continue transaction, response requested (ASCII 10h 03h)

9. 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 may cause the modem to act improperly (that is, even though the contents of a read-only S-register may 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 should never be written to, as they cause the modem to lock up. A list of the supported S-registers follows.

NOTE: S-registers **S91** and **S92** are included in the manufacturing-only commands, Section 10 on page 118.

S-Registers

Command	Function	Default	Type	Reported by &Vn	Page
S0 *	Number of rings to auto-answer on	0	R/W	yes	109
S1	Ring count	0	R/W	yes	109
S2 *	Escape character	43	R/W	yes	109
S3	Carriage return character	13	R/W	yes	109
S4	Line feed character	10	R/W	yes	109
S5	Backspace character	8	R/W	yes	109
S6 *	Wait before dialing	2	R/W	yes	110
S7 *	Wait for carrier	60	R/W	yes	110
S8 *	Pause time for dial modifier	2	R/W	yes	110
S9 *	Carrier recovery time	6	R/W	yes	110
S10 *	Lost carrier hang up delay	14	R/W	yes	110
S11 *	DTMF dialing speed	95	R/W	yes	111
S12 *	Guard time	50	R/W	yes	111
S14 *	Bit-mapped options	none	R	no	111
S16	Modem test options	none	R	no	112
S18 *	Modem test timer	0	R/W	yes	112
S21 *	Bit-mapped options	none	R	no	113
S22 *	Bit-mapped options	none	R	no	113
S23 *	Bit-mapped options	none	R	no	114
S25 *	Detect DTR change	5	R/W	yes	114
S27 *	Bit-mapped options	none	R	yes	114
S30 *	Disconnect Inactivity timer	0	R/W	no	115
S31 *	Bit-mapped options	none	R	no	115
S32 *	x2 mode enable	32	R/W	yes	115
S33 *	Sleep mode timer	10	R/W	yes	116
S37 *	Maximum line speed attempted	0	R/W	yes	116

(*) Value Saved in NVRAM
(R) Read-only register
(R/W) Read/write register

Table 9-1. S-Register Summary

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 **NOTES:** 1) n = 1-255 Auto-answer mode enabled 2) If Caller ID is enabled (**+VCID=n**), then the modem only answers after the second ring even if S0=1. 3) 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**: S2 specifies an ASCII value for the Hayes or TIES escape character. The factory default is '+' or ASCII decimal 43. The escape character may range between 0–127. Any value over 127 disables the escape sequence. Range: 0–127 Default: 43 ('+')
S3	**13**	**Carriage Return Character**: S3 specifies the AT command string terminator and modem response code terminator. The factory default is a <CR> or carriage return (ASCII decimal 13). Range: 0–127 Default: 13 (carriage return)
S4	**10**	**Line Feed Character**: S4 specifies the line feed character, which is used for verbose (text) modem result codes. Range: 0-127 Default: 10 (line feed)
S5	**8**	**Backspace Character**: S5 specifies the backspace character that is used to delete the last-entered character. After receiving a backspace character, the modem sends three characters to the DTE: a backspace character, a space character, and then another backspace character. Range: 0–32, 127 Default: 8 (BS)

9-1 S-Register Summary (cont.)

Command	Default	Description
S6	**2**	**Wait Before Blind Dialing**: S6 specifies the amount of time that must elapse after the modem goes off-hook before the modem starts dialing the first telephone number. The modem waits for at least 2 seconds before dialing the first number, even if S6 is set for a value less than 2. S6 is only used for result code type commands X0, X1, and X3 (that is, blind-dialing types of result codes). The 'W' (wait for dial tone) dial modifier causes the modem to ignore the contents of S6. Result code types X2 and X4 enable dial-tone detection and ignore the contents of **S6.** Range: 2–255 seconds Default: 2 seconds
S7	**60**	**Wait for Carrier/Dial Tone**: S7 specifies the length of time that the modem waits to detect the remote modem carrier after dialing the telephone number. If the remote modem carrier is not detected within the S7 time limit, the modem hangs up and sends a 'NO CARRIER' response code to the DTE. If the remote modem carrier is detected, the modem goes into online data mode and sends a 'CONNECT' message to the DTE. S7 also specifies the time duration for the 'W' (wait for dial tone) dial modifier. Range: 1–255 seconds Default: 60 seconds
S8	**2**	**Pause Time for Dial Modifier**: S8 specifies the length of time that the modem pauses during the dialing process each time the ',' dial modifier is detected in the dialing string. Range: 0–255 seconds Default: 2 seconds
S9	**6**	**Carrier Detect Recovery Time**: S9 specifies how long the remote modem carrier must be present on the telephone line before the modem detects it and turns on DCD. The greater the time duration, the less likely that a false carrier detection occurs due to noise on the telephone line. Range: 1–255 (1/10 of a second) Default: 6 (equals 0.6 seconds)
S10	**14**	**Lost Carrier Hang Up Delay**: 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. When set to 255, the modem does not disconnect upon loss of the remote modem carrier. Range: 1–255 (1/10 of a second) Default: 14 (equals 1.4 seconds)

9-1 S-Register Summary (cont.)

Command	Default	Description
S11	**70**	**DTMF Dialing Speed**: S11 specifies the duration of dual-tone multi-frequency (DTMF) dialing. This register is not used for pulse dialing. Range: 50-255 ms Default: 70 ms
S12	**50**	**Guard Time**: S12 is used to specify 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)
S13	**none**	**Reserved**
S14	**170**	**Bit-Mapped Options**: S14 is a read-only register that indicates 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
S15	**none**	**Reserved**

9-1 S-Register Summary (cont.)

Command	Default	Description		
S16	**0**	**Modem Test Options**: S16 indicates the test in progress.		
		Bit 0	0*	Local analog loopback disabled
			1	Local analog loopback enabled (**&T1**)
		Bit 1	0	Reserved
		Bit 2	0*	Local digital loopback disabled
			1	Local digital loopback enabled (**&T3**)
		Bit 3	0*	Remote digital loopback off
			1	Remote digital loopback in progress (**&T6**)
		Bit 4	0*	RDL not active
			1	RDL request from distant end is in service
		Bit 5	0*	Remote digital loopback with self-test disabled
			1	Remote digital loopback with self-test enabled (**&T7**)
		Bit 6	0*	Analog loopback with self-test disabled
			1	Analog loopback with self-test enabled (**&T8**)
		Bit 7	0	Reserved
S17	**none**	**Reserved**		
S18	**0**	**Modem Test Timer**: S18 specifies the length of time that the modem conducts one of the data mode (except x2 connection) loopback tests (**&Tn**). 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	
S19-S20	**none**	**Reserved**		

9-1 S-Register Summary (cont.)

Command	Default			Description
S21	**48**	**Bit-Mapped Options**: S21 is a read-only register that indicates AT command settings.		
		Bit 0	0*	**&J0** is selected
			1	**&J1** is selected
		Bit 1		Reserved
		Bit 2	0	**&R0** is selected
			1	**&R1** is selected
		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**: S22 is a read-only register that indicates 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

9-1 S-Register Summary (cont.)

Command	Default	Description		
S23	**none**	**Bit-Mapped Options**: S23 is a read-only register that indicates AT command settings.		
		Bit 0	0	**&T5** is selected
			1*	**&T4** is selected
		Bits 3-1	000	0-300 bps communications rate
			001	1200 bps
			010	2400 bps
			011	4800 bps
			100	7200 bps
			101	9600 bps
			110	19,200 bps
			111	≥38.4 bps
		Bit 5,4	00*	Even parity
			01	Space parity/no parity
			10	Odd parity
			11	Mark
		Bit 7,6	00	**&G0** is selected
			01	**&G1** is selected
			10	**&G2** is selected
			11	Reserved
S25	**5**	**Detect DTR Change**: S25 defines the minimum amount of time that DTR has to remain off (that is, on-to-off-to-on transitions) before the modem performs the function specified by **&Dn** command. A change in DTR that persists for a shorter time than the value specified in S25 is ignored by the modem (see the **&Dn** command).		
		Range:	0–255 (1/100 of a second)	
S27	**64**	**Bit-Mapped Options**: S27 is a read-only register that indicates AT command settings.		
		Bits 3,1,0	000*	**&Q0** is selected
			001	reserved
			010	reserved
			011	reserved
			100	reserved
			101	not used
			110	not used
			111	not used
		Bits 2, 4, 5		Reserved
		Bits 7,6	00	**B0** is selected
			01*	**B1** is selected
			10	**B2** is selected
			11	**B3** is selected

9-1 S-Register Summary (cont.)

Command	Default	Description
S30	**0**	**Disconnect Inactivity Timer:** This S-register sets the length of time (in minutes) that the modem stays online/off-hook before disconnecting when no data is being transmitted or received. In data and fax modes, any data transmitted or received between the DTE-DCE interface resets the timer. In all other modes (except Telephone-Emulation mode), any data transmitted resets the timer. In Telephone-Emulation mode, **S30** is ignored (that is, the modem does **not** automatically hang up the line after a given time delay). Range: n = 0–255 minutes; n = 0 Disabled
S31	**none**	**Bit-Mapped Options**: S31 is a read-only register that indicates AT command settings. Bit 0 — 0: **N0** is selected; 1*: **N1** is selected 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
S32	**32**	**x2 Mode Enable:** Bit 5 of the S32 register enables the x2 mode. When x2 is disables, the modem defaults to V.34 mode. See the **+MS=m** command on Bit 0: Reserved Bit 1: Reserved Bit 2: Reserved Bit 3: Reserved Bit 4: Reserved Bit 5 — 0: V.34 mode is enabled; 1*: x2 mode is enabled Bit 6, 7: Reserved

9-1 S-Register Summary (cont.)

Command	Default	Description
S33	**10**	**Sleep Mode Timer:** S33 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 a user-programmable time delay (S33). The modem is considered to be in an inactive state when: 1) No internal processing is being performed; 2) No activity occurs between the host and the modem within a specified time period; 3) 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
S37	**0**	**Maximum Line Speed Attempted:** This S-register selects the maximum line speed allowable (that is, the modem attempts to connect at this speed or falls back to a lower speed). Settings for Bn, +MS=m, Nn, and S37 determine the allowable modem connections. S37 provides the same information as the +MS=m **<max rate>** parameter. Changing the +MS=m **<max rate>** parameter automatically changes the value of S37. For example, setting +MS=m **<max rate>** to 0 sets S37 to 0. Note that S37 has no effect during V.32 bis retraining/rate negotiation (see Section 3.8 on page 31 for more details). n = 0–35 n = 0 DTE rate n = 1 Reserved n = 2 Reserved n = 3 300 n = 4 Reserved n = 5 1200 n = 6 2400 n = 7 4800 n = 8 7200 n = 9 9600 n = 10 12,200 n = 11 14,400 n = 12 16,800 n = 13 19,200 n = 14 21,600 n = 15 24,000 n = 16 26,400

9-1 S-Register Summary (cont.)

Command	Default	Description	
S37	**0**	**Maximum Line Speed Attempted:** (cont.)	
		n = 17	28,800
		n = 18	31,200 (reserved for future products)
		n = 19	33,600 (reserved for future products)
		n = 20	36,000
		n = 21	33,333
		n = 22	37,333
		n = 23	41,333
		n = 24	42,666
		n = 25	44,000
		n = 26	45,333
		n = 27	46,666
		n = 28	48,000
		n = 29	49,333
		n = 30	50,666
		n = 31	52,000
		n = 32	53,333
		n = 33	54,666†
		n = 34	56,000†
		n = 35	57,333†

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

10. MANUFACTURING-ONLY COMMANDS

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

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

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

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

Manufacturing-Only Commands †

Command	Function	Default	Range
%L	Receive line signal level	none	–
*NCnn *	Country Select	0	–
!P=m	Set plug-and-play board serial number	none	0–255, 0–255, 0–255, 0–255
S91 *	Select transmit level	10	0–15
S92 *	DTMF transmit level	10	0–15
-Tn	Generate continuous DTMF tones	7	6, 7
#VGP0=n	Read/write to general-purpose pins 0–7	See note	–
#VGP1=n	Read/write to general-purpose pins 8–15	See note	–
#VGP2=n	Read/write to general-purpose pins 16–23	See note	–

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

* Value saved in NVRAM.

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

Table 10-1. Manufacturing-Only Commands

Command	Default	Description
%L	**none**	**Received Line Signal Level**: This command reports (in decibels) the received signal level. Use this command during an established connection by issuing the escape sequence followed by the **%L** command. Then return to the data mode with the **On** or **\On** command.
***NCnn**	**0**	**Country Select**: This command checks whether an entered country code matches one of the codes stored in EPROM. If so, the entered code is stored in NVRAM. This code is loaded from NVRAM upon power-up or soft reset. The default value is used if no NVRAM is installed or if the NVRAM failed the self-test during reset.

10-1 Manufacturing-Only Commands (cont.)

Command	Default	Description
***NCnn**	**0**	**Country Select**: (cont.) In the case of virgin NVRAM, the country code is not initialized, and the country code 0 will be loaded as a default. This may cause an anomaly such as dial tone detection when the modem operates in the other country. The **AT*NCn;&W** (n=0 to 6) command is required to avoid this anomaly from power-up. The command **AT&F** and **ATZ** do not change the country code after the country is selected by the **AT*NCN;&W** command. The command **ATI6** shows the specific country that modem operates. The command **AT*NCn** followed by **AT&W** has the same effect as the **AT*NCn;&W** command.
!P=m	**none**	**Set Plug-and-Play Board Serial Number**: This command sets the serial number for the plug-and-play board using four fields (or bytes) of eight bits each. **m = Byte 3, Byte 2, Byte 1, Byte 0** Byte = 0–255 m = (0–255), (0–255), (0–255), (0–255) For example: `!P = 250, 0, 125, 1`
S91	**10**	**Data Transmit Level**: This S-register sets the modem's transmit level for the data mode. This value is stored in the NVRAM but is not displayed by the **&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 allowed to change the transmit level. In these countries, the country PTT checks to make sure that the end user can not change the transmit level. Range: 0 to -15 dBm Default: 10* (-10 dBm)
S92	**10**	**Fax Transmit Level**: This S-register sets the modem's transmit level for the fax mode. This value is stored in the NVRAM but is not displayed by the **&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 allowed to change the transmit level. In these countries, the country PTT checks to make sure that the end user can not change the transmit level. Range: 0 to -15 dBm Default: 10* (-10 dBm)

10-1 Manufacturing-Only Commands (cont.)

Command	Default	Description
-Tn	**7**	**Continuous DTMF Tone Generation:** This command allows the DCE to send continuous DTMF tones to the Tip and Ring for testing purposes. Range: n = 6, 7 n = 6 Enable continuous DTMF tone n = 7* Disable continuous DTMF tone
#VGP0=n **#VGP1=n** **#VGP2=n**	**See note 1**	**Read/Write General-Purpose Pins**: These commands allow the DTE to set the modem signal level at the general-purpose input-output pins (GPIO0-GPIO23) to V_{CC} or ground. The **AT#VGP0–2?** commands allow the DTE to read the signals applied at these pins.

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

1) Default values for #VGP0–#VGP2 are dependent on board design.

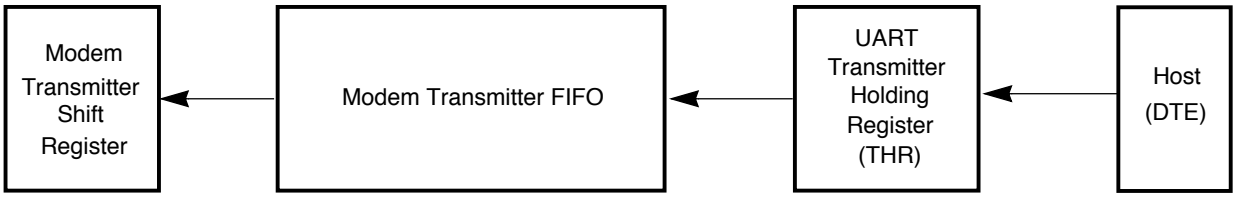
2) These commands should not be used in general-purpose application software.

Notes

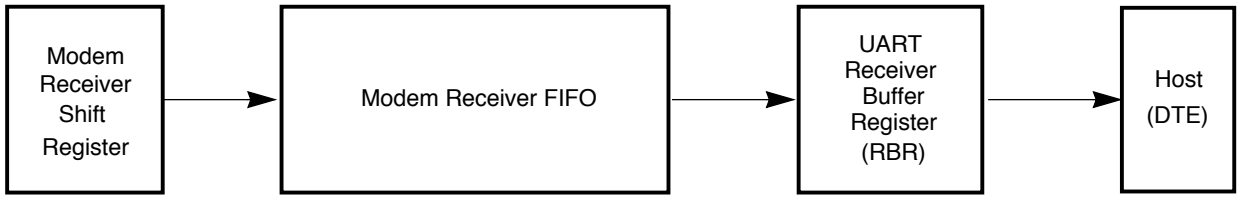
11. PARALLEL HOST INTERFACE 16C450/16C550A UART

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

In 16C450 emulation mode, the DTE and modem transfer data back and forth a byte at a time. In 16C550A emulation mode, the modem provides two 16-byte FIFO buffers, one for the transmitter and another for the receiver. Thus, up to 16 bytes of data may be sent to or received from the modem for each data interrupt, instead of only a single byte, as in 16C450 mode. The following diagram shows how the FIFO is used. Host software using this FIFO capability can significantly reduce system overhead by reducing the number of times that interrupt service routines are called.



UART Transmitter Flow Diagram



UART Receiver Flow Diagram

Figure 11-1. FIFO Buffers for Transmitter and Receiver

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

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

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

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

Table 11-1. Parallel Host Interface UART Register Bit Assignments

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

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

11.1 UART Register Definitions

11.1.1 Scratch Register (SCR)

Register 7	SCR

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

11.1.2 Modem Status Register (MSR)

Register 6	DCD	RI	DSR	CTS	DDCDD	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 (IER3), the modem generates an interrupt on the DSμP HINT pin whenever MSR bits 3:0 are set to '1'.

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

11.1.3 Line Status Register (LSR)

Register 5	RCVR Err	TEMT	THRE	BI	FE	PE	OE	DR

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

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

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

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

11.1.4 Modem Control Register (MCR)

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

This register controls the DTE-DCE UART interface.

Bit 7:5	**Not used**–These bits are permanently set to '0'.
Bit 4	**Loop Bit**–When set to '1', this bit configures the UART for loopback diagnostic testing. In diagnostic mode, any data that is written to the THR (Transmit Holding register) is looped back to the RBR (Receiver Buffer register). After writing a data byte to the THR register in loopback mode, the DTE must read the RBR register before writing a new data byte to the THR. Unlike a real 16C450 UART, the modem signals OUT1*, OUT2*, RTS*, and DTR* are not looped back to the MSR register.

Bit 3	**Out 2**–This bit, when set to '1' by the DTE, enables the HINT output pin. When set to '0', this bit causes the HINT pin to be in a high-impedance state.
Bit 2	**Out 1**–This read/write bit is not used for any specific functions.
Bit 1	**RTS (Request to Send)**–This bit when set to '1', indicates that the DTE is ready to send data to the modem.
Bit 0	**DTR (Data Terminal Ready)**–When set to '1', this bit indicates that the DTE is read to establish a communication link.

11.1.5 Line Control Register (LCR)

Register 3	DLAB	SBRK	SPAR	EPS	PEN	STB	WLS1	WLS0

This register specifies the asynchronous data communication exchange format. The modem supports up to 10-bit data characters (1 start bit + # of data character bits + parity + # of stop bits).

Bit 7	**Divisor Latch Access Bit (DLAB)** – This bit must be set to '1' to access the divisor latches of the baud rate generator during a read or write operation. The UART registers 1 and 0 are used for the divisor latches. This bit must be set to '0' to access the Receiver Buffer register (RBR), the THR (Transmitter Holding register) or the IER (Interrupt Enable register).
Bit 6	**SBRK (Set Break)**–This bit is used to send a long-space disconnect message to the remote modem. The procedure is as follows: 1)After the THRE bit has been set to '1' by the DCE and before setting the SBRK bit, the DTE needs to write a NULL ($00h) character to the THR. 2)The DTE then sets the SBRK bit after the next time the THRE bit is set by the DCE (a long space is now being transmitted). 3)To return to normal transmission mode, wait for the TEMT to be equal to '1', then reset the SBRK bit.
Bit 5	**SPAR (Stick Parity)**–When this bit is set to '1', stick parity is enabled. When configured for stick parity (SPAR = 1), even parity (EPS = 1) with parity enable (PEN = 1), then the parity bit is transmitted and checked as a logic '0'. When configured for stick parity (SPAR = 1), odd parity (EPS = 0) and parity enable (PEN = 1) are set to '1', then the parity bit is transmitted and checked as a logic '1'.
Bit 4	**EPS (Even Parity Select)**–When even parity select (LCR4) and parity enable (LCR3) are set to '1', an even number of logic 1's are transmitted or checked. When even parity select (LCR4) is a '0' and parity enable (LCR3) is a '1', an odd number of logic 1's are transmitted or checked.
Bit 3	**PEN (Parity Enable)**–When this bit is set to '1', a parity bit is generated (transmitted data) or checked (receive data) between the last data character word bit and stop bit of the serial data. **NOTE**: The parity bit is used to produce an even or odd number of 1's when the data word bits and the parity bits are summed.
Bit 2	**Number of Stop Bits (STB)** – This bit specifies the number of stop bits transmitted and received in each serial character. When STB is set to '0', one stop bit is generated for each transmitted data character. When STB is set to '1' and the word length (WLS1 and WLS0) is equal to 6, 7, or 8 bits, then two stop bits are generated for each transmitted data character. When STB is set to '1' and the word length (WLS1 and WLS0) is equal to 5 bits, then one and a half stop bits are generated for each transmitted data character. The receiver only checks for the first stop bit, regardless of the number of stops bits transmitted.
Bits 1:0	**Word Length Select Bits (WLS1 and WLS0)** – These two bits specify the data character word length of the transmitted and received data. The supported word lengths are provided below. **Bit 1** / **Bit 0** / **Word Length** 0 / 0 / 5 bits 0 / 1 / 6 bits 1 / 0 / 7 bits 1 / 1 / 8 bits

11.1.6 FIFO Control Register (FCR)

Register 2 (write-only)	RCVR Trig.	RCVR Trig.	Reserved	Reserved	DMA	XFIFOR	RFIFOR	FIFOE

This write-only register is used to enable the receiver and transmitter FIFOs, clear the FIFOs, set the RCVR FIFO trigger level, and select the DMA signaling type.

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

11.1.7 Interrupt Identity Register (IIR)

Register 2 (read-only)	FIFO EN	FIFO EN	0	VDMA	Int. ID 2	Int. ID 1	Int. ID 0	Int. Pen.

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

Table 11-2. Interrupt Control Functions

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

Bits 7:6	**FIFOs Enable Bits**–These two bits are set whenever FCR0 = 1.
Bits 5	**Not used**–This bit is permanently set to ‘0’.
Bit 4	**Reserved**
Bit 3	**Interrupt ID Bit 2**–In 16C450 mode, this bit is always a ‘0’. In FIFO mode, both this bit and bit IIR2 are set whenever a time-out interrupt is pending.
Bits 2:1	**Interrupt ID Bits ID0 and ID1**–These two bits are used to identify the highest-priority interrupt as shown in Table 11-2.
Bit 0	**Interrupt Pending**–This bit indicates when a modem interrupt is pending. Whenever this bit is equal to ‘0’, then one or more interrupts are pending. Whenever this bit is equal to ‘1’, then no interrupts are pending. When an interrupt has occurred, the host can determine the cause of the interrupt by looking at the IIR interrupt ID bits 0 and 1 (and interrupt ID bit 2 for FIFO mode).

11.1.8 Interrupt Enable Register (IER)

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

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

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

11.1.9 Transmitter Holding Register (THR)

Register 0 (DLAB = 0)	THR

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

11.1.10Receiver Buffer Register (RBR)

Register 0 (DLAB = 0)	RBR

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

11.1.11Divisor Latch Registers (DLM and DLL)

Register 1 (DLAB = 1)	DLM (MS)
Register 0 (DLAB = 1)	DLL (LS)

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

Table 11-3. 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

11.2 16C550A UART FIFO Operation

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

11.2.1 FIFO Interrupt Mode Operation

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

1) When both the receiver FIFO and the receiver interrupts are enabled (FCR0 = 1, IER0 = 1), the UART initiates RCVR interrupts under the following conditions:

a) The receive data available interrupt (IIR = 04) is issued to the DTE when the FIFO has reached its programmed trigger level; the interrupt clears as soon as the FIFO drops below the programmed trigger level

b) The data ready bit, DR (LSR0), is set as soon as a character is transferred from the Internal Shift register to the RCVR FIFO. DR is reset when the FIFO is empty.

2) When the RCVR FIFO and receiver interrupts are enabled, the UART initiates a RCVR FIFO time-out interrupt under the following conditions:

a) A RCVR FIFO time-out occurs when:

— At least one character is in the FIFO.

— The most recent serial character received was longer than four continuous character times ago.

— The most recent DTE read of the FIFO was longer than four continuous character times ago.

b) When a time-out interrupt has occurred, then it is cleared and the timer is reset when the DTE reads one character from the RCVR FIFO.

c) The time-out timer is reset after a new character is received or after the DTE reads the RCVR FIFO.

3) When the transmitter FIFO and the transmitter interrupt are enabled (FCR0 = 1, IER1 = 1), the UART initiates XMIT interrupts under the following conditions:

a) The Transmitter Holding register interrupt (IIR = 02) occurs when the XMIT FIFO is empty; it is cleared as soon as the transmitter holding register is written to or the IIR is read. During servicing, the 1–16 character interrupt can be written to the XMIT FIFO.

11.2.2 FIFO Polled Mode Operation

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

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

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

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

12. CALLER ID

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

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

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

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

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

Table 1. Caller ID Tags for Formatted Reporting

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

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

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

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

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

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

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

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

```
RING
MESG = 0412303332313133430353931343535313233343 5
RING
RING
```

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X

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