AT Command Set and Register Summary for Silicon Labs Si2493 Modems on the Cisco 1800 Series Integrated Service Routers

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This document describes how to control modem function with AT commands and register settings on Silicon Labs Si2493 modems that run on Cisco 1800 Series Integrated Services Routers.

To use this document, you should be familiar with digital modem theory and the use of modemcaps to change the configuration of a digital modem. For more information on digital modems and modemcaps, refer to the following documents:

- *Modem Management Commands*
  http://www.cisco.com/en/US/products/ps6350/products_configuration_guide_chapter09186a00800ca6e4.html
- *Modem-Router Connection Guide*
  http://www.cisco.com/warp/public/76/9.html

For information about managing modems on Cisco access gateways using Cisco IOS software commands, refer to the software configuration guide for the access server in which the modems are installed.

Note The defaults and limits on parameters described in this document are valid for the United States. They may not be appropriate for use in other countries.

This document contains the following sections:

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Silicon Labs Si2493 Modem

The Silicon Laboratories, Inc. Si2493 modem chipset consists of a 24-pin TSSOP low-voltage modem device and a 16-pin SOIC line-side Device Access Architecture (DAA) device that connects directly with the telephone local loop (TIP and RING). This modem solution is a complete controller-based hardware modem that connects to a host processor through a serial or parallel interface. Isolation is provided by Silicon Laboratories' isolation capacitor technology, which uses high-voltage capacitors instead of a transformer. This isolation technology complies with global telecommunications standards including FCC, CTR21, JATE, and all known country-specific requirements. Country, EMI/EMC, and safety test reports are available.

All required program and data memory is included in the modem device. When the modem receives a software or hardware reset, all register settings revert to the default values stored in the on-chip program memory. The host processor interacts with the modem controller through AT commands used to change register settings and control modem operation. Changing register settings and controlling the modem is described in the Software Design Reference.

Check with your Silicon Laboratories salesperson or distributor for more details and go to the following links:

- http://www.silabs.com/tgwWebApp/public/index.htm
- http://magno.cisco.com/modems/docs/si2493-designers-guide.pdf

The following sections describe the Silicon Labs Si2493 modem specifications:

Modulations and Protocols

Table 1and Table 2 list available Si2493 modem modulations and protocols.

Table 1 Modulations and Protocols for the Si2493 Modem

Specification	Data Rate (bps)	Modulation
V.92	48k, 40k, 32k, 24k PCM	PCM
V.90	56k, 54.6k, 53.3k, 52k, 50.6k, 49.3k, 48k, 46.6k, 45.3k, 44k, 42.6k, 41.3k, 40k, 38.6k, 37.3k, 36k, 34.6k, 33.3k, 32k, 30.6k, 29.3k, 28k	PCM
V.34	33.6k, 31.2k, 28.8k, 26.4k, 24k, 21.6k, 19.2k, 16.8k, 14.4k, 12k, 9600, 7200, 4800, 2400	TCM

Table 1 Modulations and Protocols for the Si2493 Modem (continued)

Specification	Data Rate (bps)	Modulation
V.92	48k, 40k, 32k, 24k PCM	PCM
V.32bis	14.4k, 12k, 9600, 7200, 4800	TCM
V.32	9600, 9600, 4800	TCM, QAM
V.29FC	9600	QAM
V.23	1200	FSK
V.22bis	2400, 1200	QAM
V.22	1200	DPSK
Bell212A	1200	DPSK
V.21	300	FSK
Bell103	300	FSK

Table 2 V.44 Modulations and Protocols for the Si2493 Modem

Protocol	Function
V.44	Compression
V.44 and V.42bis	Compression
V.42	Error Correction
MNP5	Compression
MNP2-4	Error Correction

Note While the Si2493 modem allows any supported protocol with any modulation, modems from other manufacturers may not permit some combinations. This is particularly common with 300 bps modulations.

Carriers and Tones

Table 3 lists available carriers and tones for the Si2493 modem.

Table 3 Carriers and Tones

Specification	Transmit Carrier (Hz)	Receive Carrier (Hz)	Answer Tone (Hz)	Carrier Detect (Acquire/Release)
V.92	Variable	Variable	-	per ITU-T V.92
V.90	Variable	Variable	-	per ITU-T V.90
V.34	Variable	Variable	-	per ITU-T V.34
V.32bis	1800	1800	2100	per ITU-T V.32bis
V.32	1800	1800	2100	per ITU-T V.32
V.29	1700	1700	-	per ITU-T V.29
V.22bis, V.22 Originate Answer	1200, 2400	1200, 2400	2100	–43 dBm/–48 dBm –43 dBm/–48 dBm

Table 3 Carriers and Tones (continued)

Specification	Transmit Carrier (Hz)	Receive Carrier (Hz)	Answer Tone (Hz)	Carrier Detect (Acquire/Release)
V.92	Variable	Variable	-	per ITU-T V.92
V.21 Originate (M/S) Answer (M/S)	1200, 2400	1200, 2400	2100	–43 dBm/–48 dBm –43 dBm/–48 dBm
Bell212A Originate Answer	1200, 2400	1200, 2400	2225	–43 dBm/–48 dBm –43 dBm/–48 dBm
Bell103 Originate (M/S) Answer (M/S)	1270/1070 2225/2025	2225/2025 1270/1070	2225	–43 dBm/–48 dBm –43 dBm/–48 dBm

Enabling Error Correction and Data Compression

The following sections describe error correction and instructions for enabling error correction and data compression on the Silicon Labs Si2493 modem:

Error Correction

The Si2493 ISO modem can employ error correction (reliable) protocols to ensure error-free delivery of data that is sent between two modems. The error control methods are based on grouped data, which is contained in frames along with checksums that are determined by the contents of each frame. The receiving modem checks the frames and sends acknowledgments to the transmitting modem. When the transmitting modem detects a faulty frame, the receiving modem requests a re-transmission. Frame length varies according to the amount of data that is transmitted or the number of re-transmissions that are requested from the receiving modem.

The Si2493 modem supports V.42 and MNP2–4 error correction protocols. V.42 (LAPM) is the most commonly used protocol and is enabled in \N3 and \N4 modes. In the default mode (\N3), the Si2493 modem attempts to connect with V.42 error correction and V.44 and V.42bis data compression and falls back to either V.42 only, MNP 2–5, or no error correction (wire mode) if necessary. The modem hangs up if a V.42 connection cannot be established in \N4 mode. If the ISO modem hangs up in V.42 mode after all data is successfully sent, the result code is “OK.” If the modem hangs up before all data is successfully sent, the result code is “No Carrier.” If the modem connects without a protocol, “No Carrier” is always sent.

The V.42 specification allows an alternate error correction protocol, MNP2-4. This protocol is enabled in \N2 mode. While in this mode, the Si2493 modem hangs up if an MNP2, 3, or 4 connection cannot be established.

Enabling Error Correction and Data Compression

To enable error correction and data compression, use the AT commands in Table 4.

Table 4 Enabling Error Correction and Data Compression

Modem	AT Command
V.44[1] V.44 and V.42bis V.42 (LAPM) MNP5 MNP2–4 Wire	+DS44 (argument), \N3, and %C1 (default)
V.42 and V.42bis	\N4 and %C1
V.42 only	\N4 and %C0
MNP2-4 only	\N2 and %C0
MNP2-5 only	\N2 and %C1
No data compression and no error correction	\N0 and %C0

Note V.44 is available only on Si2493.

AT Command Set for Si2493 Modems

AT commands begin with the letters AT, end with a carriage return, and are case insensitive. However, case cannot be mixed in a single command. The only exception to this format is the A/ command. This command is neither preceded by AT nor followed by a carriage return but re-executes the previous command immediately when the "/" character is typed. Generally, AT commands can be divided into two groups, control commands and configuration commands. Control commands, such as ATD, cause the modem to perform an action (in this case, dialing). Configuration commands change modem characteristics until they are modified or reversed by a subsequent configuration command or the modem is reset.

For more information about how to use AT commands, see the *Entering AT Commands* section of the *AT Command Set and Register Summary for Cisco MICA Six-Port Modules* document on Cisco.com.

The following sections describe AT commands that are used with the Silicon Labs Si2493 modem:

AT Command Status

Table 5 contains the AT commands that are used for reading configuration status on the Silicon Labs Si2493 modem. Each command is followed by a carriage return.

Table 5 AT Command Status

Configuration Status	Command Action
ATY$	Displays status of a group of settings.
AT$	Basic AT command settings.
AT&$	AT& command settings.
AT%$	AT% command settings.
AT\$	AT\ command settings.
ATSn?	Displays contents of S-Register n.
ATS$	Displays contents of all S-Registers.
AT:Raa	Displays contents of U-Register aa.
AT:R	Displays the current contents of all U-Registers.
AT+VCID?	Displays caller ID setting.

AT Command Examples

The examples in Table 6 and Table 7 assume that the modem is reset to its default condition. Each command is followed by a carriage return.

Table 6 AT Command Examples

Command	Result	Comment
AT$	E = 001	Configuration status of basic AT commands.
	M = 000	
	Q = 000	
	V = 001	
	X = 004	
	Y = 000	
AT&$	&D = 001	Configuration of &AT commands.
	&G = 017	
	&H = 000	
	(Si2457)	
	&P = 000	
ATS2?	043	S-Register 2 value—Escape code character (+).
AT:R2C	00A0	Value stored in register U2C.

AT Commands on a Single Line

The modem has a 48-character buffer, which makes it possible to enter multiple AT commands on a single line. The multiple commands can be separated with spaces or linefeed characters to improve readability.

Neither the AT nor the space (or linefeed characters) are loaded into the buffer and are not included in the 48 characters. The command must end with a carriage return character to instruct the modem to process the command. The modem ignores command lines greater than 48 characters and reports "ERROR".

Table 7 shows examples of multiple AT commands on a single line.

Table 7 Multiple AT Commands on a Single Line

Command	Result
ATS0=4M1X1<CR>	The modem auto-answers on the fourth ring. The speaker is on during dial and handshake only. Blind dialing is enabled. Spaces do not matter.
AT S0=4 M1 X1 <CR>	
ATS0=4<CR>	
ATM1<CR>	
ATX1<CR>	

AT Commands and Result Codes

AT commands and result codes are listed in Tables 20– 24. The default settings are shown in bold type.

Table 8 Basic AT Command Set

Command	Action
$	Displays Basic AT command mode settings
A	Answers incoming call.
A/	Re-execute last command (executes immediately—not preceded by "AT" or followed by <CR>).
Dn	Dial. The dial command dials a phone number and may be followed by one or more dial command modifiers:

Table 8 Basic AT Command Set (continued)

Command	Action	
	Modifier	**Function**
	! or &	Flash hook-switch for U4F (FHT) ms (default: 500 ms)
	, or <	Pause before continuing for S8 seconds (default: 2 seconds)
	;	Return to AT command mode after verifying dialtone and dialing any digits.
	G	Telephone voting mode. This modifier, intended for use in Japan, enables a special dial-in voting mode that may be used with certain automated voting systems. When this modifier is placed anywhere in the dial string (for example, ATDG), the Si2493 dials the phone number and waits S7 seconds (60 by default) to detect a busy tone. When the busy tone is detected, the Si2493 reports whether a polarity reversal occurs between the time the last digit is dialed and the detection of the busy tone. If the S7 timeout occurs prior to a busy tone detect, "NO CARRIER" will be reported. Polarity reversal monitoring begins after the last digit is dialed and ends when a busy tone is detected or S7 times out. The Si2493 reports either "POLARITY REVERSAL" or NO POLARITY REVERSAL." It is not possible to establish a modem connection when using this command.
	L	Radial Last Number
	P	Pulse (rotary) dialing—pulse digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
	T	Tone (DTMF) dialing—DTMF digits: *, #, A, B, C, D, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
	W	Wait for dial tone before continuing for S14 seconds (default: 12 seconds). Blind dialing modes X0, X1, and X3 do not affect the W command. If the DOP bit (U7A, bit 7) is set, the "ATDTW" command causes the Si2457/34/15 to pause dialing and either report an "OK" if a dialtone is detected or "NO DIALTONE" if a dial tone is not detected.
En	Local DTE echo.	
E0	Disable.	
E1	Enable.	
Hn	Hook-switch.	
H0	Go on-hook (hang up modem).	
H1	Go off-hook.	
In	Identification and checksum.	
I0	Display Si2493 revision code. A = Revision A. B = Revision B, etc.	

Table 8 Basic AT Command Set (continued)

Command	Action	
I1	Display Si2493 firmware revision code (numeric).	
I3	Display line-side revision code. 18(10)C = Si3018/10 revision C.	
I6	Display the ISO modem model number. 2404 = Si2404 2415 = Si2415 2434 = Si2434 2457 = Si2457 2493 = Si2493	
	Diagnostic Results Format	**Description**
I7	RX <rx_rate>,TX <tx_rate>	Receive/transmit data rate in bps
	PROTOCOL: <protocol>	Error correction/data compression protocol.
	LOCAL NAK <rre>	Number of V.42 receive errors
	REMOTE NAK <rte>	Number of V.42 transmit errors
	RETRN/RR <rn>	Number of retrains/rate renegotiations
	DISC REASON <dr>	Disconnect reason code (see Table 25)
I8	RX LEVEL <rx_level>	Receive level power in dBm
	TX LEVEL <tx_level>	Transmit level power in dBm.
	EFFECTIVE S/N <esn>	Effective signal-to-noise ratio in dB
	RESIDUAL ECHO <re>	Ratio of residual echo to signal in dB
Ln	Speaker Volume	
L1	Low	
L2	Medium	
L3	High	
Mn	Speaker operation (via AOUT).	
M0	Speaker is always off.	
M1	Speaker is on while dialing and handshaking; off in data mode.	
M2	Speaker is always on.	
M3	Speaker is off while dialing; on during handshaking and retraining.	
On	Return to data mode from command mode.	
O0	Return to data mode.	
O1	Return to data mode and perform a full retrain (at any speed except 300 bps).	
O2	Return to data mode and perform rate renegotiation.	
Qn	Response mode.	
Q0	**Enable result codes.** (See Table 24.)	
Q1	Disable result codes. (Enable quiet mode.)	

Table 8 Basic AT Command Set (continued)

Command	Action
Sn	S-Register operations. (See Table 32.)
S$	List contents of all S-registers.
Sn?	Displays contents of S-register n.
Sn=x	Set S-register n to value x. (n and x are decimal values.)
Vn	Result code type. (See Table 24.)
V0	Numeric result codes.
V1	Verbal result codes.
Xn	Call Progress Monitor (CPM)—This command controls which CPM signals are monitored and reported to the host from the Si2493. (See Table 24.)
X0	Basic results; disable CPM—Blind dial (does not wait for dial tone). CONNECT message does not include speed.
X1	Extended results; disable CPM—Blind dial. CONNECT message includes speed.
X2	Extended results and detect dial tone only. X1 with dial tone detection.
X3	Extended results and detect busy only. X1 with busy tone detection.
X4	Extended results, full CPM. X1 with dial and busy tone detection.
X5	Extended results—Full CPM enabled including ringback detection. X4 with ring back detection.
Yn	Long space disconnect—Modem hangs up after 1.5 seconds or more of continuous space while on-line.
Y0	Disable
Y1	Enable
Z	Hard Reset—This command is functionally-equivalent to pulsing the RESET pin low.
:R	U-Register Read—This command reads U-Register values in hexadecimal. The format is AT:Raa, where aa = A particular U-Register address in hexadecimal. The AT:R command displays all U- register values. Only one :R command is allowed per AT command line.
:U	U-Register Write—This command writes to the 16-bit U-Registers. The format is AT:Uaa,xxxx,yyyy,zzzz,..., where aa = user-access address in hexadecimal. xxxx = data in hexadecimal to be written to location aa. yyyy = data in hexadecimal to be written to location (aa + 1). zzzz = data in hexadecimal to be written to location (aa + 2), etc. Only one :U command is allowed per AT command line.

Table 8 Basic AT Command Set (continued)

Command	Action
+DR=X	Data compression reporting. X Mode • 0 – Disabled • 1 – Enabled If enabled, the intermediate result code is transmitted at the point after error control negotiation. The format of this result code is as follows: • Result code Mode – +DR:NONE Data compression is not in use – +DR:V42B Rec. V.44 and V.42bis is in use in both directions – +DR:V42B RD Rec. VV.44 and .42bis is in use in receive direction only – +DR:V42B TD Rec. V.44 and V.42bis is in use in transmit directions only – +DR:V44 Rec. V.44 is in use in both directions – +DR:V44 RD Rec. V.44 is in use in receive direction only – +DR:V44 TD Rec. V.44 is in use in transmit directions only
+DS= A,B,C,D	Controls V.44 and V.42bis data compression function. • A – Direction – 0= No compression (V.44 and V.42bis P0 = 0) – 1= Transmit only – 2= Receive only – 3= Both Directions (V.44 and V.42bis P0 = 11) • B – Compression_negotiation – 0= Do not disconnect if Rec. V.42 is not negotiated. – 1= Disconnect is Rec. V.42 is not negotiated. • C – Max_dict 512 to 65535 • D – Max_string 6 to 250

Table 8 Basic AT Command Set (continued)

Command	Action
+DS44 = A,B,C,D,E,F, P,G,H,I	Controls V.44 data compression function on the Si2493 only. • A – Direction – 0= No compression (V.44 and V.42bis P0 = 0) – 1= Transmit only – 2= Receive only – 3= Both Directions (V.44 and V.42bis P0 = 11) • B – Compression_negotiation – 0= Do not disconnect if Rec. V.42 is not negotiated – 1= Disconnect is Rec. V.42 is not negotiated • C – Capability – 0= Stream method – 1= Packet method – 2= Multi-packet method • D – Max_codewords_tx 256 to 65536 • E – Max_codewords_rx 256 to 65536 • F – Max_string_tx 32 to 255 • G – Max_string_rx 32 to 255 • H – Max_history_tx .. 512 • I – Max_history_rx .. 512
+ES = A, B, C	Enables synchronous access mode. • A – Specifies the mode of operation when initiating a modem connection – D = Disable synchronous assess mode – 6 = Enable synchronous access mode when connection is completed and data state is entered. • B – This parameter should not be used. • C – Specifies the mode of operation when answer a modem connection – D = Disable synchronous assess mode – 8 = Enable synchronous access mode when connection is completed and data state is entered.

Table 8 Basic AT Command Set (continued)

Command	Action
+ESA = A,B,C,D,E,F,G	Synchronous access mode control options • A – Specifies action taken if an underrun condition occurs during transparent sub-mode – 0 = Modem transmits 8-bit SYN sequences (see +ESA[G]) on idle. • B – Specifies action taken if an underrun condition occurs after a flag during framed submode – 0 = Modem transmits 8-bit HDLC flags on idle. • C – Specifies action taken if an underrun or overrun condition occurs after a non-flag during framed sub-mode – 0 = Modem transmit**s abort on** underrun in middle of frame. – 1 = Modem transmits flag on underrun in middle of frame and notifies host of underrun or overrun. • D – Specifies V.34 half duplex operation. This parameter should not be used. • E – Specifies CRC polynomial used while in framed sub-mode – 0 = CRC generation checking disable – 1 = 16-bit CRC generation and checking is performed by the modem • F – Specifies NRZI encoding and decoding – 0 = NRZI encoding and decoding disabled • G – Defines 8-bit SYN – 255 = Fixed at 255 (marks)
+FCLASS = X	Class 1 Mode Enable. • X Mode – 0 Off – 1 Enables support for V.29 Fast Connect mode. – 256 SMS mode
+FRM = X	Class 1 Receive Carrier. • X Mode – 2 Detect V.21 (980 Hz) tone for longer than 100 ms, then send answer tone – (2100/2225 Hz) for 200 ms. – 95 V.29 short synchronous. – 96 V.29 full synchronous. – 200 Returns to data mode prepared to receive an SMS message.

Table 8 Basic AT Command Set (continued)

Command	Action
+FTM = X	Class 1 Transmit Carrier. • X Mode – 2 Transmit V.21 (980 Hz) tone and detect (2100/2225 Hz). Stop transmit 980 Hz when – (2100/2225 Hz is detected. – 53 Same as &T4, but transmit V.29 7200 bps. Data pattern set by S40 register. AT + – FCLASS = 0 must be sent to restore the ISOmodem to normal operation after test. – 54 Same as &T4, but transmit V.29 9600 bps. Data pattern set by S40 register. AT + – FCLASS = 0 must be sent to restore the ISOmodem to normal operation after test. – 95 V.29 short synchronous. – 96 V.29 full synchronous. – 201 Returns to data mode prepared to transmit an SMS protocol 1 message. – 202 Returns to data mode prepared to transmit an SMS protocol 2 message.

Table 8 Basic AT Command Set (continued)

Command	Action	
+GCI = X	Country settings - Automatically configure all registers for a particular country. X= Country 9 Australia A Austria F Belgium 16 Brazil 1B Bulgaria 20 Canada 26 China 27 Columbia 2E Czech Republic 31 Denmark 35 Ecuador 3C Finland 3D France 42 Germany 46 Greece 551 Hungary 53 India 57 Ireland 58 Israel 59 Italy 50 Hong Kong 0 Japan 61 South Korea 69 Luxembourg	6C Malaysia 73 Mexico 7B Netherlands 7E New Zealand 82 Norway 87 Paraguay 89 Philippines 8A Poland 8B Portugal 9C Singapore 9F South Africa A0 Spain A5 Sweden A6 Switzerland B8 Russia FE Taiwan B4 United Kingdom**B5 United States** **Note** U-Registers are configured to Silicon Laboratories' recommended values. Changes may be made by writing individual registers after sending the AT+GCI command. The +GCI command resets U-Registers through U86, S7, and S6 (in Japan) to default values before setting country-specific values.
+GCI?	List current country code setting (response is: + GCI:<setting>)	
+GCI = ?	List all possible country code settings.	

Table 8 Basic AT Command Set (continued)

Command	Action
+IFC Options +IFC = A +IFC = A,B	Specifies the flow control that is to be implemented. • A=Specifies the flow control method used by the host to control data from the modem – 0= None – 1= Local XON/OFF flow control. Does not pass XON/XOFF character to the remote modem. – 2= Hardware flow control (RTS) • B= Specifies the flow control method used by the modem to control data from the host – 0 =None – 1=Local XON/OFF flow control. – 2= Hardware flow control (CTS).
+ITF Options +ITF = A +ITF = A,B +ITF = A,B,C	Transmit flow control threshold. • A= Threshold above which the modem will generate a flow off signal <0 to 511> bytes • B= Threshold below which the modem will generate a flow on signal <0 to 511> bytes • C =Polling interval for <EM><BNUM> indicator – 0 =to 300 in 10 msec units.
+MR=X	Modulation reporting control. X=Mode • 0=Disabled • 1= Enabled If enabled, the intermediate result code is transmitted at the point during connect negotiation. The format of this result code is as follows: +MCR: <carrier> e.g. +MCR: V32B +MRR: <rate> e.g. +MRR: 14400

Table 8 Basic AT Command Set (continued)

Command	Action
+MS Options +MS = A +MS = A,B +MS = A,B,C +MS = A,B,C, D +MS = A,B,C, D,E +MS = A,B,C, D,E,F	Modulation Selection. • A =(Preferred carrier) – V21 ITU-T V.21 – V22 ITU-T V.22 – V22B ITU-T V.22bis (default for Si2404) – V32 ITU-T V.32 – V32B ITU-T V.32bis (default for Si2415) – V34 ITU-T V.34 (default for Si2434) – V90 ITU-T V.90 (default for Si2457) – V92 ITU-T V.92 (default for Si2493) • B= Automatic modulation negotiation – 0 Disabled – 1 Enabled • C,D = Min Tx rate/Max Tx rate are optional numeric values that specify the lowest value at which the DCE may establish a connection. If unspecified (set to 0), they are determined by the carrier and automode settings. • E,F Min Rx rate/max Rx rate are optional numeric values which specify the highest value at which the DCE may establish a connection. If unspecified (set to 0), they are determined by the carrier and automode settings.
+PCW = X	Controls the action to be taken upon detection of call waiting. X =Mode • 0= Toggle RI and collect type II Caller ID if enabled by +VCID. • 1= Hang up. • 2= Ignore call waiting.
+PIG=X	Controls the use of PCM upstream in a V.92 DCE. X =Mode • 0 Enable PCM upstream. • 1 Disable PCM upstream.
+PMH=X	Controls the modem-on-hold procedures. X =Mode • 0 Enables V.92 MOH. • 1 Disables V.92 MOH.
+PMHF=X	V.92 MOH hook flash. This command causes the DCE to go on-hook and then return off-hook. If this command is initiated and the modem is not On Hold, Error is returned.

Table 8 Basic AT Command Set (continued)

Command	Action
+PMHR=X	Initiate MOH. Requests the DCE to initiate or to confirm a MOH procedure. Valid only if MOH is enabled. X=Mode • 0 V.92 MOH request denied or not available. • 1= MOH with 10 s timeout granted. • 2= MOH with 20 s timeout granted. • 3= MOH with 30 s timeout granted. • 4=MOH with 40 s timeout granted. • 5= MOH with 1 min. timeout granted. • 6= MOH with 2 min. timeout granted. • 7= MOH with 3 min. timeout granted. • 8= MOH with 4 min. timeout granted. • 9= MOH with 6 min. timeout granted. • 10= MOH with 8 min. timeout granted. • 11= MOH with 12 min. timeout granted. • 12= MOH with 16 min. timeout granted. • 13= MOH with indefinite timeout granted. • 14= MOH request denied. Future request will also be denied.
+PMHT=X	Controls access to MOH request and sets the timeout value. X =Mode • 0=Deny V.92 MOH request. • 1= Grant MOH with 10 s timeout. • 2= Grant MOH with 20 s timeout. • 3= Grant MOH with 30 s timeout. • 4= Grant MOH with 40 s timeout. • 5= Grant MOH with 1 min. timeout. • 6= Grant MOH with 2 min. timeout. • 7= Grant MOH with 3 min. timeout. • 8= Grant MOH with 4 min. timeout. • 9= Grant MOH with 6 min. timeout. • 10= Grant MOH with 8 min. timeout. • 11= Grant MOH with 12 min. timeout. • 12= Grant MOH with 16 min. timeout. • 13= Grant MOH with indefinite timeout.

Table 8 Basic AT Command Set (continued)

Command	Action
+PQC=X	V.92 Phase 1 and Phase 2 Control. X =Mode • 0= Enable Short Phase 1 and Short Phase 2. • 1= Enable Short Phase 1. • 2= Enable Short Phase 2. • 3= Disable Short Phase 1 and Short Phase 2.
+PSS=X	Selection of full or short startup procedures. X= Mode • 0= The DCEs decide to use short startup procedures. • 1= Forces the use of short startup procedures on next and subsequent connections. • 2= Forces the use of full startup procedures on next and subsequent connections.
+VCDT = n	Caller ID Type. n= Mode • 0 = After ring only (Bellcore) • 1 = Always on (Bellcore) • 2 = UK • 3 = Japan
+VCID = n	Caller ID Enable. n= Mode • **0 = Off** • 1 = Formatted caller ID enabled. • 2 = Raw data caller ID enabled.
+VCIDR?	Type II caller ID information—"+VCIDR:" will be followed by raw caller ID information including checksum. "No Data" will be displayed if no Type II data is available.

Extended AT Commands

The following extended AT commands are supported by the Si2493:

- AT& Commands, page 19
- AT% Commands, page 22

AT& Commands

Table 9 lists available AT& commands.

Table 9 Extended AT& Command Set

&$	Display AT& current settings.
&D0	ESC (pin 22) is not used
&D1	ESC (pin 22) escapes to command mode from data mode if also enabled by HES U70, bit 15.
&D2	ESC (pin 22) assertion during a modem connection causes the modem to go on-hook and return to command mode.
&D3	ESC (pin 22) assertion causes ATZ command (reset and return OK result code).
&Gn	Line connection rate limit—This command sets an upper limit on the line speed that the Si2493 can connect. Note that the &Hn commands may limit the line speed as well (&Gn not used for &H0 or &H1). Not all modulations support rates given by &G. Improper settings are ignored.
&G3	1200 bps max
&G4	2400 bps max
&G5	4.8 kbps max.
&G6	7.2 kbps max.
&G7	9.6 kbps max.
&G8	12 kbps max.
&G9	14.4 kbps max
&G10	16.8 kbps max.
&G11	19.2 kbps max.
&G12	21.6 kbps max.
&G13	24 kbps max.
&G14	26.4 kbps max.
&G15	28.8 kbps max.
&G16	31.2 kbps max.
&G17	33.6 kbps max.
&Hn	Switched network handshake mode—&Hn commands must be on a separate command line from ATD, ATA, or ATO commands.
&H0	V.90 with automatic fallback (56 kbps to 300 bps).
&H1	V.90 only (56 kbps to 28 kbps).
&H2	V.34 with automatic fallback (33.6 kbps to 300 bps).

Note The initial number attempted to test for an outside line is controlled by S51 (default = 1).

Note AT&$ reflects the last AT&P command issued but does not reflect any subsequent changes made by writing U-registers with AT:U.

&H3	V.34 only (33.6 kbps to 2400 bps).
&H4	ITU-T V.32bis with automatic fallback (14.4 kbps to 300 bps).
&H5	ITU-T V.32bis only (14.4 kbps to 4800 bps)
&H6	ITU-T V.22bis only (2400 bps or 1200 bps).
&H7	ITU-T V.22 only (1200 bps).

Table 9 Extended AT& Command Set (continued)

&H8	Bell 212 only (1200 bps).
&H9	Bell 103 only (300 bps).
&H10	ITU-T V.21 only (300 bps).
&H11	V.23 (1200/75 bps).
&H12	**V.92 with automatic fallback** (default for Si2493)
&Pn	Japan pulse dialing*
&P0	Configure Si2493 for 10 pulse-per-second pulse dialing. For Japan.
&P1	Configure Si2493 for 20 pulse-per-second pulse dialing. For Japan.
&Tn	Test mode.
&T0	Cancel Test Mode (Escape to Command mode to issue AT&T0). This command also reports the number of bit errors encountered on the previous &T4 or &T5 test.
&T2	Initiate ITU-T V.54 (ANALOOP) test. Modem mode set by &H. Test loop is through the DSP and DAA interface section of the Si2493 only. ISOmodem echoes data from TX pin (Register 0 in parallel mode) back to RX pin (Register 0 in parallel mode). *This test mode is typically* used during board-level debug.
&T3	Initiate ITU-T V.54 (ANALOOP) test. Modem mode set by &H. Test loop is through the DSP (Si2493/ 57/34/15/04), DAA interface section (Si2493), ISOcap™ interface (Si3018/10), and analog hybrid circuit (Si3018/10). ISOmodem echoes data from TX pin (Register 0 in parallel mode) back to RX pin (Register 0 in parallel mode). Phone line termination required as in Figure 10. In order to test only the ISOcap link operation, the hybrid and AFE codec can be removed from the test loop by setting U62[1] (DL) = 1.
&T4	Initiate transmit as originating modem with automatic data generation. Modulation, data rate, and symbol rate are set by &H, &G, and S41. Data pattern is set by the S40 register. Continues until the ATH command is sent after an escape into command mode. Data is also demodulated as in ANALOOP, and any bit errors are counted to be displayed after the test using &T0.
&T5	Initiate transmit as answering modem with automatic data generation. Modulation, data rate, and symbol rate are set by &H, &G, and S41. Data pattern is set by the S40 register. Continues until the ATH command is sent after an escape into command mode. Data is also demodulated as in ANALOOP, and any bit errors are counted to be displayed after the test using &T0.
&T6	Compute checksum for firmware-upgradeable section of program memory. If no firmware upgrade is installed, &T6 returns C:4474.
&Xn	Automatic determination of telephone line type.
&X0	Abort &x1 or &x2 command.

Note The initial number attempted to test for an outside line is controlled by S51 (default = 1).

Note AT&$ reflects the last AT&P command issued but does not reflect any subsequent changes made by writing U-registers with AT:U.

Table 9 Extended AT& Command Set (continued)

&X1	Result code: WXYZn W: 0 = line supports DTMF dialing. 1 = line is pulse dial only. X: 0 = line supports 20 pps dialing. 1 = line supports 10 pps dialing only. Y: 0 = extension network present (PBX). 1 = outside line (PSTN) connected directly. Z: 0 = continuous dialtone. 1 = make-break dialtone. n: 0–9 (number required for outside line if Y = 0).[1]
&X2	Same as &X1, but Y result (PBX) is not tested.
Y2A[2]	Produce a constant answer tone (ITU-T) and return to command mode. The answer tone continues until the ATH command is received or the S7 timer expires.
&Z	Enter low-power wake-on-ring mode.

Note The initial number attempted to test for an outside line is controlled by S51 (default = 1).

Note AT&$ reflects the last AT&P command issued but does not reflect any subsequent changes made by writing U-registers with AT:U.

AT% Commands

Table 10 lists available extended AT% commands.

Table 10 Extended AT% Command Set

%$	Display AT% command settings
%B	Report blacklist.
%Cn	Data compression.
%C0	Disable V.44 and V.42bis and MNP5 data compression.
%C1	Enable V.44 and V.42bis in transmit and receive paths. If MNP is selected (\N2), %C1 enables MNP5 in transmit and receive paths.
%C2	Enable V.44 and V.42bis in transmit path only.
%C3	Enable V.44 and V.42bis in receive path only.
%On	Answer mode.
%O1	Si2493 answers a call in answer mode.
%O2	Si2493 answers a call in originate mode.

Table 10 Extended AT% Command Set (continued)

%$	Display AT% command settings
%Vn	Automatic Line Status Detection. After the %V1 and %V2 commands are issued, the Si2493 automatically checks the telephone connection for whether a line is present. If a line is present, the Si2493 automatically checks if the line is already in use. Finally, the Si2493 checks line status both before going off-hook and again before dialing. %V1 uses the fixed method, and %V2 uses the adaptive method. %V0 (default) disables this feature.
%V0	Disable automatic line-in-use detection.
%V1	Automatic Line Status Detection - Fixed Method. Description: Before going off-hook with the ATD, ATO, or ATA commands, the Si2493 compares the line voltage (via LVCS) to registers NOLN (U83) and LIUS (U84): Loop Voltage Action 0 .. LVCS .. NOLN Report “NO LINE” and remain on-hook. NOLN .. LVCS .. LIUS Report “LINE IN USE” and remain on-hook. LIUS .. LCVS Go off-hook and establish a modem connection. Once the call has begun, the off-hook intrusion algorithm operates normally. In addition, the Si2493 reports “NO LINE” if the telephone line is completely disconnected. If the HOI bit (U77, bit 11) is set, “LINE IN USE” is reported upon intrusion.
%V2	Automatic Line Status Detection - Adaptive Method. Description: Before going off-hook with the ATD, ATO, or ATA commands, the Si2493 compares the line voltage (via LVCS) to the NLIU (U85) register: Loop Voltage Action: • 0 .. LVCS .. (0.0625 x NLIU) Report “NO LINE” and remain on-hook. • (0.0625 x NLIU) < LVCS .. (0.85 x NLIU) Report “LINE IN USE” and remain on-hook. • (0.85 x NLIU) < LCVS Go off-hook and establish a modem connection. The NLIU register is updated every 1 ms with the minimum non-zero value of LVCS in the last 30 ms. This allows the Si2493= to eliminate errors due to 50/60 Hz interference and also adapt to relatively slow changes in the on-hook dc reference value on the telephone line. This algorithm does not allow any non-zero values for NLIU below 0x0007. The host may also initialize NLIU prior to issuing the %V2 command. Once the call has begun, the off-hook intrusion algorithm operates normally. In addition, the Si2493 reports “NO LINE” if the telephone line is completely disconnected. If the HOI (U77, bit 11) bit is set, “LINE IN USE” is reported upon intrusion.

Table 11 Extended AT\ Command Set

Command	Action
\$	Display AT\ command settings (see text for details).
\Bn	Character length is automatically set in autobaud mode.
\B0	6N1—six data bits, no parity, one stop bit, one start bit, eight bits total (\N0 only)
\B1	7N1—seven data bits, no parity, one stop bit, one start bit, nine bits total (\N0 only)

Table 11 Extended AT\ Command Set (continued)

Command	Action
\B2	7P1—seven data bits, parity optioned by \P, one stop bit, one start bit, 10 bits total
\B3	8N1—eight data bits, no parity, one stop bit, one start bit, 10 bits total
\B5	8P1—eight data bits, parity optioned by \P, one stop bit, one start bit, 11 bits total (\N0 only)
\B6	8X1—eight data bits, one escape bit, one stop bit, one start bit, 11 bits total (enables ninth-bit escape mode)
\Nn	Asynchronous protocol.
\N0	Wire mode (no error correction, no compression).
\N2	MNP reliable mode. The Si2493 attempts to connect with the MNP protocol. If unsuccessful, the call is dropped. Compression is controlled by %Cn.
\N3	V.42 auto-reliable—The Si2493 attempts to connect with the V.42 protocol. If unsuccessful, the MNP protocol is attempted. If unsuccessful, wire mode is attempted. Compression is controlled by %Cn.
\N4	V.42 (LAPM) reliable mode (or drop call)—Same as \N3 except that the Si2493 drops the call instead of connecting in MNP or wire mode. Compression is controlled by %Cn.
\N5	V.42 and MNP reliable mode - The Si2493 attempts to connect with V.42. If unsuccessful, MNP is attempted. If MNP is unsuccessful, the call is dropped. Wiremode is not attempted. Compression is controlled by %Cn.
\Pn	Parity type is automatically set in autobaud mode.
\P0	Even
\P1	Space[1]
\P2	Odd

Note When in autobaud mode, \B0, \B1, and \P1 is not detected automatically. The combination of \B2 and \P3 is detected. This is compatible with seven data bits, no parity, two stop bits. Seven data bits, no parity, one stop bit may be forced by sending AT\T17\B1.

Note When changing rates, the result code “OK” is sent at the old DTE rate. Subsequent commands must be sent at the new rate. When the Si2493 is configured in autobaud mode, \T0 through \T15 lock the new baud rate and disable autobaud. To eliminate any possibility of a race condition between the receipt of the result code and the changing of the UART speed, CTS is de-asserted while the result code is being sent until after the rate has been successfully changed. The host should send the \T command and wait for the “OK” response. After the “OK” has been received, the host may send data at the new rate as soon as CTS is asserted. The \T command should be the last command sent in a multi-command line and may not be used on the same command line as :U or :R commands. If it is not, the “OK” from the \T command is sent at the old DTE rate, and any other result codes are sent at the new DTE rate.

Note The autobaud feature does not detect this rate.

Note Default is \T16 (autobaud); otherwise, \T9 (19.2 kbps) if a pulldown is connected to pin 18.

\P3	Mark.
\Qn	Modem-to-DTE flow control.
\Q0	Disable all flow control—This may only be used if the DTE speed and the line (DCE) speed are guaranteed to match throughout the call.
\Q2	Use CTS only.

Table 11 Extended AT\ Command Set (continued)

Command	Action
\Q3	Use RTS/CTS.
\Q4	Enable XON/XOFF flow control for modem-to-DTE interface. Does not enable modem-to-modem flow control.
\Tn	DTE rate.2
\T0	300 bps.
\T1	600 bps.
\T2	1200 bps.
\T3	2400 bps.
\T4	4800 bps.
\T5	7200 bps.
\T6	9600 bps.
\T7	12.0 kbps.3
\T8	14.4 kbps.
\T9	19.2 kbps.4
\T10	38.4 kbps.
\T11	57.6 kbps.
\T12	115.2 kbps.
\T13	230.4 kbps.
\T14	245.760 kbps.3
\T15	307.200 kbps.

Note When in autobaud mode, \B0, \B1, and \P1 is not detected automatically. The combination of \B2 and \P3 is detected. his is compatible with seven data bits, no parity, two stop bits. Seven data bits, no parity, one stop bit may be forced by sending AT\T17\B1. When changing rates, the result code "OK" is sent at the old DTE rate. Subsequent commands must be sent at the new rate. When the Si2493 is configured in autobaud mode, \T0 through \T15 lock the new baud rate and disable autobaud. To eliminate any possibility of a race condition between the receipt of the result code and the changing of the UART speed, CTS is de-asserted while the result code is being sent until after the rate has been successfully changed. The host should send the \T command and wait for the "OK" response. After the "OK" has been received, the host may send data at the new rate as soon as CTS is asserted. The \T command should be the last command sent in a multi-command line and may not be used on the same command line as :U or :R commands. If it is not, the "OK" from the \T command is sent at the old DTE rate, and any other result codes are sent at the new DTE rate.

Note The autobaud feature does not detect this rate.

Note Default is \T16 (autobaud); otherwise, \T9 (19.2 kbps) if a pulldown is connected to pin 18.

\T16	Autobaud On.4
\T17	Autobaud Off. Lock at current baud rate.

Table 11 Extended AT\ Command Set (continued)

Command	Action
\U	Serial mode—causes a low pulse (25 ms) on RI and DCD. INT to be the inverse of ESC. RTS to be inverse of CTS. Parallel mode—causes a low pulse (25 ms) on INT. This command terminates with a RESET and does not generate an "OK" message.
\Vn	Connect message type.
\V0	Report connect and protocol message.
\V2	Report connect message only (exclude protocol message).
\V4	Report connect and protocol message with both upstream and downstream connect rates.

Note When in autobaud mode, \B0, \B1, and \P1 is not detected automatically. The combination of \B2 and \P3 is detected. This is compatible with seven data bits, no parity, two stop bits. Seven data bits, no parity, one stop bit may be forced by sending AT\T17\B1.

Note When changing rates, the result code "OK" is sent at the old DTE rate. Subsequent commands must be sent at the new rate. When the Si2493 is configured in autobaud mode, \T0 through \T15 lock the new baud rate and disable autobaud. To eliminate any possibility of a race condition between the receipt of the result code and the changing of the UART speed, CTS is de-asserted while the result code is being sent until after the rate has been successfully changed. The host should send the \T command and wait for the "OK" response. After the "OK" has been received, the host may send data at the new rate as soon as CTS is asserted. The \T command should be the last command sent in a multi-command line and may not be used on the same command line as :U or :R commands. If it is not, the "OK" from the \T command is sent at the old DTE rate, and any other result codes are sent at the new DTE rate.

Note The autobaud feature does not detect this rate.

Note Default is \T16 (autobaud); otherwise, \T9 (19.2 kbps) if a pulldown is connected to pin 18.

Table 12 lists possible result codes.

Table 12 Result Codes

Numeric	Meaning	Verbal Response						
1	Command was successful	Ok	X	X	X	X	X	X
2	Link established at 300 bps or higher	Connect	X	X	X	X	X	X
3	Incoming ring detected	Ring	X	X	X	X	X	X
4	Link dropped	No Carrier	X	X	X	X	X	X
5	Command failed	Error	X	X	X	X	X	X
6	Link establish at 1200	Connect 1200		X	X	X	X	X
7	Dial tone not present	No Dialtone			X		X	X
8	Line busy	Busy				X	X	X
9	Remote not answering	No Answer	X	X	X	X	X	X
10	Ringback detected	Ringing						X
11	Link established at 2400	Connect 2400		X	X	X	X	X
12	Link established at 4800	CONNECT 4800		X	X	X	X	X

Table 12 Result Codes (continued)

Numeric	Meaning	Verbal Response						
13	Link established at 9600	CONNECT 9600[5]		X	X	X	X	X
14	Link established at 19200	CONNECT 19200[1]		X	X	X	X	X
15	Link established at 7200	CONNECT 7200[5]		X	X	X	X	X
16	Link established at 12000	CONNECT 12000[5]		X	X	X	X	X
17	Link established at 14400	CONNECT 14400[5]		X	X	X	X	X
18	Link established at 16800	CONNECT 16800[1]		X	X	X	X	X
19	Link established at 21600	CONNECT 21600[1]		X	X	X	X	X
20	Link established at 24000	CONNECT 24000[1]		X	X	X	X	X
21	Link established at 26400	CONNECT 26400[1]		X	X	X	X	X
22	Link established at 28800	CONNECT 28800[1]		X	X	X	X	X
23	Link established at 31200	CONNECT 31200[1]		X	X	X	X	X
24	Link established at 33600	CONNECT 33600[1]		X	X	X	X	X
30	Caller ID mark detected	CIDM	X	X	X	X	X	X
31	Hookswitch flash detected	Flash	X	X	X	X	X	X
32	UK CID State Tone Alert Signal detected	STAS	X	X	X	X	X	X

Note This message is only supported on the Si2493, Si2457 and Si2434.

Note X is the only verbal response code that does not follow the <CR><LF>Result Code<CR><LF> standard. here is no leading <CR><LF>.

Note This message is only supported on the Si2493 and Si2457.

Note Numeric mode: Result code <CR>.

33	Overcurrent condition	X[2]	X	X	X	X	X	X
40	Blacklist is full	BLACKLIST FULL (enabled via S42 register)	X	X	X	X	X	X
41	Attempted number is blacklisted.	BLACKLISTED (enabled via S42 register)	X	X	X	X	X	X
42	No phone line present	NO LINE (enabled via %Vn commands)	X	X	X	X	X	X
43	Telephone line is in use	LINE IN USE (enabled via %Vn commands)	X	X	X	X	X	X
44	Polarity reversal detected	POLARITY REVERSAL (enabled via G modifier)	X	X	X	X	X	X
45	Polarity reversal NOT detected	NO POLARITY REVERSAL (enabled via G modifier)	X	X	X	X	X	X
52	Link established at 56000	CONNECT 56000[3]		X	X	X	X	X
60	Link established at 32000	CONNECT 32000[3]		X	X	X	X	X

Table 12 Result Codes (continued)

Numeric	Meaning	Verbal Response						
61	Link established at 48000	CONNECT 48000[3]		X	X	X	X	X
63	Link established at 28000	CONNECT 28000[3]		X	X	X	X	X
64	Link established at 29333	CONNECT 29333[3]		X	X	X	X	X
65	Link established at 30666	CONNECT 30666[3]		X	X	X	X	X
66	Link established at 33333	CONNECT 33333[3]		X	X	X	X	X
67	Link established at 34666	CONNECT 34666[3]		X	X	X	X	X
68	Link established at 36000	CONNECT 36000[3]		X	X	X	X	X
69	Link established at 37333	CONNECT 37333[3]		X	X	X	X	X
70	No protocol	PROTOCOL: NONE	Set with \V0 command.					
75	Link established at 75	CONNECT 75		X	X	X	X	X
77	V.42 protocol	PROTOCOL: V42	Set with \V0 command.					
79	V.44 and V.42bis protocol	PROTOCOL: V42bis[5]	Set with \V0 command.					
80	MNP2 protocol	PROTOCOL: ALTERNATE, +CLASS 2	Set with \V command.					
81	MNP3 protocol	PROTOCOL: ALTERNATE, +CLASS 3	Set with \V command.					

Note This message is only supported on the Si2493, Si2457 and Si2434.

Note X is the only verbal response code that does not follow the <CR><LF>Result Code<CR><LF> standard. There is no leading <CR><LF>.

Note This message is only supported on the Si2493 and Si2457.

Note Numeric mode: Result code <CR>.

82	MNP4 protocol	PROTOCOL: ALTERNATE, +CLASS 4	Set with \V command.					
83	MNP5 protocol	PROTOCOL: ALTERNATE, +CLASS 5[5]	Set with \V command.					
84	V.44 protocol	PROTOCOL: V.44	Set with +DR command					
90	Link established at 38666	CONNECT 38666[3]		X	X	X	X	X
91	Link established at 40000	CONNECT 40000[3]		X	X	X	X	X
92	Link established at 41333	CONNECT 41333[3]		X	X	X	X	X
93	Link established at 42666	CONNECT 42666[3]		X	X	X	X	X
94	Link established at 44000	CONNECT 44000[3]		X	X	X	X	X
95	Link established at 45333	CONNECT 45333[3]		X	X	X	X	X
96	Link established at 46666	CONNECT 46666[3]		X	X	X	X	X
97	Link established at 49333	CONNECT 49333[3]		X	X	X	X	X
98	Link established at 50666	CONNECT 50666[3]		X	X	X	X	X

Table 12 Result Codes (continued)

Numeric	Meaning	Verbal Response						
99	Link established at 52000	CONNECT 52000[3]		X	X	X	X	X
100	Link established at 53333	CONNECT 53333[3]		X	X	X	X	X
101	Link established at 54666	CONNECT 54666[3]		X	X	X	X	X
102	DTMF dial attempted on a pulse dial only line	UN-OBTAINABLE NUMBER	X	X	X	X	X	X

Note This message is only supported on the Si2493, Si2457 and Si2434.

Note X is the only verbal response code that does not follow the <CR><LF>Result Code<CR><LF> standard. There is no leading <CR><LF>. This message is only supported on the Si2493 and Si2457.

Note Numeric mode: Result code <CR>.

Note This message is only supported on the Si2493, Si2457, Si2434, and Si2415.

Table 13 lists possible disconnect codes.

Table 13 Disconnect Codes

Code	Reason
8002	Handshake stalled.
8	No dialtone detected.
8008	No line available.
9	No loop current detected.
8009	Parallel phone pickup disconnect.
A	No ringback.
B	Busy signal detected.
D	V.42 requested disconnect.
E	MNP requested disconnect.
10	Drop dead timer disconnect.
8014	Loop current loss.
8017	Remote modem requested disconnect.
8018, 8019	Soft reset command received.
1a	V.42 Protocol error.
1b	MNP Protocol error.
801	Loss-of-carrier disconnect.
801e	Long space disconnect.
801f	Character abort disconnect.
802a	Rate request failed.
802b	Answer modem energy not detected.

Table 13 Disconnect Codes (continued)

Code	Reason
802c	V.8 negotiation failed.
2d	TX data timeout.

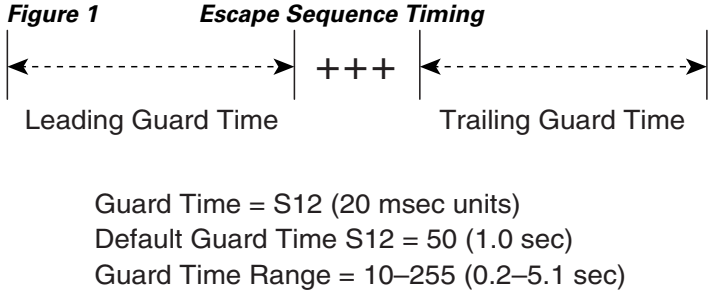
Related Codes and Registers

This section contains the following information:

Escape Codes

The "+++" escape code is enabled by default and is controlled by U70[13] (TES). There are equal guard time periods before (leading) and after (trailing) the "+++" set by the S-Register S12, during which there must be no UART activity. If this UART inactivity criterion is met, the Si2493 escapes to the command mode at the end of the S12 time period following the "+++". Any activity in the UART during either the leading or trailing time period causes the ISOmodem to ignore the escape request and remain in data mode. Timing for this escape sequence is illustrated in Figure 1.

Figure 1 Escape Sequence Timing



S-Registers

S-Registers are typically used to set modem configuration parameters during initialization and are not usually changed during normal modem operation. S-Register values other than defaults must be write n via the ATSn=x command after every reset event. S-Registers are specified as a decimal value (S01 for example), and the contents of the register are always a decimal number. Table 32 lists the S-Registers available on the Si2493, their function, default value, range of values, and units.

Many S-Registers are becoming industry standards, such as S0 (number of rings for auto answer), S1 (ring count), and S2 (escape character) among others. However, there are usually variations in the function (and availability) of S-Registers from one chipset to another or from one chipset manufacturer to another. These variations are due to a combination of feature availability and choices made during the chip design. Verify S-Register functions, defaults, ranges, and values when adapting the Si2493 to an existing design. This simple step can save time and help speed product development. If a particular S-Register is not available on the Si2493, the register may not be necessary or the function of the S-Register may be available with the use of U-Registers (discussed later) or through an AT command.

Table 14 lists S-Register descriptions.

Table 14 S-Register Descriptions

S-Register (Decimal)	Function	Default (Decimal)	Range	Units
0	Automatic answer—This value represents the number of rings the Si2493 must detect before answering a call. 0 disables auto answer.	0	0–255	rings
1	Ring counter—Counts rings received on current call.	0	0–255	rings
2	ESC code character	43 (+)	0–255	ASCII
3	Carriage return character	13 (CR)	0–255	ASCII
4	Linefeed character	10 (LF)	0–255	ASCII
5	Backspace character	08 (BS)	0–255	ASCII
7	Carrier wait timer—This timer starts when dialing is completed. It sets the number of seconds the modem waits without carrier before hanging up and the number of seconds the modem waits for ringback when originating a call before hanging up. The register also sets the number of seconds the answer tone continues while using the AT*Y2A command.	80	0–255	seconds
8	Dial pause timer for “,” and “<” dial command modifiers	02	0–255	seconds
9	Carrier presence timer—Time the remote modem carrier must be detected before activating or reactivating DCD (carrier loss debounce time).	06	1–255	0.1 second
10	Carrier loss timer—The time a remote modem carrier must be lost before the Si2493 disconnects. Setting this timer to 255 disables the timer, and the modem does not time out and disconnect. If S10 is less than S9, even a momentary loss of carrier causes a disconnect. Use for V.22bis and lower data rates.	14	1–255	0.1 second
12	Escape code guard timer—Minimum guard time before and after “+++” to recognize a valid escape sequence.	50	10–255	0.02 second
14	Wait for dial tone delay timer. This timer starts when the “W” command is executed in the dial string.	12	0–255	seconds
24	Sleep Inactivity Time—This is the time the modem operates in normal power mode with no activity on the serial port, parallel port, or telephone line before entering the low-power sleep mode and waking on ring. The modem remains in the normal power mode, regardless of activity, if the timer is set to 0.	0	0–255	seconds

Table 14 S-Register Descriptions (continued)

S-Register (Decimal)	Function	Default (Decimal)	Range	Units
30	Disconnect Activity Timer—Sets the length of time that the modem stays online before disconnecting with no activity on the serial port, parallel port, or telephone line (ring, hookswitch flash, or caller ID). This feature is disabled if set to 0.	0	0–255	minutes
38	Hang Up Delay Time—Maximum delay between receipt of ATH0 command and hang up. If time out occurs before all data can be sent, the NO CARRIER (3) result code is sent. OK response sent if all data transmitted prior to time out. This register applies to V.42 mode only. S38=255 disables time out, and the modem only disconnects if data is successfully sent or carrier is lost.	20	0–255	seconds
40	Data Pattern - Data pattern generated during &T4 and &T5 transmit tests. 0 – All spaces (0s) 1 – All marks (1s) 2 – Random data	0	0-2	-
41	V.34 symbol rate - Symbol rate for V.34 when using the &T4 and &T5 commands. 0 – 2400 symbols/second 1 – 2743 symbols/second 2 – 2800 symbols/second 3 – 3000 symbols/second 4 – 3200 symbols/second 5 – 3429 symbols/second A valid combination of symbol rate (S41) and data rate (&G) must be selected. The following symbol rates and allowable data rates are supported: • 2400—2400 – 21600 • 2743—4800 – 26400 • 2800—4800 – 26400 • 3000—4800 – 28800 • 3200—4800 – 31200 • 3429—4800 – 33600	5	0-5	-

Table 14 S-Register Descriptions (continued)

S-Register (Decimal)	Function	Default (Decimal)	Range	Units
42	Blacklisting - The Si2493 does not dial the same number more than two times in S44 seconds. An attempt to dial a third time within S44 seconds results in a "BLACKLISTED" result code. If the blacklist memory is full, any dial to a new number will result in a "BLACKLIST FULL" result code. Numbers are added to the blacklist only if the modem connection fails. The %B command lists the numbers on the blacklists. 0 – disabled (default) 1 – enabled	0 (disabled)	0–1	-
43	Dial attempts to blacklist —When blacklisting is enabled with S42, this value controls the number of dial attempts that result in a number being blacklisted.	4	0-4	-
44	Blacklist Timer—Period during which blacklisting is active	180	0–255	seconds
50	Minimum on-hook time – Modem remains on-hook for S50 seconds. Any attempt to go off-hook is delayed until this timer expires.	3	0–255	seconds
51	Number to start checking for an outside PBX line.	1	0-9	-

U-Registers

U-Registers (user-access registers) are 16-bit registers directly written by the AT:Uaa command and read by the AT:R (read all U-Registers) or AT:Raa (read U-Register aa) commands. (See the AT command list in Table 8.). The U-Register number is the last two digits of the register's hexadecimal address. All values associated with the U-Registers, the address, and the value written to or read from the register are hexadecimal.

Some U-Registers are reserved and not available to the user. Therefore, there are gaps in the available URegister address sequence. Additionally, some bits within available U-Registers are reserved. Any attempt to write to a non-listed U-Register or to write a reserved bit to a value other than 0b causes unpredictable modem operation.

There are two types of U-Registers. The first represents a single 16-bit term, such as a filter coefficient, threshold, delay, or other quantity. These registers can be read from or written to as a single 16-bit value. The second type of U-Register is bit-mapped. Bit-mapped registers are written and/or read in hexadecimal, but each bit or combination of bits in the register represents an independent value or status information. These individual bits are used to enable or disable features and indicate states. Groups of bits in a bit-mapped register can be used to represent a value. Bits in these registers can be read/write, read only, or reserved, or they may be required to be set as a 1 or 0. Most reserved bits return a 0 when read. Pay particular attention when writing to bit-mapped registers to ensure that no reserved bits are overwritten. All U-Registers revert to their default setting after a reset.

The following Section describes U-Register information as it is supported on the Silicon Labs Si2493 modem:

- U86 and V.90 Support, page 34
- Consecutive U-Registers on a Single Line, page 34

U86 and V.90 Support

The U86 U-Register supports V.90 rate reduction in 1333 bps units. The V.90 connect rate is reduced by this amount during negotiation. The following attributes are supported:

- Register name: V9AGG
- Address: 0x0086
- Default value: 0x0000

Consecutive U-Registers on a Single Line

Restrictions for Consecutive U-Registers

Caution Some U-Register addresses are reserved for internal use and are not available. Consequently, there are gaps in the addresses of available U-Registers. Writing to reserved registers can cause unpredictable results. Be certain that the U-Register addresses written with a consecutive write command have consecutive addresses.

Only one :U or :R command is allowed per AT command line. If a command line has multiple commands, there can be only one :U or :R command, and it must be the last command in the string. For example, ATS0=3M1X1:U42,0022.

Consecutive U-Registers can be written in a single command as “AT:Uaa,xxxx,yyyy,zzzz” where aa is the first U-Register address in the three register consecutive series. This command writes a value of xxxx to Uaa, yyyy to Uaa+1, and zzzz to Uaa+2. Additional consecutive values may be written up to the 48 character limit. Table 15 shows consecutive U-Register examples.

This restriction also applies to all commands beginning with the “+” character (eg. +VCID). For example, AT:U42,0022:U43,0010<CR> is an illegal command and causes unpredictable behavior. Also, \Tn commands may not be used on the same command line as an :U or :R command. The AT command execution time is less than 200 ms. The host must wait for a response after each command (e.g., “OK”) before issuing additional commands. The reset recovery time (the time between a hardware reset or the carriage return of an ATZ command and the time the next AT command can be executed) is less than 300 ms. Characters must not be sent between the ATDT command and the protocol message. During this time, the modem is in a transition between command and data modes. Any characters sent during this time will cause the connection attempt to fail.

Blind dialing (dialing without waiting for dial tone) is enabled by ATX0, ATX1, and ATX3. Whether or not blind dialing is enabled, use of the W dial modifier causes the modem to look for a dial tone before dialing the number string after the W. For example, an AT command string, “ATX1 DT 9, W123456<CR>”, causes the modem to dial 9 immediately without detecting a dial tone but does not dial 123456 until a dial tone is detected.

Table 15 AT Command Consecutive U-Registers

Command	Result
AT:U00,0078,67EF,C4FA	0x0078 written to U00
	0x67EF written to U01
	0xC4FA written to U02

SMS Support

Short Message Service (SMS) is a service that allows text messages to be sent and received from one telephone to another via an SMS service center. The Si2493 provides an interface that offers a great deal of flexibility in handling multiple SMS standards. This flexibility is possible because most of the differences between standards is handled by the host in the data itself. The Si24xx performs the necessary modulation of the data and provides two options for message packet structure (protocol 1 and protocol 2 as defined in ETSI ES 201 912). The rest of the data link layer and the transfer layer are defined by the host system. The Si24xx uses a V.23 half-duplex modulation to transmit and receive the data over the PSTN. Two packet structures are provided: protocol 1 and protocol 2. Protocol 2 differs from protocol 1 in that a packet is preceded by 300 bits of channel seizure. ETSI ES 201 912 describes the other differences between protocols 1 and 2, but the host processor handles these when structuring the data within the packet.

Enabling SMS

To enable the SMS features on the Si24xx, the host must send “AT+FCLASS = 256” to the modem prior to handling an SMS call. The host can then dial or answer an SMS call using the “ATDTxxxx;”, where xxx is the number to be dialed, or “ATDT;” commands, respectively. Note the semi-colon at the end of the command, which places the modem immediately into command mode after dialing and responds with “OK”. The host can then prepare the modem for transmitting or receiving SMS data.

To receive protocol 1 or protocol 2 data, the host must send “AT+FRM = 200”. This causes the modem to return to data mode silently listening for data from the remote SMS server. If the modem detects a valid protocol 1 or protocol 2 packet, it responds with a “CONNECT” message followed by the SMS message (without channel seizure and mark). When the carrier stops, the modem returns to command mode and responds with OK”

To transmit protocol 1 or protocol 2 data, the host must send “AT+FTM = 201” or “AT+FTM = 202”, respectively. This causes the modem to return to data mode and wait silently until data is received from the host processor for transmission. Once data is received from the host, the modem transmits the proper number of channel seizure and mark bits followed by the data it received from the host. After the modem has begun transmitting, it will send marks when it does not have data to send and will continue to do so until the host escapes to command mode.

The content of the data message is entirely up to the host including any checksum or CRC. ETSI ES 201 912 describes two standard data and transfer layers that are commonly used. SMS typically relies on caller identification information to determine if the call should be answered using an SMS device or not. Please refer to the section on caller ID for more information on how to configure the modem for caller ID detection.

Table 16 lists supported SMS protocols

Table 16 SMS Protocols

Protocol 1		
80 bits of mark (constant 1s)		Message
Protocol 2		
300 bits of channel seizure (alternating 1’s and 0’s)	80 bits of mark (constant 1s)	Message

Table 17 lists the commands that control the SMS feature.

Table 17 SMS Feature Commands

Command Name	SMS Feature
AT+FCLASS = 256	Prepares the modem for handling SMS calls.
ATDT;	Goes off hook and returns to command mode. If a phone number is provided, it is dialed prior to returning to command mode.
AT+FRM = 200	Returns to data mode prepared to receive an SMS message.
AT+FTM = 201	Returns to data mode prepared to transmit an SMS protocol 1 message.
AT+FTM = 202	Returns to data mode prepared to transmit an SMS protocol 2 message.

Modem On Hold

The Si2493 supports modem-on-hold as defined by the ITU-T V.92 specification. This feature allows a connected Si2493 to place a server modem on-hold while a second call, typically a voice call, uses the phone line. The maximum time the modems will remain on-hold is controlled by the modem receiving the modem-on-hold request. Once the second call has completed, the Si2493 will re-initiate the data connection if the time elapsed has not exceed the time negotiated by the two modems. The Si2493 can also be placed on hold itself by a remote modem allowing a far-end user to make or receive a voice call. Modem on hold is only supported on the Si2493 for V.34 (14400–33600 bps) and higher speed modulations. The AT+PMH command is used to enable (+PMH = 0) or disable (+PMH = 1) modem-on-hold.

Initiating Modem On Hold

Modem on hold is typically initiated when a connected client modem receives a subscriber alert signal SAS) tone. However, it may be initiated any time the modem is on-line in command mode. The command AT+PMHR is used to initiate a modem on hold request. After this command is issued, the modem will place a modem on hold request to the server and the command response +PMHR: will indicate the server's response to the request. The possible responses may be seen in Table 83. If the server refuses to grant a modem on hold request, the modem will use the +PMHT setting to determine what to do. If +PMHT = 0 then the modem will remain connected to the server. If +PMHT is set to a non-zero value, the modems will disconnect. The Si2493 will indicate these conditions with the following result code:

```
MHnack; Disconnecting…
```

or

```
MHnack; Reconnecting…
```

Once modem on hold has been initiated, it may be necessary for the Si2493 to perform a hook-flash to indicate to the central office the incoming call may be accepted. This is initiated with the AT+PMHF command. The Si2493 will go on-hook for the time in user register U4F and remain off-hook while n-hold. Usually a second hook-flash is necessary to reestablish a data connection with the remote modem The Si2493 will attempt to reestablish a data connection with the remote modem upon receipt of the ATO command and will indicate the connection has been reestablished with the CONNECT message. If the modems fail to renegotiate the connection, the Si2493 will send the NO CARRIER message.

Table 18 lists possible responses to PMHR commands from a remote modem.

Table 18 PMHR Command Responses

Value	Description
0	V.92 Modem on Hold Request Denied or not available. The modem may initiate another Modem-on-hold request later.
1	MOH with 10 second timeout Granted
2	MOH with 20 second timeout Granted
3	MOH with 30 second timeout Granted
4	MOH with 40 second timeout Granted
5	MOH with 1 minute timeout Granted
6	MOH with 2 minute timeout Granted
7	MOH with 3 minute timeout Granted

Table 18 PMHR Command Responses

Value	Description
8	MOH with 4 minute timeout Granted
9	MOH with 6 minute timeout Granted
10	MOH with 8 minute timeout Granted
11	MOH with 12 minute timeout Granted
12	MOH with 16 minute timeout Granted
13	MOH with indefinite timeout Granted
14	MOH Request denied. Future requests will also be denied during this session.

Receiving Modem On Hold Requests

If Modem On Hold is enabled via the +PMH=1 command, the Si2493 may be placed on hold by a remote modem. The maximum time the modem will remain on hold is configured with the +PMHT setting. Possible values of +PMHT are given in Table 84. Upon receipt of a Modem On Hold request, the Si2493 will indicate +PMHR: followed by the code corresponding to the timeout granted. The DCD pin will e-assert while the modem is on hold and the CONNECT result code will indicate a return to data mode. modem disconnect due to a timeout or failed negotiation will result in a NO CARRIER result code.

V.92 Quick Connect

The Si2493 supports ITU-T V.92 shortened phase 1 and phase 2 to decrease the time required to connect to a server modem using the V.90 modulation. After the first call, the Si2493 will retain line parameters that allow it to use shortened phase 1 and 2 to reduce the total negotiation time. If line conditions change or the remote server does not support the shortening of these phases, the modem will automatically connect with the normal phase 1 and phase 2 negotiation unless specifically commanded not to. Two AT commands control this feature, AT+PQC and AT+PSS. The AT+PQC command controls the enabling and disabling of shortened phase 1 and phase 2 individually according to Table 85. It is recommended that both shortened phases be used to realize the maximum reduction in connect time. The possible settings of the AT+PSS command are shown below in Table 86. The AT+PSS command may be used to force quick connect by setting AT+PSS = 1; however, this is not recommended as calling a server that does not support this feature will result in a failed connection.

Table 19 lists possible +PMHT settings.

Table 19 PMHT Settings

Value	Description
0	Deny V.92 Modem-on-Hold Request
1	Grant MOH with 10 second timeout
2	Grant MOH with 20 second timeout
3	Grant MOH with 30 second timeout
4	Grant MOH with 40 second timeout
5	Grant MOH with 1 minute timeout
6	Grant MOH with 2 minute timeout

Table 19 PMHT Settings

Value	Description
7	Grant MOH with 3 minute timeout
8	Grant MOH with 4 minute timeout
9	Grant MOH with 6 minute timeout
10	Grant MOH with 8 minute timeout
11	Grant MOH with 12 minute timeout
12	Grant MOH with 16 minute timeout
13	Grant MOH with indefinite timeout

Table 20 lists AT+PQC command parameters.

Table 20 AT+PQC Commands

Value	Description
0	Enable Short Phase 1 and Short Phase 2
1	Enable Short Phase 1
2	Enable Short Phase 2
3	Disable Short Phase 1 and Short Phase 2

Table 21 lists AT+PSS command parameters.

Table 21 AT+PSS Commands

Value	Description
0	The DCEs decide whether or not to use the short startup procedures. The short startup procedures shall only be used if enabled by the +PQC command.
1	Forces the use of the short startup procedures on the next and subsequent connections if they are enabled by the +PQC command.
2	Forces the use of the full startup procedures on the next and subsequent connections independent of the setting of the +PQC command.

Related Documentation

- *Access-Dial Technical Tips*
- *Access Product Support Page*
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