Table 18. Basic AT Command Set

Command	Action
$	Display Basic AT command mode settings (see text for details).
A	Answer incoming call.
A/	Re-execute last command (executes immediately—not preceded by “AT” or followed by <CR>).

Table 18. Basic AT Command Set (Continued)

Command	Action	
Dn	Dial The dial command, which may be followed by one or more dial command modifiers, dials a phone number:	
	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 dial tone and dialing any digits.
	@	Wait for silence. Returns “No Answer” when call is terminated without a silent period after ringing.
	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 (e.g, ATDG), the Si2493/57/34/15/04 dials the phone number and waits S7 seconds (60 by default) to detect a busy tone. When the busy tone is detected, the Si2493/57/34/15/04 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 Si2493/57/34/15/04 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 dial tone is detected or “NO DIALTONE” if a dial tone is not detected.
En	Local DTE echo.	
E0	Disable.	
E1	**Enable.**	

Table 18. Basic AT Command Set (Continued)

Command	Action	
Hn	Hook-switch.	
H0	Go on-hook (hang up modem).	
H1	Go off-hook.	
In	Identification and checksum.	
I0	Display Si2493/57/34/15/04 revision code. A = Revision A. B = Revision B, etc.	
I1	Display Si2493/57/34/15/04 firmware revision code (numeric).	
No Patch		
AT Command	**Chip Revision**	**Response**
ATI0	B	B
ATI1	B	00
ATI0	C	C
ATI1	C	00
Revision B Patch (rb_pX_YYYY)		
AT Command	**Chip Revision**	**Response**
ATI0	B	B
ATI1	B	X
ATI0	C	B
ATI1	C	X
Revision C Patch (rc_pX_YYYY)		
AT Command	**Chip Revision**	**Response**
ATI0	B (not allowed)	N/A
ATI1	B (not allowed)	N/A
ATI0	C	C
ATI1	C	X
Command	**Action**	
I3	Display line-side revision code. 18(10)C = Si3018/10 revision C.	
I6	Display the ISOmodem model number. 2404 = Si2404 2415 = Si2415 2434 = Si2434 2457 = Si2457 2493 = Si2493	

Table 18. Basic AT Command Set (Continued)

Command	Action	
I7	Diagnostic Results 1. **Format** RX <rx_rate>,TX <tx_rate> PROTOCOL: <protocol> LOCAL NAK <rre> REMOTE NAK <rte> RETRN/RR <rn> DISC REASON <dr>	 **Description** Receive/transmit data rate in bps Error correction/data compression protocol. Number of V.42 receive errors Number of V.42 transmit errors Number of retrains/rate renegotiations Disconnect reason code (see Table 23)
I8	Diagnostic Results 2. **Format** RX LEVEL <rx_level> TX LEVEL <tx_level> EFFECTIVE S/N <esn> RESIDUAL ECHO <re>	 **Description** Receive level power in dBm Transmit level power in dBm. Effective signal-to-noise ratio in dB 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 22.)	
Q1	Disable result codes. (Enable quiet mode.)	
R	Initiate V.23 Reversal (U53 bit 15 must be set.)	
Sn	S-Register operations. (See Table 31.)	
S$	List contents of all S-registers.	
Sn?	Display 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 22.)	
V0	Numeric result codes.	
V1	**Verbal result codes.**	

Table 18. Basic AT Command Set (Continued)

Command	Action
Xn	Call Progress Monitor (CPM)—This command controls which CPM signals are monitored and reported to the host from the Si2493/57/34/15/04. (See Table 22.)
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.
:E	Read from serial EEPROM. The format is AT:Ehhhh where hhhh = EEPROM address in hexadecimal.
:I	Interrupt Read—This command causes the ISOmodem to report the lower eight bits of the interrupt register U70 (IO0). The CID, OCD, PPD, and RI bits of this register are cleared, and the $\overline{INT}$ pin (INT bit in parallel mode) is deactivated on this read.
:LPhh	Read Quick Connect data. hh is a hex value. Data is read as follows: $:LP_0$ $d_1...d_8$ $:LP_8$ $d_9...d_{16}$ $:LP_{10}$ $d_{17}...d_{24}$ $:LP_{18}$ $d_{25}...d_{32}$
:M	Write to serial EEPROM. The format is AT:Mhhhh,xxxx where hhhh = EEPROM address in hexadecimal, and xxxx = EEPROM data in hexadecimal.
:P	Program RAM Write—This command is used to upload firmware supplied by Silicon Labs to the Si2493/57/34/15/04. The format for this command is AT:Phhhh,xxxx,yyyy,.... where hhhh is the first address in hexadecimal, and xxxx,yyyy,.... is data in hexadecimal. Only one :P command is allowed per AT command line. No other commands can be concatenated in the :P command line. This command is ***only*** for use with special files provided by Silicon Laboratories. Do not attempt to use this command for any other purpose. Use &T6 to display checksum for patch verification.
:R	U-Register Read—This command reads U-Register values in hexadecimal. The format is AT:Rhh, where hh = 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.

Table 18. Basic AT Command Set (Continued)

Command	Action
:U	U-Register Write—This command writes to the 16-bit U-Registers. The format is AT:Uhh,xxxx,yyyy,zzzz,..., where hh = user-access address in hexadecimal. xxxx = data in hexadecimal to be written to location hh. yyyy = data in hexadecimal to be written to location (hh + 1). zzzz = data in hexadecimal to be written to location (hh + 2). etc. Only one :U command is allowed per AT command line.
+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.42bis is in use in both directions +DR:V42B RD Rec. V.42bis is in use in receive direction only +DR:V42B TD Rec. 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.42bis data compression function. A Direction 0 No compression (V.42bis P0 = 0) 1 Transmit only 2 Receive only 3 Both Directions (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 18. Basic AT Command Set (Continued)

Command	Action
+DS44 = A,B,C,D,E,F,G,H,I	Controls V.44 data compression function*. A Direction 0 No compression (V.42bis P0 = 0) 1 Transmit only 2 Receive only 3 Both Directions (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 ***Note:** Si2493 only
+ES = A, B, C	Enable synchronous access mode **A – specifies the mode of operation when initiating a modem connection** **D** = **Disable synchronous access 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 access mode** 8 = Enable synchronous access mode when connection is completed and data state is entered.

Table 18. 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 sub-mode** **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 transmits 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.
+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 18. 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 50 — Hong Kong 51 — Hungary 53 — India 57 — Ireland 58 — Israel 59 — Italy 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 and S6 (in Japan) to default values before setting country-specific values. Refer to the chart and setup tables beginning with "3.5.20.7. Country Parameters Table" on page 142.
+GCI?	List current country code setting (response is: + GCI:<setting>)
+GCI = ?	List all possible country code settings.

Table 18. Basic AT Command Set (Continued)

Command	Action
+IFC Options +IFC = A +IFC = A,B	Specifies the flow control 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 18. 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 modem 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 Min Tx rate. Specifies minimum transmission rate. 0 Not configurable; always set to 0. D Max Tx rate. Specifies highest transmission rate. If not specified, they are determined by the carrier and automode settings. V21 300 V32 9600 V90 33600 V22 1200 V32B 14400 V92 48000 V22B 2400 V34 33600 E Min Rx rate. Specifies minimum receive rate. 0 Not configurable; always set to 0. F Max Rx rate. Specifies maximum receive rate. If not specified (set to 0), they are determined by the carrier and automode settings. V21 300 V32 9600 V90 54666 V22 1200 V32B 14400 V92 54666 V22B 2400 V34 33600
+PCW = X	Controls the action to be taken upon detection of call waiting. X Mode 0 Toggle $\overline{RI}$ 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 18. 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.
+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.

Table 18. Basic AT Command Set (Continued)

Command	Action
+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 **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.

3.1.9. Extended AT Commands

The extended AT commands, described in Tables 19–21, are supported by the Si2493/57/34/15/04.

Table 19. Extended AT& Command Set

Command	Action
&$	Display AT& current settings (see text for details).
&Dn	Escape Pin Function (Similar to DTR)
&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 Si2493/57/34/15/04 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** (default for Si2415).
&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** (default for Si2457 transmit and Si2434).
&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)** (default for Si2457).
&H1	V.90 only (56 kbps to 28 kbps).

Notes:
1. The initial number attempted to test for an outside line is controlled by S51 (default = 1).
2. AT&$ reflects the last AT&P command issued but does not reflect any subsequent changes made by writing U-registers with AT:U.

Table 19. Extended AT& Command Set (Continued)

&H2	**V.34 with automatic fallback (33.6 kbps to 300 bps)** (default for Si2434).
&H3	V.34 only (33.6 kbps to 2400 bps).
&H4	**ITU-T V.32bis with automatic fallback (14.4 kbps to 300 bps)** (default for Si2415).
&H5	ITU-T V.32bis only (14.4 kbps to 4800 bps).
&H6	**ITU-T V.22bis only (2400 bps or 1200 bps)** (default for Si2404).
&H7	ITU-T V.22 only (1200 bps).
&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 Si2493/57/34/15/04 for 10 pulse-per-second pulse dialing. For Japan.
&P1	Configure Si2493/57/34/15/04 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 Si2493/57/34/15/04 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 (Si2493/57/34/15/04), 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.

Notes:
1. The initial number attempted to test for an outside line is controlled by S51 (default = 1).
2. AT&$ reflects the last AT&P command issued but does not reflect any subsequent changes made by writing U-registers with AT:U.

Table 19. Extended AT& Command Set (Continued)

&X0	Abort &x1 or &x2 command.
&X1	Automatic determination of telephone line type. 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 dial tone. 1 = make-break dial tone. 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.

Notes:
1. The initial number attempted to test for an outside line is controlled by S51 (default = 1).
2. AT&$ reflects the last AT&P command issued but does not reflect any subsequent changes made by writing U-registers with AT:U.

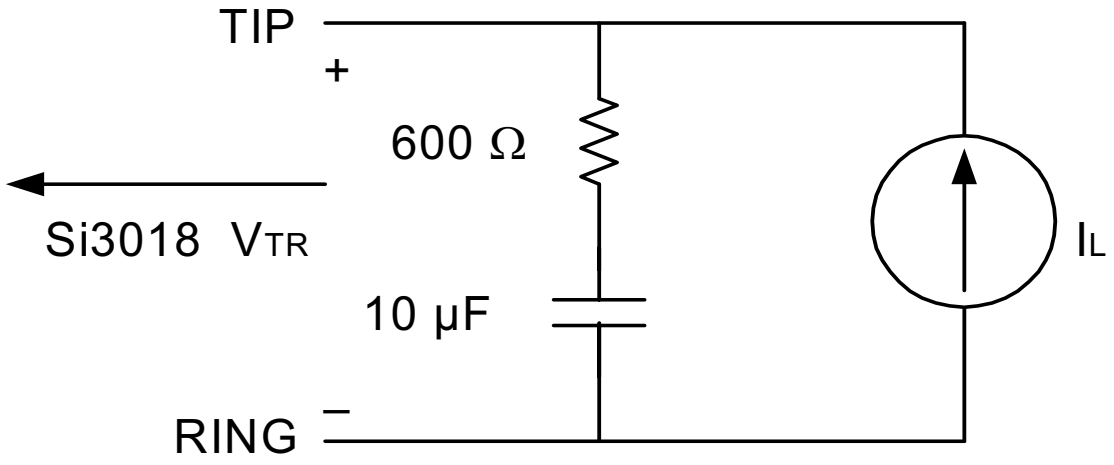


Figure 10. Phone Line Termination Circuit

Table 20. Extended AT% Command Set

Command	Action
%$	Display AT% command settings (see text for details).
%B	Report blacklist. See also S42 register.
%Cn	Data compression.
%C0	Disable V.42bis and MNP5 data compression.
%C1	**Enable V.42bis in transmit and receive paths.** If MNP is selected (\N2), %C1 enables MNP5 in transmit and receive paths.
%C2	Enable V.42bis in transmit path only.
%C3	Enable V.42bis in receive path only.
%On	Answer mode.
%O1	**Si2493/57/34/15/04 answers a call in answer mode.**
%O2	Si2493/57/34/15/04 answers a call in originate mode.
%Vn	Automatic Line Status Detection. After the %V1 and %V2 commands are issued, the Si2493/57/34/15/04 automatically checks the telephone connection for whether a line is present. If a line is present, the Si2493/57/34/15/04 automatically checks if the line is already in use. Finally, the Si2493/57/34/15/04 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 Si2493/57/34/15/04 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 (described in "3.5.9. Intrusion Detection—Off-Hook Condition" on page 124) operates normally. In addition, the Si2493/57/34/15/04 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.

Table 20. Extended AT% Command Set (Continued)

%V2	Automatic Line Status Detection - Adaptive Method. Description: Before going off-hook with the ATD, ATO, or ATA commands, the Si2493/57/34/15/04 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 Si2493/57/34/15/04 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 (described in "3.5.9. Intrusion Detection—Off-Hook Condition" on page 124) operates normally. In addition, the Si2493/57/34/15/04 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.

The connect messages shown in Table 21 are sent when link negotiation is complete.

Table 21. 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)
\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 Si2493/57/34/15/04 attempts to connect with the MNP protocol. If unsuccessful, the call is dropped. Compression is controlled by %Cn.
\N3	**V.42 auto-reliable—The Si2493/57/34/15/04 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 Si2493/57/34/15/04 drops the call instead of connecting in MNP or wire mode. Compression is controlled by %Cn.
\N5	V.42 and MNP reliable mode - The Si2493/57/34/15/04 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

Notes:

1. 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.
2. 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 Si2493/57/34/15/04 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.
3. The autobaud feature does not detect this rate.
4. Default is \T16 (autobaud); otherwise, \T9 (19.2 kbps) if a pulldown is connected to pin 18 (24-pin device only).

Table 21. Extended AT\ Command Set (Continued)

Command	Action
\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.**
\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]

Notes:

1. 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.
2. 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 Si2493/57/34/15/04 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.
3. The autobaud feature does not detect this rate.
4. Default is \T16 (autobaud); otherwise, \T9 (19.2 kbps) if a pulldown is connected to pin 18 (24-pin device only).

Table 21. Extended AT\ Command Set (Continued)

Command	Action
\T15	307.200 kbps
\T16	**Autobaud On[4]**
\T17	Autobaud Off. Lock at current baud rate.
\U	Serial mode—causes a low pulse (25 ms) on $\overline{RI}$ and $\overline{DCD}$. $\overline{INT}$ to be the inverse of ESC. $\overline{RTS}$ to be inverse of $\overline{CTS}$. Parallel mode—causes a low pulse (25 ms) on $\overline{INT}$. This command terminates with a $\overline{RESET}$ 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.

Notes:

1. 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.
2. 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 Si2493/57/34/15/04 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.
3. The autobaud feature does not detect this rate.
4. Default is \T16 (autobaud); otherwise, \T9 (19.2 kbps) if a pulldown is connected to pin 18 (24-pin device only).

Table 22. Result Codes

Numeric[4]	Meaning	Verbal Response	X0	X1	X2	X3	X4	X5
0	Command was successful	OK	X	X	X	X	**X**	X
1	Link established at 300 bps or higher	CONNECT	X	X	X	X	**X**	X
2	Incoming ring detected	RING	X	X	X	X	**X**	X
3	Link dropped	NO CARRIER	X	X	X	X	**X**	X
4	Command failed	ERROR	X	X	X	X	**X**	X
5	Link establish at 1200	CONNECT 1200		X	X	X	**X**	X
6	Dial tone not present	NO DIALTONE			X		**X**	X
7	Line busy	BUSY				X	**X**	X
8	Remote not answering	NO ANSWER	X	X	X	X	**X**	X
9	Ringback detected	RINGING						X
10	Link established at 2400	CONNECT 2400		X	X	X	**X**	X
11	Link established at 4800	CONNECT 4800[5]		X	X	X	**X**	X
12	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

Notes:

1. This message is only supported on the Si2493, Si2457 and Si2434.
2. 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>.
3. This message is only supported on the Si2493 and Si2457.
4. Numeric mode: Result code <CR>.
5. This message is only supported on the Si2493, Si2457, Si2434, and Si2415.
6. V.44 with data compression disabled (+DS = 0) emits this result code.
7. Protocol :V42 message is sent if data compression is disabled (+DS = Q).

Table 22. Result Codes (Continued)

Numeric[4]	Meaning	Verbal Response	X0	X1	X2	X3	X4	X5
32	UK CID State Tone Alert Signal detected	STAS	X	X	X	X	**X**	X
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 black-listed.	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
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[6]	Set with \V0 command.					
79	V.42bis protocol	PROTOCOL: V42bis[5]	Set with \V0 command.					

Notes:

1. This message is only supported on the Si2493, Si2457 and Si2434.
2. 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>.
3. This message is only supported on the Si2493 and Si2457.
4. Numeric mode: Result code <CR>.
5. This message is only supported on the Si2493, Si2457, Si2434, and Si2415.
6. V.44 with data compression disabled (+DS = 0) emits this result code.
7. Protocol :V42 message is sent if data compression is disabled (+DS = Q).

Table 22. Result Codes (Continued)

Numeric[4]	Meaning	Verbal Response	X0	X1	X2	X3	X4	X5
80	MNP2 protocol	PROTOCOL: ALTERNATE, +CLASS 2	Set with \V command.					
81	MNP3 protocol	PROTOCOL: ALTERNATE, +CLASS 3	Set with \V command.					
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[7]	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
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

Notes:

1. This message is only supported on the Si2493, Si2457 and Si2434.
2. 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>.
3. This message is only supported on the Si2493 and Si2457.
4. Numeric mode: Result code <CR>.
5. This message is only supported on the Si2493, Si2457, Si2434, and Si2415.
6. V.44 with data compression disabled (+DS = 0) emits this result code.
7. Protocol :V42 message is sent if data compression is disabled (+DS = Q).

Table 23. Disconnect Codes

Disconnect Code	Reason
8002	Handshake stalled.
8	No dial tone 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.
801c	Loss-of-carrier disconnect.
801e	Long space disconnect.
801f	Character abort disconnect.
802a	Rate request failed.
802b	Answer modem energy not detected.
802c	V.8 negotiation failed.
2d	TX data timeout.

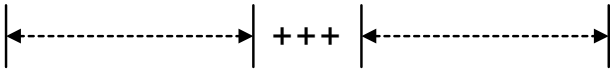
3.1.10. Escape Methods

There are four ways to escape from data mode and return to command mode once a connection is established. Three of these, “+++”, “9th Bit”, and the “Escape Pin”, allow the connection to be maintained while one or both modems are in the command mode. These three escape methods can be concurrently enabled, and any enabled escape method functions. For example, if “+++” and the “Escape Pin” are both enabled, either returns the modem to the command mode from the data mode. The fourth escape method is to terminate the connection.

Always wait for the “OK” before entering the next command after an escape. When making a new connection, do not try to escape between the connect message and the protocol message. An escape attempt in this interval may fail because the modem is not in data mode until after the protocol message.

3.1.10.1. “+++” Escape

The “+++” escape 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 Si2493/57/34/15/04 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 11.



Guard Time = S12 (20 msec units)
Default Guard Time S12 = 50 (1.0 sec)
Guard Time Range = 10–255 (0.2–5.1 sec)

Figure 11. “+++” Escape Timing

3.1.10.2. “9th Bit” Escape

The “9th Bit” escape mode feature is enabled by sending the AT\B6 command through autobaud, which detects a 9th bit space as “9th bit” escape mode. If this escape method is selected, a 1 detected on the ninth bit in a data word returns the modem to the command mode. The 9th bit is ignored when the modem is in the command mode. Timing for this escape sequence is illustrated in Figure 12.

3.1.10.3. “Escape Pin” Escape

The “Escape Pin” is controlled by U70[15] (HES). This bit is 0 by default, which disables the Escape pin, ESC, (Si2493/57/34/15/04, pin 22). If HES is set to a 1, a high level on Si2493/57/34/15/04, pin 22, causes the modem to transition to the on-line command mode. The ESC pin status is polled by the processor, and there is a latency before the “OK” is received and the modem is in command mode. Keep the “escape pin” active until the “OK” is received. In parallel interface mode, the function of the Escape pin is replaced by bit 2 in the Parallel Interface Register 1. Setting bit 2 to a 1 causes the modem to escape to the command mode.

While in data mode, an escape to command mode occurs if ESC is sampled as negated for at least 60 ms, then sampled asserted for at least 60 ms. The modem is then prepared to accept AT commands, regardless of whether the “OK” has been sent to the host. If the modem is already in command mode, the modem does not send the “OK”.

In practice, it is difficult to determine the exact boundary between command mode and data mode. Time the ESC 100 ms low and 100 ms high, and expect that the modem has transitioned to command mode. Then, dump the receive buffer after 100 ms, send “AT”, and wait for “OK”. This way, you know the modem is in command mode because the “OK” is caused by the “AT” and not by the ESC toggling.

UART Timing for Modem Transmit Path (9N1 Mode with 9th Bit Escape)

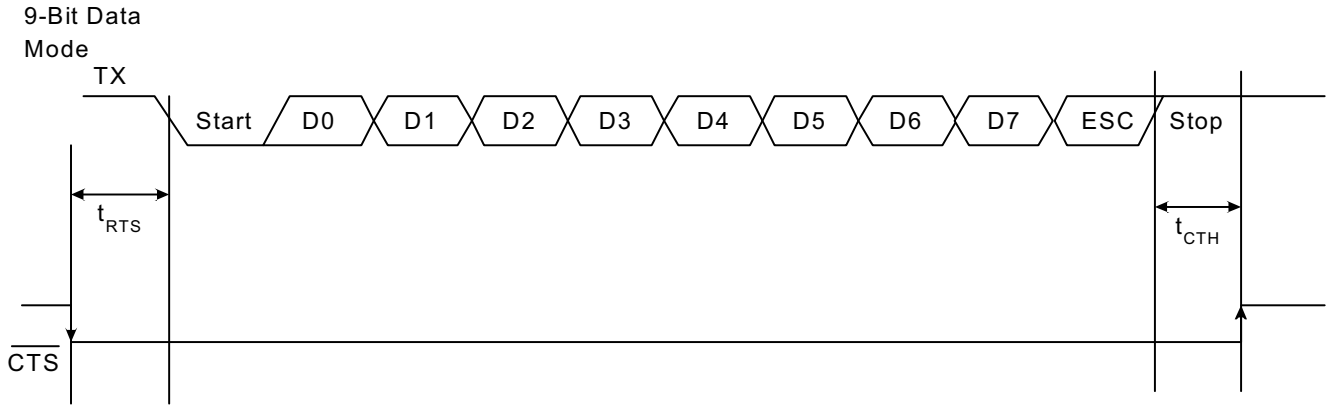


Figure 12. “9th Bit” Escape Timing

3.1.11. Sleep Mode

The Si2493/57/34/15/04 can be set to enter a low-power sleep mode when not connected and after a period of inactivity determined by the S24 register.

The Si2493/57/34/15/04 enters the sleep mode S24 seconds after the last DTE activity, after the TX FIFO is empty, and after the last data is received from the remote modem. The Si2493/57/34/15/04 returns to the active mode when there is a 1 to 0 transition on TXD in the serial mode or a 1 to 0 transition on $\overline{CS}$ in the parallel mode or if an incoming ring is detected. The delay range for S24 is 1 to 255 seconds. The default setting of S24 = 0 disables the sleep timer and keeps the modem in the normal power mode regardless of activity level.

3.1.12. Powerdown

The powerdown mode is a lower power state than sleep mode but is entered immediately upon writing U65[13] (PDN) = 1. Once in the powerdown mode, the modem requires a hardware reset via the $\overline{RESET}$ pin (Si2493/57/34/15/04, pin 12) to become active.

3.1.13. Reset/Default Settings

The modem must be reset after power is stable and prior to the first “AT” command. The reset pin (Si2493/57/34/15/04, pin 12) must be asserted at least 5 ms low to adequately reset the on-chip registers.

$\overline{CTS}$ (pin 11) must remain at a Logic 1 (high state) during Reset. The internal pull-up resistor is adequate for most applications. If leakage or transients are present on $\overline{CTS}$ during Reset, the high value internal resistor should be supplemented with an external 10 kΩ resistor to V_{CC}.

Autobaud is enabled on the DTE by default. A 10 kΩ resistor connected from EESD/D2 (Si2493/57/34/15/04 pin 18) to GND (Si2493/57/34/15/04 pin 20) disables autobaud on powerup or reset and forces 19.2 kbps. Serial or parallel interface selection depends upon the state of Si2493/57/34/15/04, pin 15, AOUT/$\overline{INT}$, at the rising edge of the reset pulse. If AOUT/$\overline{INT}$ is left open, an internal pullup resistor holds the pin at a logic 1, and the serial interface is selected (default). If AOUT/$\overline{INT}$ is connected to ground through a 10 kΩ resistor, the parallel interface is selected.

A 10 kΩ resistor between D6 (Si2493/57/34/15/04 pin 4) and GND (Si2493/57/34/15/04 pin 20) enables the EEPROM interface on powerup or reset. Table 24 summarizes the options for enabling features on powerup and reset by connecting a 10 kΩ resistor between the indicated Si2493/57/34/15/04 pin and GND (Si2493/57/34/15/04 Pin20). Zeroes indicate a <10 kΩ pulldown to ground at startup or reset; “1”s indicate internal pullup (do not pull down externally), and “X”s indicate a don’t care.

Table 24. Si2493/57/34/15/04 Pull-Downs and Features

Mode	Pin4	Pin9	Pin10	Pin11	Pin15	Pin18	Pin23*
Serial, EEPROM, 27 MHz, Autobaud	0	1	X	1	1	1	0
Serial, EEPROM, 27 MHz, 19.2K DTE	0	1	X	1	1	0	0
Serial, EEPROM, 4.9152 MHz, Autobaud	0	1	X	1	1	1	1
Serial, EEPROM, 4.9152 MHz, 19.2K DTE	0	1	X	1	1	0	1
Serial, 27 MHz, Autobaud*	1	1	X	1	1	1	0
Serial, 27 MHz, 19.2K DTE	1	1	X	1	1	0	0
Serial, 4.9152 MHz, Autobaud*	1	1	X	1	1	1	1
Serial, 4.9152 MHz, 19.2K DTE	1	1	X	1	1	0	1
Parallel, 4.9152 MHz	X	1	1	1	0	X	X
Parallel, 27 MHz	X	1	1	0	0	X	X
***Note:** 27 MHz is the only pulldown option available on the 16-pin devices and can be enabled with a pulldown on pin 15 rather than pin 23.							

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 approximately 300 ms.

There is no non-volatile memory on the Si2493/57/34/15/04 other than Program ROM. When reset, the Si2493/57/34/15/04 reverts to the original factory default settings. Any set-up or configuration data and software updates must be reloaded after every reset. This is true whether the reset occurs due to a power-down/powerup cycle, a power-on reset through a manual reset switch, by writing U6E[4] (RST) = 1, or executing ATZ.

A suggested reset sequence is as follows:

1. Apply reset pulse to $\overline{\text{RESET}}$ (Si2493/57/34/15/04, pin 12); write RST bit or ATZ<CR>.
2. Wait > 300 ms.
3. Load firmware updates (if required).
4. Set non-default DAA interface parameters—DCV, ACT, ILIM, OHS2, OHS, RZ, RT, (U67), LIM, (U68).
5. Set non-default cadence values—Busy Tone, Ringback, Ring.
6. Set non-default frequency values—Ring.
7. Set non-default filter parameters.
8. Set non-default S-register (values).

The modem is now ready to detect rings, answer another modem, call, or dial out to a remote modem.

Some key default settings for the modem after reset or powerup include the following:

- Serial interface.
- V.92 and fall-backs enabled (Si2493).
- V.90 and fall-backs enabled (Si2457).
- V.34 and fall-backs enabled (Si2434).
- V.32bis and fall-backs enabled (Si2415).
- V.22bis and fall-backs enabled (Si2404).
- V.42/42bis enabled.
- “+++” escape sequence enabled.
- Answer-on-ring is disabled.
- Speaker off.
- DTE echo enabled.
- Verbal result codes enabled.
- CTS only enabled.
- FCC (US) DAA and call progress settings.

Review the AT command tables and register lists for complete details on all default settings. AT commands and register writes must be used to modify factory defaults after *every* reset.

3.2. DSP

The DSP (data pump) is primarily responsible for modulation, demodulation, equalization, and echo cancellation. Because the ISOmodem is controller-based, all interaction with the DSP is via the controller through AT commands, S-Registers, and/or U-Registers.

3.3. Memory

The user accessible memory in the Si2493/57/34/15/04 consists of the S-Registers accessed via the ATSn command, and the U-Registers from 0x0000 to 0x0079 in the main memory space, accessed via the AT:Rhh (register read) and the AT:Uhh (register write) commands (where hh is the two digit hexadecimal address of the register) and the external EEPROM. These memory locations allow the modem to be configured for a wide variety of functions and applications and for global operation.

3.3.1. Firmware Upgrades

The Si2493/57/34/15/04 contains an on-chip Program ROM that includes the firmware required for the features listed in the data sheet. Additionally, the Si2493/57/34/15/04 contains on-chip Program RAM to accommodate minor changes to ROM firmware. This allows Silicon Labs to provide future firmware updates to optimize the characteristics of new modem designs and those already deployed in the field.

Firmware upgrades (patches) provided by Silicon Labs are files loaded into the Si2493/57/34/15/04 Program RAM after a reset using the AT:P command (see Table 18). Once loaded, the upgrade status can be read using the ATI1 command to verify the firmware revision number. The entire firmware upgrade in RAM is always cleared on a reset. To reload the file after a reset or powerdown, the host processor rewrites the file using the AT:P command during post-reset initialization.

Patch files may be more than 6000 characters in some cases. They come in a .txt file containing multiple lines that are sent serially to the ISOmodem. There are several patch loading techniques that can be used in different environments. See the description and Table 25. Whichever technique is used, it is wise to do an AT&T6 to verify the CRC of the loaded patch.

3.3.1.1. Method 1 (The Fastest)

Send the entire file in quiet mode using a program that waits for a precise amount of time after every line. This can give load times as short as 0.7 seconds for a 6235 byte patch (at 115 kBaud). The file transfer should be preceded by an ATZ or RESET followed by an ATE0 and an ATQ1. After the transfer, perform an ATE1 and/or ATQ0 if needed.

1. Low pulse on RESET signal for at least 5.0 ms.
2. Wait 300 ms.
3. Send ATE0.
4. Wait for an OK.
5. Send ATQ1 to the modem.
6. Wait 0.5 ms.
7. Send AT:PIC (First line of the patch).
8. Wait 0.5 ms.

...

(n-5) Send AT:PIC0 (Last Line of Patch).

(n-4) Wait 0.5 ms.

(n-3) Send ATQ0 to the modem.

(n-2) Wait for an OK.

(n-1) Send AT&T6 to the modem.

(n) Wait for an OK.

3.3.1.2. Method 2

Send the entire file using a program that waits for an OK after every line. This will give 3.98 seconds for a 6235 byte patch (at 115 kBaud). Perhaps longer if the OS has some latency issues.

3.3.1.3. Method 3

For development purposes, send the entire patch file using a program that allows a timed preprogrammed pause between lines, e.g. Hyper terminal or ProComm. This will give times of around 16 seconds for a 6235 byte patch (at 115 kBaud). Due to the granularity of a typical desktop operating system, be sure to set the time delay between lines to 100 ms.

Table 25. Load Technique and Speed Table*

Start Condition:	Delay between lines	Load Time (sec) for a 6235 byte patch (at 115 kBaud)	Approach used with:
RESET then ATE0 & ATQ1	0.5 ms	0.694	Embedded Systems
	1.0 ms	0.771	Embedded Systems
	2.0 ms	0.925	Embedded Systems
	5.0 ms	1.385	Embedded Systems
	10.0 ms	2.152	Embedded Systems
RESET	Wait for OK/ CR/LF	3.998	Windows or Embedded System where time precision is poorer than 10 ms
RESET	100.0 ms	15.962	Windows without writing a patch loader

***Note:** The delay times do not include the time to empty the UART's possibly long TX buffer. The time quoted is between the end of transmission of the last character of a line and the start of transmission of the first character of the next line.

A CRC can be run on the upgrade file loaded into on-chip Program RAM with the AT&T6 command to verify that the upgrade was correctly written to the on-chip memory. The CRC value obtained from executing the AT&T6 command should match the CRC value provided with the upgrade code.

The following memory notation conventions are followed in this document:

- Single variable U-Registers are identified in this document as the register type (i.e., U) followed by the last two digits of the register's hexadecimal address and finally the register "name" in parenthesis. Example: U4A(RGFD). Once the full register reference is made, continuing discussion refers to the register name to simplify the text. The address and value of a single variable U-Register are *always* read from or written to the Si2493/57/34/15/04 in hexadecimal.
- Bit-mapped U-Registers are identified in this document at the top level as the register type (i.e., U) followed by the last two digits of the register's hexadecimal address and finally the register "name" in parenthesis. Example: U67 (ITC1). Once the full register reference is made, continuing discussion of the register at the top level refers to the register name to simplify the text. The address and value of a bit-mapped U-Register is *always* read from or written to the Si2493/57/34/15/04 in hexadecimal.
- Bits within bit-mapped registers are identified in this document as the register type (i.e., U) followed by the last two digits of the register's hexadecimal address, the bit or bit range within the register in brackets, and finally the bit or bit range "name" in parenthesis. Example: U67[6](OHS) or U67[3:2](DCT). Once the full register reference is made, continuing discussion of the bits or bit range refers to the bit or bit range name to simplify the text. The bit or bit range inside the bracket represents the actual bit or bit range within the register. The value of a bit or bit range is presented in binary for clarity. However, the address and value of a bit-mapped U-Register is *always* read from or written to the Si2493/57/34/15/04 in hexadecimal.
- Si2493/57/34/15/04 S-Registers are identified with a decimal address (e.g., S38), and the number stored in an S-Register is also a decimal value.

3.3.2. EEPROM Interface (24-Pin TSSOP Only)

The ISOmodem chipset supports an optional serial peripheral interface (SPI) bus EEPROM. The EEPROM must support SPI mode 3 with a 16-bit (8 kbit – 64 kbit range) address. Upon powerup, if a pulldown resistor ≤10 kΩ is placed between D6 (Si2493/57/34/15/04, pin 4) and GND, the Si2493/57/34/15/04 attempts to detect an EEPROM. The modem looks for a carriage return in the first 10 memory locations. If none is found (unprogrammed EEPROM), the modem stops reading the EEPROM. An installed EEPROM may contain custom default settings, firmware upgrades, and/or user-defined AT command macros for use in custom AT commands or country codes.

Once the EEPROM is detected, customer defaults that are programmed into the EEPROM between the optional heading "BOOT" and the "<CR><CR>" delimiter execute immediately, and AT command macros are loaded into on-chip RAM. The memory that

may be allocated to the <commands> portion of the EEPROM is limited to 1000 bytes.

Firmware upgrades may also be automatically loaded into the Si2493/57/34/15/04 using the BOOT format. Note that three <CR>'s must be the last three entries in the EEPROM.

The Si2493/57/34/15/04 includes a simple three-wire interface that may be directly connected to serial SPI EEPROMs that are available from several different manufacturers.

For example:

25LC080—25LC640 Microchip

AT25080—AT25640 Atmel

The EEPROM must be between 8192 and 65536 bits in size and support the commands given in Table 27. The EEPROM must also support 16-bit addressing regardless of size, allow a minimum clock frequency of 1 MHz, and should assert its output on falling edges of EECLK and latch input data on rising edges of EECLK. A four-wire EEPROM (with separate serial input and output data wires may be used with the input and output pins connected to EESD so long as SDO is tristated on the last falling edge of EECLK during a read cycle. All data is sent to and from the EEPROM with the LSB first.

Figure 13 shows the connection diagram for the EEPROM feature.

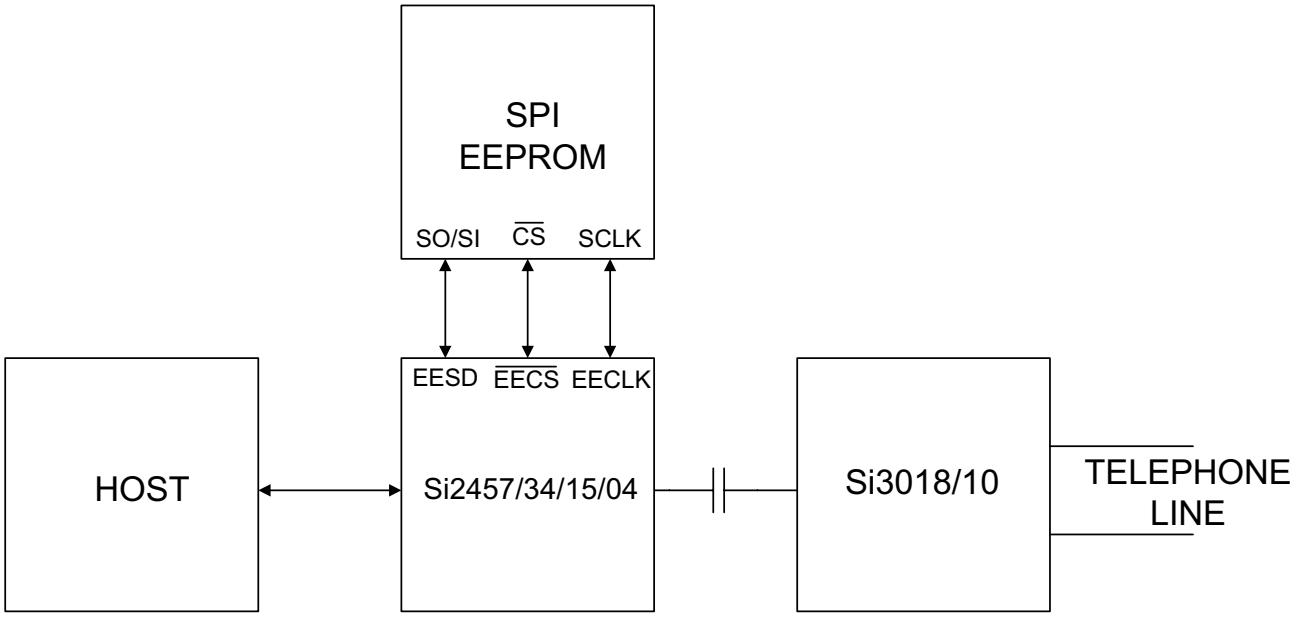


Figure 13. EEPROM Connection Diagram

Table 26. EEPROM Status Register (Any Other Bits are Unused)

7	6	5	4	3	2	1	0
—	—	—	—	—	—	WEL	WIP

WEL = write enable latch

WIP = write in progress

Table 27. EEPROM Commands

Instruction Name	Instruction Format	Description
READ	0000 0011	Read data from memory at address
WRITE	0000 0010	Write data to memory array beginning at address
WRDI	0000 0100	Clear write enable bit (disable write operation)
RDSR	0000 0101	Read status register
WRSR	0000 0001	Write status register
WREN	0000 0110	Set write enable bit (enable write operations)

Table 28. EEPROM Timing

Parameter	Symbol	Min.	Typ.	Max.	Unit
EECLK period	ECLK	1.0	—	—	µs
EESD input setup time	EISU	100	—	—	ns
EESD input hold time	EIH	100	—	—	ns
EESD output setup time*	EOSU	500	—	—	ns
EESD output hold time*	EOH	500	—	—	ns
$\overline{\text{EECS}}$ asserted to EECLK positive edge	ECSS	500	—	—	ns
EESD tristated before last falling EECLK edge during read cycle. Last positive half of EECLK cycle is extended to provide both 500 ns minimum EOH and 100 ns EESD before EECLK falling edge.	EOZ	100	—	—	ns
$\overline{\text{EECS}}$ disable time between accesses	ECSW	500	—	—	ns
$\overline{\text{EECS}}$ asserted after final EECLK edge	ECSH	1	—	—	µs
***Note:** EESD output at negative EECLK edge					

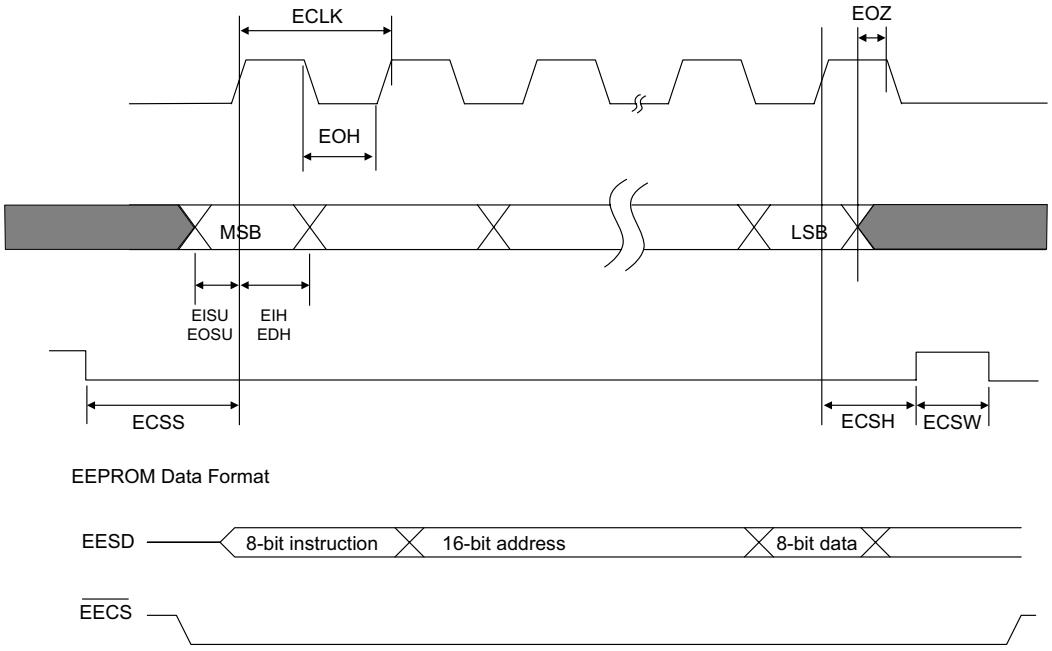


Figure 14. EEPROM Serial I/O Timing

3.3.3. Detailed EEPROM Examples

EEPROM Data is stored and read in hex ascii format in eight address blocks beginning at a specified hex address. For example, the AT:M0000,y0,y1,y2,y3,y4,y5,y6,y7 command writes the hex values y0…y7 at the hex addresses from 0000 to 0007, respectively. The AT:E0000 command reads the hex values y0…y7 from the hex addresses 0000 to 0007, respectively.

3.3.4. Boot Commands (custom defaults)

Commands to be executed upon boot-up are stored between the heading “BOOT” and the first <CR><CR> delimiter. The boot command has the following format:

```
BOOT<CR>
<commands><CR>
<commands><CR>
<CR>
```

The commands end with a <CR>, which, in combination with the final<CR>, provides the <CR><CR> delimiter. Boot commands must be the first entry in the EEPROM and are used to set the modem up with custom defaults, such as settings for specific countries, auto answer, or other special settings upon power-up or after a hardware or software reset. This saves the host processor from reloading special configuration strings at power up or after a reset and allows the modem to be customized by programming the EEPROM or substituting preprogrammed EEPROMs. If the BOOT command is the final entry in the EEPROM, it must end with an additional <CR> to provide the <CR><CR><CR> delimiter indicating the end of the EEPROM.

3.3.5. AT Command Macros (customized AT commands)

Macros allow the creation of single custom AT commands that execute combinations of default AT commands including special register configurations. AT command macros have the following format:

```
<command name><CR>
<commands><CR>
<commands><CR>
<CR>
```

Each AT Command Macro ends with a <CR><CR>. The final entry in the EEPROM ends with an additional <CR> to provide the <CR><CR><CR> delimiter indicating the end of the EEPROM. AT command macros can have a name consisting of any string of characters but must be the only command on a line.

3.3.6. Firmware Upgrades

Firmware upgrades (“patches”) are typically executed upon boot-up and stored between the heading, “BOOT”, and the first <CR><CR> delimiter. A firmware upgrade has the format: BOOT<firmware upgrade><CR>. The firmware upgrade ends with a <CR>, which, in combination with the final<CR>, provides the <CR><CR> delimiter. Firmware upgrades can also be stored as an AT command macro if there are cases when using the firmware upgrade is optional.