Analog Socket Modem

AL2094S Series

Designer's Guide

Version 102

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1. INTRODUCTION

1.1 Overview

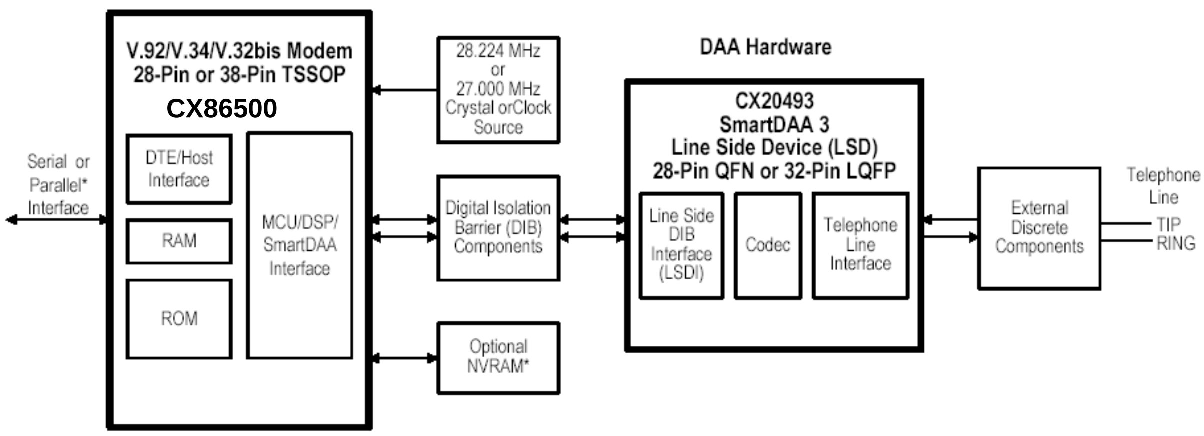
The xmodus AL2094S Socket Modem Family provides the OEM with a complete V.92, V.34 and V.32bis data/fax/voice modem in a compact socket-mountable DIL-40 module. This designer's guide describes the modem hardware. AT commands and S registers are defined in the AT Command Reference Manual.

The compact size and high level of integration of the Socket Modem minimizes real estate and cost for motherboard and box modem applications. Its low power consumption makes it ideal for portable applications such as pocket modems or laptop, notebook and palmtop computers, and for a wide variety of embedded control applications. The pin compatibility between the full range of AL Series Socket Modems, ISDN and GSM Socket Modems allows upgrading and production configurability without hardware changes.

Data compression (V.44/V.42 bis/MNP 5) and error correction (V.42/MNP 2-4) modes are supported to maximize data throughput and data transfer integrity. V.44 is a more efficient data compression than V.42 bis that significantly increases downstream throughput thus reducing the download time for the types of files associated with Internet use, such as Web pages and uncompressed files such as graphics, image, audio, and document files. V.44 data compression can achieve compression rates of more than 25% over V.42bis. Typical compression ratio for V.44 on Web type data is approximately 6-1 resulting in overall effective data throughput rate up to 300 kbps for a 56 kbpsconnection. Non-error-correcting mode is also supported.

In V.22 bis fast connect mode, the modem can connect at 2400 bps with a very short training time, which is very efficient for small data transfers.

The SmartDAA system-powered DAA operates reliably without drawing power from the line, unlike line-powered DAAs which operate poorly when line current is insufficient due to long lines or poor line conditions. Enhanced features, such as monitoring of local extension status without going off-hook, are also supported.



1.2 FEATURES

1.2.1 General Modem Features

- Data modem
  - QuickConnect and Modem-on-hold functions
  - ITU-T V.92 , V.34 , V.32bis, V.32,
  - V.22 bis, V.22, V.23, and V.21; Bell 212A and Bell 103
  - V.250 and V.251 commands
- V.22 bis fast connect
- Data compression and error correction
  - V.44 data compression
  - V.42 bis and MNP 5 data compression
  - V.42 LAPM and MNP 2-4 error correction
- Hardware-based modem controller
- Hardware-based digital signal processor (DSP)
- Worldwide operation
  - Complies to TBR21 and other country requirements
  - Caller ID detection for many countries
  - Call progress, blacklisting
  - Internal ROM includes default values for 29 countries
  - Additional modified country profiles can be stored in internal SRAM
- Caller ID detect
  - On-hook Caller ID detection
  - Off-hook Call Waiting Caller ID detection during data mode in V.90, V.34,

  V.32bis, and V.32
- Distinctive ring detect
- Built-in DTE interface
- Serial ITU-T V.24 (EIA/TIA-232-E) logical interface up to 115.2 kbps
- Direct mode (serial DTE interface)
- Flow control and speed buffering
- Automatic format/speed sensing
- Serial async/sync data
- +3.3V operation with +5V tolerant digital inputs
- Typical power use
  - 220 mW (Normal Mode)
  - 56 mW (Sleep Mode)

1.2.2 SmartDAA Features

- System side powered DAA operates under poor line current supply conditions
- Modem Wake-on-Ring
- Ring detection
- Line polarity reversal detection
- Line current loss detection
- Pulse dialing
- Line-in-use detection during on-hook operation
- Remote hang-up detection for efficient call termination
- Extension pickup detection
- Call waiting detection
- Digital PBX line protection
- Meets worldwide DC VI masks requirements

1.3 TECHNICAL OVERVIEW

1.3.1 General Description

Modem operation, including dialing, call progress, telephone line interface, telephone handset interface, and host DTE interface functions are supported and controlled through the V.250, V.251, and V.253-compatible command set.

1.3.2 MCU Firmware

MCU firmware performs processing of general modem control, command sets, data modem, error correction and data compression (ECC), fax class 1, fax class 1.0, voice/audio/TAM, worldwide, V.80, and serial DTE host interface functions according to modem models (Table 1-1).

1.3.3 Operating Modes

In V.90 data modem mode (V.92 models), the modem can receive data from a digital source using a V.92-compatible central site modem at line speeds up to 56 kbps. Asymmetrical data transmission supports sending data at line speeds up to V.34 rates. This mode can fallback to full-duplex V.34 mode and to lower rates as dictated by line conditions.
The following modes are also supported in V.92 models:

- QuickConnect which allows quicker subsequent connection to a server using stored line parameters obtained during the initial connection. The server must support quick connect profiles.

- Modem-on-Hold which allows detection and reporting of incoming phone calls on the PSTN with enabled Call Waiting. If the incoming call is accepted by the user, the user has a pre-defined amount of time of holding the data connection for a brief conversation. The data connection resumes upon incoming call termination. The server must support Modem-on-Hold functionality.

In V.34 data modem mode (V.90+ and V.34 models), the modem can operate in 2-wire, full-duplex, asynchronous modes at line rates up to 33.6 kbps. Data modem modes perform complete handshake and data rate negotiations. Using V.34 modulation to optimize modem configuration for line conditions, the modem can connect at the highest data rate that the channel can support from 33600 bps down to 2400 bps with automatic fallback. Automode operation in V.34 is provided in accordance with PN3320 and in V.32 bis in accordance with PN2330. All tone and pattern detection functions required by the applicable ITU or Bell standards are supported.

In V.32 bis data modem mode, the modem can operate at line speeds up to 14.4 kbps.

In V.22 bis fast connect data mode, the modem can connect at 2400 bps with a very short training time, which is very efficient for small data transfers.

1.3.4 V.44 Data Compression

V.44 provides more efficient data compression than V.42 bis that significantly decreases the download time for the types of files associated with Internet use. This significant improvement is most noticeable when browsing and searching the web since HTML text files are highly compressible. (The improved performance amount varies both with the actual format and with the content of individual pages and files.)

1.3.5 Synchronous Access Mode (SAM) - Video Conferencing

V.80 Synchronous Access Mode between the modem and the host/DTE is provided for host-controlled communication protocols, e.g., H.324 video conferencing applications. Voice-call-first (VCF) before switching to a videophone call is also supported.

1.3.6 Worldwide Operation

The modem operates in TBR21-compliant and other countries. Country-dependent modem parameters for functions such as dialing, carrier transmit level, calling tone, call progress tone detection, answer tone detection, blacklisting, caller ID, and relay control are programmable.
SmartDAA technology allows a single PCB design and single BOM to be homologated worldwide. Advanced features such as extension pickup detection, remote hang-up detection, line-in-use detection, and digital PBX detection are supported. Country code IDs are defined by ITU-T T.35.
Internal ROM includes default profiles for 29 countries including TBR21-compliant profiles. Additional country profiles can be stored in internal SRAM (request additional country profiles from a Conexant Sales Office). Duplicate country profiles stored in internal SRAM will override the profiles in internal RAM firmware. The default countries supported are listed in Table 1-2.

Country	Country Code	Call Waiting Tone Detection (CW) Supported	On-Hook Type 1 Caller ID (CID) Supported	Off-Hook Type 2 Called ID (CID2) Supported
Australia	09	X		
Austria	0A	X	X	
Belgium	0F	X		
Brazil	16	X		
China	26	X	X	
Denmark	31	X	X	
Finland	3C	X	X	
France	3D	X	X	X
Germany	42	X	X	
Greece	46	X		
India	53		X	
Ireland	57			
Italy	59	X		
Japan	00	X	X	X
Korea	61	X		
Malaysia	6C	X		
Mexico	73			
Netherlands	7B			
Norway	82	X		
Poland	8A	X		
Portugal	8B	X		
Singapore	9C	X	X	X
South Africa	9F	X		
Spain	A0	X		
Sweden	A5	X		
Switzerland	A6	X		
Taiwan	FE	X	X	
United Kingdom	B4	X	X	X
United States	B5	X	X	X

2. TECHNICAL SPECIFICATIONS

2.1 Serial DTE Interface Operation

2.1.1 Automatic Speed/Format Sensing

Command Mode and Data Modem Mode. The modem can automatically determine the speed and format of the data sent from the DTE. The modem can sense speeds of 300, 600, 1200, 2400, 4800, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 38400, 57600, and 115200 bps and the following data formats:

Parity	Data Length (No. of Bits)	No. of Stop Bits	Character Length (No. of Bits)
None	7	2	10
Odd	7	1	10
Even	7	1	10
None	8	1	10
Odd	8	1	11*
Even	8	1	11*
*11-bit characters are sensed, but the parity bit is stripped off during data transmission in Normal and Error Correction modes.			

The modem can speed sense data with mark or space parity and configures itself as follows:

DTE Configuration	Modem Configuration
7 mark	7 none
7 space	8 none
8 mark	8 none
8 space	8 even

Fax Modem Mode. In V.17 fax mode, the modem can sense speeds up to 115.2 kbps.

2.2 Establishing Data Modem Connections

2.2.1 Telephone Number Directory

The modem supports four telephone number entries in a directory that can be saved in a serial NVRAM. Each telephone number can be up to 32 characters (including the command line terminating carriage return) in length. A telephone number can be saved using the &Zn=x command, and a saved telephone number can be dialed using the DS=n command.

2.2.2 Dialing

DTMF Dialing. DTMF dialing using DTMF tone pairs is supported in accordance with ITU-T Q.23. The transmit tone level complies with Bell Publication 47001.

Pulse Dialing. Pulse dialing is supported in accordance with EIA/TIA-496-A.

Blind Dialing. The modem can blind dial in the absence of a dial tone if enabled by the X0, X1, or X3 command.

2.2.3 Modem Handshaking Protocol

If a tone is not detected within the time specified in the S7 register after the last digit is dialed, the modem aborts the call attempt.

2.2.4 Call Progress Tone Detection

Ringback, equipment busy, congested tone, warble tone, and progress tones can be detected in accordance with the applicable standard.

2.2.5 Answer Tone Detection

Answer tone can be detected over the frequency range of 2100 ± 40 Hz in ITU-T modes and 2225 ± 40 Hz in Bell modes.

2.2.6 Ring Detection

A ring signal can be detected from a TTL-compatible 15.3 Hz to 68 Hz square wave input.

2.2.7 Billing Protection

When the modem goes off-hook to answer an incoming call, both transmission and reception of data are prevented for 2 seconds (data modem) or 4 seconds (fax adaptive answer) to allow transmission of the billing tone signal.

2.2.8 Connection Speeds

The modem functions as a data modem when the +FCLASS=0 command is active. Line connection can be selected using the +MS command. The +MS command selects modulation, enables/disables automode, and selects minimum and maximum line speeds (Table 2-1).

2.2.9 Automode

Automode detection can be enabled by the +MS command to allow the modem to connect to a remote modem in accordance with draft PN-3320 for V.34 (Table 2-1).

Table 2-1. +MS Command Automode Connectivity

<mod>	Modulation	Possible Rates (bps) [1]	Notes
V21	V.21	300	
V22	V.22	1200	
V22B	V.22 bis	2400 or 1200	
V23	V.23	1200	See Note 2
V32	V.32	9600 or 4800	
V32B	V.32 bis	14400, 12000, 9600, 7200, or 4800	Default for V.32 bis models
V34	V.34	33600, 31200, 28800, 26400, 24000, 21600, 19200, 16800, 14400, 12000, 9600, 7200, 4800, or 2400	Default for V.34 models
V90	V.90	56000, 54667, 53333, 52000, 50667, 49333, 48000, 46667, 45333, 44000, 42667, 41333, 40000, 38667, 37333, 36000, 34667, 33333, 32000, 30667, 29333, 28000	Default for V.90+ models
B103	Bell 103	300	
B212	Bell 212	1200	

Notes:

1. See optional <automode>, <min_rate>, and <max_rate> subparameters for the +MS command.
2. For V.23, originating modes transmit at 75 bps and receive at 1200 bps; answering modes transmit at 1200 bps and receive at 75 bps. The rate is always specified as 1200 bps. V.23 half duplex is not supported.
3. If the DTE speed is set to less than the maximum supported DCE speed in automode, the maximum connection speed is limited to the DTE speed.

2.3 Data Mode

Data mode exists when a telephone line connection has been established between modems and all handshaking has been completed.

2.3.1 Speed Buffering (Normal Mode)

Speed buffering allows a DTE to send data to, and receive data from, a modem at a speed different than the line speed. The modem supports speed buffering at all line speeds.

2.3.2 Flow Control

DTE-to-Modem Flow Control. If the modem-to-line speed is less than the DTE-tomodem speed, the modem supports XOFF/XON or RTS/CTS flow control with the DTE to ensure data integrity.

2.3.3 Escape Sequence Detection

The +++ escape sequence can be used to return control to the command mode from the data mode. Escape sequence detection is disabled by an S2 Register value greater than 127.

2.3.4 BREAK Detection

The modem can detect a BREAK signal from either the DTE or the remote modem. The \Kn command determines the modem response to a received BREAK signal.

2.3.5 Telephone Line Monitoring

GSTN Cleardown (V.90, V.34, V.32 bis, V.32). Upon receiving GSTN Cleardown from the remote modem in a non-error correcting mode, the modem cleanly terminates the call.
Loss of Carrier (V.22 bis and Below). If carrier is lost for a time greater than specified by the S10 register, the modem disconnects (except MNP 10).

2.3.6 Fall Forward/Fallback (V.90/V.34/V.32 bis/V.32)

During initial handshake, the modem will fallback to the optimal line connection within V.90/V.34/V.32 bis/V.32 mode depending upon signal quality if automode is enabled by the +MS or N1 command.
When connected in V.90/V.34/V.32 bis/V.32 mode, the modem will fall forward or fallback to the optimal line speed within the current modulation depending upon signal quality if fall forward/fallback is enabled by the %E2 command.

2.3.7 Retrain

The modem may lose synchronization with the received line signal under poor or changing line conditions. If this occurs, retraining may be initiated to attempt recovery depending on the type of connection. The modem initiates a retrain if line quality becomes unacceptable if enabled by the %E
command. The modem continues to retrain until an acceptable connection is achieved, or until 30 seconds elapse resulting in line disconnect.

2.3.8 Programmable Inactivity Timer

The modem disconnects from the line if data is not sent or received for a specified length of time. In normal or error-correction mode, this inactivity timer is reset when data is received from either the DTE or from the line. This timer can be set to a value between 0 and 255 seconds by using register S30. A value of 0 disables the inactivity timer.

2.3.9 DTE Signal Monitoring (Serial DTE Interface Only)

DTR#. When DTR# is asserted, the modem responds in accordance with the &Dn and &Qn commands.
RTS#. RTS# is used for flow control if enabled by the &K command in normal or error correction mode.

2.4 Modem-on-Hold

The Modem-on-Hold (MOH) function (V.92 models only) enables the modem to place a data call to the Internet on hold while using the same line to accept an incoming or place an outgoing voice call. This feature is available only with a connection to a server supporting MOH. MOH can be executed through either of two methods:

- One method is to enable MOH through the +PMH command. With Call Waiting Detection (+PCW command) enabled, an incoming call can be detected while online. Using a string of commands, the modem negotiates with the server to place the data connection on hold while the line is released so that it can be used to conduct a voice call. Once the voice call is completed, the modem can quickly renegotiate with the server back to the original data call.
- An alternative method is to use communications software that makes use of the Conexant Modem-on-Hold drivers. Using this method, the software can detect an incoming call, place the data connection on hold, and switch back to a data connection.

2.5 Error Correction and Data Compression

2.5.1 V.42 Error Correction

V.42 supports two methods of error correction: LAPM and, as a fallback, MNP 4. The modem provides a detection and negotiation technique for determining and establishing the best method of error correction between two modems.

2.5.2 MNP 2-4 Error Correction

MNP 2-4 is a data link protocol that uses error correction algorithms to ensure data integrity. Supporting stream mode, the modem sends data frames in varying lengths depending on the amount of time between characters coming from the DTE.

2.5.3 V.44 Data Compression

V.44 data compression encodes pages and files associated with Web pages more efficiently than V.42 bis. These files include WEB pages, graphics and image files, and document files. V.44 can provide an effective data throughput rate up to DTE rate for a 56-kbps connection. The improved performance amount varies both with the actual format and with the content of individual pages and files.

2.5.4 V.42 bis Data Compression

V.42 bis data compression mode, enabled by the %Cn command or S46 register, operates when a LAPM or MNP 10 connection is established. The V.42 bis data compression employs a “string learning” algorithm in which a string of characters from the DTE is encoded as a fixed length codeword. Two 2-KB dictionaries are used to store the strings. These dictionaries are dynamically updated during normal operation.

2.5.5 MNP 5 Data Compression

MNP 5 data compression mode, enabled by the %Cn command, operates during an MNP connection.
In MNP 5, the modem increases its throughput by compressing data into tokens before transmitting it to the remote modem, and by decompressing encoded received data before sending it to the DTE.

2.6 MNP 10 Data Throughput Enhancement

MNP 10 protocol and MNP Extended Services enhance performance under adverse channel conditions such as those found in rural, long distance, or cellular environments. An MNP 10 connection is established when an MNP 2-4 connection is negotiated with a remote modem supporting MNP 10.
MNP Extended Services. The modem can quickly switch to MNP 10 operation when the remote modem supports MNP 10 and both modems are configured to operate in V.42.
V.42 bis/MNP 5 Support. V.42 bis/MNP 10 can operate with V.42 bis or MNP 5 data compression.

2.7 Telephony Extensions

The following telephony extension features are supported and can be typically be implemented in designs for set-top box applications and TAM software applications to enhance end-user experience:

- Line In Use detection
- Extension Pickup detection
- Remote Hang-up detection

2.7.1 Line In Use Detection

The Line In Use Detection feature can stop the modem from disturbing the phone line when the line is already being used. When an automated system tries to dial using ATDT and the phone line is in use, the modem will not go off hook and will respond with the message “LINE IN USE”.

2.7.2 Extension Pickup Detection

The Extension Pickup Detection feature (also commonly referred as PPD or Parallel phone detection) allows the modem to detect when another telephony device (i.e., fax machine, phone, satellite/cable box) is attempting to use the phone line. This feature can be used to quickly drop a modem connection in the event when a user picks up a extension phone line. For example, this feature allows set top boxes with an integrated SmartV.XX modem to give normal voice users the highest priority over the telephone line. This feature can also be used in Telephone Answering Machine applications (TAM). Its main use would be to stop the TAM operation when a phone is picked up.

2.7.3 Remote Hangup Detection

The Remote Hangup Detection feature will cause the modem go back onhook during a data connection when the remote modem is disconnected for abnormal termination reasons (remote phone line unplugged, remote server/modem shutdown. For Voice applications, this method can be used in addition to silence detection to determine when a remote caller has hung up to terminate a voice recording.

2.8 Caller ID

Both Type I Caller ID (On-Hook Caller ID) and Type II Caller ID (Call Waiting Caller ID) are supported for U.S. and many other countries (see Section 2.11). Both types of Caller ID are enabled/disabled using the +VCID command. Call Waiting Tone detection must be enabled using the +PCW command to detect and decode Call Waiting Caller ID.
When enabled, caller ID information (date, time, caller code, and name) can be passed to the DTE in formatted or unformatted form. Inquiry support allows the current caller ID mode and mode capabilities of the modem to be retrieved from the modem. Type II Caller ID (Call Waiting Caller ID) detection operates only during data mode in V.90, V.34, V.32bis, or V.32.

2.9 Worldwide Country Support

Internal modem firmware supports 29 country profiles (see Section 1.3.2). These country profiles include the following country-dependent parameters:

- Dial tone detection levels and frequency ranges.
- DTMF dialing parameters: Transmit output level, DTMF signal duration, and DTMF interdigit interval.
- Pulse dialing parameters: Make/break times, set/clear times, and dial codes are programmable
- Ring detection frequency range.
- Type I and Type II Caller ID are supported for many countries. Consult firmware release notes for a list of the supported countries and the criteria for additional country support.
- Blind dialing enabled/disable.
- Carrier transmit level (through S91 for data and S92 for fax). The maximum, minimum, and default values can be defined to match specific country and DAA requirements.

- Calling tone is generated in accordance with V.25. Calling tone may be toggled (enabled/disabled) by inclusion of a “^” character in a dial string. It may also be disabled.
- Frequency and cadence of tones for busy, ringback, congested, warble, dial tone 1, and dial tone 2.
- Answer tone detection period.
- Blacklist parameters. The modem can operate in accordance with requirements of individual countries to prevent misuse of the network by limiting repeated calls to the same number when previous call attempts have failed. Call failure can be detected for reasons such as no dial tone, number busy, no answer, no ringback detected, voice (rather than modem) detected, and key abort (dial attempt aborted by user). Actions resulting from such failures can include specification of minimum inter-call delay, extended delay between calls, and maximum numbers of retries before the number is permanently forbidden ("blacklisted").

2.10 Diagnostics

Commanded Tests

Diagnostics are performed in response to &T commands.

Analog Loopback (&T1 Command). Data from the local DTE is sent to the modem, which loops the data back to the local DTE.

2.11 Low Power Sleep Mode

Sleep Mode Entry. The modem enters the low power sleep mode when no line connection exists and no host activity occurs for the period of time specified in the S24 register. All modem circuits are turned off except the internal clock circuitry in order to consume reduced power while being able to immediately wake up and resume normal operation.

Wake-up. Wake-up occurs when a ring is detected on the telephone line or the DTE sends a character to the modem.

3. HARDWARE INTERFACE

3.1 AL2094S Modem Hardware Pins and Signals

3.1.1 Phone Line Interface

The phone-line interface signals are:

- TIP
- RING

3.1.2 Call Progress Speaker Interface

The call progress speaker interface signal is:

- Digital speaker output (DSPKOUT); output

DSPKOUT is a square wave output in Data/Fax mode used for call progress or carrier monitoring. This output can be optionally connected to a low-cost on-board speaker, e.g., a sounducer, or to an analog speaker circuit.

3.1.3 Serial DTE Interface and Indicator Outputs

The supported DTE interface signals are:

- Serial Transmit Data input (TXD#)
- Serial Receive Data output line (RXD#)
- Clear to Send output (CTS#)
- Received Line Signal Detector (DCD#)
- Ring Indicator (RI#)
- Data Terminal Ready control input (DTR#)
- Request to Send control input (RTS#)

Additional clock signals provided for synchronous mode are:

- Receive Data Clock (RXCLK#)
- Transmit Data Clock (TXCLK#)

3.1.4 External Reset Input

The supported reset input interface signals are:

- External Reset Input (EXTRESET#)

3.1.5 AL2094S Modem Pin Assignments and Signal Definitions

AL2094S Modem DIL-40 hardware interface signals are shown by major interface in Figure 3-1, are shown by pin number in Figure 3-2, and are listed by pin number in Table 1-1.

AL20XX Modem hardware interface signals are defined in Table 3-2.

I/O types are defined in Table 3-3.

DC electrical characteristics are listed in Table 3-4.

FIGURE 3-1. AL2094S MODEM HARDWARE SIGNALS

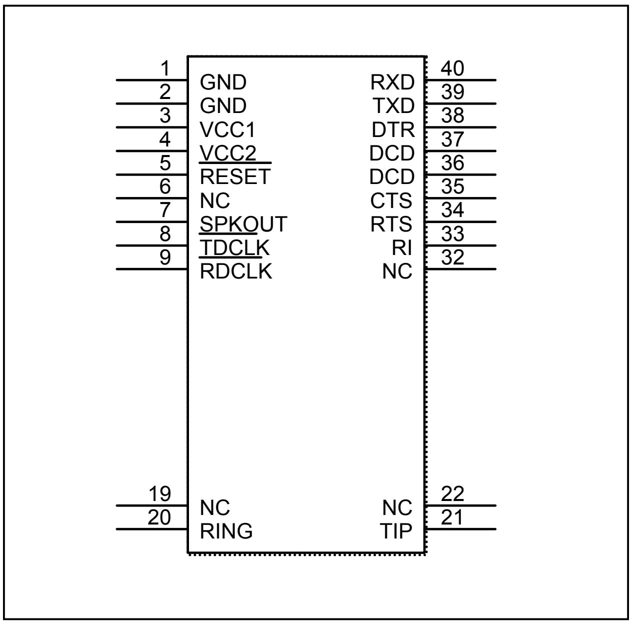


Table 3-1. AL2094S Modem DIL-40 Pin Signals

Pin No	NAME	Pin No	NAME
1	GND	40	RXD
2	GND	39	TXD
3	VCC1	38	DTR
4	VCC2	37	DCD
5	EXTRESET	36	DSR/DCD
6	NC	35	CTS
7	DSPKOUT	34	RTS
8	TDCLK	33	RI
9	RDCLK	32	NC
10 …18	No pin	31… 23	No pin
19	NC	22	NC
20	RING	21	TIP

Table 3-2. Signal Descriptions

Label	Pin	I/O	I/O Type	Signal Name/Description
VCC	3,4	P	PWR	**Digital Supply Voltage.** Connect to VCC (+3.3V, filtered).
GND	1,2	G	GND	**Digital Ground.** Connect to digital ground (GND).
RESET	5	I	IC/OC	**Reset. .** Open collector input/output. Drive only with open-collector circuit. The active low RESET# input resets the Modem logic and clears the internal SRAM. RESET# low holds the modem in the reset state; RESET# going high releases the modem from the reset state. RESET# is connected to a built-in reset circuit on the Socket Modem. Connect to Ground through an 1nF capacitor to ensure good ESD immunity and to comply with ESD tests according to EN 61000-4-2.
SPKOUT	7	O	It/Ot2	**Modem Speaker Digital Output.** The DSPKOUT digital output reflects the received analog input signal digitized to TTL high or low level by an internal comparator.
TIP	21	P	Passive	**TIP Signal from Telco/PTT**
RING	20	P	Passive	**RING Signal from Telco/PTT**
TXD	39	I	It/Ot2	**Transmitted Data (EIA BA/ITU-T CT103).** The DTE uses the TXD# line to send data to the modem for transmission over the telephone line or to transmit commands to the modem.
RXD	40	O	It/Ot2	**Received Data (EIA BB/ITU-T CT104).** The modem uses the RXD# line to send data received from the telephone line to the DTE and to send modem responses to the DTE. During command mode, RXD# data represents the modem responses to the DTE.
CTS	35	O	Ith/Ot8	**Clear To Send (EIA CB/ITU-T CT106).** CTS# output ON (low) indicates that the modem is ready to accept data from the DTE. In asynchronous operation, in error correction or normal mode, CTS# is always ON (low) unless RTS/CTS flow control is selected by the &Kn command. In synchronous operation, the modem also holds CTS# ON during asynchronous command state. The modem turns CTS# OFF immediately upon going off-hook and holds CTS# OFF until both DSR# and DCD# are ON and the modem is ready to transmit and receive synchronous data. The modem can also be commanded by the &Rn command to turn CTS# ON in response to an RTS# OFF-to-ON transition.
DCD	37	O	Ith/Ot8	**Received Line Signal Detector (EIA CF/ITU-T CT109).** When AT&C0 command is not in effect, DCD# output is ON when a carrier is detected on the telephone line or OFF when carrier is not detected.
DSR	36	O	Ith/Ot8	**Data set ready.** This signal is not supported. This output is hardwired to the DCD signal. Same as pin 37.
RI	33	O	Ith/Ot8	**Ring Indicator (EIA CE/ITU-T CT125).** RI# output ON (low) indicates the presence of an ON segment of a ring signal on the telephone line.
DTR	38	I	It	**Data Terminal Ready (EIA CD/ITU-T CT108).** The DTR# input is turned ON (low) by the DTE when the DTE is ready to transmit or receive data. DTR# ON prepares the modem to be connected to the telephone line, and maintains the connection established by the DTE (manual answering) or internally (automatic answering). DTR# OFF places the modem in the disconnect state under control of the &Dn and &Qn commands.

Table 3-3. Signal Descriptions (Cont'd)

Label	Pin	I/O	I/O Type	Signal Name/Description
RTS	34	I	Ithpu	**Request To Send (EIA CA/ITU-T CT105).** RTS# input ON (low) indicates that the DTE is ready to send data to the modem. In the command state, the modem ignores RTS#. In asynchronous operation, the modem ignores RTS# unless RTS/CTS flow control is selected by the &Kn command. In synchronous on-line operation, the modem can be commanded by the &Rn command to ignore RTS# or to respond to RTS# by turning on CTS# after the delay specified by Register S26.
RXCLK	9	O	Itpu/Ot2	**Receive Data Clock.** A synchronous Receive Data Clock (RXCLK) is output in synchronous modes. The RXCLK frequency is the data rate (±0.01%) with a duty cycle of 50±1%. Leave open if not used.
TXCLK	8	O	Itpu/Ot2	**Transmit Data Clock.** A synchronous Transmit Data Clock (TXCLK) is output in synchronous modes. The TXCLK frequency is the data rate (±0.01%) with a duty cycle of 50±1%. Leave open if not used.

Table 3-4. AL2094S Modem I/O Type Definitions

I/O Type	Description
It/Ot2	Digital input, +5V tolerant/ Digital output, 2 mA, ZINT = 120 Ω
Itpu/Ot2	Digital input, +5V tolerant, 75k Ω pull up/ Digital output, 2 mA, ZINT = 120 Ω
Ith/Ot8	Digital input, +5V tolerant, hysteresis/Digital output, 8 mA, ZINT = 50 Ω
It	Digital input, +5V tolerant
Ithpu	Digital input, +5V tolerant, hysteresis, 75k Ω pull up
IC/OC	Open collector input/output, internal 10k pull-up
PWR	VCC Power
GND	Ground
NOTES: I/O Type corresponds to the device Pad Type. The I/O column in signal interface tables refers to signal I/O direction used in the application.	

Table 3-5. AL2094S Modem DC Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Input Voltage Low	VIL					
+5V tolerant		0	-	0.8	V	
+5V tolerant hysteresis		0	-	0.3 * VGG	V	
Input Voltage High	VIH					
+5V tolerant		2	-	5.25	V	
+5V tolerant hysteresis		0.7 * VDD	-	5.25	V	
Input Hysteresis	VH					
+3V hysteresis		0.5	-		V	
+5V tolerant,hysteresis		0.3	-		V	
Output Voltage Low	VOL					
ZINT = 120 Ω		0	-	0.4	V	IOL = 2 mA
ZINT = 50 Ω		0	-	0.4	V	IOL = 8 mA
Output Voltage High	VOH					
ZINT = 120 Ω		2.4	-	VDD	V	IOL = - 2 mA
ZINT = 50 Ω		2.4	-	VDD	V	IOL = - 8 mA
Pull-Up Resistance	Rpu	50	-	200	kΩ	
Pull-Down Resistance	Rpd	50	-	200	kΩ	
Test Conditions unless otherwise stated: VDD = +3.3 ± 0.3 VDC; TA = 0°C to 70°C; external load = 50 pF.						

3.3 Electrical and Environmental Specifications

3.3.1 Operating Conditions, Maximum Ratings, Power Requirements.

The operating conditions are specified in Table 3-9.
The absolute maximum ratings are listed in Table 3-10.
The current and power requirements are listed in Table 3-11.

Table 3-9. Operating Conditions

Parameter	Symbol	Limits	Units
Supply Voltage	VDD	+ 3.0 to +3.6	VDC
Operating Ambient Temperature	T_A	0 to + 70	°C

Table 3-10. Absolute Maximum Ratings

Parameter	Symbol	Limits	Units
Supply Voltage	VDD	-0.5 to + 4.0	VDC
Input Voltage	V_{IN}	-0.5 to (VGG +0.5)*	VDC
Storage Temperature Range	T_{STG}	-55 to + 125	°C
Analog Inputs	V_{IN}	-0.3 to (VAA + 0.5)	VDC
Voltage Applied to Outputs in High Impedance (Off) State	V_{HZ}	-0.5 to (VGG + 0.5)*	VDC
DC Input Clamp Current	I_{IK}	±20	mA
DC Output Clamp Current	I_{OK}	±20	mA
Static Discharge Voltage (25°C)	V_{ESD}	±2500	VDC
Latch-up Current (25°C)	I_{TRIG}	±400	mA
* VGG = +3.3V ± 0.3V or +5V ± 5%.			

Handling CMOS Devices

The device contains circuitry to protect the inputs against damage due to high static voltages. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltage.
An unterminated input can acquire unpredictable voltages through coupling with stray capacitance and internal cross talk. Both power dissipation and device noise immunity degrades. Therefore, all inputs should be connected to an appropriate supply voltage. Input signals should never exceed the voltage range from -0.5V to VGG + 0.5V. This prevents forward biasing the input protection diodes and possibly entering a latch up mode due to high current transients.

Table 3-11. Current and Power Requirements

Mode	Typical Current (Ityp) (mA)	Maximum Current (Imax) (mA)	Typical Power (Ptyp) (mW)	Maximum Power (Pmax) (mW)
Normal Mode: Off-hook, normal data connection	66	73	220	240
Normal Mode: On-hook, idle, waiting for ring	61	67	200	220
Sleep Mode	17	19	56	63

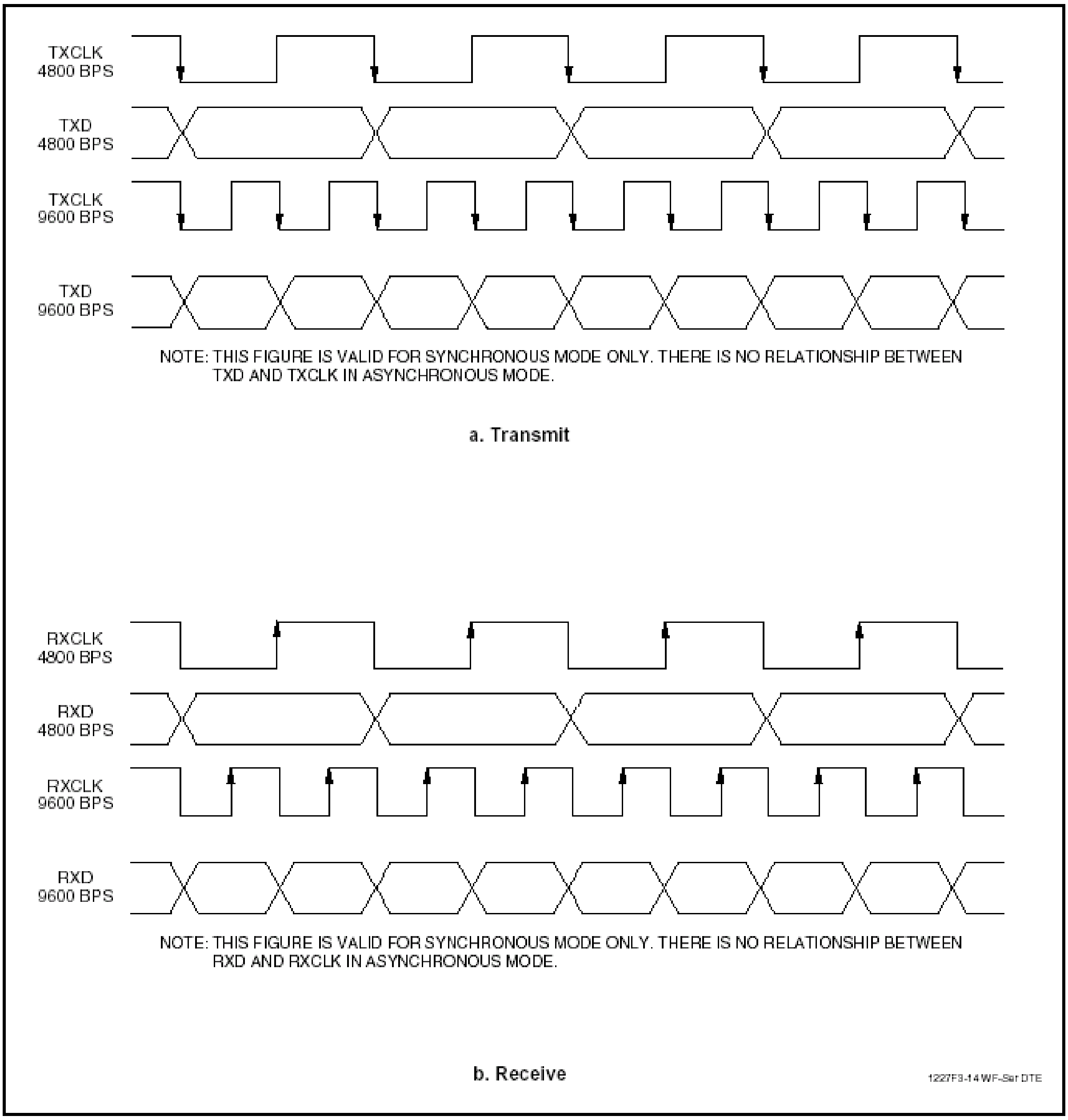
Notes:
1. Operating voltage: VDD = +3.3V ± 0.3V.
2. Test conditions: VDD = +3.3V for typical values; VDD = +3.6V for maximum values.
3. Input Ripple ≤ 0.1 Vpeak-peak.
4. f = Internal frequency.
5. Maximum current computed from Ityp: Imax = Ityp * 1.1.
6. Typical power (Ptyp) computed from Ityp: Ptyp = Ityp * 3.3V; Maximum power (Pmax) computed from Imax: Pmax = Imax * 3.6V.

3.3.2 Interface and Timing Waveforms

3.3.2.1 Serial DTE Interface

The serial DTE interface waveforms for 4800 and 9600 bps are illustrated in Figure 3-5.

FIGURE 3-5. WAVEFORMS - SERIAL DTE INTERFACE



3.4 DAA Interface

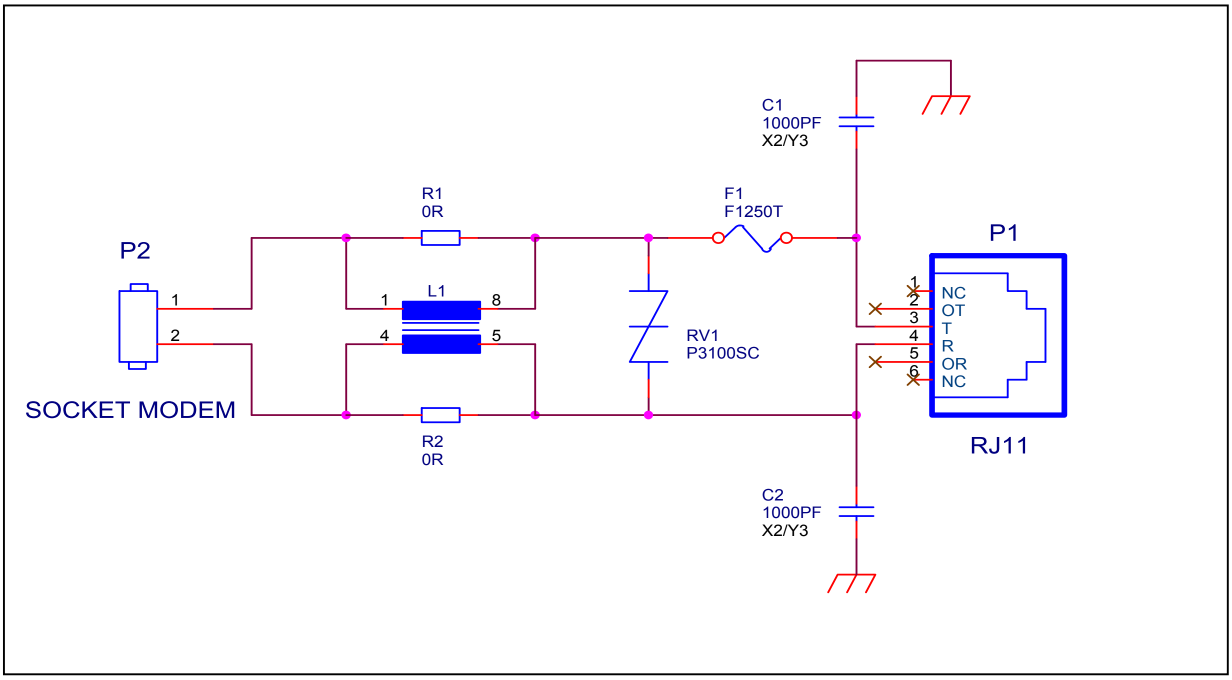
The Socket Modem is configured to be an on-board DAA (World Class DAA).

Provide TIP and RING signals from the telco jack to pins 20 and 21 of the Socket Modem. Only EMI suppression and surge protection components may be used. If other components are used, the PTT certification for these Socket Modems will no longer apply, and recertification will be required.

The recommended telco interface for U.S. Socket Modems is shown in Figure 3-3.

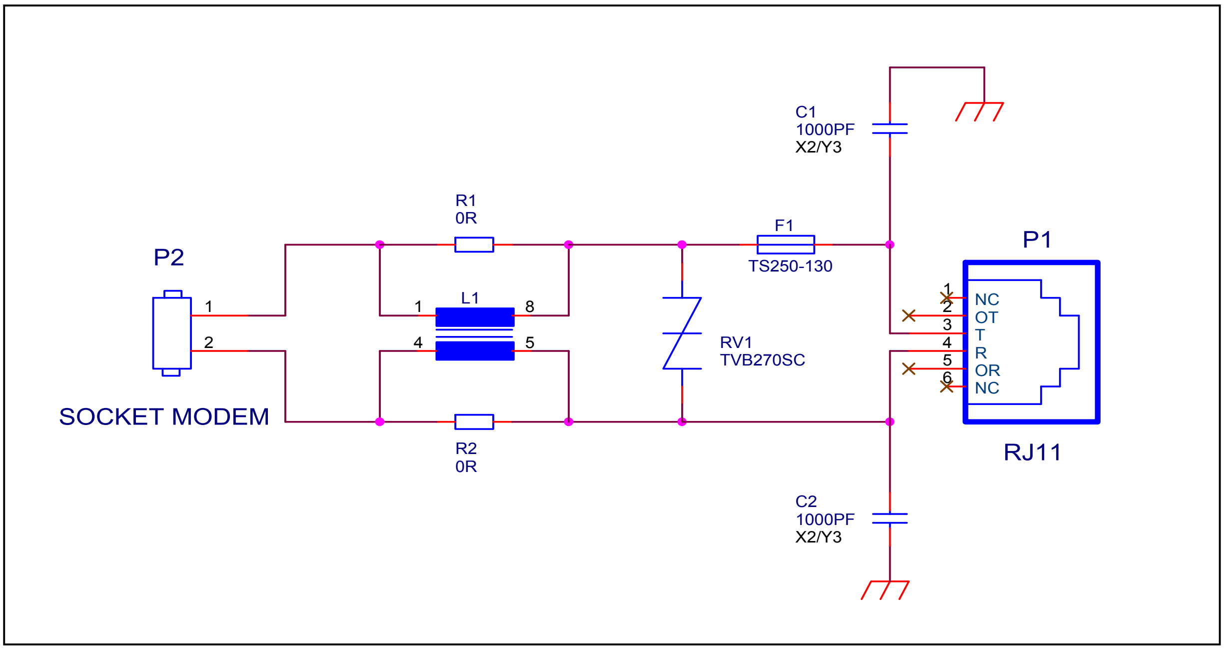
The recommended telco interface for World Class Socket Modems is shown in Figure 3-4.

TIP and RING signal traces are to be no closer than 2.5mm (0.1") from any other traces for European applications. 2.5mm spacing must be used if the host board is to support both U.S. and European Socket Modems.



Note: Meets FCC Part 68 Type A and Type B Surge Requirements (Type A Non-Operational)

FIGURE 3-3. RECOMMENDED TELEPHONE LINE INTERFACE FOR U.S. SOCKET MODEM



Note: Meets ITU-T K.21 Surge Requirements

FIGURE 3-4. RECOMMENDED TELEPHONE LINE INTERFACE FOR WORLD CLASS SOCKET MODEM.

> The common mode choke L1 is optional in both Figures 3.3 and 3.4 and it's need depends on the characteristics of the target hardware. The need for this choke must be evaluated at EMV measurement (conducted emission) of the final product. If not used populate R1, R2.

Table 3-7. DAA Part List

REF	TYPE	Manufacturer	PART No
L1	**Common Mode Coke**	**Epcos** **Microspire**	**B82790-C0475-N265** **ESC-X1-M47-1S**
C1, C2	**High Voltage Capacitor / MLCC** **X2 / Y3 Types**	**Johansson** **Novacap** **Syfer**	**302R29W102KV3E** **LS1808N102K302** **1808JA250102KCT**
F1	**Fuse: U.S. Models** **Europe Models**	**Littlefuse** **Raychem**	**F1250T** **TS250-130**
RV1	**Thyristor Surge Protectors:** **U.S. Models** **Europe Models**	 **Teccor** **Raychem**	 **P3100SC** **TVB270SC**

4. DESIGN CONSIDERATIONS

Good engineering practices must be adhered to when designing a printed circuit board (PCB) containing the Socket Modem module. Suppression of noise is essential to the proper operation and performance of the modem itself and for surrounding equipment.

Two aspects of noise in an OEM board design containing the Socket Modem module must be considered: on-board/off-board generated noise that can affect analog signal levels and analog-to-digital conversion (ADC)/digital-to-analog conversion (DAC), and on-board generated noise that can radiate off-board. Both on-board and off-board generated noise that is coupled on-board can affect interfacing signal levels and quality, especially in low level analog signals. Of particular concern is noise in frequency ranges affecting modem performance.
On-board generated electromagnetic interference (EMI) noise that can be radiated or conducted off-board is a separate, but equally important, concern. This noise can affect the operation of surrounding equipment. Most local governing agencies have stringent certification requirements that must be met for use in specific environments.

Proper PC board layout (component placement, signal routing, trace thickness and geometry, etc.), component selection (composition, value, and tolerance), interface connections, and shielding are required for the board design to achieve desired modem performance and to attain EMI certification.

The aspects of proper engineering practices are beyond the scope of this designer's guide. The designer should consult noise suppression techniques described in technical publications and journals, electronics and electrical engineering text books, and component supplier application notes. Seminars addressing noise suppression techniques are often offered by technical and professional associations as well as component suppliers.

4.1 PC Board Layout Guidelines

4.1.1 General

1. In a 2-layer design, provide an adequate ground grid in all unused space around and under components (judiciously near analog components) on both sides of the board, and connect in such a manner as to avoid small islands. A grid is preferred over a plane to improve solderability. Typically, the grid is composed of 0.012 in. traces and 0.012 in. spaces on a 0.025 in. grid. Connect each grid to other grids on the same side at several points and to grids on the opposite side through the board at several points. Connect Socket Modem DGND and AGND pins to the ground grid.

2. In a 4-layer design, provide an adequate ground plane covering the entire board. Socket Modem DGND and AGND pins are tied together on the Socket Modem.

3. As a general rule, route digital signals on the component side of the PCB and the analog signals on the solder side. The sides may be reversed to match particular OEM requirements. Route the digital traces perpendicular to the analog traces to minimize signal cross coupling.

4. Route the modem signals to provide maximum isolation between noise sources and noise sensitive inputs. When layout requirements necessitate routing these signals together, they should be separated by neutral signals.

5. All power and ground traces should be at least 0.05 in. wide.

6. TIP and RING signal traces are to be no closer than 2.5mm (0.1") from any other traces for European applications. 2.5mm spacing must be used if the host board is to support both U.S. and European Socket Modems.

7. If the Socket Modem is mounted flush with the host PCB, the host PCB should be clear of all traces directly underneath the Socket Modem oscillator section. It is strongly suggested that the Socket Modem is mounted at least 0.130 inch above the host board. (See section 4.4)

4.1.2 Electromagnetic Interference (EMI) Considerations

The following guidelines are offered to specifically help minimize EMI generation. Some of these guidelines are the same as, or similar to, the general guidelines but are mentioned again to reinforce their importance.
In order to minimize the contribution of the Socket Modem-based design to EMI, the designer must understand the major sources of EMI and how to reduce them to acceptable levels.

1. Keep traces carrying high frequency signals as short as possible.

2. Provide a good ground plane or grid. In some cases, a multilayer board may be required with full layers for ground and power distribution.

3. Decouple power from ground with decoupling capacitors as close to the Socket Modem module power pins as possible.

4. Eliminate ground loops, which are unexpected current return paths to the power source and ground.

5. Decouple the telephone line cables at the telephone line jacks. Typically, use a combination of series inductors, common mode chokes, and shunt capacitors. Methods to decouple telephone lines are similar to decoupling power lines, however, telephone line decoupling may be more difficult and deserves additional attention. A commonly used design aid is to place footprints for these components and populate as necessary during performance/EMI testing and certification.

6. Decouple the power cord at the power cord interface with decoupling capacitors. Methods to decouple power lines are similar to decoupling telephone lines.

7. Locate high frequency circuits in a separate area to minimize capacitive coupling to other circuits.

8. Locate cables and connectors so as to avoid coupling from high frequency circuits.

10. If a mulilayer board design is used, make no cuts in the ground or power planes and be sure the ground plane covers all traces.

11. Minimize the number of through-hole connections on traces carrying high frequency signals.

12. Avoid right angle turns on high frequency traces. Forty-five degree corners are good, however, radius turns are better

13. On 2-layer boards with no ground grid, provide a shadow ground trace on the opposite side of the board to traces carrying high frequency signals. This will be effective as a high frequency ground return if it is three times the width of the signal traces.

14. Distribute high frequency signals continuously on a single trace rather than several traces radiating from one point.

4.2 Other Considerations

The pins of all Socket Modems are grouped according to function. The DAA interface, Host interface, and LED interface pins are all conveniently arranged, easing the host board layout design.
Altec Electronic has tested each of the SocketModems for compliance with their respective country's PTT requirements and has received PTT certificates that cover, without additional expense to the user, all applications that use these Socket Modems in their respective countries. The certificates apply only to designs that route TIP and RING (pins 20 and 21) directly to the telco jack. Only specified EMI filtering components are allowed on these two signals as shown in figure 3-3.

4.3 Manufacturing Considerations

The Socket Modem has been designed to be mounted onto the host board in one of two ways.

The first method consists of soldering a DIP-40 socket to the host board and inserting the Socket Modem into the socket.

The second way is to solder the Socket Modem directly to the host board. The most efficient way to do this is through a wave solder process. The recommended hole size for the Socket Modem pins is 0.036 in. ±0.003 in. in diameter. Spacers can be used to hold the Socket Modem vertically in place during the wave solder process.

Socket Modems can be put through a water wash process.

5. PACKAGE DIMENSIONS

Package Dimensions are shown in Figure 5-1.

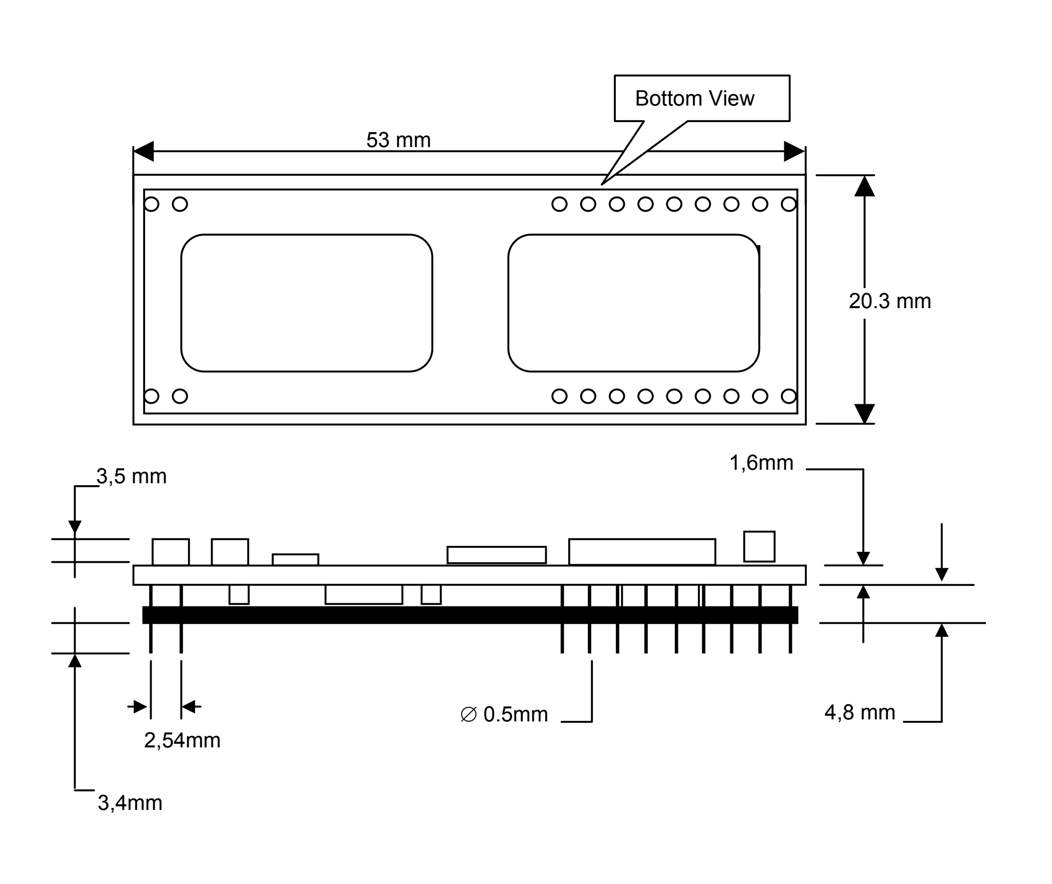


Figure 5-1. AL2094S Socket Modem Physical Dimensions

6. SOCKET MODEM APPROVALS

The Socket Modem module is approved as a host-independent modem card. To maintain type approvals, permits and/or licenses valid, the guidelines described in this document must be followed.

6.1 Considerations for Telecom Approvals

The Socket Modem has been assessed and has been found to comply with the relevant harmonized standards as defined by the European ETSI Directive (ETSI TC-TE).

These standards are: **TBR21 / CTR21**

6.1.1 PSTN Connection

The Socket Modem can be connected to the Public Switched Telephone Network (PSTN) either

a) by using a 2-wire flying cable to connect pins 20 and 21 of the card to an RJ-11 connector which can be assembled in a suitable location of the host system enclosure,

OR

b) by providing traces on the host system motherboard for the PSTN connection signals (TIP and RING) between the card and an RJ-11 connector

If connection option a) is used, the cable and its installation inside the host system must be in accordance with the guidelines in IEC950/EN60950 (e.g. the insulation material must withstand electric strength tests as described in section 3.4).

If connection option b) is used, NO additional components except those used for EMI filtering (specified in figure 3-3) must be connected to the TIP and RING signals. Other components not intended for use with this design may affect the network access characteristics of the modem and may therefore invalidate the type approvals, permits and/or licences.

In both cases, for the connection between the host and the PSTN wall connector, a cable with RJ-11 modular jack and an appropriate national plug must be used. Note that in Germany, an F-coded connector/plug must be used (this is one of the two typical plugs used for PSTN connection in Germany, the other type is called N-coded).

6.2 Considerations for Electrical Safety

6.2.1 Conditions for Maintaining Safety Compliance (European Countries)

The Socket Modem has been assessed with respect to electrical safety and has been found to comply with relevant standards as defined by the European Low Voltage Directive (72/23EEC). The particular standard is **EN 60950-1:2001**.

The card is rated as Class III equipment and it is intended for use in Pollution Degree 2 environments only [see EN60950-1:2001, 2.10.4]. Material Group IIIa or IIIb (Comparative Tracking Index below 400 according o IEC 112, method A) is assumed for any host system PCB that has traces and/or circuitry with TNV potential.

It is assumed that the modem card will only be assembled in a host system unit that complies with IEC60950/EN60950.

Some particular requirements are [see EN60950-1:2001, 2.1.1, 2.2, 2.3, 2.9, 2.10 and 4.7.3.2]:

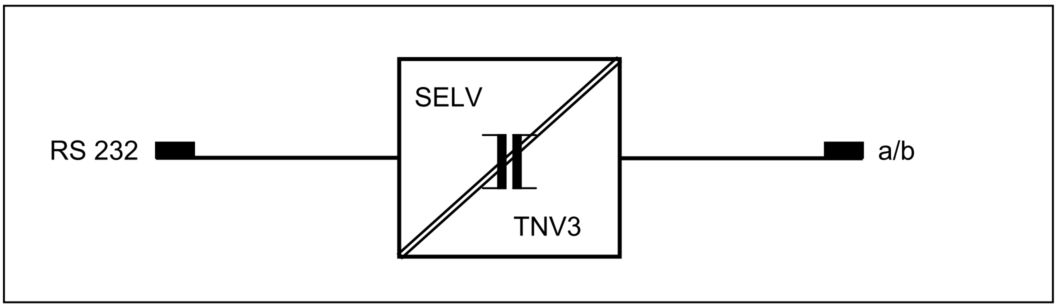
- the host system must have a compliant fire enclosure (e.g. made of material with flammability class 94V-1 or better).
- the power supply unit of the host system must have double or reinforced insulation.

6.2.2 Power Supply [EN60950-1:2001, 1.6]

Before installing the Socket Modem in a host system, the installer must ensure that the power drawn by the card, together with the host and any auxiliary cards drawing power from the host, is within the rating of the host power supply unit.

The Socket Modem's power consumption is typically 0.25 W (+3.3 Vdc).

6.2.3 Clearances, Creepage Distances and Distances through Insulation [EN60950-1:2001, 2.10.3 and 2.10.4]



This card must be installed such that with the exception of the connections to the host, clearance and creepage distances shown in the table below are maintained between

a) the TNV3 area of the card (the DAA) and conductive parts of other assemblies inside the host,
b) if applicable, the PSTN connection traces (TIP and RING) routed through the host system motherboard and any other conductive area (i.e. traces, through holes, SMD pads, copper areas, etc.) on that motherboard,

which use or generate a voltage shown in the table below **(values only for secondary circuits)**:

EN60950:2000 Table 2K / 2L		
Clearance (mm)	**Creepage (mm)**	**Voltage used or Generated by Host or Other cards**
1.0	1.5 (2.4)	Up to 125 Vrms or Vdc
2.0	2.5 (4.0)	Up to 250 Vrms or Vdc
2.5	3.2 (5.0)	Up to 300 Vrms or Vdc

The larger distances shown in brackets applies for Pollution Degree 3 environments (where the local environment within the host is subject to conductive pollution or dry non-conductive pollution, which could become conductive due to expected condensation).

The same clearance and creepage distances also apply between TNV3 areas of the card and earth connections inside the host system.

Clearance and creepage between primary (mains) and secondary circuits according EN 60950-1:2001, clause 2.10.3.2 table 2H and clause 2.10.4 table 2L.

Minimum distances between primary and secondary circuits (f.g. for mains voltage 230 V_{AC}):

Clearance = 4 mm
Creepage = 5 mm

Failure to maintain these minimum distances would invalidate the approval.

NOTE: For a host or other expansion cards fitted in the host using or generating voltages greater than 300 V (rms or dc), *advice from a competent telecommunications safety engineer must be obtained.*

If these clearance and creepage distances cannot be provided inside the host due to space limitations, a dielectric material may be used as a physical insulation barrier. The dielectric material used in this insulation must have a thickness of at least 0.4mm.

After installation (or implementation) of the Socket Modem inside a host system, it is recommended that a competent telecommunications safety engineer inspects the complete system to ensure that safety compliance is maintained.

(TNV = Telecommunications Network Voltages)

6.3 Considerations for EMC

6.3.1 EMC Compliance (European Countries)

The Socket Modem has been assessed with respect to emission of and immunity to electromagnetic disturbances and has been found to comply with the relevant harmonized standards as defined by the European EMC Directive (89/336/EEC).

These standards are:

- Generic emission standards which refers to

  EN 55022:1998 +A1:2000, Class B

- Generic immunity standards which refers to

  EN 55024:1998 +A1:2001
  EN 61000-6-2:2001 (industrial environment)

6.3.2 Installation in Host Systems (European Countries)

It is assumed that the Socket Modem will only assembled in host systems that comply with the EMC Directive.

As per definition of the EMC Directive, the card and its host system will constitute an "installation" similar to e.g. a PC card modem installed in a personal computer. Therefore, if the host system complies with the EMC Directive, there should be no need for verifying continued compliance of the complete system.

However, note that it is the responsibility of the professional installer of Socket Modem to ensure that the complete system placed on the market complies with the Directive.