CX93021-2x CSM92-SP

V.92 Controllered Serial Modem with Speakerphone with CX20548 SmartDAA® and CX20452 Codec

Data Sheet

CONEXANT®

Revision Record

Revision	Date	Comments
A	7/14/2008	Initial release
B	7/29/2008	Rev B release
C	7/31/2008	Rev C release
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1.   Introduction

1.1   Overview

The Conexant® CSM92-SP V.92 Modem supports V.92 analog data modem operation and 14.4 kbps fax modem operation. In addition, the modem supports remote telephone answering machine (TAM) and speakerphone. The modem also supports V.44/V.42bis/MNP 5 data compression for greater data throughput and V.42 LAPM/MNP2-4 error correction protocol for increased data integrity and reliability.

The CSM92-SP device set consists of a CX93021-2x V.92 Modem device in a 36-pin QFN, a CX20548 SmartDAA® 4 Line Side Device (LSD) in a 16-pin QPN, and a CX20452 Codec in a 24-pin QFN. The CSM92 device set is also available that does not include the CX20452 Codec and does not support speakerphone. The CX93021-2x has a serial interface and codec interface for connection to the optional CX20452 Codec for speakerphone applications. Table 1-1 lists the ordering information.

The CX93021-2x modem device integrates a microcontroller (MCU), a digital signal processor (DSP), internal RAM, internal ROM, and a SmartDAA system side device (SSD) onto a 36-pin QFN. Figure 1-1 illustrates the top-level modem interface.

Conexant's SmartDAA technology used in the SmartDAA 4 LSD eliminates the need for bulky analog transformers, relays, and opto-isolators typically used in discrete DAA implementations. The SmartDAA 4 LSD operates without drawing power from the phone line, unlike line-powered DAAs, and is therefore not subject to variations in line voltage conditions. The SmartDAA 4 LSD also adds enhanced telephony extension features to the modem's operation and other functions such as Call Waiting detection, and Caller ID decoding. Incorporating Conexant's proprietary Digital Isolation Barrier (DIB) design and other innovative DAA features, the SmartDAA architecture simplifies application design and minimizes layout area to reduce design cost.

The CSM92-SP modem supports position independent, full-duplex speakerphone (FDSP) operation using microphone and speaker, as well as other voice/TAM applications using handset or headset.

In TAM mode, enhanced 2-bit or 4-bit per sample coding schemes at 8 kHz sample rate provide flexible format compatibility and allows efficient digital storage of voice/audio. Also supported are 8-bit A-law, μ-law, and linear coding and IMA 4-bit ADPCM coding. This mode supports applications such as digital telephone answering machine, voice annotation, and recording from and playback to the telephone line.

The modem operates by executing masked code from internal ROM. The modem features internal RAM memory that enhances the modem's flexibility. The modem's internal RAM can be used to load new country profiles, override existing country profiles or add customized firmware code. An optional external serial NVRAM is supported. The optional external NVRAM adds the convenience of permanent storage, just like internal RAM, NVRAM can be used to store new country profiles, override existing ones or add customized firmware code.

Small, low-profile packages, reduced voltage operation, and low power consumption make this device set an ideal solution for embedded applications.

Table 1-1. CSM92-SP Ordering Information

Model/Order/Part Numbers					Supported Functions			
Marketing Name	Device Set Order No.	Modem Device [36-Pin QFN] Part No.	Line Side Device (LSD) [16-Pin QFN] Part No.	Codec [24-Pin QFN] Part No.	V.92 Data	V.34 Data	V.32bis Data	Fax Class 1 & 2, TAM, Speakerphone
CSM92-SP	DS92-CSMSP-21Z	CX93021-21Z	CX20548-11Z (Note 3)	CX20452-A	Y	Y	Y	Y
CSM34-SP	DS34-CSMSP-22Z	CX93021-22Z	CX20548-11Z (Note 3)	CX20452-A	—	Y	Y	Y
CSM32-SP	DS32-CSMSP-23Z	CX93021-23Z	CX20548-11Z (Note 3)	CX20452-A	—	—	Y	Y

Notes:

1. Supported functions (Y = Supported; — = Not supported).

2. All devices are lead-free (Pb-free) and RoHS-compliant. These devices are compatible with leaded reflow processes.

3.. Device is marked 20548-A on the package

Figure 1-1. CSM92-SP Modem Simplified Interface Diagram

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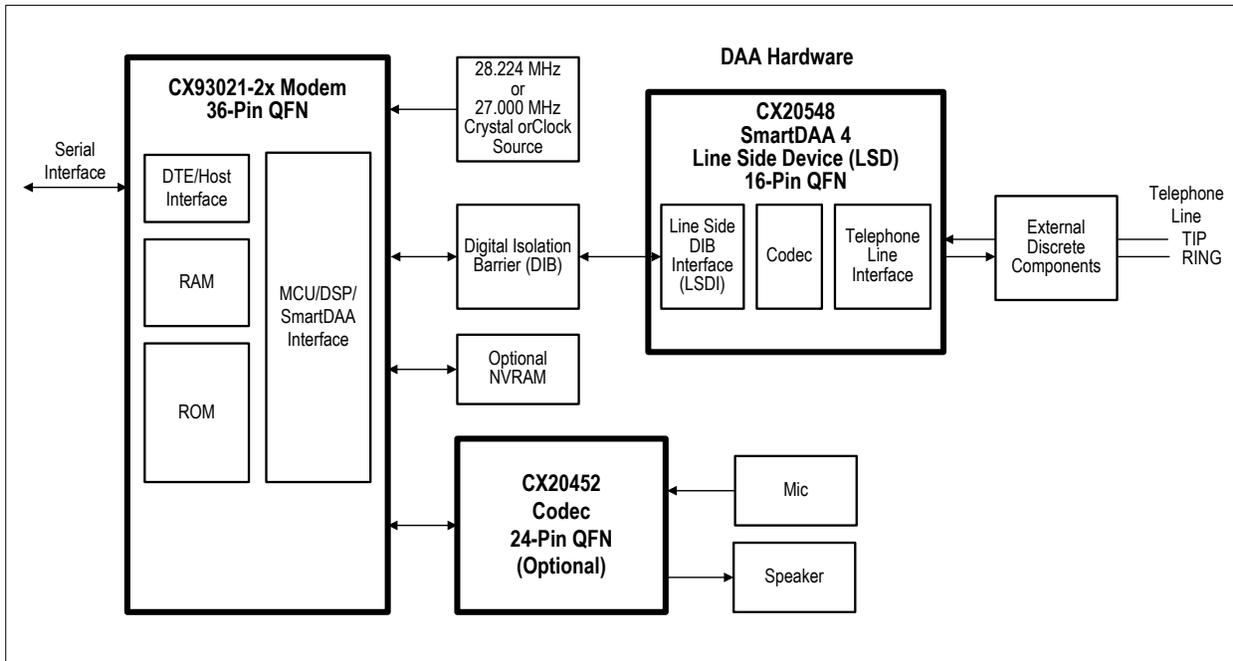
1.2 Features

- Modulations and protocols
  - ITU-T V.92 (V.92 model)
    - ♦ Modem-on-Hold (MOH)
    - ♦ Quick connect (QC)
    - ♦ PCM upstream
  - V.90 (V.92 model)
  - V.34 (V.92 and V.34 models)
  - V.32bis, V.32, V.22bis, V.22, V.23, V.21
  - V.23 reverse, V.23 half-duplex
  - Bell 212A/Bell 103
  - V.29 FastPOS
  - V.22bis fast connect
  - V.80 Synchronous Access Mode
- Data compression and error correction
  - V.44 data compression
  - V.42bis and MNP 5 data compression
  - V.42 LAPM and MNP 2-4 error correction
- Fax modem send and receive rates up to 14.4 kbps
  - V.17, V.29, V.27 ter, and V.21 channel 2
  - EIA/TIA 578 Class 1, T.31 Class 1.0, and Class 2
- Call Waiting (CW) detection and Type II Caller ID decoding during data mode
- Type I Caller ID (CID) decoding
- Telephony/TAM
  - V.253 commands
  - 2-bit and 4-bit ADPCM, 4-bit IMA ADPCM, 8-bit and 16-bit linear PCM, and 8-bit μ-law and A-law PCM coding
  - 8 kHz sample rate
  - Concurrent DTMF, ring, and Caller ID detection
- DTE/host interface
  - Serial DTE interface
  - Direct Mode
  - Asynchronous Mode
- No external memory required
- Sixty-three embedded and upgradeable country profiles
- Serial NVRAM interface for optional permanent country profile storage
- Embedded AT commands
- Full-duplex speakerphone (FDSP) mode using CX20452 Codec (optional)
  - Microphone and speaker interface
  - Telephone handset or headset interface
  - Acoustic and line echo cancellation
  - Microphone gain and muting
  - Speaker volume control and muting

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- SmartDAA
  - Extension pick-up detection
  - Digital line protection
  - Line reversal detection
  - Line-in-use detection
  - Remote hang-up detection
  - Worldwide compliance
- Selectable 28.224 MHz or 27.000 MHz frequency of operation
- Low power and voltage
  - Single +5V supply
  - Low power consumption mode
  - +3.3V I/O level
- Compact, robust board design
  - Small, low-profile modem packages
  - SmartDAA and DIB technologies
  - Reference design supports 5 kV isolation
- Small packages
  - CX93021-2x Modem: 36-pin QFN
  - CX20548 LSD: 16-pin QFN
  - CX20452 Codec: 24-pin QFN

1.2.1   Applications

- Internet appliances
- Video game consoles
- Video phone terminals
- Retail modems

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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 and V.253-compatible command set.

The OEM adds a crystal circuit, DIB components, telephone line interface, telephone handset/telephony extension interface, and other supporting discrete components as supported by the modem model (Table 1-1) and required by the application to complete the system.

1.3.2 Embedded MCU Firmware

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

1.3.3 Operating Modes

1.3.3.1 Data/Fax Modes

Data modem modes perform complete handshake and data rate negotiations. Using modem modulations to optimize modem configuration for line conditions, the modem can connect at the highest data rate that the channel can support from 56 kbps down to 2400 bps with automatic fallback.

In V.92 data modem mode, the modem can receive data from a digital source using a V.92-compatible central site modem at line speeds up to 56 kbps. With PCM upstream enabled, data transmission supports sending data at line speeds up to 48 kbps. When PCM upstream is disabled, data transmission supports sending data at line speeds up to V.34 rates. This mode can fallback to V.34 mode and to lower rates as dictated by line conditions.

The following modes in V.92 models are also supported when connected to a V.92-compatible server supporting the feature listed.

- Quick connect, 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.

- PCM upstream, which boosts the upstream data rates between the user and V.92 server. A maximum of 48 kbps upstream rate is supported when connected to a V.92 server that supports PCM upstream.

In V.34 data modem mode, 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.32bis in accordance with PN2330. All tone and pattern detection functions required by the applicable ITU or Bell standards are supported.

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

In fax modem mode, the modem can operate in 2-wire, half-duplex, synchronous modes and can support Group 3 facsimile send and receive speeds of 14400, 12000, 9600, 7200, 4800, and 2400 bps. Fax data transmission and reception performed by the modem are controlled and monitored through the EIA/TIA-578 Fax Class 1, T.31 Fax Class 1.0, or Fax Class 2 command interface. Full HDLC formatting, zero insertion/deletion, and CRC generation/checking are provided.

1.3.3.2   V.44 Data Compression

V.44 provides more efficient data compression than V.42bis 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.)

1.3.3.3   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.

1.3.3.4   TAM Mode

TAM Mode features include 2-bit/4-bit ADPCM, 4-bit IMA ADPCM, 8-bit and 16-bit linear PCM, and 8-bit µ-law and A-law PCM coding at 8 kHz sample rate. Tone detection/ generation, call discrimination, and concurrent DTMF detection are also supported.

TAM Mode is supported by four submodes:

- Online Voice Command Mode supports connection to the telephone line.
- Voice Receive Mode supports recording voice or audio data input from the telephone line.
- Voice Transmit Mode supports playback of voice or audio data to the telephone line.
- Full-duplex Receive and Transmit Mode.

1.3.3.5   Speakerphone Mode (Optional)

When using the optional CX20452 Codec, the modem includes additional telephone handset, external microphone, and external speaker interfaces which support voice and full-duplex speakerphone (FDSP) operation.

Hands-free full-duplex telephone operation is supported in Speakerphone Mode under host control. Speakerphone Mode features an advanced proprietary speakerphone algorithm which supports full-duplex voice conversation with acoustic, line, and handset echo cancellation. Parameters are constantly adjusted to maintain stability with automatic fallback from full-duplex to pseudo-duplex operation. The speakerphone algorithm allows position independent placement of microphone and speaker. The host can separately control volume, muting, and AGC in microphone and speaker channels.

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1.3.3.6   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 pick-up detection, remote hang-up detection, line-in-use detection, and digital PBX line protection are supported.

Country code IDs are defined by ITU-T T.35.

Internal ROM includes default profiles for 63 countries including TBR21-compliant profiles. An additional or modified country profile can be loaded into internal SRAM. A duplicate country profile stored in internal SRAM will override the profile in internal ROM firmware. Additional country profiles can be loaded into external NVRAM for permanent storage. The default countries supported are listed in Table 1-2. Request additional country profiles from a Conexant Sales Office.

Table 1-2. Default Countries Supported

Country	Country Code	Call Waiting Tone Detection (CW) Supported	On-Hook Type 1 Caller ID (CID) Supported	Off-Hook Type 2 Caller ID (CID2) Supported
Argentina	7	X		X
Australia	9	X	X	X
Austria	0A	X	X	X
Belgium	0F	X		X
Brazil	16	X		X
Bulgaria	1B	X		X
Canada	20	X	X	X
Chile	25	X		X
China	26	X	X	X
Colombia	27	X		X
Croatia	FA	X		X
Cyprus	2D	X		X
Czech Republic	2E	X		X
Denmark	31	X	X	X
Egypt	36	X		X
Estonia	F9	X		X
Finland	3C	X	X	X
France	3D	X	X	X
Germany	42	X	X	X
Greece	46	X		X
Hong Kong	50	X	X	X
Hungary	51	X		X
Iceland	52	X		X
India	53	X	X	X
Indonesia	54	X		X
Ireland	57	X	X	X
Israel	58	X		X
Italy	59	X	X	X
Japan	00	X	X	X
Korea	61	X	X	X
Kuwait	62	X		X
Lebanon	64	X		X

Country	Country Code	Call Waiting Tone Detection (CW) Supported	On-Hook Type 1 Caller ID (CID) Supported	Off-Hook Type 2 Caller ID (CID2) Supported
Luxembourg	69	X		X
Malaysia	6C	X		X
Mexico	73	X		X
Morocco	77	X		X
Netherlands	7B	X	X	X
New Zealand	7E	X	X	X
Norway	82	X	X	X
Pakistan	84	X		X
Philippines	89	X		X
Poland	8A	X		X
Portugal	8B	X		X
Romania	8E	X		X
Russia	B8	X		X
Saudi Arabia	98	X		X
Senegal	99	X		X
Singapore	9C	X	X	X
Slovakia	FB	X		X
Slovenia	FC	X		X
South Africa	9F	X		X
Spain	A0	X	X	X
Sri Lanka	A1	X		X
Sweden	A5	X	X	X
Switzerland	A6	X		X
Taiwan	FE	X	X	X
Thailand	A9	X		X
Tunisia	AD	X		X
Turkey	AE	X		X
UK	B4	X	X	X
United Arab Emirates	B3	X		X
Uruguay	B7	X		X
USA	B5	X	X	X
Reserved	FD			

1.3.4   Reference Designs

A reference design consisting of a motherboard and daughtercard set is available to minimize modem design time, reduce development cost, and accelerate market entry. The part numbers for this design are: CX-9Z-C00217 (motherboard) and CX-9Z-C00234 (daughtercard).

A reference modem user's guide (USG-201693) is available in electronic form. This user's guide includes schematics, bill of materials (BOM), vendor part list (VPL), board layout files, and complete documentation.

1.4 Hardware Description

1.4.1 CX93021-2x Modem

The CX93021-2x modem includes a Microcontroller (MCU), a Modem Data Pump (MDP), internal ROM, internal RAM, and SmartDAA interface functions.

The modem connects to host via a logical V.24 (EIA/TIA-232-E) serial DTE interface.

The modem MCU/DSP performs the command processing, host interface functions and telephone line signal modulation/demodulation which reduces computational load on the host processor.

The SmartDAA Interface communicates with, and supplies power and clock to the LSD through the DIB.

1.4.2 Digital Isolation Barrier

The OEM-supplied Digital Isolation Barrier (DIB) electrically DC isolates the CX93021-2x from the LSD and telephone line. The modem is connected to a fixed digital ground and operates with standard CMOS logic levels. The LSD is connected to a floating ground and can tolerate high voltage input (compatible with telephone line and typical surge requirements).

The DIB transformer couples power and clock from the CX93021-2x to the LSD.

The DIB data channel supports bidirectional half-duplex serial transfer of data, control, and status information between the CX93021-2x and the LSD over two lines.

1.4.3 CX20452 Codec (Optional)

The optional CX20452 Codec (VC), packaged in a 24-pin QFN, supports voice/full-duplex speakerphone (FDSP) operation with interfaces to a microphone and speaker and to a telephone handset/headset.

1.4.4 CX20548 SmartDAA Line Side Device

The CX20548 SmartDAA 4 Line Side Device (LSD) includes a Line Side DIB Interface, a coder/decoder (codec), and a Telephone Line Interface (TLI).

The Line Side DIB Interface communicates with, and receives power and clock from, the SmartDAA 4 interface in the host side device (HSD) through the DIB transformer. The clock signal passing through the transformer is rectified in the LSD and filtered using external capacitors.

Information is transferred between the LSD and the HSD through the DIB transformer using pulse width modulation

The TLI integrates DAA and direct telephone line interface functions and connects directly to the line TIP and RING pins, as well as to external line protection components.

Direct LSD connection to TIP and RING allows real-time measurement of telephone line parameters, such as the telephone central office (CO) battery voltage, individual telephone line (copper wire) resistance, and allows dynamic regulation of the off-hook

TIP and RING voltage and total current drawn from the central office (CO). This allows the modem to maintain compliance with U.S. and worldwide regulations.

1.5   Commands

The modem supports data modem, fax class 1, 1.0, or 2 modem, TAM, V.80 commands, and S Registers in accordance with modem model options. See Doc. REM-201692 for a description of the commands.

Data Modem Operation. Data modem functions operate in response to the AT commands when +FCLASS=0. Default parameters support U.S./Canada operation.

Fax Mode Operation. Facsimile functions operate in response to fax class 1 commands when +FCLASS=1, to fax class 1.0 commands when +FCLASS=1.0, or to fax class 2 commands when +FCLASS=2.

2. Technical Specifications

2.1 Serial DTE Interface Operation

2.1.1 Automatic Speed/Format Sensing

Command Mode and Data 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

2.2 Establishing Data Modem Connections

2.2.1 Dialing

DTMF Dialing. DTMF dialing using DTMF tone pairs is supported in accordance with ITU-T Q.23.

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.

2.2.2 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.

2.2.3 Call Progress Tone Detection

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

2.2.4 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.

2.2.5 Ring Detection

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

2.2.6 Billing Protection

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

2.2.7   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).

Table 2-1. +MS Command Automode Connectivity

Modulation	<carrier>	Possible (<min_rx_rate>, <min_rx_rate>, (<min_tx_rate>), and <max_tx_rate>) Rates (bps)
Bell 103	B103	300
Bell 212	B212	1200 Rx/75 Tx or 75 Rx/1200 Tx
V.21	V21	300
V.22	V22	1200
V.22bis	V22B	2400 or 1200
V.23	V23C	1200
V.32	V32	9600 or 4800
V.32bis	V32B	14400, 12000, 9600, 7200, or 4800
V.34/V.90 upstream	V34/V90	33600, 31200, 28800, 26400, 24000, 21600, 19200, 16800, 14400, 12000, 9600, 7200, 4800, or 2400
V.90 downstream	V90	56000, 54667, 53333, 52000, 50667, 49333, 48000, 46667, 45333, 44000, 42667, 41333, 40000, 38667, 37333, 36000, 34667, 33333, 32000, 30667, 29333, 28000
V.92 downstream	V92	56000, 54667, 53333, 52000, 50667, 49333, 48000, 46667, 45333, 44000, 42667, 41333, 40000, 38667, 37333, 36000, 34667, 33333, 32000, 30667, 29333, 28000
V.92 upstream	V92	48000, 46667, 45333, 44000, 42667, 41333, 40000, 38667, 37333, 36000, 34667, 33333, 32000, 30667, 29333, 28000, 26667, 25333, 24000

2.2.8   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).

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-to-modem 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.92, V.90, V.34, V.32bis, 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.22bis and Below). If carrier is lost for a time greater than specified by the S10 register, the modem disconnects.

2.3.6　Fall Forward/Fallback (V.92/V.90/V.34/V.32bis/V.32)

During initial handshake, the modem will fallback to the optimal line connection within V.92/V.90/V.34/V.32bis/V.32 mode depending upon signal quality if automode is enabled by the +MS or N1 command.

When connected in V.92/V.90/V.34/V.32bis/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

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.

2.3.10 Call Progress Speaker Interface

A digital speaker output (DSPKOUT) is supported. DSPKOUT is a square wave output in Data 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.

2.3.11 Serial EEPROM Interface

The 36-pin QFN supports a 2-line serial interface to an optional serial EEPROM.

The EEPROM can hold information such as firmware customization, and country code parameters. Data stored in EEPROM takes precedence over the factory default settings.

A serial EEPROM is required only if additional storage is required for more country profiles or customized firmware code.

The EEPROM size can range from 2 Kb (256 x 8) to 256 Kb (32K x 8) and must support a clock frequency of at least 400 kHz. For overriding, adding new country profiles, or loading NVRAM patches, the EEPROM size must be larger than 2Kb. The size of the EEPROM device will depend on the number of country profiles added or patch size.

2.4 V.92 Features

Modem-on-Hold, quick connect, and PCM upstream are only available when connecting in V.92 data mode. V.92 features are only available when the server called is a V.92 server that supports that particular feature.

2.4.1 Modem-on-Hold

The Modem-on-Hold (MOH) function enables the modem to place an Internet data connection 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 on-line. 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.

2.4.2 Quick Connect

The quick connect function enables the modem to shorten the connect time of subsequent calls to a server supporting quick connect. The quick connect feature is supported by the +PQC command.

2.4.3 PCM Upstream

PCM upstream boosts the upstream data rates between the user and ISP to reduce upload times for large files and email attachments. A maximum of 48 kbps upstream rate is supported with PCM upstream enabled, in contrast to a maximum of 32.2 kbps upstream rate with PCM upstream not enabled. PCM upstream is supported by the +PCM command. PCM upstream is disabled by default.

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.42bis. 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.42bis Data Compression

V.42bis data compression mode, enabled by the %Cn command or S46 register, operates when a LAPM connection is established.

The V.42bis data compression employs a "string learning" algorithm in which a string of characters from the DTE is encoded as a fixed length codeword and stored in a dictionary. The dictionary is 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   Voice/Audio Mode

Voice and audio functions are supported by the Voice Mode. Voice Mode includes four submodes: Online Voice Command Mode, Voice Receive Mode, Voice Transmit Mode and Full-Duplex Receive and Transmit Mode.

2.6.1   Online Voice Command Mode

This mode results from the connection to the telephone line or a voice/audio I/O device (e.g., microphone, speaker, or handset) through the use of the +FCLASS=8 and +VLS commands. After mode entry, AT commands can be entered without aborting the connection.

2.6.2   Voice Receive Mode

This mode is entered when the +VRX command is active in order to record voice or audio data input at the RIN pin, typically from a microphone/handset or the telephone line.

Received analog voice samples are converted to digital form and compressed for reading by the host. AT commands control the codec bits-per-sample rate.

Received analog mono audio samples are converted to digital form and formatted into 8-bit unsigned linear PCM format for reading by the host. AT commands control the bit length and sampling rate. Concurrent DTMF/tone detection is available at the 8 kHz sample rate.

2.6.3   Voice Transmit Mode

This mode is entered when the +VTX command is active in order to playback voice or audio data to the TXA output, typically to a speaker/handset or to the telephone line.

Digitized voice data is decompressed and converted to analog form at the original compression quantization sample-per-bits rate then output to the TXA output.

Digitized audio data is converted to analog form then output to the TXA output.

2.6.4   Full-Duplex Receive and Transmit Mode

This mode is entered when the +VTR command is active in order to concurrently receive and transmit voice.

2.6.5   Tone Detectors

The tone detector signal path is separate from the main received signal path thus enabling tone detection to be independent of the configuration status. In Tone Mode, all three tone detectors are operational.

2.6.6   Speakerphone Mode (Optional)

Speakerphone mode is controlled in voice mode with the following commands:

Use Speakerphone After Dialing or Answering (+VSP=1). +VSP=1 selects speakerphone mode while in +FCLASS=8 mode. Speakerphone operation is entered during Voice Online Command mode after completing dialing or answering.

Speakerphone Settings. The +VGM and +VGS commands can be used to control the microphone gain and speaker volume, respectively. VGM and +VGS commands are valid only after the modem has entered the Voice Online mode while in the +VSP=1 setting.

2.7   V.80 Synchronous Access Mode (SAM)

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.

2.8   Full-Duplex Speakerphone (FDSP) Mode (Optional)

The modem operates in FDSP mode when +FCLASS=8 and +VSP=1 (Section 2.6.6).

In FDSP Mode, speech from a microphone or handset is converted to digital form, shaped, and output to the telephone line through the line interface circuit. Speech received from the telephone line is shaped, converted to analog form, and output to the speaker or handset. Shaping includes both acoustic and line echo cancellation.

2.9   Telephony Extensions

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

• Line-in-use detection
• Extension pick-up detection
• Remote hang-up detection

The telephony extension features are enabled through the -STE command. The -TTE command can be used to adjust the voltage thresholds for the telephony extension features.

2.9.1   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 attempt is made 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".

2.9.2   Extension Pick-up Detection

The extension pick-up 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. When an extension pick-up has been detected, the modem will go on-hook and respond with the message "OFF-HOOK INTRUSION".

This feature can be used to quickly drop a modem connection in the event when a user picks up an extension phone line. For example, this feature allows set top boxes with an integrated CSM92-SP modem to give normal voice users the highest priority over the telephone line.

2.9.3   Remote Hang-up Detection

The remote hang-up detection feature will cause the modem to go back on-hook and respond with the message "LINE REVERSAL DETECTED" during a data connection when the remote modem is disconnected for abnormal termination reasons (remote phone line unplugged, remote server/modem shutdown).

2.10   Point-of-Sales Support

Point-of-Sales (POS) terminals usually need to exchange a small amount of data in the shortest amount of time. Low speed modulations such as Bell212A or V.22 are still mainly used in POS applications. Additionally, new non-standard sequences have been developed to better support POS applications.

Industry standard and shortened answer tone B103 and V.21 are supported, as well as FastPOS (V.29) and V.22 FastConnect. POS terminal modulations are supported by the $F command.

2.11   Fax Class 1, Fax Class 1.0, and Fax Class 2 Operation

Facsimile functions operate in response to fax class 1 commands when +FCLASS=1, to fax class 1.0 commands when +FCLASS=1.0, or to fax class 2 commands when +FCLASS=2.

In the fax mode, the on-line behavior of the modem is different from the data (non-fax) mode. After dialing, modem operation is controlled by fax commands. Some AT commands are still valid but may operate differently than in data modem mode.

Calling tone is generated in accordance with T.30.

2.12   Tone Detectors

The modem is equipped with three tone detectors with separate signal paths from the main received signal path thus enabling tone detection to be independent of the configuration status.

2.13   Call Waiting Tone Detection

Call Waiting tones can be detected when in V.92, V.90, V.34, and V.32bis data modes.

2.14   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 2.15). 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.92, V.90, V.34, V.32bis, or V.32.

2.15   Worldwide Country Support

Internal modem firmware supports 63 country profiles (see Table 1-2). 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 detection are supported for many countries. Contact your local Conexant sales office for additional country support.
- Blind dialing enabled/disable.
- Carrier transmit level. 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").

The country profiles may be altered or customized by modifying the country-dependent parameters. Additional profiles may also be included. Additional and modified country profiles are supported by internal SRAM.

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Please contact an FAE at the local Conexant sales office for additional and modified country profile support.

2.16   Diagnostics

Diagnostics are performed in response to test commands.

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

PTT Signal Generation (%TTn Command). Continuous tones or modulation are generated by the DSP and output through the DAA.

2.17   Low Power Modes

The modem enters a low power mode when no line connection exists and no host activity occurs for the period of time specified in the S24 register. The modem supports four low power modes: Idle Mode, Sleep Mode, Deep Sleep Mode, and Stop Mode. The low power mode entered depends on the setting of the –SLP command.

2.17.1   Idle Mode

In Idle mode, the CPU and SPX clocks stop, and the SSD clock runs at low frequency. The modem can detect and qualify ring signals and process AT commands. The modem returns to normal mode upon receiving an AT command or receiving a qualified ring.

2.17.2   Sleep Mode

In Sleep mode, the SPX clock stops, and the CPU and SSD clocks run at low frequency. The modem can detect and qualify ring signals. The modem cannot process AT commands. The modem can be awakened by the host sending a single (any) character (typically followed by an AT command) or by the modem receiving a qualified ring.

2.17.3   Deep Sleep Mode

In Deep Sleep mode, the SPX and SSD clocks stop, and the CPU clock runs at low frequency. The modem can detect and qualify ring signals. The modem cannot process AT commands. The modem can be awakened by the host sending a single (any) character (typically followed by an AT command) or by the modem receiving a qualified ring.

2.17.4   Stop Mode

In Stop mode, the CPU, SPX and SSD clocks stop. The modem cannot process AT commands and cannot detect and qualify ring signals. The modem can be awakened by the host sending a single (any) character (typically followed by an AT command).

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3. Hardware Interface

3.1 CX93021-2x Modem Hardware Interface Signals

3.1.1 CX93021-2x Modem Interface Signal Summary

3.1.1.1 LSD Interface (Through DIB)

The DIB interface signals are:

- DIBP
- DIBN

3.1.1.2 Call Progress Speaker Interface

The call progress speaker interface signal is:

- Digital speaker output (DSPKOUT); output

3.1.1.3 Clock Select Interface

The clock select interface signal is:

- Clock Select (CLKSEL); input

3.1.1.4 Serial EEPROM Interface

The 2-line serial interface signals to an optional serial EEPROM are:

- Bidirectional Data input/output (NVMDATA)
- Clock output (NVMCLK)

3.1.1.5 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 output (RLSD#)
- Ring Indicator output (RI#)
- Data Terminal Ready control input (DTR#)
- Request to Send control input (RTS#)
- Data Set Ready output (DSR#)

3.1.1.6   CX20452 Codec Interfaces

The supported codec interface signals are:

- Codec Clock output (IACLK).
- Codec Sleep Control output (IASLEEP).
- Codec Receive Data Serial input (SRIN).
- Codec Transmit Data Serial output (SROUT).
- Codec Shift Clock input (SRCLK).
- Codec Strobe input (SACLK).
- Codec Control output (SRCTL).

3.1.2   CX93021-2x Modem Pin Assignments and Signal Definitions

CX93021-2x Modem 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 3-1.

CX93021-2x Modem hardware interface signals are defined in Table 3-2.

Figure 3-1. CX93021-2x Modem Hardware Interface Signals
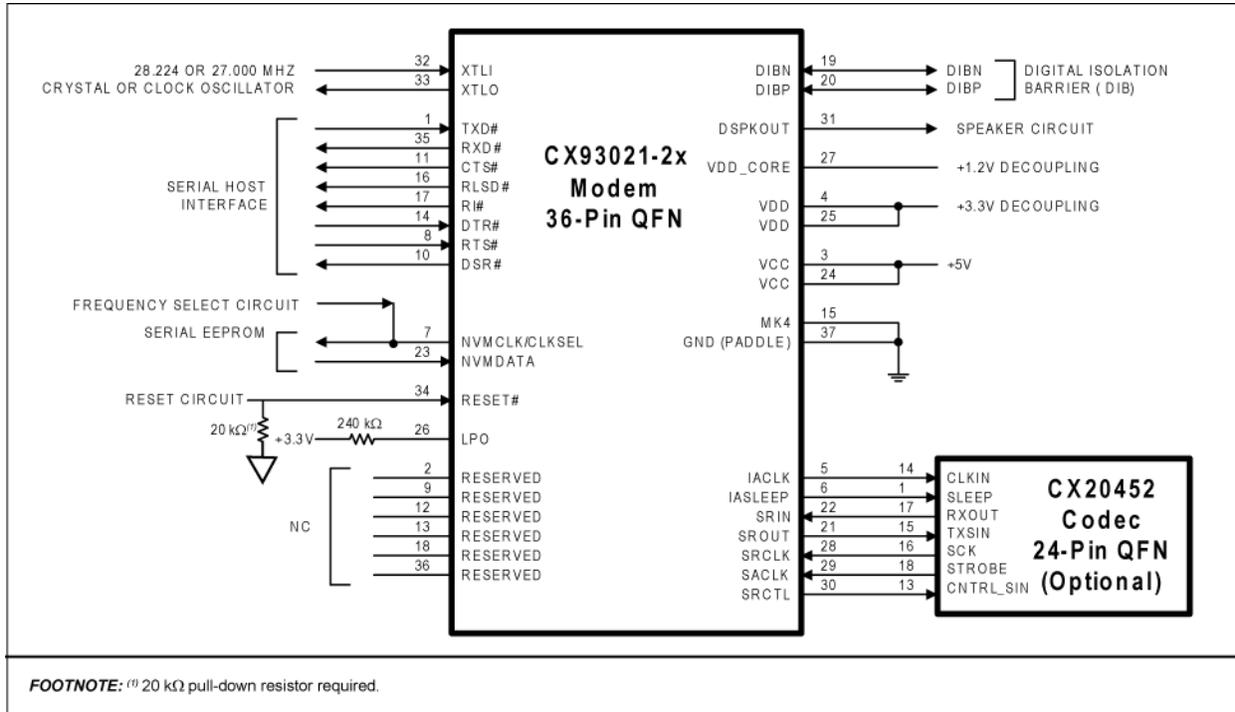
Figure 3-2. CX93021-2x Modem 36-Pin QFN Pin Signals

GND (PADDLE), referred to as pin 37, is the connective surface located on the bottom of the package.
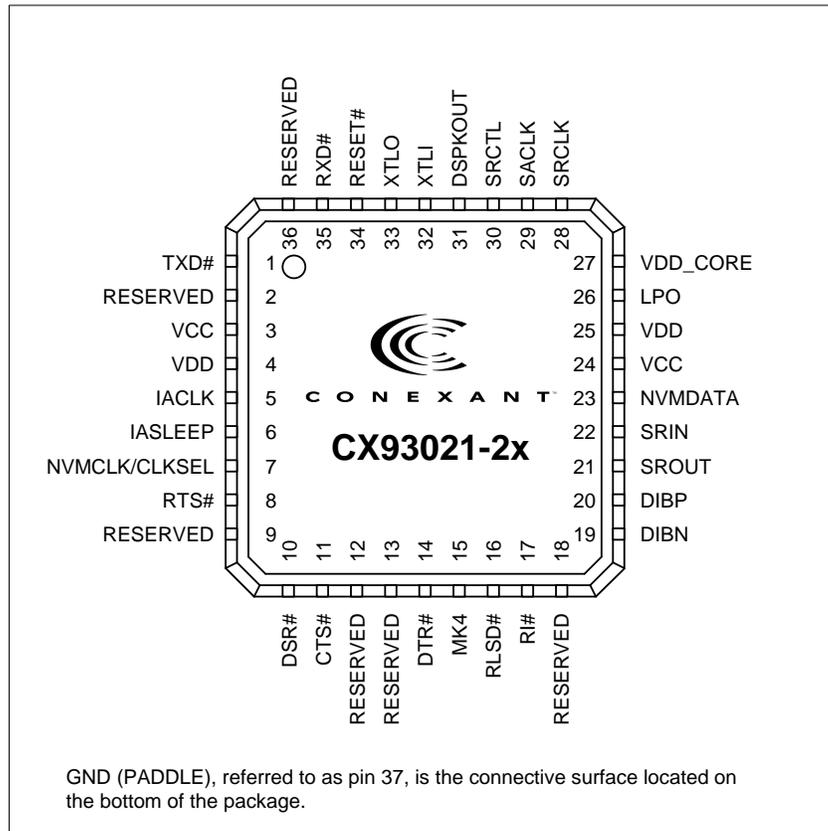
Table 3-1. CX93021-2x Modem 36-Pin QFN Pin Signals

Pin No.	Signal Name	Pin No.	Signal Name
		37	GND (PADDLE)
1	TXD#	19	DIBN
2	RESERVED	20	DIBP
3	VCC	21	SROUT
4	VDD	22	SRIN
5	IACLK	23	NVMDATA
6	IASLEEP	24	VCC
7	NVMCLK/CLKSEL	25	VDD
8	RTS#	26	LPO
9	RESERVED	27	VDD_CORE
10	DSR#	28	SRCLK
11	CTS#	29	SACLK
12	RESERVED	30	SRCTL
13	RESERVED	31	DSPKOUT
14	DTR#	32	XTLI
15	MK4	33	XTLO
16	RLSD#	34	RESET#
17	RI#	35	RXD#
18	RESERVED	36	RESERVED
Note: Pin 37 is the paddle on the bottom of the package.			

Table 3-2. CX93021-2x Modem Hardware Signal Definitions

Label	Pin	I/O	I/O Type	Signal Name/Description
				System
XTLI XTLO	32 33	I O	Ix Ox	**Crystal In and Crystal Out.** If an external 27 or 28.224 MHz crystal circuit is used instead of an external clock circuit, connect XTLI and XTLO to the external crystal circuit. When an external clock circuit is used, connect the clock signal to XTLI and leave XTLO open. (See CLKSEL pin description.)
NVMCLK/CLKSEL	7	I	Ipu/O2	**Clock Frequency Select (CLKSEL)**. Clock frequency is selected by CLKSEL during reset processing. Leave open for 28.224 MHz operation; connect pin to digital ground (GND) through 10 kΩ for 27.000 MHz operation. This signal is multiplexed with NVMCLK.
RESET#	34	I	Ipu/O2	**Reset.** 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. During application of VDD, RESET# must be held low before VDD power is applied and for at least 15 ms after VDD reaches operating range. The modem device set is ready to use 25 ms after the low-to-high transition of RESET#. Since some application may use external host GPIO to control RESET# signal, it will be necessary to have an external 20 kΩ pull-down resistor on RESET# to ensure signal is low while applying VDD to the system.
LPO	26	I		**Low Power Oscillator.** Connect to +3.3V through 240 kΩ.
VDD_CORE	27	O	PWR	**+1.2V Internal Core Voltage Filter.** Internal +1.2 V core voltage for decoupling. Do not connect this pin to an external +1.2 V power supply.
VDD	4, 25	O	PWR	**+3.3V I/O Circuits Voltage.** Internal +3.3V I/O circuits voltage for decoupling. Do not connect this pin to an external +3.3 V power supply.
VCC	3, 24	I	PWR	**Digital Supply Voltage.** Connect to +5V.
GND (PADDLE)	37	I	GND	**Digital Ground.** Connect to digital ground (GND).
MK4	15	I		**Control.** Connect to digital ground (GND).
				Speaker Interface
DSPKOUT	31	O	Ipd/O2	**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.
				DIB Interface
DIBN	19	O	Odpc	**DIB Negative.** Provides clock and power to the LSD, and transfers data, control and status information between the SSD and LSD. Connect to DIB transformer primary winding terminal.
DIBP	20	O	Odpc	**DIB Positive.** Provides clock and power to the LSD and transfers data, control and status information between the SSD and LSD. Connect to DIB transformer primary winding terminal.
				NVRAM Interface
NVMCLK/CLKSEL	7	I/O	Ipu/O2	**NVRAM Clock (NVMCLK).** During normal operation, NVMCLK/CLKSEL output high enables the EEPROM. Connect to EEPROM SCL pin. This signal is multiplexed with CLKSEL.
NVMDATA	23	I/O	Ipu/O2	**NVRAM Data.** The NVMDATA pin supplies a serial data interface to the EEPROM. Connect to EEPROM SDA pin and to +3.3V through 10 KΩ.

Table 3-2. CX93021-2x Modem Hardware Signal Definitions (Continued)

Label	Pin	I/O	I/O Type	Signal Name/Description
V.24 (EIA/TIA-232-E) DTE Serial Interface				
TXD#	1	I	Ipu/O2	**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#	35	O	Ipu/O2	**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#	11	O	Ipu/O2	**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 error correction or normal mode, CTS# is always ON (low) unless RTS/CTS flow control is selected by the &Kn command.
RLSD#	16	O	Ipu/O2	**Received Line Signal Detector (EIA CF/ITU-T CT109).** During normal operation, when AT&C0 command is not in effect, RLSD# output is ON when a carrier is detected on the telephone line or OFF when carrier is not detected.
RI#	17	O	Ipu/O2	**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#	14	I	Ipu/O2	**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.
RTS#	8	I	Ipu/O2	**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#. The modem ignores RTS# unless RTS/CTS flow control is selected by the &Kn command.
DSR#	10	O	Ipu/O2	**Data Set Ready (EIA CC/ITU-T CT107).** DSR# indicates modem status to the DTE. DSR# OFF (high) indicates that the DTE is to disregard all signals appearing on the interchange circuits except Ring Indicator (RI#). DSR# output is controlled by the AT&Sn command.
CX20452 Codec Interface for Speakerphone				
IACLK	5	O	It/Ot2	**Codec Clock.** Connect to CX20452 CLKIN pin.
IASLEEP	6	O	Ot2	**Codec Sleep Control.** Connect to CX20452 SLEEP pin.
SRIN	22	I	Itk/Ot2	**Codec Receive Serial Data.** Connect to CX20452 RXOUT pin.
SROUT	21	O	Ot2	**Codec Transmit Serial Data.** Connect to CX20452 TXSIN pin.
SRCLK	28	I	Itpu/Ot2	**Codec Shift Clock.** Connect to CX20452 SCK pin.
SACLK	29	I	Itpu/Ot2	**Codec Strobe.** Connect to CX20452 STROBE pin.
SRCTL	30	O	It/Ot2	**Codec Control.** Connect to CX20452 CNTRL_SIN pin.
Reserved				
RESERVED	2, 9, 12, 13, 18, 36			**Reserved.** Leave open.
Note: I/O Types: See Table 3-3.				

3.1.3 CX93021-2x Modem Electrical Characteristics

CX93021-2x I/O types are defined in Table 3-3.

CX93021-2x DC electrical characteristics are listed in Table 3-4.

Table 3-3. CX93021-2x Modem I/O Type Definitions

I/O Type	Description
Idd/Odd	Digital input/output, DIB data transceiver
Ix/Ox	I/O, wire
Ipd/O2	Digital input, 120 kΩ pull-down / Digital output, 2 mA
Ipu/O2	Digital input, 120 kΩ pull-up / Digital output, 2 mA
Ippu/O2	Digital input, Programmable 120 kΩ pull-up / Digital output, 2 mA
Odpc	Digital output with adjustable drive, DIB clock and power
Rx	Oscillator Pad, place 120 kΩ resistor from pad to VDD
PWR	Power
GND	Ground

NOTES:
1. See DC characteristics in Table 3-4.
2. 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 3-4. CX93021-2x Modem DC Electrical Characteristics

Parameter	Symbol	Min.	Max.	Units	Test Conditions
Input Voltage Low	VIL	0	0.3 *VDD	V	
Input Voltage High	VIH	0.7 * VDD	VDD	V	
Input Current (no Pull-Down or Pull-Up)	IIL	-1	+1	uA	OEN = 1
Input Current (Pull-Down)	IPD	+6	+30	uA	VIN = VDD
Input Current (Pull-Up)	IPU	-300	-60	uA	VIN = GND
Output Voltage Low	VOL	0	0.4	V	IOL = +2 mA
Output Voltage High	VOH	VDD-0.4	VDD	V	IOL = -2 mA
Output Impedance	Z	25	95	Ω	
Pull-Up Resistance	Rpu	120	500	kΩ	VIN = GND
Pull-Down Resistance	Rpd	120	500	kΩ	VIN = VDD

Test Conditions unless otherwise stated: VCC = +5 ± 0.25 VDC; TA = 0°C to 70°C; external load = 50 pF.

3.2 CX20548 LSD Hardware Pins and Signals

3.2.1 General

3.2.1.1 Host Side Device (HSD) Interface (Through DIB)

The DIB interface signals are:
- DIB Positive (DIBP, pin 14); input/output
- DIB Negative (DIBN, pin 16); input/output

3.2.1.2 Power and Ground

The power and ground signals are:
- Unregulated Power Output (PWR, pin 15)
- Regulated Digital Power Output (DVDD, pin 1)
- Regulated Analog Power Output (AVDD, pin 2)
- Analog Ground (PADDLE [AGND]); Analog ground

3.2.1.3 Telephone Line Interface

The telephone line interface signals are:
- RING AC Coupled (RAC, pin 4); input
- TIP AC Coupled (TAC, pin 5); input
- Electronic Inductor Capacitor (EIC, pin 11)
- Electronic Inductor Output (EIO, pin 10)
- Electronic Inductor Feedback (EIF, pin 9)
- Receive Analog Input (RXI, pin 6); input
- Transmit Output (TXO, pin 8); output
- Transmit Feedback (TXF, pin 7); input

3.2.1.4 Voltage References

There is one reference voltage pin:
- Output Middle (Center) Reference Voltage (VC, pin 3); output for decoupling

3.2.1.5 General Purpose Input/Output

There is one unassigned general purpose input/output pin:
- General Purpose Input/Output (GPIO, pin 13); input/output

3.2.2 Pin Assignments and Signal Definitions

CX20548 LSD hardware interface signals are shown by major interface in Figure 3-3, are shown by pin number in Figure 3-4, and are listed by pin number in Table 3-5.

Note: *Pin 17 is shown in Figure 3-3 to ensure that the PADDLE is considered when laying out the printed circuit board. The PADDLE is the analog ground pin of the CX20548 device and must be connected to LSD analog ground (AGND_LSD) when the CX20548 is populated in a PCB.*

CX20548 LSD hardware interface signals are defined in Table 3-6.

CX20548 LSD GPIO DC characteristics are specified in Table 3-7.

CX20548 LSD AVDD DC characteristics are specified in Table 3-8.

Figure 3-3. CX20548 LSD Hardware Interface Signals

NOTES:

1. Consult applicable reference design for exact component placement and values, and for layout guidelines.

2. The PADDLE (indicated as Pin 17) is the analog ground pin of the CX20548 device and must be connected to LSD analog ground (AGND_LSD) when the CX20548 is populated in a printed circuit board (PCB).

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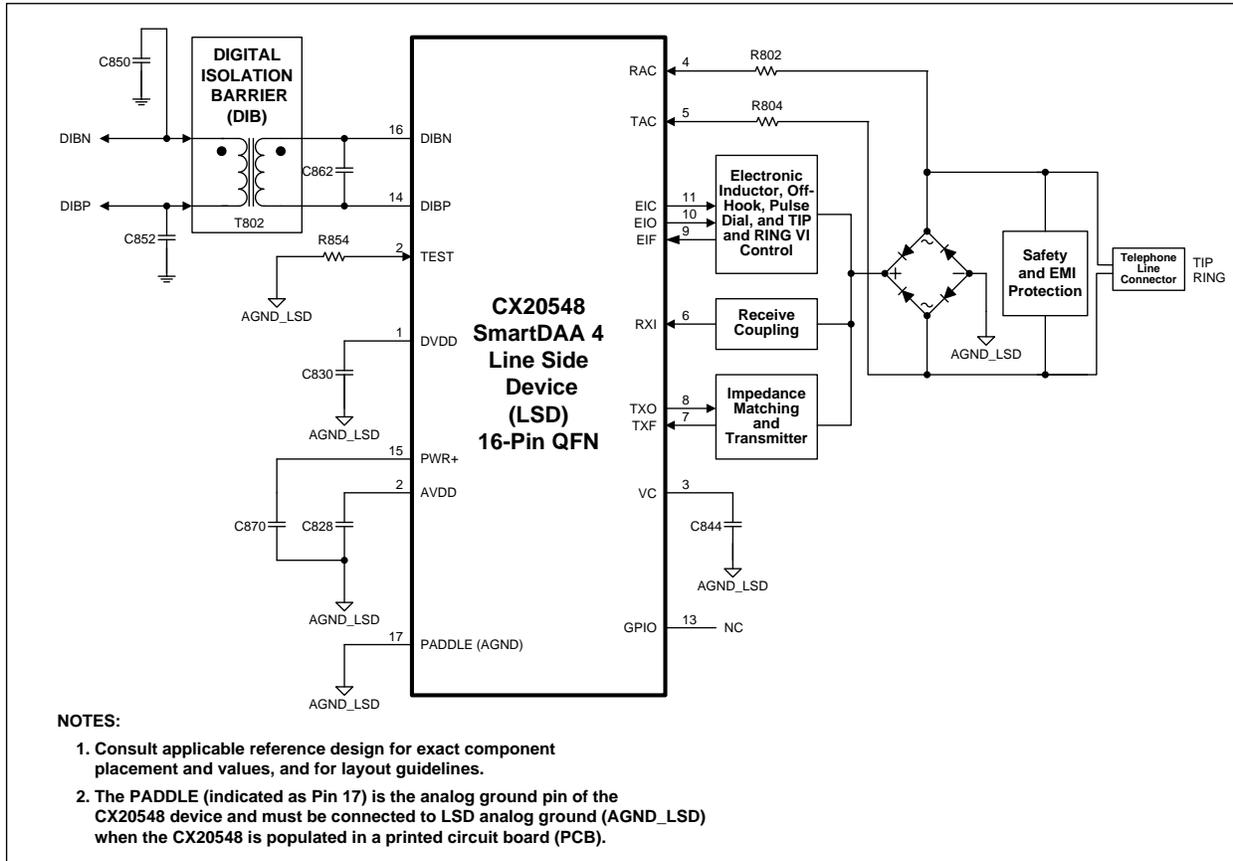
Figure 3-4. CX20548 LSD 16-Pin QFN Pin Signals

The PADDLE, a connective surface located on the bottom of the package and referred to as pin 17, is connected internally to analog ground (AGND).
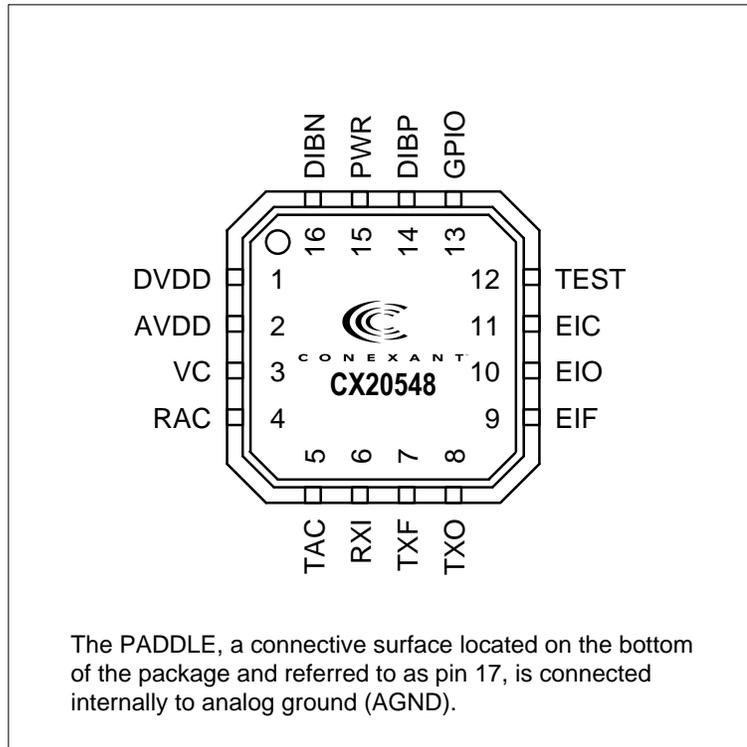
Table 3-5. CX20548 LSD 16-Pin QFN Pin Signals

Pin	Signal Label	Pin	Signal Label
1	DVDD	9	EIF
2	AVDD	10	EIO
3	VC	11	EIC
4	RAC	12	TEST
5	TAC	13	GPIO
6	RXI	14	DIBP
7	TXF	15	PWR
8	TXO	16	DIBN
		17	PADDLE (AGND)

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Table 3-6. CX20548 LSD Hardware Signal Definitions

Label	Pin	I/O	I/O Type	Signal Name/Description
System Interface Signals				
PWR	15	PWR	PWR	**Unregulated Power Output.** Unregulated power output from the internal rectifier, connect to AGND_LSD through C870.
VC	3	REF	REF	**Output Middle Reference Voltage.** Connect to AGND_LSD through C844, which must be placed close to pin 3. Use a short path and a wide trace to AGND_LSD pin.
AVDD	2	PWR	PWR	**Analog Power Output.** Provides external connection point for decoupling. (AVDD is routed internally to LSD analog circuits.). Connect to AGND_LSD through C828. C828 must be placed close to pins 2.
DVDD	1	PWR	PWR	**Digital Power Output.** Provides external connection point for decoupling. Connect to AGND_LSD through C830. Place C830 near pin 1.
PADDLE (AGND)	17	AGND_LSD	AGND_LSD	**Paddle Analog Ground.** The conductive surface located on the bottom of the package and referred to as pin 17 is connected internally to device analog ground. Connect to AGND_LSD.
DIB Interface Signals				
DIBP	14	I/O	I/O	**DIB Positive.** Positive terminal of DIB, connect to secondary of DIB transformer.
DIBN	16	I/O	I/O	**DIB Negative.** Negative terminal of DIB, connect to secondary of DIB transformer.
TIP and RING Interface Signals				
RAC TAC	4 5	I I	Ia a	**RING AC Coupled and TIP AC Coupled.** Un-rectified voltage from telephone line used to detect ring. Connect RAC to the diode bridge AC node (RING) through R802 (connects to pin 4). Connect TAC to the diode bridge AC node (TIP) through R804 (connects to pin 5).
EIC	11	O	Oa	**Electronic Inductor Capacitor.** Electronic inductor filtering capacitor. Connect to AGND_LSD through C858.
EIO	10	O	Oa	**Electronic Inductor Output.** Calculated voltage is applied to this output to control off-hook and DC VI mask operation. Connect to base of Q804.
EIF	9	I	Ia	**Electronic Inductor Feedback.** Connect to emitter of Q804 through R826.
RXI	6	I	Ia	**Receive Analog Input.** Receiver operational amplifier inverting input. AC coupled to the Bridge_CC node through R810 (connects to pin 6) and C810 in series. R810 and C810 must be placed very close to pin 6. The length of the PCB trace connecting R810 to the RXI pin must be kept at an absolute minimum.
TXO	8	O	Oa	**Transmit Output.** Outputs transmit signal and impedance matching signal; connect to base of transistor Q802.
TXF	7	I	Ia	**Transmit Feedback.** Connect to emitter of transistor Q802.
Not Used				
GPIO	1	I/O	It/Ot12	**General Purpose I/O**. Leave open if not used.
Notes: 1. I/O types*: Ia Analog input It Digital input* Oa Analog output Ot12 Digital output* AGND_LSD Isolated LSD Analog Ground (isolated from the host system ground) *See Section CX20548 LSD GPIO DC Electrical Characteristics (Table 3-7). 2. Refer to applicable reference design for exact component placement and values.				

Table 3-7. CX20548 LSD GPIO DC Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Input Voltage	V_{IN}	-0.30	–	3.465	V	DVDD = +3.465V
Input Voltage Low	V_{IL}	–	–	1.0	V	
Input Voltage High	V_{IH}	1.6	–	–	V	
Output Voltage Low	V_{OL}	0	–	0.33	V	
Output Voltage High	V_{OH}	2.97	–	–	V	
Input Leakage Current	–	-10	–	10	µA	
Output Leakage Current (High Impedance)	–	-10	–	10	µA	
GPIO Output Sink Current at 0.33 V maximum	–	2.4	–	-	mA	
GPIO Output Source Current at 2.97 V minimum	–	2.4	–	-	mA	
GPIO Rise Time/Fall Time		20		100	ns	
Test Conditions unless otherwise stated: DVDD = +3.3V +5%; TA = 0°C to 70°C; external load = 50 pF						

Table 3-8. CX20548 LSD AVDD and DVDD DC Electrical Characteristics

PWR Input	AVDD Output	DVDD Output
+3.3 V < PWR < +4.5 V	+3.3 V ± 5%	+3.0 V ± 5%
PWR must be at least 100mV higher than AVDD.		
See PWR, AVDD, and DVDD descriptions in Table 3-6.		

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3.3   CX20452 Codec Hardware Interface Signals

3.3.1   CX20452 Codec Pin Assignments and Signal Definitions

The CX20452 Codec hardware interface signals for a typical speakerphone application are shown in Figure 3-5.

The CX20452 Codec pin assignments are shown in Figure 3-6 and are listed in Table 3-9.

The CX20452 Codec hardware interface signals are described in Table 3-10.

Figure 3-5. CX20452 Codec Hardware Interface Signals
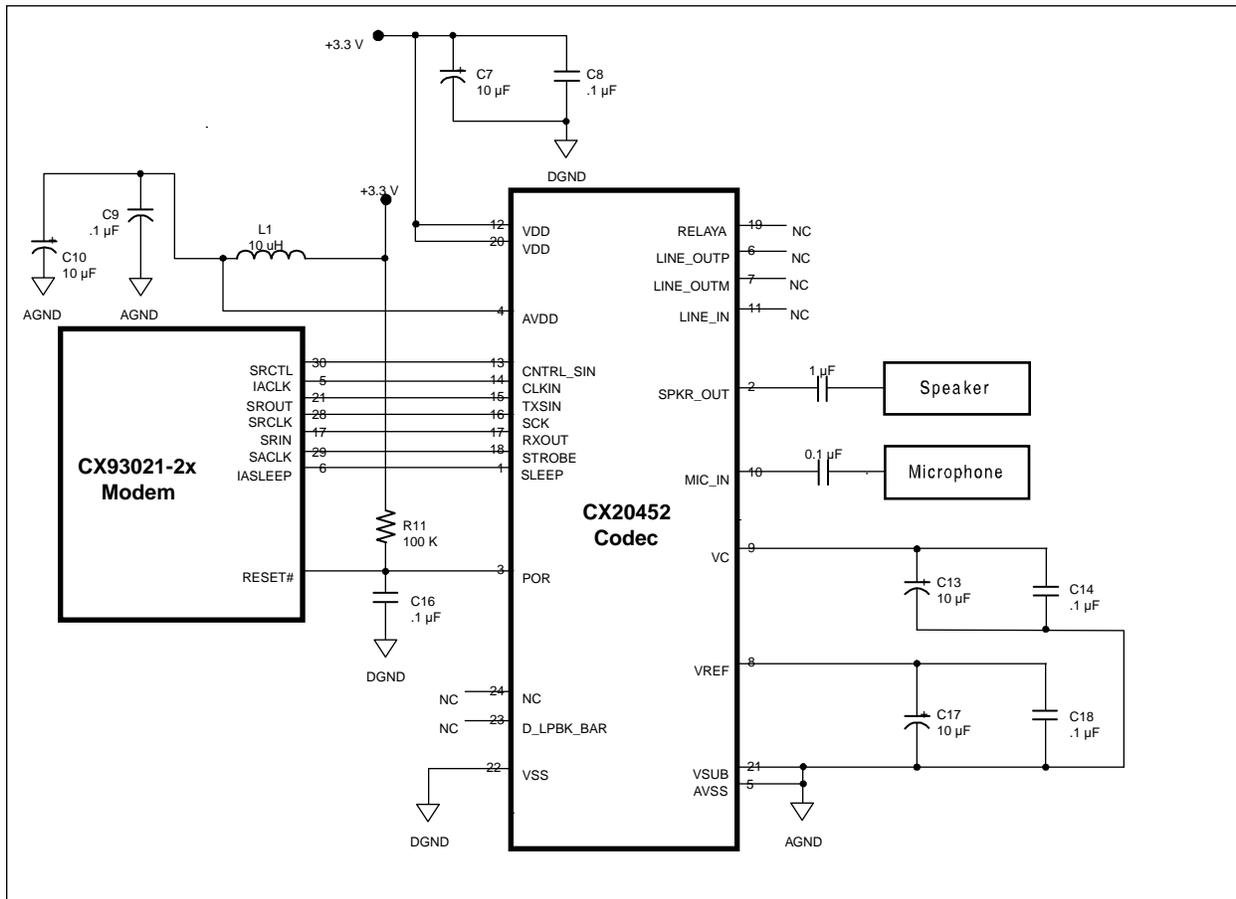
Figure 3-6. CX20452 Codec 24-Pin QFN Pin Signals
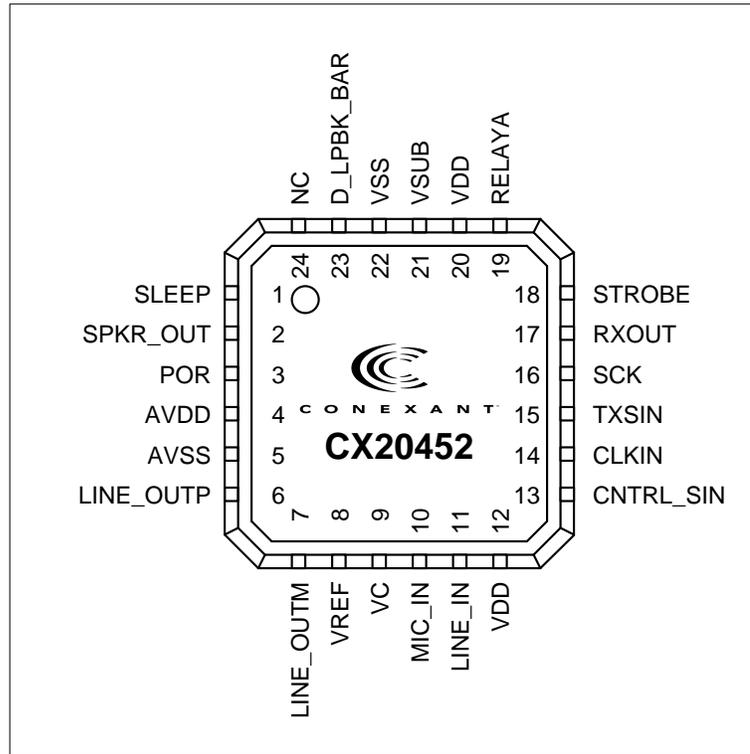
Table 3-9. CX20452 Codec 24-Pin QFN Pin Signals

Pin No.	Signal Name	Pin No.	Signal Name
1	SLEEP	13	CNTRL_SIN
2	SPKR_OUT	14	CLKIN
3	POR	15	TXSIN
4	AVDD	16	SCK
5	AVSS	17	RXOUT
6	LINE_OUTP	18	STROBE
7	LINE_OUTM	19	RELAYA
8	VREF	20	VDD
9	VC	21	VSUB
10	MIC_IN	22	VSS
11	LINE_IN	23	D_LPBK_BAR
12	VDD	24	NC

Table 3-10. CX20452 Codec Hardware Signal Definitions

Signal Name	Pin No.	I/O Type	Signal Description
Power and Ground			
VDD	12, 20	PWR	**Digital Power Supply.** Connect to 3.3 V and to digital circuits power supply filter.
AVDD	4	PWR	**Analog Power Supply.** Connect to 3.3 V and to analog circuits power supply filter.
VSS	22	GND	**Digital Ground.** Connect to GND.
AVSS	5	AGND	**Analog Ground.** Connect to AGND.
Control			
POR	3	IPU	**Power-On Reset In.** Active low reset input. Connect to reset circuit and to CX93021-2x RESET# pin.
D_LPBK_BAR	23	IPU	**Digital Loopback Control.** Active low input asserted to loopback DAC to SINC. Used for factory test only. Leave open for normal operation.
CX93021-2x Interface			
CLKIN	14	IPD	**Clock Input.** Connect to CX93021-2x IACLK pin.
SLEEP	1	IPD	**Sleep Control Input.** Active low input asserted to power down the CX20452 Codec. CX93021-2x IASLEEP pin.
RXOUT	17	O	**Receive Data Serial Output**. Connect to CX93021-2x SRIN pin.
TXSIN	15	IPD	**Transmit Data Serial Input.** Connect to CX93021-2x SROUT pin.
SCK	16	O	**Shift Clock Output.** Connect to CX93021-2x SRCLK pin.
STROBE	18	O	**Strobe Output.** Connect to CX93021-2x SACLK pin.
CNTRL_SIN	13	IPD	**Control Input.** Connect to CX93021-2x SRCTL pin.
Microphone and Speaker Interface			
MIC_IN	10	IA	**Microphone Input.** Single-ended analog data input from the microphone circuit.
SPKR_OUT	2	OA	**Analog Speaker Output.** The SPKR_OUT analog output reflects the selected analog signal. When the speaker is turned off, SPKR_OUT is clamped to the voltage at the VC pin. The SPKR_OUT output can drive an impedance as low as 150 Ω.
Line Interface (Not Used)			
RELAYA	19	OD	**Relay A Control.** Leave open.
LINE_OUTP	6	OA	**Line Output Plus.** Single-ended analog data output. Leave open.
LINE_OUTM	7	OA	**Line Output Minus.** Single-ended analog data output. Leave open.
LINE_IN	11	IA	**Line Input.** Single-ended analog data input. Leave open.
Reference			
VREF	8	OA	**Analog Reference Voltage.** 0. 5 V nom. Connect to AGND through 10 µF (polarized, + terminal to VREF) and 0.1 µF (ceramic) in parallel. Position these capacitors very close to the VREF pin. Use a short path and a wide trace to AGND pin.
VC	9	OA	**Analog Reference Voltage.** 1.5 V nom. Connect to AGND through 10 µF (polarized, + terminal to VC) and 0.1 µF (ceramic) in parallel. Position these capacitors very close to the VC pin. Use a short path and a wide trace to AGND pin.
VSUB	21	GND	**Digital Substrate Pin.** Connect to AGND.
No Connect			
NC	24	—	**No Internal Connection.** Leave open.

Notes:

1. I/O types*:

I	Digital Input: CMOS receiver, I_{PD} = 130 kΩ pull-down, I_{PU} = 130 kΩ pull-up	
O	Digital Output: CMOS driver, 2 mA, 120 Ω	
OD	Digital Output: CMOS driver, open drain	
IA	Analog Input: Analog receiver	
OA	Analog Output: Analog driver	
PWR	Power	
AGND	Analog ground	
GND	Digital ground	

*See DC Electrical Characteristics (Table 3-11) and Analog Electrical Characteristics (Table 3-12).

3.3.2   CX20452 Codec Electrical Characteristics

CX20452 Codec DC electrical characteristics are listed in Table 3-11.

CX20452 Codec analog electrical characteristics are listed in Table 3-12.

Table 3-11. CX20452 Codec DC Electrical Characteristics

Parameter	Symbol	Min	Max	Unit
Input high voltage	V_{IH}	0.4 * VDD	VDD + 0.3	V
Input low voltage	V_{IL}	-0.3	0.2 * VDD	V
Output high voltage	V_{OH}	0.8 * VDD	VDD	V
Output low voltage	V_{OL}	—	0.4	V
Input leakage current	I_{IN}	—	±10	μA
Output leakage current	I_{OUT}	—	±10	μA
Notes: Applies to types I and O unless otherwise indicated. All voltages referenced to ground (VSS). Currents are positive when flowing into the device.				

Table 3-12. CX20452 Codec Analog Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit
DAC to Line Driver output at -10 dBm, 600 Ω	SNR	—	72	—	dB
DAC to Speaker Driver output at -10 dBm, 150 Ω	SNR	—	72	—	dB
Line input to ADC at –10 dBm	SNR	—	80	—	dB
Input leakage current	I_{IN}	—	—	± 10	μA
Output leakage current	I_{OUT}	—	—	± 10	μA

3.4   Operating Conditions, Absolute Maximum Ratings, and Power Requirements

The CX93021-2x and CX20452 operating conditions are specified in Table 3-13.

The CX93021-2x and CX20452 absolute maximum ratings are listed in Table 3-14.

The CX93021-2x current and power requirements are listed in Table 3-15.

The CX20452 current and power requirements are listed in Table 3-16.

Table 3-13. CX93021-2x Modem and CX20452 Codec Operating Conditions

Parameter	Symbol	Limits	Units
CX93021-2x Supply Voltage	VCC	+4.75 to +5.25	VDC
CX20452 Digital Supply Voltage	VDD	+3.0 to +3.6	VDC
CX20452 Analog Supply Voltage	AVDD	+3.0 to +3.6	VDC
Operating Ambient Temperature	T_A	0 to +70	°C
Note: Voltages referenced to ground (VSS).			

Table 3-14. Absolute Maximum Ratings

Parameter	Symbol	Limits	Units
Common			
Storage Temperature Range	T_{STG}	-55 to +125	°C
Relative humidity	H_{REL}	Up to 90% non-condensing, or a wet bulb temperature up to 35 °C, whichever is less.	
CX93021-2x Modem			
CX93021-2x VCC Supply Voltage	VCC	-0.5 to +6.0	VDC
Input Voltage	V_{IN}	-0.5 to VDD + 0.5	VDC
Voltage Applied to Outputs in High Impedance (Off) State	V_{HZ}	-0.5 to +5.5	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
CX20452 Codec			
Analog Supply Voltage (+3.3 V operation)	AVDD	-0.3 to +4.6	V
Digital Supply Voltage (+3.3 V operation)	VDD	-0.3 to +4.6	V
Digital Input Voltage	V_{IN}	–0.3 to (VDD + 0.3)	V
Analog Input Voltage	V_{IN}	–0.3 to + (AVDD + 0.3)	V
DC Input Clamp Current	I_{IK}	±10	mA
DC Output Clamp Current	I_{OK}	±10	mA
Static Discharge Voltage (25°C)	V_{ESD}	±2500	V
Latch-up Current (25°C)	I_{TRIG}	±150	mA

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 (VDD + 0.5) V. This prevents forward biasing the input protection diodes and possibly entering a latch up mode due to high current transients.

Table 3-15. CX93021-2x Current and Power Requirements

Mode	Typical Current (mA)	Maximum Current (mA)	Typical Power (mW)	Maximum Power (mW)
Normal Mode: On-hook, Idle, waiting for ring	75	85	375	446
Normal Mode: Off-hook, normal data connection	87	97	435	509
Idle Mode (-SLP=0)	16	23	80	120
Sleep Mode (-SLP=1)	16	23	80	120
Deep Sleep Mode (-SLP=2)	7	13	35	68
Stop Mode (-SLP=3)	5	11	25	58
Notes: 1. Test conditions: VCC = +5.0V for typical values; VCC = +5.25V for maximum values. Temperature = 25 °C. 2. Ptyp = Ityp * 5.0V; Pmax = Imax * 5.25V. 3. Input Ripple ≤ 0.1 Vpeak-peak.				

Table 3-16. CX20452 Codec Current Requirements

Mode	Typical Current (Ityp)	Maximum Current (Imax)	Typical Power (Ptyp)	Maximum Power (Pmax)
VDD				
Operating	0.5 mA		1.65 mW	
Sleep	< 0.3 μA		1 μW	
AVDD				
Operating	2.7 mA		8.9 mW	
Sleep	0.6 μA		1.98 μW	
Notes: 1. Test conditions: VDD = AVDD = +3.3V for typical values; VDD = AVDD = +3.6V for maximum values. 2. Input Ripple ≤ 0.1 Vpeak-peak.				

3.5 Crystal and Clock Specifications

Crystal specifications are listed in Table 3-17. Clock specifications are listed in Table 3-18.

Table 3-17. Crystal Specifications

Characteristic	Value
Frequency	28.224 or 27.000 MHz nominal
Calibration Tolerance	±50 ppm at 25°C (C_L = 16.5 and 19.5 pF)
Frequency Stability vs. Temperature	±35 ppm (0°C to 70°C)
Frequency Stability vs. Aging	±20 ppm/5 years
Oscillation Mode	Fundamental
Calibration Mode	Parallel resonant
Load Capacitance, C_L	18 pF nom.
Shunt Capacitance, C_O	7 pF max.
Series Resistance, R_1	35-60 Ω max. @20 nW drive level
Drive Level	100 μW correlation; 500 μW max.
Operating Temperature	0°C to 70°C
Storage Temperature	–40°C to 85°C

Table 3-18. Clock Specifications

| Characteristic	Value
Type	Square wave
Frequency	28.224 or 27.000 MHz nominal
Level	3.3 Vp-p ± 0.3 V zero offset
Duty Cycle	50 ± 10 %
Stability	±50 ppm

.

4.   Package Dimensions

The 36-pin QFN package dimensions are shown in Figure 4-1.

The 24-pin QFN package dimensions are shown in Figure 4-2.

The CX93021-2x comes in a 16-pin QFN package, in either punch or sawn style. Both are electrically equivalent and share the same footprint. Table 4-1 provides a dimension table that is common to both QFN styles. The punch-style package is shown in Figure 4-3, and the sawn-style package is shown in Figure 4-4.

Figure 4-1. Package Dimensions for 36-Pin QFN

NOTES

1. NOT APPLICABLE
2. DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M. -1994.
3. N IS THE NUMBER OF TERMINALS.
   Nd IS THE NUMBER OF TERMINALS IN X-DIRECTION
   Ne IS THE NUMBER OF TERMINALS IN Y-DIRECTION
4. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.
5. THE PIN #1 IDENTIFIER (INDENTATION MARK OR OTHER FEATURE)
6. EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL
7. ALL DIMENSIONS ARE IN MILLIMETERS.
8. THE SHAPE SHOWN ON FOUR CORNERS ARE NOT ACTUAL I/O.
9. PACKAGE WARPAGE IS 0.05mm MAXIMUM.
10. APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING.
11. APPLIED ONLY FOR TERMINALS.
12. Q AND R APPLIES ONLY FOR STRAIGHT TIE BAR SHAPES.

SYMBOL	DIMENSIONS (mm)			NOTE
	MIN.	NOM.	MAX.	
A	-	0.85	0.90	
A1	0.00	0.01	0.05	11
A2	-	0.65	0.70	
A3	0.20 REF.			
D	6.00 BSC			
D1	5.75 BSC			
E	6.00 BSC			
E1	5.75 BSC			
θ			12°	
P	0.24	0.42	0.60	
R	0.13	0.17	0.23	12
e	0.50 BSC			
N	36			3
Nd	9			3
Ne	9			3
L	0.50	0.60	0.75	
b	0.18	0.23	0.30	4
Q	0.30	0.40	0.65	12
D2	3.95	4.10	4.25	
E2	3.95	4.10	4.25	

36-PIN 6x6mm QFN_(REF: 45278_PVC_EPVC)

POD_36QFN_6x6mm_PVC_EPVC (05-1499ill)

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Figure 4-2. Package Dimensions for 24-Pin QFN

TOP VIEW

SIDE VIEW

BOTTOM VIEW

TERMINAL TIP

SECTION "C-C"

SCALE: NONE

SYMBOL	DIMENSIONS			NOTE
	MIN.	NOM.	MAX.	
A	-	0.85	0.90	
A1	0.00	0.01	0.05	11
A2	-	0.65	0.70	
A3	0.20 REF.			
e	0.50 BSC			
N	24			3
Nd	6			3
Ne	6			3
L	0.30	0.40	0.50	
b	0.18	0.23	0.30	4
D	4.00 BSC			
D1	3.75 BSC			
E	4.00 BSC			
E1	3.75 BSC			
D2	2.35	2.50	2.65	
E2	2.35	2.50	2.65	
θ			12°	
P	0.24	0.42	0.60	

NOTES:

1. NOT APPLICABLE.

2. DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M. - 1994

3. N IS THE NUMBER OF TERMINALS.
   Nd IS THE NUMBER OF TERMINALS IN X-DIRECTION &
   Ne IS THE NUMBER OF TERMINALS IN Y-DIRECTION

4. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED
   BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.

5. THE PIN #1 IDENTIFIER.

6. EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL

7. ALL DIMENSIONS ARE IN MILLIMETERS

8. THE SHAPES SHOWN ON FOUR CORNERS ARE NOT ACTUAL I/O.

9. PACKAGE WARPAGE MAX 0.05mm.

10. APPLIED FOR EXPOSED PAD AND TERMINALS

11. APPLIED ONLY FOR TERMINALS.

PD_24QFN

Table 4-1. Common Table for 16-QFN Punch and Sawn Style Package Dimensions

Dim.	Minimum	Nominal	Maximum	Note
e	0.65 BSC			
L	0.5		0.75	
b	0.21		0.35	(1)
D2	1.95	2.10	2.25	
E2	1.95	2.10	2.25	
A	0.8		1.00	
A1	0.00		0.05	
A3	0.20 REF.			
D	4.00 BSC			
D1	3.75 BSC			(2)
E	4.00 BSC			
E1	3.75 BSC			(2)

General Notes:
1. All dimensions in mm.
2. Shape of Pin #1 indicator on the bottom of package can be different (i.e., Chamfer or Half Circle).

Footnotes:
(1) Dimension b applies to plated terminal and is measured between 0.20 and 0.30 mm from terminal tip.
(2) This dimension is applied only for Punched QFN.

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Figure 4-3. Package Dimensions for 16-Pin QFN, Punch Style
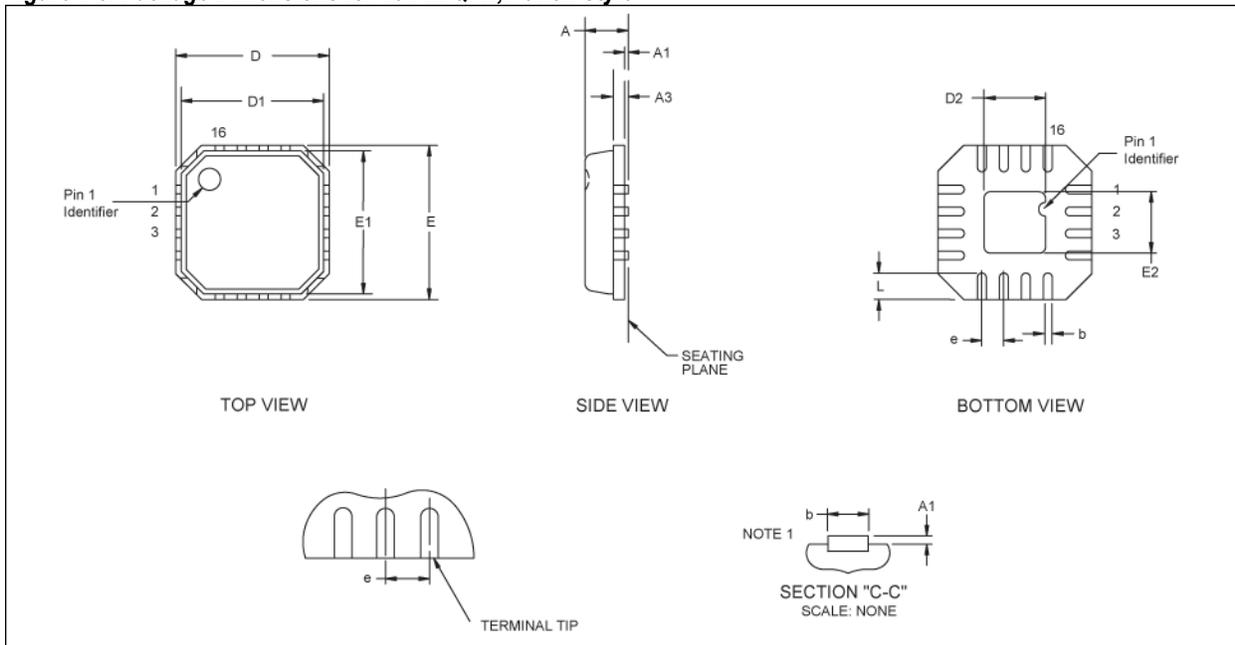
Figure 4-4. Package Dimensions for 16-Pin QFN, Sawn Style
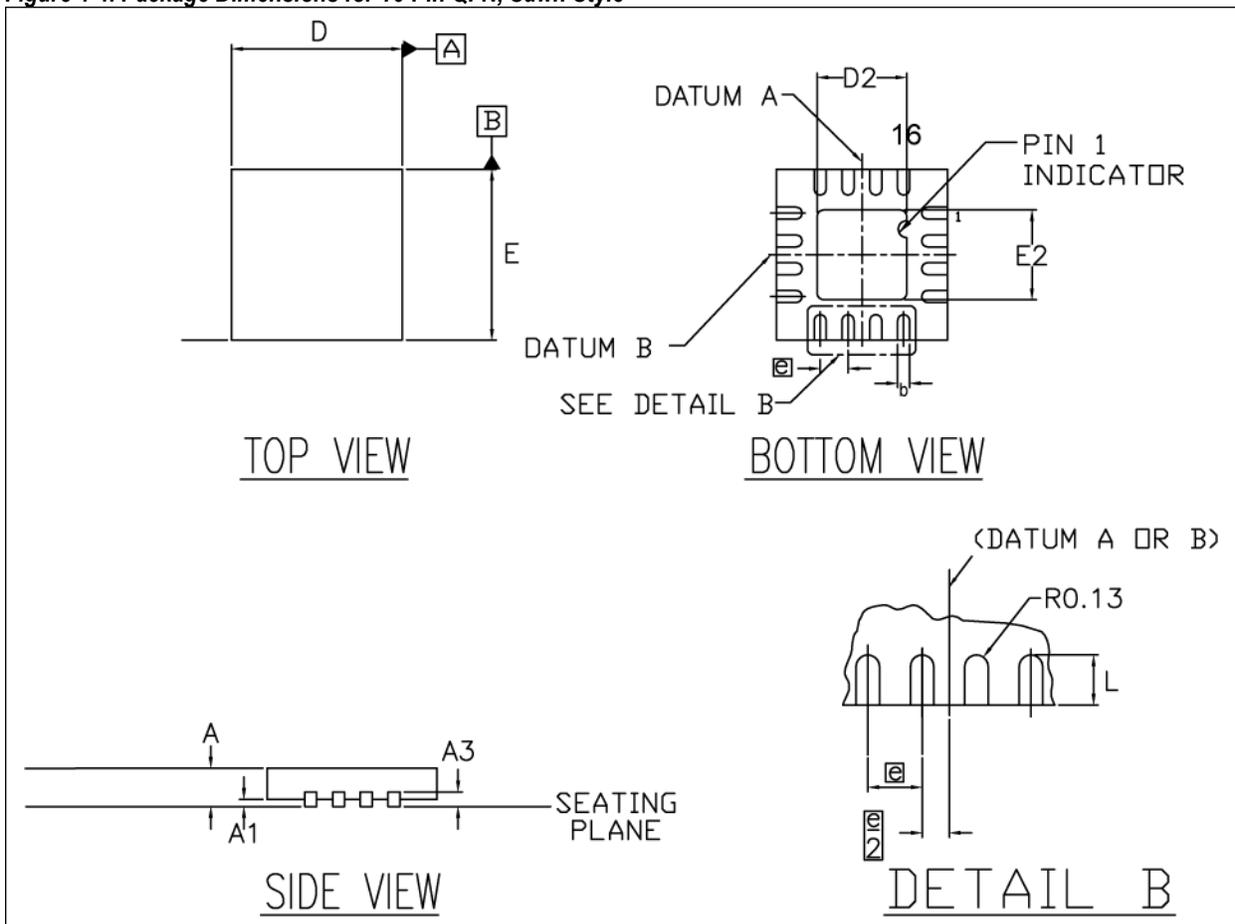
5.   Recommended QFN Surface Mount Land Pattern

The recommended surface mount land patterns based on the IPC-SM-782 standard for board layout are shown in Figure 5-1 for the 36-pin QFN, Figure 5-2 for the 24-pin QFN, and Figure 5-3 for the 16-pin QFN.

*Figure 5-1. Recommended Surface Mount Land Pattern for 36-Pin QFN*
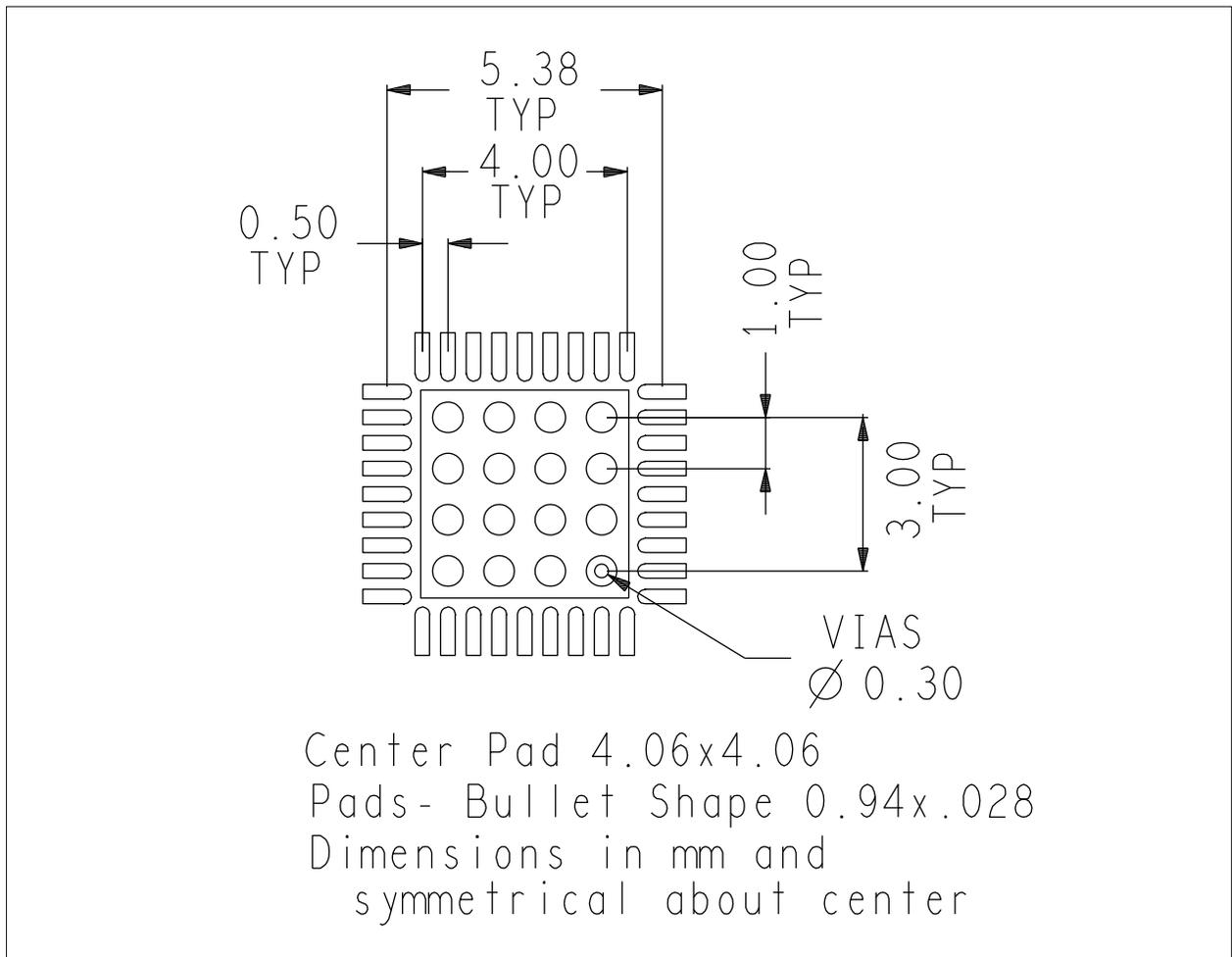
*Figure 5-2. Recommended Surface Mount Land Pattern for 24-Pin QFN*

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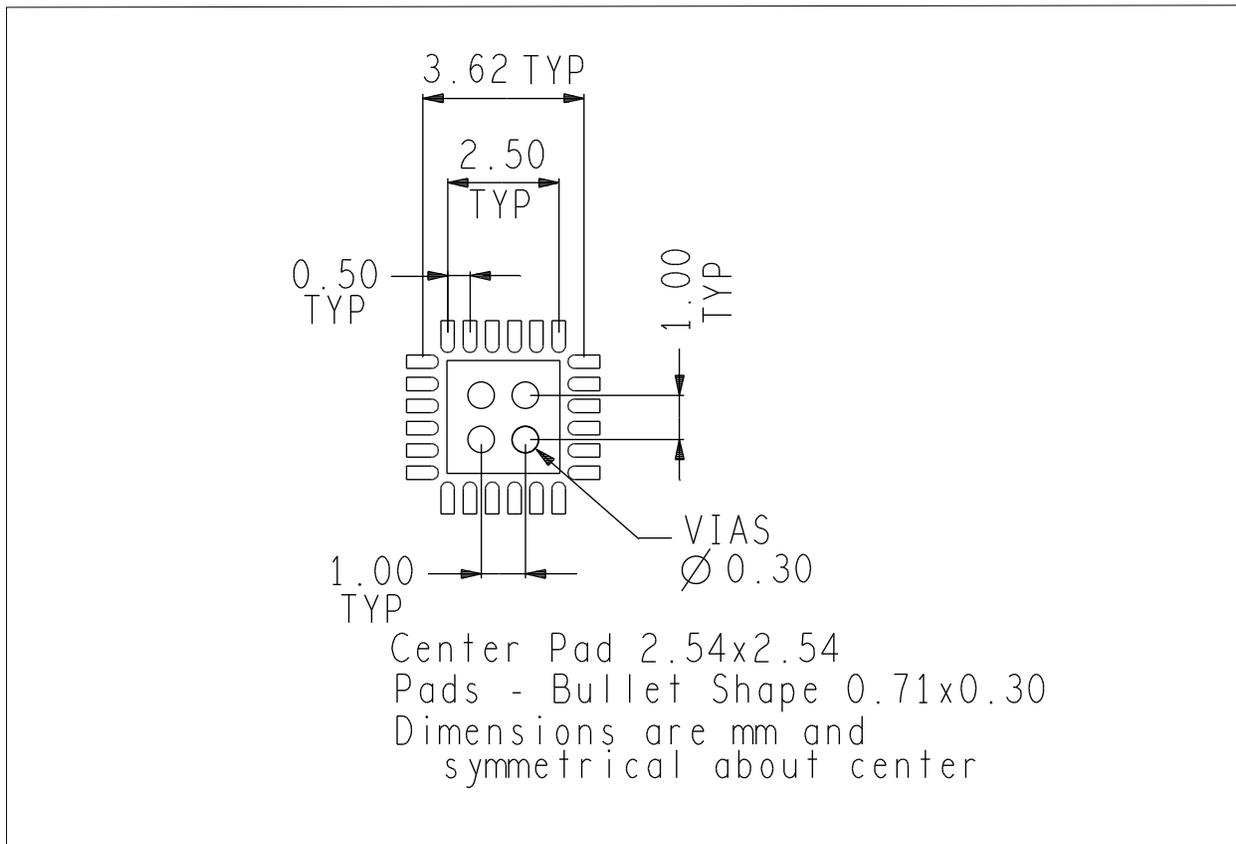
Figure 5-3. Recommended Surface Mount Land Pattern for 16-Pin QFN

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NOTES

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