Rockwell

# SMV144AC SocketModem™ Family

## INTRODUCTION

Rockwell's SMV144AC SocketModem™ family provides the OEM with a complete V.32 or V.32bis modem in a compact socket-mountable module. This complete solution allows OEMs to bring new features to market immediately, with minimal engineering resources. Its socketable design provides system designers the flexibility to include optional modem functionality in any system product. The small size of the modem module makes it ideally suited for use directly on portable computer motherboards, in pocket modems, or anywhere users demand computer communications on the go.

The V.32/V.32bis SocketModem provides data communication utilizing CCITT V.32bis for 14.4 kbps (SMV144AC) or V.32 for 9.6 kbps (SMV96AC), full-duplex data transmission, with fallback capabilities to V.32 (SMV144AC), V.22bis, V.22, V.23, and V.21, as well as Bell 212, and Bell 103. In addition, MNP2-4 and V.42bis error correction, MNP5 and V.42bis data compression, and MNP10 cellular protocols are supported. High speed Group 3 Fax capabilities are provided, compliant with CCITT V.17 (SMV144AC), V.29, V.27ter, and V.21. Fax protocol support is provided with EIA/TIA Class 1 and Class 2 fax. Voice capabilities include a voice pass-through mode, and ADPCM 2-, 4-, and 8-bit compression and decompression, with silence deletion and interpolation.

The SMV144AC SocketModem is available with or without an on-board modular DAA, and is configured for either serial-RS-232, serial-TTL, or parallel host interface, and for either a simple, inexpensive sounducer or a voice-quality speaker circuit.

The SocketModem with the on-board modular DAA is a complete, self-contained modem engine, requiring only an OEM-supplied ROM, TIP and RING from the telephone line, and interface circuitry to the host computer. The SocketModem without the on-board modular DAA also requires an OEM-supplied external DAA.

Additional SMV144AC information can be found in the SocketModem™ Designer's Guide (Order No. 1009), and in the RC96ACL/RC144ACL Modem Designer's Guide (Order No. 876).





## FEATURES

- Data modem throughput to 57.6 kbps
  - V.32bis (SMV144AC), V.32, V.22bis, V.22A/B, V.23, and V.21;
  - Bell 212A and 103
  - V.42 LAPM and MNP 2-4 error correction
  - V.42bis and MNP 5 data compression
- Fax modem send and receive rates up to 14.4 kbps
  - V.17 (SMV144AC), V.29, V.27ter, and V.21 channel 2
- MNP 10 data throughput enhancement
- Voice mode (option)
  - Enhanced ADPCM compression/decompression
  - Tone detection/generation and call discrimination
  - Concurrent DTMF detection
- World-class operation (option)
  - V.25 bis commands
  - Call progress and blacklisting parameters
  - Multiple country support
- Expanded functions (option)
  - Callback security; remote configuration and access
  - Hayes AutoSync
- ConfigurACE utility program
- Communication software compatible command sets
  - AT, fax class 1 and 2, and voice commands
- Built-in DTE interfaces
  - Serial CCITT V.24 (EIA-232-D) or TTL interface DTE speed to 57.6 kbps
  - Parallel 16450 or 16C550A UART-compatible interface
- Line quality monitoring and retrain
- NVRAM directory and stored profiles
- Flow control and speed buffering
- Automatic line speed selection in V.32 bis/V.32
- Auto dial and auto answer
- Tone, pulse, and adaptive dialing
- Calling Number Delivery (Caller ID) detect
- Diagnostics
- Low power consumption (typical):

| Interface | Operating | Sleep |
|---|---|---|
| Serial EIA-232 | 525 mW | 225 mW |
| Serial TTL | 375 mW | 48 mW |
| Parallel | 370 mW | 45 mW |

- Single +5VDC power supply

## ORDERING INFORMATION

Part Number: **SMn-Hm-Dx-Ay-Pz**

| n: Device Function | m: Host Interface | x: DAA Configuration | y: Audio Output | z: Pin Length |
|---|---|---|---|---|
| **SM144AC** | **H0** = Parallel | **D0** = W-Class or other Customer Designed DAA | **A0** = SPKR2 Direct | **P0** = 0.400" |
| **SMV144AC** | **H1** = TTL Serial | **D1** = Off-board modular DAA | **A1** = SPKR1 Sounducer | **P1** = 0.310" |
| **SM144ACW** | **H2** = RS-232 Serial | **D2** = Designer's Guide External HS DAA | | |
| **SMV144ACW** | | **D3** = Designer's Guide External LS DAA | | |
| **SM96AC** | | **D4** = Modular DAA on SocketModem | | |
| **SMV96AC** | | | | |
| **SM96ACW** | | | | |
| **SMV96ACW** | | | | |

## TECHNICAL SPECIFICATIONS

### GENERAL DESCRIPTION

**Modem Data Pump.** V.32 and V.32bis SocketModems use Rockwell V.32 and V.32bis Data Pumps.

**Microcontroller (MCU).** The microcontroller (MCU) performs the command processing and host interface functions. The MCU is a Rockwell C29 or C39 microcomputer. The MCU connects to the host via a V.24 (EIA-232-D) or TTL serial interface or a parallel microcomputer bus. The MCU connects to the OEM-supplied 64k/128k-byte ROM. The C29 provides a 16C450-compatible parallel interface. The C39 provides a 16C450/16C550A-compatible parallel interface and a Stop mode.

**MCU Firmware.** MCU firmware performs processing of general modem control, command sets, error correction, data compression, MNP 10, fax Class 1 and Class 2, voice, and DTE interface functions. The MCU firmware is provided by Rockwell in object code form for the OEM to program into external ROM. The MCU firmware may also be provided in source code form under a source code addendum license agreement.

### SUPPORTED INTERFACES

#### Parallel Interface

A 16450 UART-compatible (C29 MCU), or 16450/16550A UART-compatible (C39 MCU) with a supporting Stop mode, parallel interface is provided.

**Host Bus Interface.** Eight data lines, three address lines, and four (C29) or eight (C39) control lines are supported.

**Stop Mode Control (C39).** The STPMODE/ input is supported which controls modem entry into Stop Mode.

#### Serial/Indicator Interface

A DTE serial interface and indicator outputs are supported.

**Serial Interface.** A 9-line V.24/EIA-232-D or TTL logic serial interface to the DTE is supported. Serial interface is asynchronous only: 'AT' commands for synchronous operation are not supported.

**LED Indicator Interface.** Four direct connect LED indicator outputs are supported.

#### Speaker Interface

A speaker output, controlled by AT or V.25 bis commands, is provided for an optional OEM-supplied speaker or sounducer.

#### External Bus Interface (High Speed)

An external bus interface is provided on SMV144AC SocketModems to OEM-supplied 128k/64k-byte ROM. The non-multiplexed bus supports eight bidirectional data lines and 17 address lines.

#### Line Interface

The SocketModem connects to the line interface circuitry in one of two ways: if an on-board modular DAA is used, the SocketModem connects to the telephone line via a receive analog input, a transmit analog output, and a ring signal output.

If an external DAA is used, the SocketModem connects to the line interface circuitry via a receive analog input, two transmit analog outputs, and a ring signal input. The relay outputs may be used to drive Caller ID and voice relays.

The SocketModem provides four relay control outputs to the line interface. These outputs may be used to control relays such as off-hook, pulse, mute, A/A1, earth, and talk/data.

## ConfigurACE™ UTILITY PROGRAM

The PC-based ConfigurACE utility program allows the OEM to customize the modem W-Class firmware to suit specific application and country requirements. This program, which runs on a PC-compatible computer, modifies the hex object code which can be programmed directly into the system ROM.

ConfigurACE allows programming of functions such as:

- Loading of multiple sets of country parameters
- Loading of NVRAM factory profiles
- Call progress and blacklisting parameters
- Entry of S register maximum/minimum values
- Use of "soft switches" instead of panel switches
- Modification of result codes
- Modification of factory default values
- Customization of the ATI4 response
- Customization of fax OEM messages

This program directly modifies the hex object code which can be programmed directly into the SocketModem EPROM. Lists of the generated parameters can be displayed or printed.

Rockwell-provided country parameter files allow a complete set of country-specific call progress and blacklisting parameters to be selected.

Refer to the ConfigurACE II Utility Program User's Manual (Order No. 893) for a detailed description of capabilities and the operating procedure.

## COMMANDS

The modem supports data modem, fax Class 1 and Class 2, MNP 10, voice, and W-Class commands and S Registers depending on the modem model.

**Data Modem Operation.** All models operate as a data modem in response to the basic AT commands when +FCLASS=0. Default parameters support US/Canada operation. AutoSync operation is available in 128k-byte ROM models.

**Fax Modem Operation.** Models supporting facsimile functions operate in response to fax Class 1 and Class 2 commands when +FCLASS=2.

**Voice Operation.** Models supporting voice mode functions operate in response to voice commands.

**MNP 10 Operation.** Models supporting MNP 10 functions operate in response to MNP 10 commands.

**World Class (W-Class) Operation.** Models supporting W-Class functions operate in response to W-Class AT and V.25bis commands.

**Expanded Function Operation.** Expanded function (Secure Access, Remote Configuration and Access) operation is available in W-Class models.

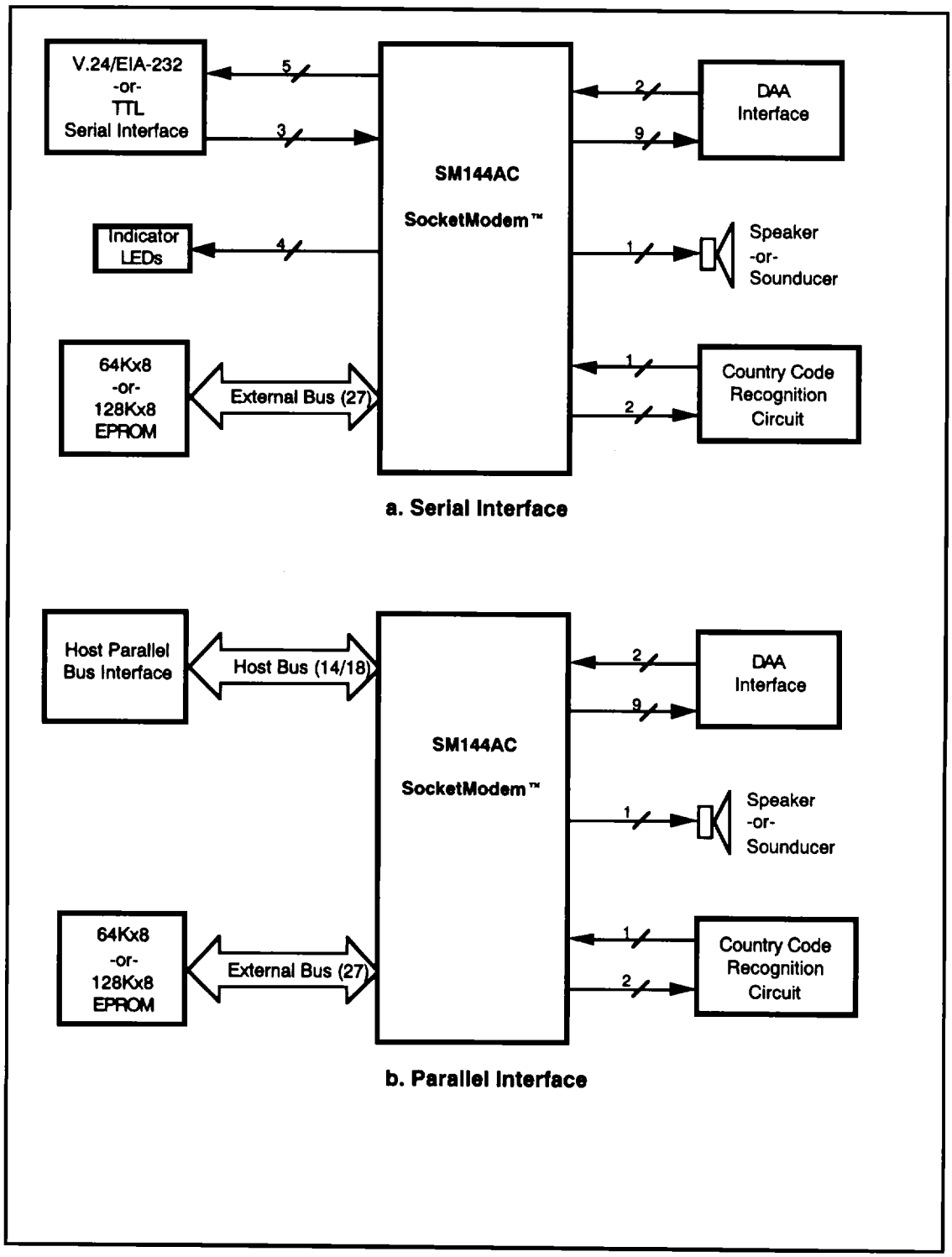


**Figure 1. SocketModem Integrated System Block Diagram**

## COMMAND SETS

Modem operation is controlled by AT and S register commands issued by the DTE or, when using remote configuration, AT commands issued by the remote modem. The AT commands are identified in Table 1. The S registers are identified in Table 2. The AT commands and S registers are described in the AT Command Reference Manual (Order No. 883).

**Table 1. AT Commands**

| Command | Function |
|---|---|
| | **Basic AT Commands** |
| A/ | Re-execute command |
| A | Answer a call |
| Bn | Select CCITT or Bell Mode |
| Cn | Carrier control |
| Dn | Dial modifier |
| En | Command echo |
| Fn | Select line modulation |
| Hn | Disconnect (hangup) |
| In | Identification |
| Ln | Speaker volume |
| Mn | Speaker control |
| Nn | Automode enable |
| On | Go on-line |
| P | Force pulse dialing |
| Qn | Quiet Result codes control |
| Sn | Select S register as default |
| Sn? | Return the value of S register |
| =v | Set default S register to value |
| ? | Return the value of S register |
| T | Force DTMF dialing |
| Vn | Report codes form |
| Wn | Error correction message control |
| Xn | Extended result codes |
| Yn | Long space disconnect |
| Zn | Soft reset and restore profile |
| \Gn | Modem to modem flow control |
| \Kn | Break control |
| \Nn | Operating mode |
| &Cn | RLSD (DCD) option |
| &Dn | DTR option |
| &F | Recall (restore) factory profile |
| &Gn | Select guard tone |
| &Jn | Telephone jack control |

**Table 1. AT Commands (Cont'd)**

| Command | Function |
|---|---|
| &Kn | Flow control |
| &Ln | Leased-line operation |
| &Mn | Asynchronous/synchronous mode |
| &Pn | Pulse dial make/break ratio |
| &Qn | Asynchronous/synchronous mode |
| &Rn | RTS/CTS option |
| &Sn | DSR override |
| &Tn | Test and diagnostic |
| &V | Display current configurations |
| &Wn | Store current configuration |
| &Xn | Select synchronous clock source |
| &Yn | Select default profile |
| &Zn=x | Store dial string to location n |
| %En | Enable line quality monitor and auto retrain |
| %L | Return received line signal level |
| %Q | Report the line signal quality |
| %TTn | PTT certification test signals |
| #CID=n | Enable Caller ID |
| *F | Initiate flash memory download |
| | **ECC AT Commands** |
| %Cn | Select data compression |
| \An | Maximum MNP block size |
| \Bn | Send BREAK |
| \Ln | MNP block transfer control |
| | **MNP 10 AT Commands** |
| )Mn | Enable cellular power level |
| *Hn | Set link negotiation speed |
| -Kn | Disable MNP 10 extended services |
| -K1 | MNP extended services |
| -Qn | Enable MNP 10 fallback to V.22 bis/V.22 |
| @Mn | Select initial transmit level |

Table 1. AT Commands (Cont'd)

| Command | Function |
|---|---|
| | **W-Class AT Commands** |
| %Fn | Select split-speed direction |
| %Mn | AUXCTL output line control |
| *B | Display blacklisted numbers |
| *C | Remote configuration password |
| *D | Display delayed numbers |
| *E | End remote configuration |
| *L | Display callback numbers |
| *NCn | Select country |
| *Pn | Store callback password |
| *R | Request remote configuration |
| *Zn | Change dial codes |
| \F | Display telephone directory |
| \S | Display active configuration |
| \Wn | Split speed operation |
| | **W-Class V.25 Commands** |
| CNL | Execute AT command |
| CRN | Call request with number |
| CRS | Call request w/memory address |
| DIC | Disregard incoming call |
| PRN | Program normal |
| RLD | Request delayed call numbers |
| RLF | Request forbidden call numbers |
| RLN | Request stored number list |
| | **Voice AT# Commands** |
| #CLS | Select data, fax, or voice |
| #MDL? | Identify model |
| #MFR? | Identify manufacturer |
| #REV? | Identify revision level |
| #VBQ? | Query buffer size |
| #VBS | Bits per sample |
| #VBT | Beep tone timer |
| #VCI? | Identify compression method |
| #VLS | Voice line select |
| #VRA | Ringback goes away timer |
| #VRN | Ringback never came timer |
| #VRX | Voice receive mode |
| #VSD | Enable silence deletion |
| #VSK | Buffer skid setting |
| #VSP | Silence detection period |
| #VSR | Sampling rate selection |
| #VSS | Silence detection tuner |
| #VTD | DTMF/tone reporting |
| #VTS | Generate tone signals |
| #VTX | Voice transmit mode |

Table 1. AT Commands (Cont'd)

| Command | Function |
|---|---|
| | **Fax Class 1 AT+F Commands** |
| +FRH=n | Receive data in HDLC |
| +FRM=n | Receive data |
| +FRS=n | Receive silence |
| +FTH=n | Transmit data in HDLC |
| +FTM=n | Transmit data |
| +FTS=n | Stop transmission and wait |
| | **Fax Class 2 AT+F Commands** |
| +FAXERR | Fax error value |
| +FBOR | Phase C data bit order |
| +FBUF? | Buffer size (read only) |
| +FCFR | Confirmation to receive |
| +FCLASS= | Service class |
| +FCON | Facsimile connection response |
| +FCR | Capability to receive |
| +FCR= | Capability to receive |
| +FCSI: | Report the called station ID |
| +FDCC= | DCE capabilities parameters |
| +FDCS: | Report current session |
| +FDCS= | Current session results |
| +FDIS: | Report remote identification |
| +FDIS= | Current sessions parameters |
| +FDR | Phase C receive data |
| +FDT= | Data transmission |
| +FET: | Post page message response |
| +FET=N | Transmit page punctuation |
| +FHNG | Call termination with status |
| +FK | Session termination |
| +FLID= | Local ID string |
| +FMDL? | Identify model |
| +FMFR? | Identify manufacturer |
| +FPHCTO | Phase C time out |
| +FPTS: | Page transfer status |
| +FPTS= | Page transfer status |
| +FREV? | Identify revision |
| +FTSI: | Report transmit station ID |

**Table 2. S Registers**

| Register | Function |
|---|---|
| S0 | Rings to auto-answer* |
| S1 | Ring counter |
| S2 | Escape character* |
| S3 | Carriage return character |
| S4 | Line feed character |
| S5 | Backspace character |
| S6 | Maximum time to wait for dial tone* |
| S7 | Wait for carrier* |
| S8 | Pause time for dial delay modifier* |
| S9 | Carrier detect response time* |
| S10 | Carrier loss disconnect time* |
| S11 | Reserved* |
| S12 | Escape code guard time* |
| S13 | Reserved |
| S14 | General bit mapped options* |
| S15 | Reserved |
| S16 | Test mode bit mapped options (&T)* |
| S17 | Reserved |
| S18 | Test timer* |
| S19 | Reserved |
| S20 | Reserved |
| S21 | V24/general bit mapped options* |
| S22 | Speaker/results options* |
| S23 | General bit mapped options* |
| S24 | Sleep inactivity timer |

**Table 2. S Registers (Cont'd)**

| Register | Function |
|---|---|
| S25 | Delay to DTR off* |
| S26 | RTS-to-CTS delay* |
| S27 | General bit mapped options* |
| S28 | General bit-mapped options |
| S29 | Flash modifier time |
| S30 | Inactivity timer* |
| S31 | General bit-mapped options |
| S32 | XON character |
| S33 | XOFF character |
| S34 -S35 | Reserved |
| S36 | LAPM failure control* |
| S37 | Line connection speed* |
| S38 | Delay before forced hangup* |
| S39 | Flow control* |
| S40 | General bit-mapped options |
| S41 | General bit-mapped options |
| S42-S45 | Reserved |
| S46 | Data compression control* |
| S48 | V.42 negotiation control* |
| S80 | Soft-switch functions |
| S82 | Break handling control |
| S86 | Call failure reason code |
| S91 | PSTN transmit level |
| S95 | Result code messages control* |
| S99 | Leased line transmit level |

* Register value may be stored in one of two user profiles with the AT&W command.

## DATA MODEM OPERATION

### Automatic Speed/Format Sensing (Serial Interface)

The modem can automatically determine the speed and format of the data sent from the DTE (serial interface only). The modem can sense speeds of 300, 600, 1200, 2400, 4800, 7200, 9600, 12000, 14400, 19200, 38400, and 57600 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 bits are stripped off during data transmission in Normal and Error Correction modes. Direct mode does not strip off the parity bits.

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 |

## ESTABLISHING DATA MODEM CONNECTIONS

### Phone Number Directory

The modem contains four telephone number entries in a directory that is saved in a 256-byte NVRAM. Each telephone number can be up to 45 characters in length. The four entries can be manipulated using the &Zn=x and DS=n commands.

### Dialing

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

**Pulse Dialing.** Pulse dialing is supported in accordance with EIA RS-496.

**Adaptive Dialing.** If set to DTMF dial (T command) and the telephone network will not recognize DTMF tones, the modem will switch to pulse dialing on the first call after hardware reset or Z command.

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

### 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.

### Call Progress Tone Detection

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

### Answer Tone Detection

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

### Ring Detection

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

### Billing Protection

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

### Connection Speeds

The modem functions as a data modem when the +FCLASS=0 command is active. The possible data connection modes/speeds are listed in Table 3. Two methods of establishing a connection are supported: use of the F command; and use of N command, speed sense, and S37 register combination.

### Automode Detect

Automode detection can be enabled by the N1 or F0 commands to allow the modem to connect to a remote modem in accordance with EIA/TIA-PN2330. Automode is disabled on a leased line.

## DATA MODE

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

### Speed Buffering (Normal Mode)

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

**Table 3. Connection Speed Options**

| Configuration | Rate |
|---|---|
| V.32bis (SMV144AC) | 14400, 12000, 9600, 7200, or 4800 bps |
| V.32 | 9600 or 4800 bps |
| V.22bis | 2400 or 1200 bps |
| V.22 | 1200 bps |
| V.23 | 1200Tx/75Rx or 75Tx/1200Rx |
| V.21 | 0-300 bps |
| Bell 212A | 1200 bps |
| Bell 103 | 0-300 bps |

### 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.

**Modem-to-Modem Flow Control.** When enabled by the \G1 command, the modem supports XON/XOFF flow control with the remote modem to ensure data integrity. Modem-to-modem flow control is not used in error correction mode. In this case, flow control is accomplished within the error-correction protocol.

### Escape Sequence Detection

The "+++" escape sequence with guard time can be used to return control to the command mode from the data mode. Escape sequence detection is disabled by a S2 Register value greater than 127. Escape sequence detection is disabled in synchronous mode.

### 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.

### Telephone Line Monitoring

**Loss of Carrier.** If carrier is lost for a time greater than specified by the S10 register, the modem will disconnect.

**Receive Space Disconnect.** If selected by the Y1 command in non-error-correction mode, the modem will disconnect after receiving 1.6 ± 10% seconds of continuous SPACE.

### Send SPACE on Disconnect

If selected by the Y1 command in non-error-correction mode, the modem will send 4 ± 10% seconds of continuous SPACE when a locally commanded hang-up is issued by the &Dn, &Qn, or H command.

### Fall Forward/Fallback

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

When connected in V.32 bis/V.32 mode, the modem will fall forward or fallback to the optimal line speed within V.32 bis/V.32 mode depending upon signal quality if fall forward/fallback is enabled by the %E2 command.

### Retrain

The modem may lose synchronization with the received line signal under poor 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 which will result in telephone line disconnect.

### Direct Mode (Serial Interface Only)

The Direct mode allows data to be transmitted and received directly from the DTE and remote modem. The Direct mode is selected with the &Q0 or \N1 command. In Direct mode, no flow control characters are recognized or transmitted, the modem cannot execute error correction, and the inactivity timer is not used.

### Programmable Inactivity Timer

The modem will disconnect 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 2550 seconds by register S30.

### 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, or to affect the CTS/ output if enabled by the &R command in synchronous mode.

### AutoSync

AutoSync operation, when used in conjunction with the Hayes Synchronous Interface (HSI) capability in the DTE, provides synchronous communication capability from an asynchronous terminal.

## ERROR CORRECTION AND DATA COMPRESSION

### 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.

### MNP 2-4 Error Correction

MNP 2-4 is a data link protocol that uses error correction algorithms to ensure data integrity. MNP block or stream mode operation may be selected by the \Ln command.

In stream mode, the modem sends data frames in varying lengths depending on the amount of time between characters coming from the DTE.

In block mode, the modem sends data frames of 256 characters in length. Special communication software must be used when using block mode.

### V.42 bis Data Compression

V.42 bis data compression mode, selected by the %Cn or S46 command, operates when a LAPM or an MNP 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 2k-byte dictionaries are used to store the strings. These dictionaries are dynamically updated during normal operation.

### MNP 5 Data Compression

MNP 5 data compression mode, selected 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.

## MNP 10 DATA THROUGHPUT ENHANCEMENT

MNP10 protocol, cellular functionality, 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 10 functions include:

**Robust Auto-Reliability.** Higher connection success rate is achieved by attempting to overcome channel interference during the modem negotiation phase while maintaining backward compatibility with non-MNP 10 modems.

**Negotiated Speed Upshift.** Initial connection and MNP handshake is performed at the most dependable speed, then the connection upshifts to the highest supported modem/channel speed. This function is particularly useful in channel conditions with high connection failure rates.

**Aggressive Adaptive Packet Assembly.** Frame size is dynamically changed to quickly adapt to varying levels of interference.

**Dynamic Speed Shifting.** Connection speed is shifted upward or downward to optimize data throughput for the channel conditions by continuously monitoring the line quality and link performance.

**Dynamic Transmit Level Adjustment.** Transmit level is dynamically adjusted to adapt to the varying cellular network environment and to prevent "clipping," which causes data corruption, due to the Preemphasis and Compander effect.

**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.** MNP 10 can operate with V.42bis or MNP 5 data compression.

## FAX CLASS 1 AND CLASS 2 OPERATION

The modem operates as a facsimile (fax) DCE whenever the +FCLASS=1 or +FCLASS=2 command is active. 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 the fax commands. Some AT commands are still valid but may operate differently from data modem mode.

### Calling Tone

Calling tone is generated in accordance with T.30.

## VOICE MODE

Voice Mode includes three submodes: Online Voice Command Mode, Voice Receive Mode, and Voice Transmit Mode.

**Online Voice Command Mode.** This mode is the default Voice submode entered when the #CLS=8 (Voice) command is active, and may also be entered from Voice Receive Mode or Voice Transmit Mode. After mode entry, AT commands can be entered without aborting the line connection.

**Voice Receive Mode.** This mode is entered when the #VRX command is active in order to receive voice data, which typically occurs when recording either a greeting message or voice messages from a remote station.

Received voice samples are compressed and can then be read by the host. AT commands control the codec bits-per-sample rate and, optionally, select silence deletion including silence detection period adjustment.

**Voice Transmit Mode.** This mode is entered when the #VTX command is active in order to transmit voice data, which typically occurs when playing back a greeting message or previously received/recorded messages.

Voice data is decompressed and reconstituted into analog voice at the original compression quantization sample-per-bits rate then transmitted. Optional silence interpolation is enabled if silence deletion was selected for voice compression.

## WORLD CLASS COUNTRY SUPPORT

The W-Class models include functions which support modem operation in multiple countries. The following capabilities are provided in addition the data modem functions previously described. Country dependent parameters are all programmable by ConfigurACE.

### V.25 bis Commands

The V.25 bis commands can operate in asynchronous or synchronous mode. The synchronous command set is valid in BSC or HDLC formats.

### Phone Number Directory

The modem can contain 20 telephone number entries in a 2048-byte NVRAM.

### Dialing

**Dial Tone Detection.** Dial tone detection levels and frequency ranges are programmable by ConfigurACE.

**DTMF Dialing.** Transmit output level, DTMF signal duration, and DTMF interdigit interval parameters are programmable by ConfigurACE.

**Pulse Dialing.** Parameters such as make/break times, set/clear times, and dial codes are programmable by ConfigurACE.

**Ring Detection.** The frequency range is programmable by ConfigurACE.

**Adaptive Dialing.** Adaptive dialing may be disabled by ConfigurACE.

**Blind Dialing.** Blind dialing may be disabled by ConfigurACE.

### Carrier Transmit Level

The carrier transmit level is programmable by ConfigurACE to match specific country and DAA characteristics.

### Calling Tone

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 enabled or disabled by programming a country specific parameter using ConfigurACE.

### Call Progress Tone Detection

Frequency and cadence of tones for busy, ringback, congested, dial tone 1, and dial tone 2 are programmable by ConfigurACE.

### Answer Tone Detection

The answer tone detection period is programmable by ConfigurACE.

### 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"). Up to 40 such numbers may be tabulated. The blacklist parameters are established by ConfigurACE.

### Relay Control

On-hook/off-hook, make/break, and set/clear relay control parameters are programmable by ConfigurACE.

## EXPANDED FUNCTION SUPPORT

General functions that extend the ROM requirement beyond 64k bytes are also included in 128k-byte models, i.e., models supporting W-Class. These functions include:

- Secure access
- Remote configuration
- Remote access

### Secure Access

Two levels of secure access are provided by the answering (local) modem (containing this modem device set). No special capability is required of the calling (remote) modem which may be any dial-up modem conforming to the modulation standard used by the answering modem.

**Level 1 Access.** Level 1 provides a direct connection to the calling modem after password verification.

**Level 2 Access (Callback Security).** Level 2, or Callback Security, provides a connection to the calling modem by calling it back after password verification.

### Remote Configuration Mode (RCM)

The Remote Configuration Mode (RCM) allows a local modem containing a compatible RCM to control the remote modem (containing this modem device set) during an MNP connection in asynchronous mode.

### Remote Access Mode (RACM)

The Remote Access Mode (RACM) allows a local modem to control the remote modem (containing this modem device set) during any connection (normal, LAPM or MNP) except direct mode. The local modem on which the remote commands are entered does not need any special code associated with the remote access.

## DIAGNOSTICS

### Commanded Tests

Diagnostics are performed in response to &T commands, serial interface control signals.

**Analog Loopback.** Data from the local DTE is sent to the modem, which loops the data back to the local DTE.

**Analog Loop Self Test.** An internally generated test pattern of alternating 1s and 0s (reversals) is sent to the modem. An error detector within the modem checks for errors in the string of reversals.

**Remote Digital Loopback (RDL).** Data from the local DTE is sent to the remote modem which loops the data back to the local DTE.

**Remote Digital Loopback with Self Test.** An internally generated pattern is sent from the local modem to the remote modem which loops the data back to the local modem.

**Local Digital Loopback.** When local digital loop is requested from the local DTE, two data paths are set up in the local modem. Data from the local DTE is looped back to the local DTE (path 1) and data received from the remote modem is looped back to the remote modem (path 2).

**Power On Reset Tests**

Upon power on, or receipt of the Z command, the modem performs tests of the RAM, ROM, NVRAM, and data pump.

## LOW POWER MODES

**Sleep Mode**

**Entry.** The modem will enter 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 SocketModem circuits are turned off except the internal MCU clock circuitry in order to consume lower power but are able to immediately wake up and resume normal operation.

**Wake-up - Parallel Interface Configuration.** Wake-up occurs when the host writes to the modem or ring is detected on the telephone line.

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

**Stop Mode (C39 Only)**

**Entry.** The modem will enter the low power stop mode when the STPMODE/ input is asserted. All SocketModem circuits are turned off except the internal MCU clock circuitry in order to consume lower power but are able to immediately wake up and resume normal operation.

STPMODE/ must be returned high before the modem can wake-up.

**Wake-up - Parallel Interface Configuration.** Wake-up occurs when the host writes to the modem or ring is detected on the telephone line.

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

## CALLER ID

Caller ID can be enabled/disabled using the #CID command. 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.

# ADDITIONAL INFORMATION

Additional information is described in the RC96ACL and RC144ACL Modem Designer's Guide (Order No. 876) and the AT Command Reference Manual (Order No. 883).

# HARDWARE INTERFACE

## HARDWARE INTERFACE SIGNALS

The modem hardware interface signals for serial EIA-232, serial TTL, and parallel interface configurations are shown in Figures 2, 3 and 4, respectively.

The SocketModem pin assignments for serial EIA-232 interface selected are shown in Figure 2 and are listed in Table 4.

The SocketModem pin assignments for serial TTL interface selected are shown in Figure 3 and are listed in Table 5.

The SocketModem pin assignments for parallel interface selected are shown in Figure 4 and are listed in Table 6.

The SocketModem hardware interface signals are defined in Table 7.

The digital electrical characteristics for the hardware interface signals are listed in Table 8.

The analog electrical characteristics for the hardware interface signals are listed in Table 9.

The current and power requirements are listed in Table 10.

The absolute maximum ratings are listed in Table 11.

Table 12 shows the parallel interface registers and the corresponding bit assignments.

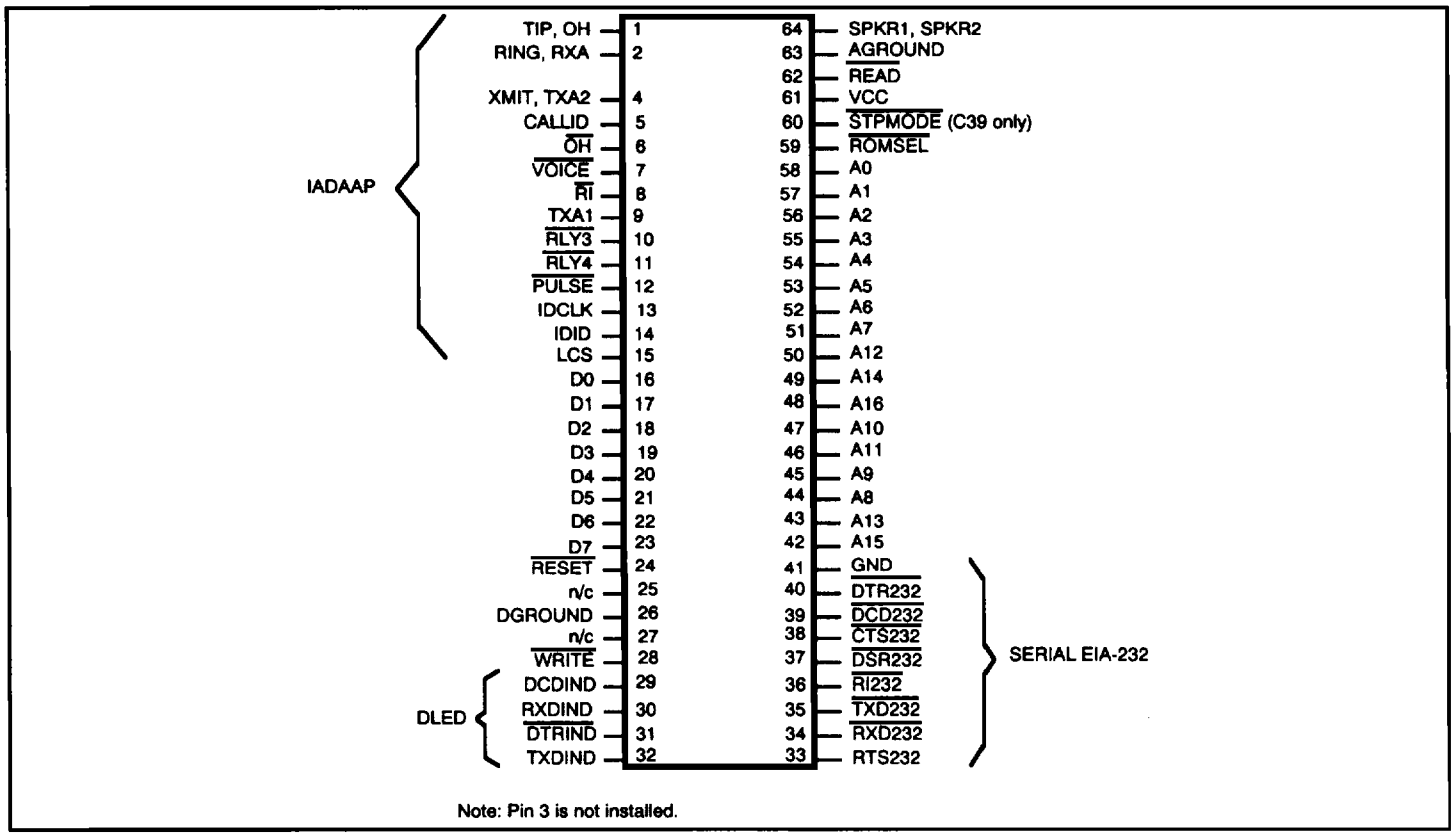


**Figure 2. Serial EIA-232 Pinout**

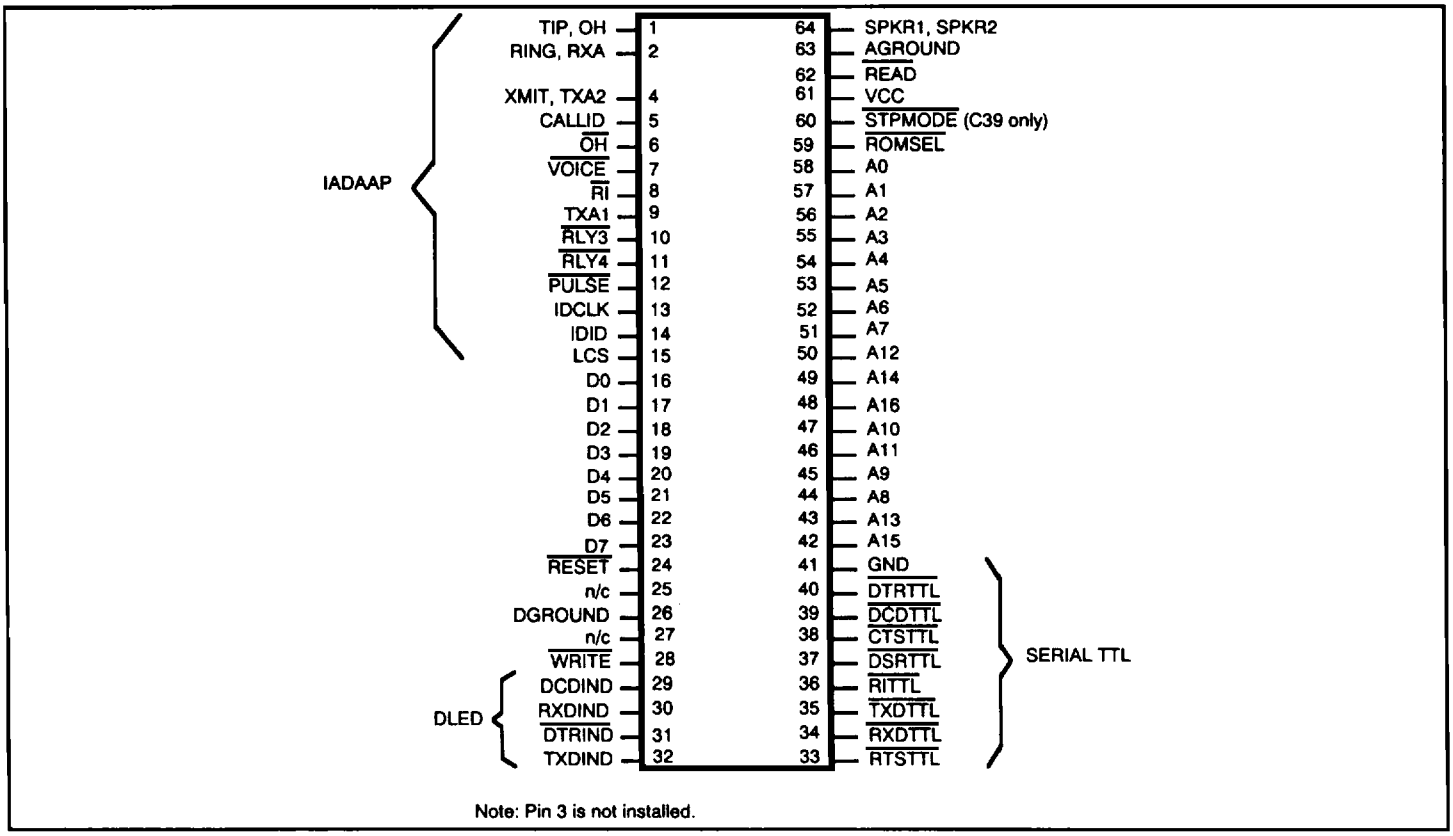


**Figure 3. Serial TTL Pinout**

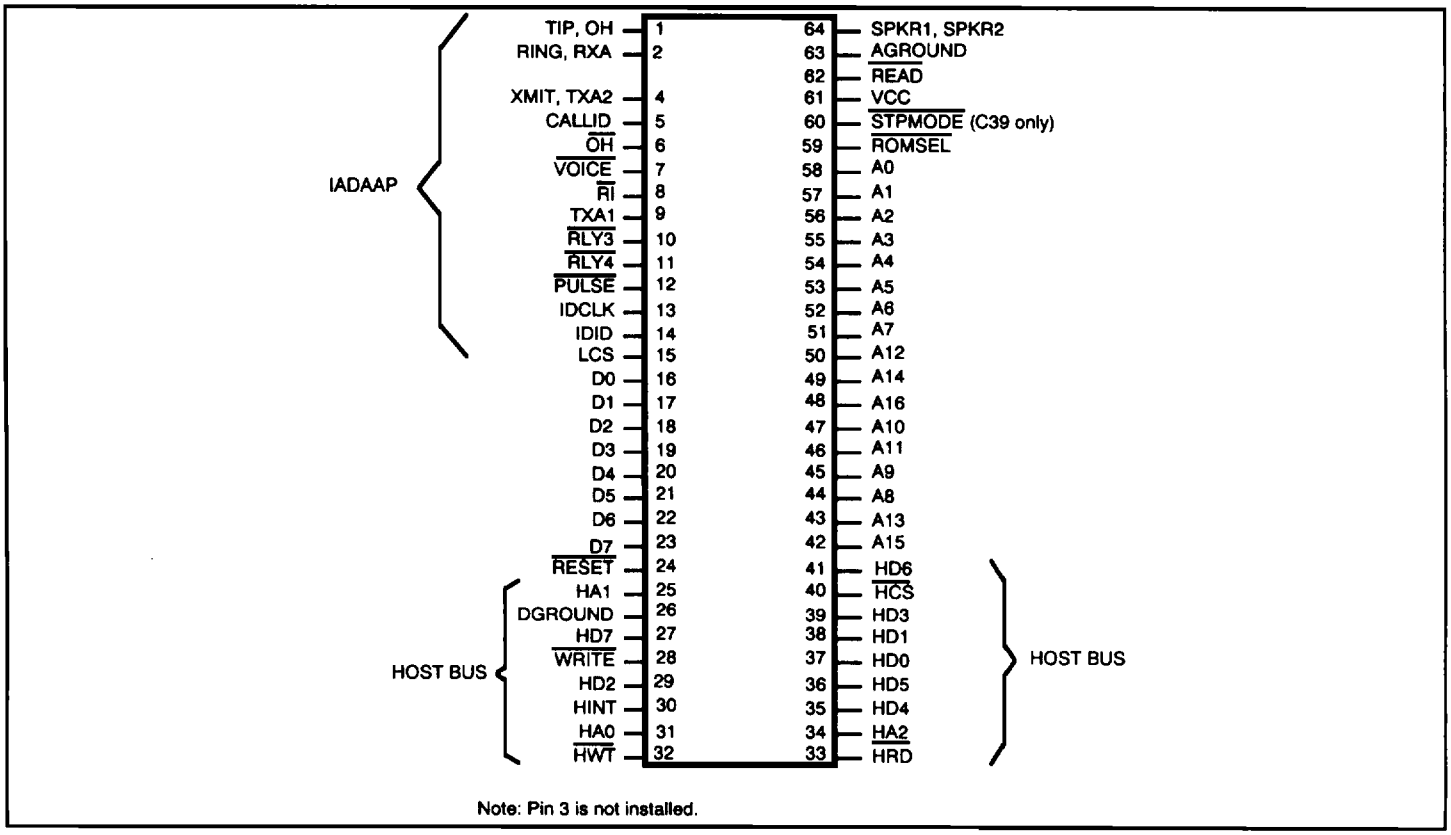


**Figure 4. Parallel Pinout**

**Table 4. Serial EIA-232 Signals**

| Pin | Signal | I/O Type |
|---|---|---|
| 1 | TIP, OH | IF, IA |
| 2 | RING, RXA | IF, I(DA) |
| 3 | NO PIN | |
| 4 | XMIT, TXA2 | O(DD), O(DD) |
| 5 | CALLID | OD |
| 6 | OH/ | OA |
| 7 | VOICE/ | OD |
| 8 | RI/ | IA, OA |
| 9 | TXA1 | O(DD) |
| 10 | RLY3/ | OA |
| 11 | RLY4/ | OA |
| 12 | PULSE/ | OA |
| 13 | IDCLK | OA |
| 14 | IDID | IA |
| 15 | LCS | IA |
| 16 | D0 | IA/OA |
| 17 | D1 | IA/OA |
| 18 | D2 | IA/OA |
| 19 | D3 | IA/OA |
| 20 | D4 | IA/OA |
| 21 | D5 | IA/OA |
| 22 | D6 | IA/OA |
| 23 | D7 | IA/OA |
| 24 | RESET/ | INPUT |
| 25 | N/C | |
| 26 | DGROUND | GND |
| 27 | N/C | |
| 28 | WRITE/ | OA |
| 29 | DCDIND | OG |
| 30 | RXDIND | OG |
| 31 | DTRIND/ | OG |
| 32 | TXDIND | OG |

| Pin | Signal | I/O Type |
|---|---|---|
| 33 | RTS232 | IH |
| 34 | RXD232/ | OH |
| 35 | TXD232/ | IH |
| 36 | RI232/ | OH |
| 37 | DSR232/ | OH |
| 38 | CTS232/ | OH |
| 39 | DCD232/ | OH |
| 40 | DTR232/ | IH |
| 41 | GND | GND |
| 42 | A15 | OA |
| 43 | A13 | OA |
| 44 | A8 | OA |
| 45 | A9 | OA |
| 46 | A11 | OA |
| 47 | A10 | OA |
| 48 | A16 | OA |
| 49 | A14 | OA |
| 50 | A12 | OA |
| 51 | A7 | OA |
| 52 | A6 | OA |
| 53 | A5 | OA |
| 54 | A4 | OA |
| 55 | A3 | OA |
| 56 | A2 | OA |
| 57 | A1 | OA |
| 58 | A0 | OA |
| 59 | ROMSEL/ | OA |
| 60 | STPMODE/ | IA |
| 61 | VCC | PWR |
| 62 | READ/ | OA |
| 63 | AGROUND | GND |
| 64 | SPKR1, SPKR2 | O(DF), O(DG) |

**Table 5. Serial TTL Signals**

| Pin | Signal | I/O Type |
|---|---|---|
| 1 | TIP, OH | IF, IA |
| 2 | RING, RXA | IF, I(DA) |
| 3 | NO PIN | |
| 4 | XMIT, TXA2 | O(DD), O(DD) |
| 5 | CALLID | OD |
| 6 | OH/ | OA |
| 7 | VOICE/ | OD |
| 8 | RI/ | IA, OA |
| 9 | TXA1 | O(DD) |
| 10 | RLY3/ | OA |
| 11 | RLY4/ | OA |
| 12 | PULSE/ | OA |
| 13 | IDCLK | OA |
| 14 | IDID | IA |
| 15 | LCS | IA |
| 16 | D0 | IA/OA |
| 17 | D1 | IA/OA |
| 18 | D2 | IA/OA |
| 19 | D3 | IA/OA |
| 20 | D4 | IA/OA |
| 21 | D5 | IA/OA |
| 22 | D6 | IA/OA |
| 23 | D7 | IA/OA |
| 24 | RESET/ | IC |
| 25 | N/C | |
| 26 | DGROUND | GND |
| 27 | N/C | |
| 28 | WRITE/ | OA |
| 29 | DCDIND | OG |
| 30 | RXDIND | OG |
| 31 | DTRIND/ | OG |
| 32 | TXDIND | OG |

| Pin | Signal | I/O Type |
|---|---|---|
| 33 | RTSTTL/ | IA |
| 34 | RXDTTL/ | OA |
| 35 | TXDTTL/ | IA |
| 36 | RITTL/ | OA |
| 37 | DSRTTL/ | OA |
| 38 | CTSTTL/ | OA |
| 39 | DCDTTL/ | OA |
| 40 | DTRTTL/ | IA |
| 41 | GND | GND |
| 42 | A15 | OA |
| 43 | A13 | OA |
| 44 | A8 | OA |
| 45 | A9 | OA |
| 46 | A11 | OA |
| 47 | A10 | OA |
| 48 | A16 | OA |
| 49 | A14 | OA |
| 50 | A12 | OA |
| 51 | A7 | OA |
| 52 | A6 | OA |
| 53 | A5 | OA |
| 54 | A4 | OA |
| 55 | A3 | OA |
| 56 | A2 | OA |
| 57 | A1 | OA |
| 58 | A0 | OA |
| 59 | ROMSEL/ | OA |
| 60 | STPMODE/ | IA |
| 61 | VCC | PWR |
| 62 | READ/ | OA |
| 63 | AGROUND | GND |
| 64 | SPKR1, SPKR2 | O(DF), O(DG) |

**Table 6. Parallel Signals**

| Pin | Signal | I/O Type |
|---|---|---|
| 1 | TIP, OH | IF, IA |
| 2 | RING, RXA | IF, I(DA) |
| 3 | NO PIN | |
| 4 | XMIT, TXA2 | O(DD), O(DD) |
| 5 | CALLID | OD |
| 6 | OH/ | OA |
| 7 | VOICE/ | OD |
| 8 | RI/ | IA, OA |
| 9 | TXA1 | O(DD) |
| 10 | RLY3/ | OA |
| 11 | RLY4/ | OA |
| 12 | PULSE/ | OA |
| 13 | IDCLK | OA |
| 14 | IDID | IA |
| 15 | LCS | IA |
| 16 | D0 | IA/OA |
| 17 | D1 | IA/OA |
| 18 | D2 | IA/OA |
| 19 | D3 | IA/OA |
| 20 | D4 | IA/OA |
| 21 | D5 | IA/OA |
| 22 | D6 | IA/OA |
| 23 | D7 | IA/OA |
| 24 | RESET/ | IA |
| 25 | HA1 | IA |
| 26 | DGROUND | GND |
| 27 | HD7 | IA/OA |
| 28 | WRITE/ | OA |
| 29 | HD2 | IA/OA |
| 30 | HINT | OA |
| 31 | HA0 | IA |
| 32 | HWT/ | IA |

| Pin | Signal | I/O Type |
|---|---|---|
| 33 | HRD/ | IA |
| 34 | HA2 | IA |
| 35 | HD4 | IA/OA |
| 36 | HD5 | IA/OA |
| 37 | HD0 | IA/OA |
| 38 | HD1 | IA/OA |
| 39 | HD3 | IA/OA |
| 40 | HCS/ | INPUT |
| 41 | HD6 | IA/OA |
| 42 | A15 | OA |
| 43 | A13 | OA |
| 44 | A8 | OA |
| 45 | A9 | OA |
| 46 | A11 | OA |
| 47 | A10 | OA |
| 48 | A16 | OA |
| 49 | A14 | OA |
| 50 | A12 | OA |
| 51 | A7 | OA |
| 52 | A6 | OA |
| 53 | A5 | OA |
| 54 | A4 | OA |
| 55 | A3 | OA |
| 56 | A2 | OA |
| 57 | A1 | OA |
| 58 | A0 | OA |
| 59 | ROMSEL/ | OA |
| 60 | STPMODE/ | IA |
| 61 | VCC | PWR |
| 62 | READ/ | OA |
| 63 | AGROUND | GND |
| 64 | SPKR1, SPKR2 | O(DF), O(DG) |

**Table 7. Signal Descriptions**

| Label | I/O | Signal Name/Description |
|---|---|---|
| Vcc | PWR | **+5VDC ± 5%.** |
| DGROUND | GND | **Digital Ground.** Connect to Digital Ground on the interface circuit. |
| RESET/ | IC | **Modem Reset.** The active low RESET/ input resets the SocketModem logic and returns the AT command set to the original factory default values and to "stored values" in NVRAM. |
| AGROUND | GND | **Analog Ground.** Connect to Analog Ground on the interface circuit. |
| TIP, OH | IF, OA | **TIP Signal From Telephone Line.** If an on-board modular DAA is used, this pin is TIP signal from the line jack.<br>**OH Signal from DAA.** If external DAA is used, this pin is the OH off-hook signal. |
| RING, RXA/ | IF, I(DA) | **RING Signal From Telephone Line.** If an on-board modular DAA is used, this pin is RING signal from the line jack.<br>**RXA Signal from DAA.** If external DAA is used, this pin is the RXA analog receive signal. |
| XMIT, TXA2 | O(OD), O(OD) | **XMIT.** If a modular DAA is used, this pin is XMIT, a single-ended transmit signal obtained by the sum of TXA1 and the inverted TXA2 input to the modular DAA.<br>**TXA2.** If an external DAA circuit is used, this pin is TXA2. The TXA1 and TXA2 outputs are differential outputs 180 degrees out of phase with each other. |
| TXA1 | O(OD) | **TXA1.** The TXA1 and TXA2 outputs are differential outputs 180 degrees out of phase with each other. |
| CALLID | OD | **Caller ID Relay Control.** Typically, the CALLID output is connected to the normally closed Caller ID relay (DPDT). When Caller ID is enabled, the modem will assert this output to open the Caller ID relay and close the Off-hook relay in order to detect Caller ID information between the first and second rings. |
| VOICE/ | OD | **Voice Relay Control.** Typically, the VOICE/ output is connected to the normally open Voice relay (DPDT). In voice mode, VOICE/ active closes the relay to switch the handset from the telephone line to a current source to power the handset so it can be used as a microphone and speaker interface to the modem.<br>The CALLID and VOICE/ output can each directly drive a +5V reed relay coil with a minimum resistance of 360Ω and having a must-operate voltage of no greater than 4.0 Vdc. A clamp diode, such as a 1N4148, should be installed across the relay coil. An external transistor, such as an MPSA20, can be used to drive heavier loads (e.g., electro-mechanical relays). |
| OH/ | OD | **OH/ Relay Control.** The active low OH/ output can be used to control the normally open off-hook relay. In this case, OH/ active closes the relay and connects the modem to the line (off-hook). |
| PULSE/ | OD | **PULSE/ Relay Control.** The active low PULSE/ output can be used to control the normally open pulse dial relay. In this case, PULSE/ active closes the relay to effect loop disconnect (pulse) dialing. When a country recognition code circuit is used, the PULSE/ output is typically connected to the 74HC165 shift register SH/LD input. |
| RLY3/ | OA | **Relay 3 Control (MUTE/, A-A1/).** The active low RLY3/ output can be used to control the normally open mute relay or the normally open key telephone hold indicator (A-A1) relay.<br>When configured to control the mute relay, MUTE/ active closes the normally open relay during dialing so that the loop disconnect (pulse) dialing is between an open and short circuit.<br>When configured to control the A/A1 relay, A-A1/ active closes the normally open relay when the modem is connected to the line. |
| RLY4/ | OA | **Relay 4 Control (EARTH/, T-DRLY/).** The active low RLY4/ output can be used to control the normally open earthing (EARTH) relay or the normally closed talk/data (T-DRLY) relay.<br>When configured to control the earth connection (EARTH) relay, in response to encountering the ">" dial modifier in a dial string, EARTH/ active closes a relay used to ground a signal on the telephone connector. This signal is used in some countries to instruct a PBX to request an external line.<br>When configured to control the T-DRLY relay, T-DRLY/ active closes the normally closed relay. |

**Table 7. Signal Descriptions (Cont'd)**

| Label | I/O | Signal Name /Description |
|---|---|---|
| LCS | IA | **Line Current Sense.** When enabled, the LCS input indicates whether the associated handset is off-hook (high) or on-hook (low). Bit 4 in Option Flags 1 must be set using ConfigurACE to enable LCS operation. |
| RI/ | IA, OA | **Ring Indicate.** If an on-board modular DAA is used, RI/ is an active-low ring-indicator output. If an external DAA is used, RI/ is an active-low ring-indicator input. |
| STPMODE | IA | **Stop Mode.** (C39 MCU only.) STPMODE low causes the SocketModem to enter the stop mode immediately after terminating a line connection if connected, terminating any test in process, and allowing any data in the receive buffer to clear. STPMODE must be high before the modem can attain normal operation after power turn-on, reset, or wake-up from sleep or stop mode. |
| HA0-HA2 | IA | **Host Bus Address Lines 0-2.** During a host read or write operation, HA0-HA2 select an internal 16C450- or 16500-compatible register. The state of the divisor latch access bit (DLAB) affects the selection of certain registers. |
| HD0-HD7 | IA/OA | **Host Bus Data Lines 0-7.** HD0-HD7 are comprised of eight three-state input/output lines providing bi-directional communication between the host and the SocketModem. Data, control words, and status information are transferred through HD0-HD7. |
| HCS/ | IA | **Host Bus Chip Select.** HCS/ input low selects the host bus. |
| HRD/ | IA | **Host Bus Read.** HRD/ is an active low, read control input. When HCS/ is low, HRD/ low allows the host to read status information or data from a selected SocketModem register. |
| HWT/ | IA | **Host Bus Write.** HWT/ is an active low, write control input. When HCS/ is low, HWT/ low allows the host to write data or control words into a selected SocketModem register. |
| HINT | OA | **Host Bus Interrupt.** HINT output is set high when the receiver error flag, received data available, transmitter holding register empty, or modem status interrupt has an active high condition. HINT is reset low upon the appropriate interrupt service or master reset operation. |
| | | **The serial interface signals are either TTL-level or EIA-232-level signals.** |
| RTSTTL/, RTS232 | IA, IH | **Request To Send.** TTL active low, EIA-232 active high. RTS/ is used to condition the local modem for data transmission and, during half-duplex operation, to control the direction of data transmission.<br>On a full-duplex channel, RTS OFF maintains the modem in a non-transmit mode. A non-transmit mode does not imply that all line signals have been removed from the telephone line. RTS OFF may be ignored if the modem is optioned to strap CTS/ ON; this allows the modem to receive from the DTE even though RTS is OFF.<br>RTS input ON causes the modem to transmit data on TXD/ when CTS/ becomes active. |
| RXDTTL/, RXD232/ | OA, OH | **Received Data.** Active low. 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. Modem responses take priority over incoming data when the two signals are in competition for RXD/. |
| DCDTTL/, DCD232/ | OA, OH | **Data Carrier Detect.** Active low. 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.<br>DCD/ can be strapped ON using AT&C0 command. |
| TXDTTL/, TXD232/ | IA, IH | **Transmitted Data.** Active low. 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. The DTE should hold this circuit in the mark state when no data is being transmitted or during intervals between characters. |

**Table 7. Signal Descriptions (Cont'd)**

| Label | I/O | Signal Name/Description |
|---|---|---|
| RITTL/, RI232/ | OA, OH | **Ring Indicate.** Active low. RI/ output ON (low) indicates the presence of an ON segment of a ring signal on the telephone line. The modem will not go off-hook when RI/ is active; the modem waits for RI/ to go inactive before going off-hook.<br>For US models, RI/ will respond to ring signals in the frequency range of 15.3 Hz to 68 Hz. The ring signal cycle is typically two seconds ON, four seconds OFF. The OFF (high) condition of the RI/ input should be maintained during the OFF segment of the ring cycle (between rings) and at all other times when ringing is not being received. |
| DSRTTL/, DSR232/ | OA, OH | **Data Set Ready.** Active low. 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.<br>If the AT&S1 option is selected, DSR/ will come ON in the handshaking state when carrier is detected in the originate mode or when carrier is first sent in the answer mode. In addition, if a test mode is entered (AT&T1, AT&T3, AT&T6-AT&T8), DSR/ will go off while the test is running. DSR/ goes OFF if DTR/ goes OFF.<br>If AT&Q0 and AT&S0 are selected, DSR/ will remain on at all times regardless of the modem's current state. |
| CTSTTL/, CTS232/ | OA, OH | **Clear To Send.** Active low. CTS/ is controlled by the modem to indicate whether or not the modem is ready to transmit data. CTS/ ON, together with the RTS/ ON, DSR/ ON, and DTR/ ON (where implemented), indicates to the DTE that signals presented on TXD will be transmitted to the telephone line. CTS/ OFF indicates to the DTE that it should not transfer data across the interface on TXD. CTS/ ON is a response to DTR/ ON and RTS/, delayed as may be appropriate for the modem to establish a telephone connection. CTS/ output is controlled by the AT&Rn command. |
| DTRTTL/, DTR232/ | IA, IH | **Data Terminal Ready.** Active low. 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. The effect of DTR/ ON and DTR/ OFF depends on the &Dn and &Qn commands. Automatic answer is enabled when DTR/ is ON if the "Answer Ring count" selectable option is not set to 0. Regardless of which device is driving DTR/, the modem will respond to an incoming ring by going off-hook and beginning the handshake sequence.<br>The response of the modem to the DTR/ signal is very slow (up to 10 ms) to prevent noise from falsely causing the modem to disconnect from the telephone line. |
| GND | GND | **Ground.** |
| | | **LED driver lines are open-drain inverter-driven (74HCT05) lines with 1.5KΩ, 1/10W pull-up resistors on-board.** |
| DCDIND | OG | **DCD LED Indicator.** Active high DCD status. |
| RXDIND | OG | **RXD LED Indicator.** Active high RXD status. |
| DTRIND/ | OG | **DTR LED Indicator.** Active low DTR status. |
| TXDIND | OG | **DCD LED Indicator.** Active high TXD status. |
| SPKR1, SPKR2 | O(DG), O(DF) | **Speaker Analog Output.** The SPKR output reflects the received analog input signal. The SPKR is controlled by the ATMn command.<br>SPKR1 output can drive an impedance as low as 300Ω. In a typical application, the SPKR output is an input to a sounducer, such as Star QMX-05.<br>SPKR2 is directly connected to the SPKR pin of the data pump. It connects to an external speaker driver circuit. |

**Table 8. Digital Interface Characteristics**

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions[1] |
|---|---|---|---|---|---|---|
| Input High Voltage | $V_{IH}$ | | | | Vdc | |
| Type IA | | 2.0 | – | $V_{CC}$ | | |
| Type IC | | 0.7 $V_{CC}$ | – | $V_{CC}$ + 0.3 | | |
| Type ID | | 0.8 $V_{CC}$ | – | $V_{CC}$ + 0.3 | | |
| Type IH | | -30 | | 30 | | |
| Input Low Voltage | $V_{IL}$ | | | | Vdc | |
| Type IA, IC, and ID | | –0.3 | | 0.8 | | |
| Input Low Voltage | $V_{IL}$ | | | | Vrms | |
| Type IF | | 38 | | | | Note 2 |
| Input Leakage Current | $I_{IN}$ | | | | µAdc | $V_{IN}$ = 0 to $V_{CC}$ |
| RESET/ | | – | – | ±2.5 | | |
| Output High Voltage | $V_{OH}$ | | | | Vdc | |
| Type OA | | 2.4 | – | – | | $I_{LOAD}$ = – 100 µA |
| Type OD | | – | – | $V_{CC}$ | | $I_{LOAD}$ = 0 mA |
| Type OG | | | | $V_{CC}$ | | |
| Type OH | | 5 | 8 | - | | |
| Output Low Voltage | $V_{OL}$ | | | | Vdc | |
| Type OA | | – | – | 0.4 | | $I_{LOAD}$ = 1.6 mA |
| Type OB | | – | – | 0.4 | | $I_{LOAD}$ = 0.8 mA |
| Type OD | | – | 0.75 | – | | $I_{LOAD}$ = 15 mA |
| Type OG | | 0.5 | - | - | | $I_{LOAD}$ = 8 mA |
| Type OH | | -8 | -5 | - | | |
| Three-State (Off) Current | $I_{TSI}$ | | | ±10 | µAdc | $V_{IN}$ = 0 V |

**Notes:**

1. Test Conditions: $V_{CC}$ = 5V ± 5%, $T_A$ = 0°C to 70°C (Commercial) or -40°C to 85°C (Extended), (unless otherwise stated).
   Output loads: Data bus (D0-D7), address bus (A0-A16), chip selects, READ/, and WRITE/ = 70 pF + one TTL.
   Other = 50 pF + one TTL.
2. AC $V_{rms}$ voltage between Tip and Ring, using the on-board modular DAA.

**Table 9. Analog Characteristics**

| Name | Type | Characteristic | Value |
|---|---|---|---|
| RXA | I (DA) | Input Impedance | > 70KΩ |
| | | Voltage Range | 2.5 ±1.6V |
| TXA1, TXA2 | O (DD) | Minimum Load | 300Ω |
| | | Maximum Capacitive Load | 0.01 µF |
| | | Output Impedance | 10Ω |
| | | Output Voltage | 2.5 ±1.6V |
| | | D.C. Offset | < 200 mV |
| SPKR1 | O (DF) | Minimum Load | 300Ω |
| | | Maximum Capacitive Load | 0.01 µF |
| | | Output Impedance | 10Ω |
| | | Output Voltage | 2.5 ±1.6V |
| | | D.C. Offset | < 20 mV |

**Table 10. Current and Power Requirements**

| Mode | Current ($I_D$) | | Power ($P_D$) | |
|---|---|---|---|---|
| | Typical Current @ 25°C | Maximum Current @ 0°C | Typical Power @ 25°C | Maximum Power @ 0°C |
| Serial EIA-232 | | | | |
| Normal mode | 105 mA | 110 mA | 523 mW | 578 mW |
| Sleep/stop mode | 45 mA | 47 mA | 225 mW | 247 mW |
| Serial TTL | | | | |
| Normal mode | 75 mA | 82 mA | 375 mW | 431 mW |
| Sleep/stop mode | 9.6 mA | 10 mA | 48 mW | 53 mW |
| Parallel TTL | | | | |
| Normal mode | 74 mA | 80 mA | 370 mW | 420 mW |
| Sleep/stop mode | 9.1 mA | 9.6 mA | 45 mW | 50 mW |

**Notes:**

1. Test conditions: VDD = 5.0 VDC for typical values; VDD = 5.25 VDC for maximum values.

**Table 11. Absolute Maximum Ratings**

| Parameter | Symbol | Limits | Units |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.5 to +7.0 | V |
| Input Voltage | $V_{IN}$ | -0.5 to +5VD +0.5 | V |
| Analog Inputs | $V_{IN}$ | -0.3 to +5VA + 0.3 | V |
| Voltage Applied to Outputs in High Z State | $V_{HZ}$ | -0.5 to +5VD + 0.5 | V |
| DC Input Clamp Current | $I_{IK}$ | ±20 | mA |
| DC Output Clamp Current | $I_{OK}$ | ±20 | mA |
| Static Discharge Voltage (@ 25°C) | $V_{ESD}$ | ±3000 | V |
| Latch-Up Current (@ 25°C) | $I_{TRIG}$ | ±200 | mA |
| Operating Temperature Range | $T_A$ | -0 to +70 | °C |
| Storage Temperature Range | $T_{STG}$ | -55 to +125 | °C |

**Table 12. Parallel Interface Registers**

| Register No. | Register Name | Bit No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 7 | Scratch Register (SCR) | Scratch Register | | | | | | | |
| 6 | Modem Status Register (MSR) | Data Carrier Detect (DCD) | Ring Indicator (RI) | Data Set Ready (DSR) | Clear to Send (CTS) | Delta Data Carrier Detect (DDCD) | Trailing Edge of Ring Indicator (TERI) | Delta Data Set Ready (DDSR) | Delta Clear to Send (DCTS) |
| 5 | Line Status Register (LSR) | RX FIFO Error* | Transmitter Empty (TEMT) | Transmitter Buffer Register Empty (THRE) | Break Interrupt (BI) | Framing Error (FE) | Parity Error (PE) | Overrun Error (OE) | Receiver Data Ready (DR) |
| 4 | Modem Control Register (MCR) | 0 | 0 | 0 | Local Loopback | Out 2 | Out 1 | Request to Send (RTS) | Data Terminal Ready (DTR) |
| 3 | Line Control Register (LCR) | Divisor Latch Access Bit (DLAB) | Set Break | Stick Parity | Even Parity Select (EPS) | Parity Enable (PEN) | Number of Stop Bits (STB) | Word Length Select Bit 1 (WLS1) | Word Length Select Bit 0 (WLS0) |
| 2 | Interrupt Identify Register (IIR) (Read Only) | FIFOs Enabled* | FIFOs Enabled* | 0 | 0 | Pending Interrupt ID Bit 2 | Pending Interrupt ID Bit 1 | Pending Interrupt ID Bit 0 | "0" if Interrupt Pending |
| 2 | FIFO Control Register (FCR)* (Write Only) | Receiver Trigger MSB | Receiver Trigger LSB | Reserved | Reserved | DMA Mode Select | TX FIFO Reset | RX FIFO Reset | FIFO Enable |
| 1 DLAB = 0 | Interrupt Enable Register (IER) | 0 | 0 | 0 | 0 | Enable Modem Status Interrupt (EDSSI) | Enable Receiver Line Status Interrupt (ELSI) | Enable Transmitter Holding Register Empty Interrupt (ETBEI) | Enable Received Data Available Interrupt (ERBFI) |
| 0 DLAB = 0 | Transmitter Buffer Register (THR) | Transmitter Buffer Register (Write Only) (C29)<br>Transmitter FIFO Buffer Register (Write Only) (C39) | | | | | | | |
| 0 DLAB = 0 | Receiver Buffer Register (RBR) | Receiver Buffer Register (Read Only) (C29)<br>Receiver FIFO Buffer Resister (Read Only) (C39) | | | | | | | |
| 1 DLAB = 1 | Divisor Latch MSB Register (DLM) | Divisor Latch MSB | | | | | | | |
| 0 DLAB = 1 | Divisor Latch LSB Register (DLL) | Divisor Latch LSB | | | | | | | |

* C39 MCU only.

## DIGITAL COMMUNICATIONS DIVISION
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Suite 100
Santa Clara, CA 95051
Tel: (408) 249-9696
Fax: (408) 249-6518

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Digital Communications Division
Rockwell International Japan Co., Ltd.
Sogo Hanzomon Bldg., 8F
7, Kojimachi 1-chome, Chiyoda-ku
Tokyo
Japan 102
Tel: (81-3) 3-265-8808
Fax: (81-3) 3-263-0639
TLX: J22198

**Australia**
Digital Communications Division
Rockwell International
3 Thomas Holt Drive
P.O. Box 165
North Ryde, NSW 2113
Australia
Tel: (61-2) 805-5555
Fax: (61-2) 805-5599
TLX: AA30450

**Hong Kong**
Digital Communications Division
Rockwell International
13th Floor, Suites 60
Harbour Centre
25 Harbour Road
Wanchai
Hong Kong
Tel: (852) 827-0181
Fax: (852) 827-6488

**Korea**
Digital Communications Division
Rockwell International
Rm. 608 Leema Bldg.
146-1 Soosong-Dong
Chongro-Ku
K.P.O. Box 527
Seoul
Korea
(Dept. 553)
Tel: (82-2) 736-9121
Fax: (82-2) 736-9124

**Taiwan**
Digital Communications Division
Rockwell International
Room 2808
International Trade Building
333 Keelung Road, Section 1
Taipei
Taiwan 10548, R.O.C.
Tel: (886-2) 720-0282
Fax: (886-2) 757-6760
TLX: 26049 ENTTPE

**Germany**
Digital Communications Division
Rockwell International GmbH
Paul-Gerhardt-Allee 50 a
8000 München 60
West Germany
Tel: (49-89) 829-1320
Fax: (49-89) 834-2734
TLX: 521-2650 rimd d

**United Kingdom**
Digital Communications Division
Rockwell International Ltd.
Central House
3, Lampton Road
Hounslow, Middlesex TW3 1HY
England
Tel: (44-81) 577-2800
Fax: (44-81) 570-0758

**France**
Digital Communications Division
Rockwell International
Tour GAN, 16 Place de l'Iris
Cedex 13
92082 Paris La Defense 2
France
Tel: (33-1) 49-06-39-80
Fax: (33-1) 49-06-39-90

**Italy**
Digital Communications Division
Rockwell International
c/o Allen Bradley Italia S.r.l.
Viale De Gasperi, 126
20017 Mazzo di Rho (MI)
Italy
Tel: (39-2) 93972-360
Fax: (39-2) 93972-366



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