Rockwell

RC144DPFL
V.32 bis Data/V.17 Fax/Voice Modem Data Pump

INTRODUCTION

The Rockwell RC144DPFL modem family consists of high speed, modem data pumps that support data rates up to 14400 bps, fax operation up to 14400 bps, and ADPCM voice coder/decoder.

The modem is packaged in either a low profile 100-pin plastic quad flat pack (PQFP) or extremely low profile 128-pin thin quad flat pack (TQFP). The following models are available:

Model	Data	Fax	Voice
RC144DPFL-D	14.4 kbps	None	No
RC144DPFL	14.4 kbps	14.4 kbps	No
RCV144DPFL	14.4 kbps	14.4 kbps	Yes
RC96DPFL-D	9.6 kbps	None	No
RC96DPFL	9.6 kbps	9.6 kbps	No
RCV96DPFL	9.6 kbps	9.6 kbps	Yes

As a data modem, the modem can operate in 2-wire, full-duplex, synchronous/asynchronous modes at 14400 (RC144DPFL), 12000 (RC144DPFL), 9600, 7200, 4800, 2400, 1200, 600, 300, or 75 bps. Automode operates in accordance with EIA/TIA PN-2330 (Draft).

Internal HDLC support eliminates the need for an external serial input/output (SIO) device in the DTE for products incorporating error correction and T.30 protocols.

Facsimile models fully support Group 3 send and receive.

Voice models include a voice pass-through mode which allows the host to transmit and receive uncompressed audio signals. These models also include an Adaptive Differential Pulse Code Modulation (ADPCM) voice coder and decoder (codec). The full-duplex codec compresses and decompresses voice signals to allow efficient digital storage of voice messages. The codec operates at 28.8k, 21.6k, or 14.4k bps (4-bit, 3-bit, or 2-bit quantization, respectively) with a default 7.2 kHz programmable sample rate. Optional coder silence detection/deletion and decoder silence interpolation are included to achieve greater compression rates.

The modem operates over the public switched telephone network (PSTN) through the appropriate line termination.

Additional information is provided in the RC144DPFL Modem Designer's Guide (Order No. 1007).

FEATURES

- 2-wire full-duplex
  - V.32 bis (RC144DPFL models), V.32, V.22 bis, V.22, V.23, and V.21; Bell 212A and 103
- 2-wire half-duplex
  - V.17 (RC144DPFL models), V.29, V.27 ter, V.26 bis, V.26 Alternative A, and V.21 channel 2
  - Short train option in V.17 and V.27 ter
- Group 3 fax transmission/reception at 14400, 12000, 9600, 7200, 4800, or 2400 bps (model dependent)
- Serial synchronous and asynchronous data
- Parallel synchronous and asynchronous data
- Parallel synchronous SDLC/HDLC support
- In-band secondary channel
- Digital near and far end echo cancellation
- Bulk delay for satellite transmission
- Auto-dial and auto-answer
- TTL and CMOS compatible DTE interface
  - ITU V.24 (EIA/TIA-232-E) (data/control)
  - Microprocessor bus (data/configuration/control)
- Internal hybrid
- Dynamic range: –43 dBm to –9 dBm
- Compromise and automatic adaptive equalizers
- Voice pass-through mode (optional)
- ADPCM voice mode (optional)
- Adjustable speaker output to monitor received signal
- DTMF detection
- DMA support interrupt lines
- Two 8-byte FIFO data buffers for burst data transfer
- NRZI encoding/decoding
- Automatic mode selection
- 511 pattern generation/detection
- Diagnostic capability
- V.13 signaling
- V.54 inter-DCE signaling
- V.54 local analog and remote digital loopback
- 5 V Supply; low power consumption

Mode	Power
Normal	225 mW
Sleep	10 mW

- Low profile, small footprint packages
  - 100-pin PQFP (2.25 mm H x 20 mm L x 14 mm W)
  - 128-pin TQFP (1.5 mm H x 20 mm L x 14 mm W)

Data Sheet
(Preliminary)

Order No. MD138
December 13, 1994

TECHNICAL DESCRIPTION

Configurations and Rates

The selectable modem configurations, signaling rates, and data rates are listed in Table 1.

Tone Generation

The modem can generate single or dual voice-band tones from 0 Hz to 3600 Hz with a resolution of 0.15 Hz and an accuracy of ± 0.01%. Tones over 3000 Hz are attenuated. DTMF tone generation allows the modem to operate as a programmable DTMF dialer.

Data Encoding

The data encoding conforms to ITU recommendation V.32 bis, V.32, V.17, V.29, V.27 ter, V.26 bis, V.26 Alternative A, V.22 bis, V.22, V.23, or V.21, or is compatible with Bell 212A or 103, depending on the configuration (see Table 1).

Equalizers

Equalization functions are provided that improve performance when operating over poor quality lines.

Compromise Equalizer: A digital finite impulse response (FIR) filter in the transmitter provides compromise equalization. The filter taps can be changed in DSP RAM for varying line conditions. The default equalizer tap coefficients compensate for 75% of the amplitude distortion of an EIA B line and for 100% of the group delay distortion of an EIA 2 line. The filter can be enabled or disabled (CEQ bit).

Automatic Adaptive Equalizer: An automatic adaptive equalizer is provided in the receiver. The equalizer can be configured as either a T or a T/2 equalizer (EQT2 bit).

NOTE: Bit notations refer to data, control, and/or status bits in the modem interface memory (see Table 3).

Transmitted Data Spectrum

When the compromise equalizer is disabled, the transmitter spectrum is shaped by raised cosine filter functions as follows:

Configuration	Raised Cosine Filter Function
V.32 bis/V.32, V.17, V.29	Square root of 12.5%
V.27 ter, V.26	Square root of 50%
V.22 bis/V.22, Bell 212A	Square root of 75%

RTS – CTS Response Time

The response times of CTS relative to a corresponding transition of RTS are listed in Table 2.

Transmit Level

The transmitter output level is selectable from 0 dBm to –15 dBm in 1 dB steps and is accurate to ±0.5 dB when used with an external hybrid. The output level can also be fine tuned to a value within a 1 dB step by changing a gain constant in RAM. The maximum V.32/V.32 bis transmit level for acceptable receive performance should not exceed –9 dBm.

Transmitter Timing

Transmitter timing is selectable between internal (±0.01%), external, or slave.

Scrambler/Descrambler

A self-synchronizing scrambler/descrambler is used in accordance with the selected configuration.

Answer Tone

The modem generates a 2100 Hz answer tone for 3.6 seconds at the beginning of the answer handshake when the NV25 bit is a zero (V.32 bis, V.32, V.22 bis, V.22, V.23, and V.21). The V.32 bis/V.32 answer tone has 180° phase reversals every 0.45 second to disable network echo cancellers.

Receive Level

The modem satisfies performance requirements for received line signal levels from –9 dBm to –43 dBm measured at the Receiver Analog (RXA) input.

Receiver Timing

The timing recovery circuit can track a frequency error in the associated transmit timing source of ±0.035% (V.22 bis) or ±0.01% (other configurations).

Carrier Recovery

The carrier recovery circuit can track a ±7 Hz frequency offset in the received carrier with less than a 0.2 dB degradation in bit error rate (BER).

Clamping

Received Data (RXD) is clamped to a constant mark whenever the Received Line Signal Detector (~RLSD) is off. ~RLSD can be clamped off (RLSDE bit).

Echo Canceller

A data echo canceller with near-end and far-end echo cancellation is included for 2-wire full-duplex V.32 bis/V.32 operation. The combined echo span of near and far cancellers is 35.8 ms. The proportion allotted to each end is automatically determined by the modem. The delay between near-end and far-end echoes can be up to 1.25 seconds. The canceller can compensate for ± 7 Hz frequency offset in the far-end echo. The echo canceller error signal may be monitored through modem interface memory.

ADPCM Voice Mode

Transmit Voice. 16-bit compressed transmit voice can be sent to the modem ADPCM codec for decompression then to the digital-to-analog converter (DAC) by the host.

Receive Voice. 16-bit received voice samples from the modem analog-to-digital converter (ADC) can be sent to the ADPCM codec for compression, and then be read by the host.

Voice Pass-Through Mode

Transmit Voice. 16-bit transmit voice samples can be sent to the modem DAC from the host.

Receive Voice. 16-bit received voice samples from the modem ADC can be read by the host.

Table 1. Configurations, Signaling Rates, and Data Rates

Configuration	Modulation	Carrier Frequency (Hz) ±0.01%	Data Rate (bps) ±0.01%	Symbol Rate (Symbols/Sec.)	Bits/Symbol - Data	Bits/Symbol - TCM	Constellation Points
V.32 bis 14400 TCM[2]	TCM	1800	14400	2400	6	1	128
V.32 bis 12000 TCM[2]	TCM	1800	12000	2400	5	1	64
V.32 bis 9600 TCM[2]	TCM	1800	9600	2400	4	1	32
V.32 bis 7200 TCM[2]	TCM	1800	7200	2400	3	1	16
V.32 bis 4800[2]	QAM	1800	4800	2400	2	0	4
V.32 9600 TCM	TCM	1800	9600	2400	4	1	32
V.32 9600	QAM	1800	9600	2400	4	0	16
V.32 4800	QAM	1800	4800	2400	2	0	4
V.17 14400 TCM/V.33[3]	TCM	1700 or 1800	14400	2400	6	1	128
V.17 12000 TCM/V.33[3]	TCM	1700 or 1800	12000	2400	5	1	64
V.17 9600 TCM[3]	TCM	1700 or 1800	9600	2400	4	1	32
V.17 7200 TCM[3]	TCM	1700 or 1800	7200	2400	3	1	16
V.29 9600[4]	QAM	1700	9600	2400	4	0	16
V.29 7200[4]	QAM	1700	7200	2400	3	0	8
V.29 4800[4]	QAM	1700	4800	2400	2	0	4
V.27 4800[4]	DPSK	1800	4800	1600	3	0	8
V.27 2400[4]	DPSK	1800	2400	1200	2	0	4
V.26 bis 2400	DPSK	1800	2400	1200	2	0	4
V.26 bis 1200	DPSK	1800	1200	1200	1	0	4
V.26 A 2400	DPSK	1800	2400	1200	2	0	4
V.22 bis 2400	QAM	1200/2400	2400	600	4	0	16
V.22 bis 1200	DPSK	1200/2400	1200	600	2	0	4
V.22 1200	DPSK	1200/2400	1200	600	2	0	4
V.22 600	DPSK	1200/2400	600	600	1	0	4
Bell 212A	DPSK	1200/2400	1200	600	2	0	4
Bell 103	FSK	1170/2125	0–300	300	1	0	–
V.23 1200/75	FSK	1700/420	1200/75	1200	1	0	–
V.21	FSK	1080/1750	0–300	300	1	0	–
V.21 Channel 2[4]	FSK	1750	300	300	1	0	–
Tone Transmit	–	–	–	–	–	–	–

Notes:

1. Modulation legend: TCM: Trellis-Coded Modulation; QAM: Quadrature Amplitude Modulation; FSK: Frequency Shift Keying; DPSK: Differential Phase Shift Keying
2. 14400 bps models only.
3. 14400 bps models with fax support only.
4. Models with fax support only.

Data Formats

Serial Synchronous Data

Data rate: 14400, 12000, 9600, 7200, 4800, 2400, 1200, 600, or 300 bps ±0.01%.

Selectable clock: Internal, external, or slave.

Serial Asynchronous Data

Data rate: 14400, 12000, 9600, 7200, 4800, 2400, 1200 or 600 bps +1% (or +2.3%), –2.5%;

0-300 bps (V.21 and Bell 103);

1200/75 bps (V.23).

Bits per character: 7, 8, 9, 10, or 11.

Parallel Synchronous Data

Normal sync: 8-bit data for transmit and receive

Data rate: 14400, 12000, 9600, 7200, 4800, 2400, 1200, 600, or 300 bps ±0.01%.

SDLC/HDLC support:

Transmitter: Flag generation, 0 bit stuffing, ITU CRC-16 or CRC-32 generation.

Receiver: Flag detection, 0 bit deletion, ITU CRC-16 or CRC-32 checking.

Parallel Asynchronous Data

Data rate: 14400, 12000, 9600, 7200, 4800, 2400, 1200 or 600 bps +1% (or 2.3%), –2.5%;

1200, 300, or 75 bps (FSK).

Data bits per character: 5, 6, 7, or 8.

Parity generation/checking: Odd, even, or 9th data bit.

Async/Sync and Sync/Async Conversion

An asynchronous-to-synchronous converter is provided in the transmitter and a synchronous-to-asynchronous converter is provided in the receiver. The converters operate in both serial and parallel modes. The asynchronous character format is 1 start bit, 5 to 8 data bits, an optional parity bit, and 1 or 2 stop bits. Valid character size, including all bits, is 7, 8, 9, 10, or 11 bits per character. Two ranges of signaling rates are provided:

- Basic range: +1% to –2.5%
- Extended overspeed range: +2.3% to –2.5%

When the transmitter's converter is operating at the basic signaling rate, no more than one stop bit will be deleted per 8 consecutive characters. When operating at the extended rate, no more than one stop bit will be deleted per 4 consecutive characters. Break handling is performed as described in V.14.

Asynchronous characters are accepted on the TXD serial input and are issued on the RXD serial output.

V.54 Inter-DCE Signaling

The modem supports V.54 inter-DCE signaling procedures in synchronous and asynchronous configurations. Transmission and detection of the preparatory, acknowledgment, and termination phases as defined in V.54 are provided. Three control bits in the transmitter allow the host to send the appropriate bit patterns (V54T, V54A, and V54P bits). Three control bits in the receiver are used to enable one of three bit pattern detectors (V54TE, V54AE, and V54PE bits). A status bit indicates when the selected pattern detector has found the corresponding bit pattern (V54DT bit).

V.13 Remote RTS Signaling

The modem supports V.13 remote RTS signaling. Transmission and detection of signaling bit patterns in response to a change of state in the RTS bit or the ~RTS input signal are provided. The RRTSE bit enables V.13 signaling. The RTSDE bit enables detection of V.13 patterns. The RTSDT status bit indicates the state of the remote RTS signal. This feature may be used to clamp/unclamp the local ~RLSD and RXD signals in response to a change in the remote RTS signal in order to simulate controlled carrier operation in a constant carrier environment. The modem automatically clamps and unclamps ~RLSD.

Table 2. RTS-CTS Response Times

Configuration	RTS-CTS Response[1]		Turn-Off Sequence[3]
	Constant Carrier	Controlled Carrier	
V.32 bis, V.32	≤ 2 ms	N/A	N/A
V.33/V.17 Long	N/A	1393 ms[2]	15 ms[4]
V.33/V.17 Short	N/A	142 ms[2]	15 ms[4]
V.29	N/A	253 ms[2]	12 ms
V.27 4800 Long	N/A	708 ms[2]	7 ms[4]
V.27 4800 Short	N/A	50 ms[2]	7 ms[4]
V.27 2400 Long	N/A	943 ms[2]	10 ms[4]
V.27 2400 Short	N/A	67 ms[2]	10 ms[4]
V.26	N/A	60 ms	10 ms
V.22 bis, V.22, Bell 212A	≤ 2 ms	270 ms	N/A
V.21	500 ms	500 ms	N/A
V.23, Bell 103	210 ms	210 ms	N/A

Notes:

1. Times listed are CTS turn-on. The CTS OFF-to-ON response time is host programmable in DSP RAM. (Full-duplex modes only.)
2. Add echo protector tone duration plus 20 ms when echo protector tone is used during turn-on.
3. Turn-off sequence consists of transmission of remaining data and scrambled ones for controlled carrier operation. CTS turn-off is less than 2 ms for all configurations.
4. Plus 20 ms of no transmitted energy.
5. N/A = not applicable.

Auto-Dialing and Auto-Answering Control

The host can perform auto-dialing and auto-answering. These functions include DTMF or pulse dialing, ringing detection, and a comprehensive supervisory tone detection scheme. The major parameters are host programmable.

Supervisory Tone Detection

Three parallel tone detectors (A, B, and C) are provided for supervisory tone detection. The signal path to these detectors is separate from the main received signal path.

Each tone detector consists of two cascaded second order IIR biquad filters. The coefficients are host programmable. Each fourth order filter is followed by a level detector which has host programmable turn-on and turn-off thresholds allowing hysteresis. Tone detector C is preceded by a prefilter and squarer. This circuit is useful for detecting a tone with frequency equal to the difference between two tones that may be simultaneously present on the line. The squarer may be disabled by the SQDIS bit causing tone detector C to be an eighth order filter. The tone detectors are disabled in data mode.

The tone detection sample rate is 7200 Hz. The default call progress filter coefficients are based on the 7200 Hz sampling rate. The maximum detection bandwidth is equal to one-half the sample rate.

Supervisory Tone Detectors, Default Characteristics

The default bandwidths and thresholds of the tone detectors are as follows:

Tone Detector	Bandwidth	Turn-On Threshold	Turn-Off Threshold
A	245 – 650 Hz	–25 dBm	–31 dBm
B	360 – 440 Hz	–25 dBm	–31 dBm
C Prefilter	0 – 500 Hz	N/A	N/A
C	50 – 110 Hz	*	*

* Tone Detector C will detect a difference tone within its bandwidth when the two tones present are in the range –1 dBm to –26 dBm.

Auto Mode Selection

When enabled, the modem will determine the communication standard supported by the remote modem and configure itself according. Configurations supported are: V.32 bis, V.32, V.22 bis, V.22, Bell 212A, Bell 103, V.23, and V.21.

DTMF Detection

A DTMF tone pair can be detected and a corresponding code loaded into interface memory for access by the host (DTMFD and DTMFW bits). The 0–9, A–D, *, and # digits are supported. The received DTMF signal must be at least 6 dB above the local voice echo if DTMF detection is used while transmitting voice.

511 Pattern Generation/Detection

In a synchronous mode, a 511 pattern can be generated and detected (control bit S511). Use of this bit pattern during self-test eliminates the need for external test equipment.

In-Band Secondary Channel

A full duplex in-band secondary channel is provided in V.32 bis/V.32 modes (except 4800 bps). Control bit SECEN enables and disables the secondary channel operation. The secondary channel operates in parallel data mode with independent transmit and receive interrupts and data buffers. The main channel may operate in parallel or serial mode. The secondary channel data rate is 150 bps. The rate is host programmable.

Transmit and Receive FIFO Data Buffers

Two 8-byte first-in first out (FIFO) data buffers allow the DTE/host to rapidly output up to 9 bytes of transmit data and input up to 9 bytes of accumulated received data. The receiver FIFO is always enabled. The transmitter FIFO is enabled by the FIFOEN control bit. TXHF and RXHF bits indicate the corresponding FIFO buffer half full (4 or more bytes loaded) status. TXFNE and RXFNE bits indicate the corresponding FIFO buffer not empty status. An interrupt mask register allows an interrupt request to be generated whenever the TXFNE, RXFNE, RXHF, or TXHF status bit changes state.

DMA Support Interrupt Request Lines

DMA support is available in synchronous, asynchronous, and HDLC parallel data modes. Control bit DMAE enables and disables DMA support. When DMA support is enabled, the modem ~RI and ~DSR lines are assigned to Transmitter Request (TXRQ) and Receiver Request (RXRQ) hardware output interrupt request lines, respectively. The TXRQ and RXRQ signals follow the assertion of the TDBE and RDBF interrupt bits thus allowing the DTE/host to respond immediately to the interrupt request without masking out status bits to determine the interrupt source.

NRZI Encoding/Decoding

NRZI data encoding/decoding may be selected in synchronous and HDLC modes instead of the default NRZ (control bit NRZIEN). In NRZ encoding, a 1 is represented by a high level and a 0 is represented by a low level. In NRZI encoding, a 1 is represented by no change in level and a 0 is represented by a change in level.

ITU CRC-32 Support

ITU CRC-32 generation/checking may be selected instead of the default ITU CRC-16 in HDLC mode using DSP RAM access.

Caller ID Demodulation

Caller ID information can be demodulated in V.23 1200 receive configuration and presented to the host/DTE in serial (RXD) and parallel (RBUFFER) form.

Telephone Line Interface

Line Transformer Interface. V.32 bis/V.32 places high requirements upon the Data Access Arrangement (DAA) to the telephone line. These modes use the same bandwidth for transmission of data in both directions. Any non-linear distortion generated by the DAA in the transmit direction cannot be canceled by the modem's echo canceller and interferes with data reception. The designer must, therefore, ensure that the total harmonic distortion seen at the RXA input to the modem be at least 30 dB below the minimum level of received signal.

Relay Control. Direct control of the off-hook and talk/data relays is provided. Internal relay drivers allow direct connection to the off-hook and talk/data relays. The talk/data relay output can optionally be used for pulse dial.

Speaker Interface

A SPKR output is provided with on/off and volume control logic incorporated in the modem, requiring only an external amplifier to drive a loudspeaker.

HARDWARE INTERFACE SIGNALS

A functional interconnect diagram showing the typical modem connection in a system is illustrated in Figure 1.

In Figure 1, any point that is active low is represented by a small circle at the signal point.

Edge triggered inputs are denoted by a small triangle (e.g., TDCLK). An active low signal is indicated by a tilde preceding the signal name (e.g., ~RESET).

A clock intended to activate logic on its rising edge (low-to-high transition) is called active low (e.g., ~RDCLK), while a clock intended to activate logic on its falling edge (high-to-low transition) is called active high (e.g., TDCLK). When a clock input is associated with a small circle, the input activates on a falling edge. If no circle is shown, the input activates on a rising edge.

The pin assignments for the modem packaged in a 100-pin PQFP are shown in Figure 2a and are listed in Table 3a.

The pin assignments for the modem packaged in a 128-pin TQFP are shown in Figure 2b and are listed in Table 3b.

The modem hardware interface signals are described in Table 4.

The digital interface characteristics are defined in Table 5.

The analog interface characteristics are defined in Table 6.

The power requirements are defined in Table 7.

The absolute maximum ratings are defined in Table 8.

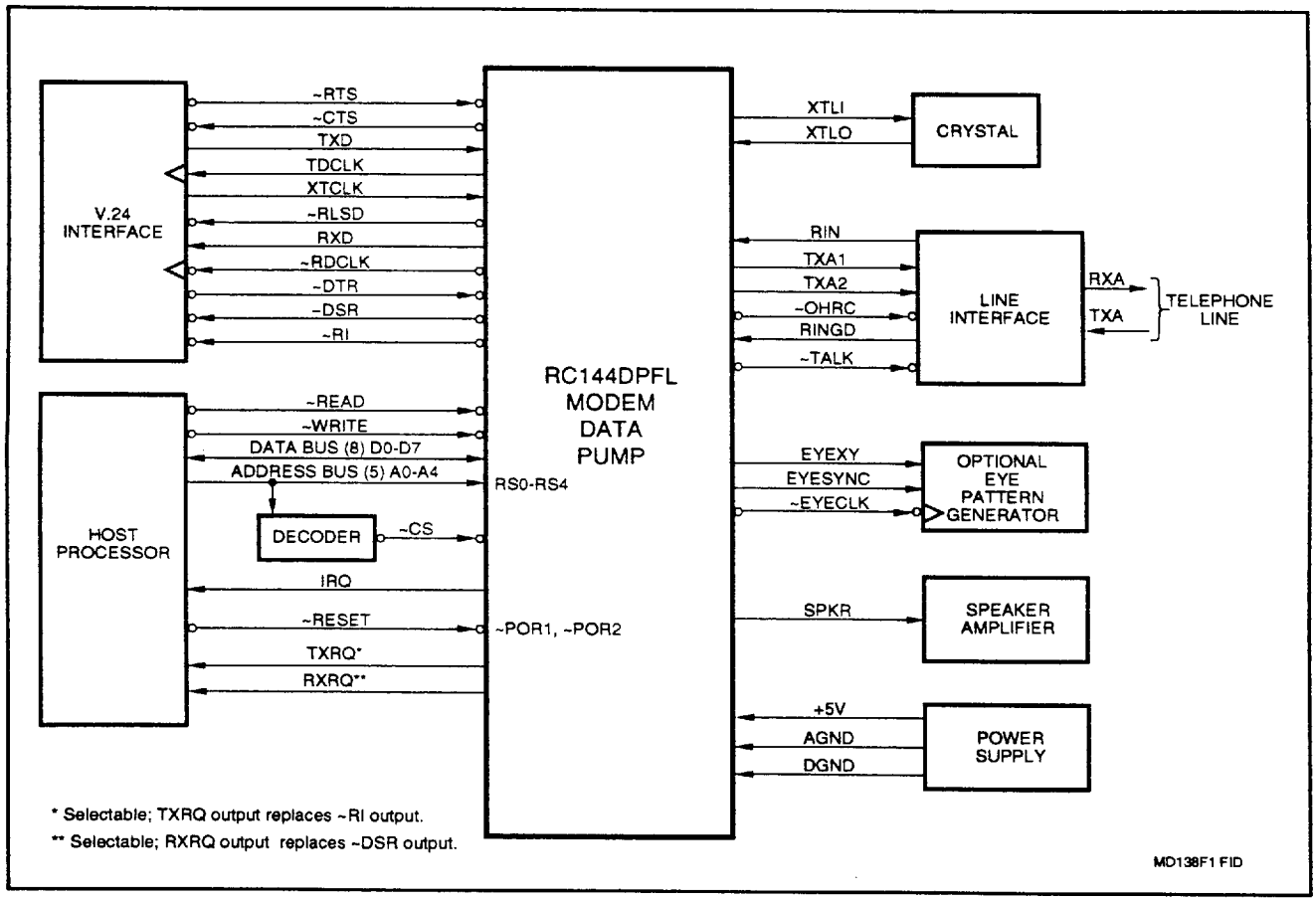


Figure 1. Modem Hardware Interface Signals

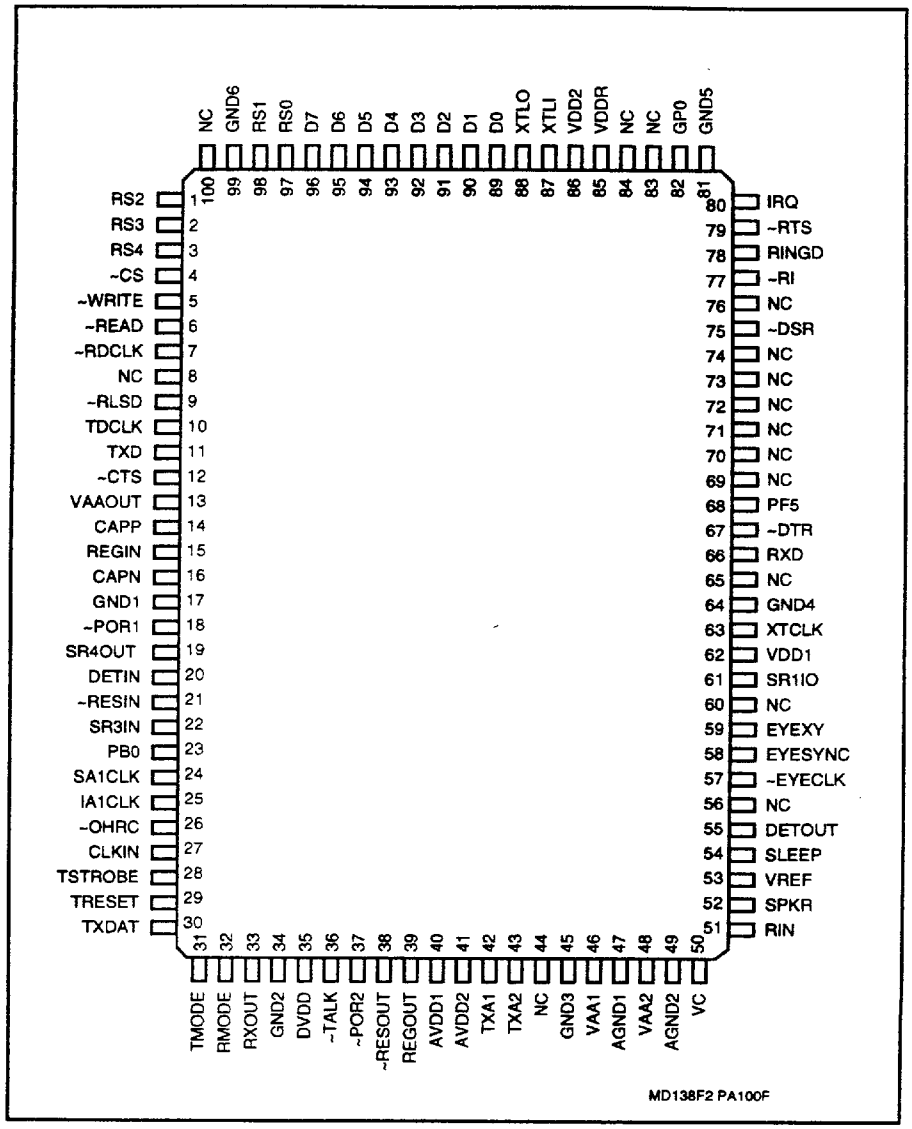


Figure 2a. MDP Pin Signals - 100-Pin PQFP

Table 3a. MDP Pin Signals - 100-Pin PQFP (MD1)

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
1	RS2	IA	Host Parallel Interface	51	RIN	I(DA)	Line Interface
2	RS3	IA	Host Parallel Interface	52	SPKR	O(DF)	Speaker Circuit
3	RS4	IA	Host Parallel Interface	53	VREF	MI	VC through capacitors
4	-CS	IA	Host Parallel Interface	54	SLEEP	MI	PF5 (68)
5	-WRITE	IA	Host Parallel Interface	55	DETOUT	MI	DETIN (20); Controller
6	-READ	IA	Host Parallel Interface	56	NC		NC
7	-RDCLK	OA	DTE Serial Interface	57	-EYECLK	OA	Eye Pattern Test Circuit
8	NC		NC	58	EYESYNC	OA	Eye Pattern Test Circuit
9	-RLSD	OA	DTE Serial Interface	59	EYEXY	OA	Eye Pattern Test Circuit
10	TDCLK	OA	DTE Serial Interface	60	NC		NC
11	TXD	IA	DTE Serial Interface	61	SR1IO	MI	TMODE (31)
12	-CTS	OA	DTE Serial Interface	62	VDD1	PWR	VCC
13	VAAOUT	MI	VAA1 and VAA2	63	XTCLK	IA	DTE Serial Interface
14	CAPP	MI	To CAPN through 1 µF	64	GND4	GND	GND
15	REGIN	MI	REGOUT (39)	65	NC		NC
16	CAPN	MI	To CAPP through 1 µF	66	RXD	OA	DTE Serial Interface
17	GND1	GND	GND	67	-DTR	IA	DTE Serial Interface
18	-POR1	IA	Reset Circuit/Host Interface	68	PF5	MI	Connect to SLEEP (54)
19	SR4OUT	MI	TXDAT (30)	69	NC		NC
20	DETIN	MI	DETOUT (55)	70	NC		NC
21	-RESIN	MI	-RESOUT (38)	71	NC		NC
22	SR3IN	MI	RXOUT (33)	72	NC		NC
23	PB0	MI	CLKIN (27)	73	NC		NC
24	SA1CLK	MI	TRESET (29)	74	NC		NC
25	IA1CLK	MI	TSTROBE (28)	75	-DSR/RXRQ	OA	DTE Serial/DMA Interface
26	-OHRC	OD	Line Interface	76	NC		NC
27	CLKIN	MI	PB0 (23)	77	-RI/TXRQ	OA	DTE Serial/DMA Interface
28	TSTROBE	MI	IA1CLK (25)	78	RINGD	IA	Line Interface
29	TRESET	MI	SA1CLK (24)	79	-RTS	IA	DTE Serial Interface
30	TXDAT	MI	SR4OUT (19)	80	IRQ	OA	Host Parallel Interface
31	TMODE	MI	RMODE (32)	81	GND5	GND	GND
32	RMODE	MI	TMODE (31)	82	GP0	MI	EYESYNC
33	RXOUT	MI	SR3IN (22)	83	NC		NC
34	GND2	GND	GND	84	NC		NC
35	DVDD	PWR	VCC	85	VDDR	MI	0.1 µF to GND
36	-TALK	OD	Line Interface	86	VDD2	PWR	VCC
37	-POR2	IA	Reset Circuit/Host Interface	87	XTLI	I	Crystal/Clock Circuit
38	-RESOUT	IA	-RESIN (21); Controller	88	XTLO	O	Crystal/Clock Circuit
39	REGOUT	MI	REGIN (15)	89	D0	IA/OA	Host Parallel Interface
40	AVDD1	PWR	VCC	90	D1	IA/OA	Host Parallel Interface
41	AVDD2	PWR	VCC with RC filter	91	D2	IA/OA	Host Parallel Interface
42	TXA1	O(DD)	Line Interface	92	D3	IA/OA	Host Parallel Interface
43	TXA2	O(DD)	Line Interface	93	D4	IA/OA	Host Parallel Interface
44	NC		NC	94	D5	IA/OA	Host Parallel Interface
45	GND3	GND	GND	95	D6	IA/OA	Host Parallel Interface
46	VAA1	PWR	VAAOUT	96	D7	IA/OA	Host Parallel Interface
47	AGND1	GND		97	RS0	IA	Host Parallel Interface
48	VAA2	PWR	VAAOUT	98	RS1	IA	Host Parallel Interface
49	AGND2	GND	GND	99	GND6	GND	GND
50	VC	MI	AGND through capacitors	100	NC		NC

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB = Digital input.
   - OA, OB = Digital output.
   - I(DA)] = Analog input.
   - O(DD), O(DF) = Analog output.
2. NC = No external connection allowed. These pins may not be isolated internally. Do not use these pins for tie points.
3. Interface Legend:
   - DTE = Data Terminal Equipment.

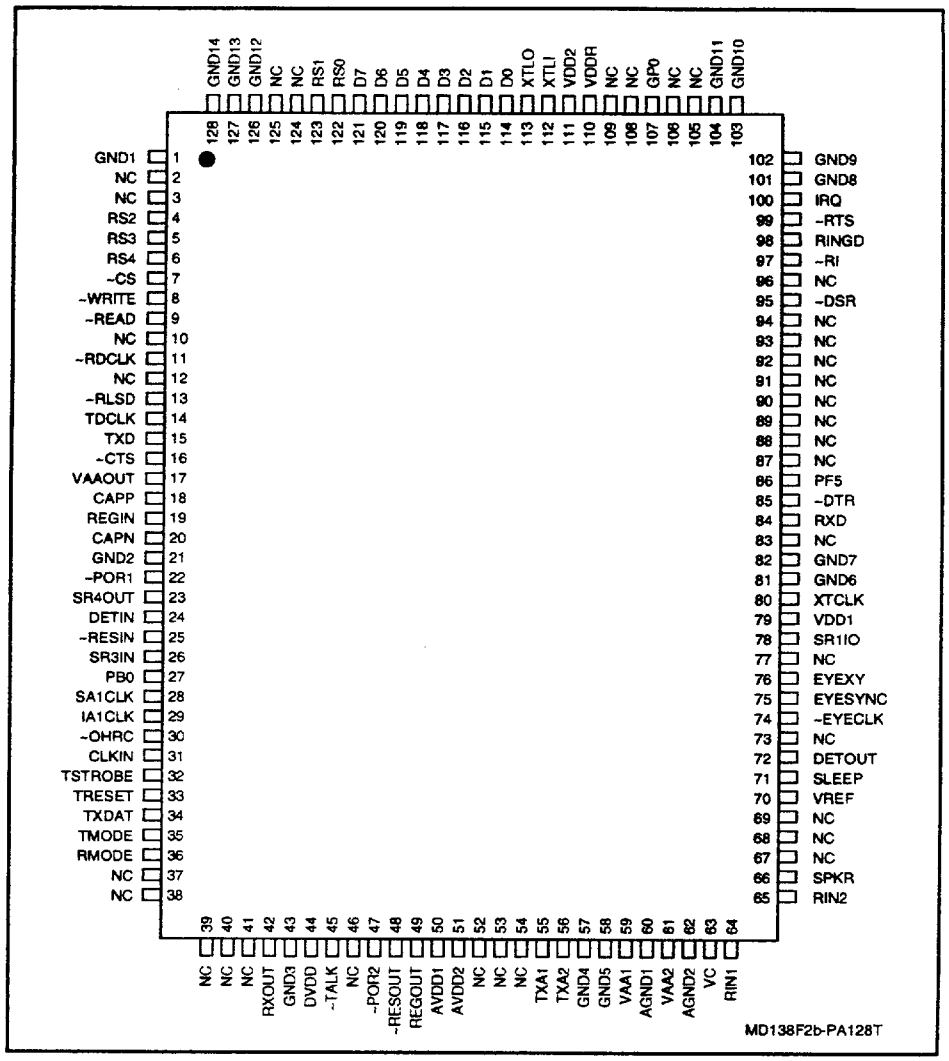


Figure 2b. MDP Pin Signals - 128-Pin TQFP

Table 3b. MDP Pin Signals - 128-Pin TQFP

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
1	GND1	GND	GND	65	RIN2	I(DA)	Line Interface
2	NC		NC	66	SPKR	O(DF)	Speaker Circuit
3	NC		NC	67	NC		NC
4	RS2	IA	Host Parallel Interface	68	NC		
5	RS3	IA	Host Parallel Interface	69	NC		NC
6	RS4	IA	Host Parallel Interface	70	VREF	MI	VC through capacitors
7	~CS	IA	Host Parallel Interface	71	SLEEP	MI	PF5 (86)
8	~WRITE	IA	Host Parallel Interface	72	DETOUT	MI	DETIN (24); Controller
9	~READ	IA	Host Parallel Interface	73	NC		NC
10	NC		NC	74	~EYECLK	OA	Eye Pattern Test Circuit
11	~RDCLK	OA	DTE Serial Interface	75	EYESYNC	OA	Eye Pattern Test Circuit
12	NC		NC	76	EYEXY	OA	Eye Pattern Test Circuit
13	~RLSD	OA	DTE Serial Interface	77	NC		NC
14	TDCLK	OA	DTE Serial Interface	78	SR1IO	MI	TMODE (35)
15	TXD	IA	DTE Serial Interface	79	VDD1	PWR	VCC
16	~CTS	OA	DTE Serial Interface	80	XTCLK	IA	DTE Serial Interface
17	VAAOUT	MI	VAA1 and VAA2	81	GND6	GND	GND
18	CAPP	MI	To CAPN through 1 µF	82	GND7	GND	GND
19	REGIN	MI	REGOUT (49)	83	NC		NC
20	CAPN	MI	To CAPP through 1 µF	84	RXD	OA	DTE Serial Interface
21	GND2	GND	GND	85	~DTR	IA	DTE Serial Interface
22	~POR1	IA	Reset Circuit/Host Interface	86	PF5	MI	SLEEP (71)
23	SR4OUT	MI	TXDAT (34)	87	NC		NC
24	DETIN	MI	DETOUT (72)	88	NC		NC
25	~RESIN	MI	~RESOUT (48)	89	NC		NC
26	SR3IN	MI	RXOUT (42)	90	NC		NC
27	PB0	MI	CLKIN (31)	91	NC		NC
28	SA1CLK	MI	TRESET (33)	92	NC		NC
29	IA1CLK	MI	TSTROBE (32)	93	NC		NC
30	~OHRC	OD	Line Interface	94	NC		NC
31	CLKIN	MI	PB0 (27)	95	~DSR/RXRQ	OA	DTE Serial/DMA Interface
32	TSTROBE	MI	IA1CLK (29)	96	NC		NC
33	TRESET	MI	SA1CLK (28)	97	~RI/TXRQ	OA	DTE Serial/DMA Interface
34	TXDAT	MI	SR4OUT (23)	98	RINGD	IA	Line Interface
35	TMODE	MI	RMODE (36)	99	~RTS	IA	DTE Serial Interface
36	RMODE	MI	TMODE (35)	100	IRQ	OA	Host Parallel Interface
37	NC		NC	101	GND8	GND	GND
38	NC		NC	102	GND9	GND	GND
39	NC		NC	103	GND10	GND	GND
40	NC		NC	104	GND11	GND	GND
41	NC		NC	105	NC		NC
42	RXOUT	MI	SR3IN (26)	106	NC		NC
43	GND3	GND	GND	107	GP0	MI	EYESYNC
44	DVDD	PWR	VCC	108	NC		NC
45	~TALK	OD	Line Interface	109	NC		NC
46	NC		NC	110	VDDR	MI	0.1 µF to GND
47	~POR2	IA	Reset Circuit/Host Interface	111	VDD2	PWR	VCC
48	~RESOUT	IA	~RESIN (25); Controller	112	XTLI	I	Crystal/Clock Circuit
49	REGOUT	MI	REGIN (19)	113	XTLO	O	Crystal/Clock Circuit
50	AVDD1	PWR	VCC	114	D0	IA/OA	Host Parallel Interface
51	AVDD2	PWR	VCC with RC filter	115	D1	IA/OA	Host Parallel Interface
52	NC		NC	116	D2	IA/OA	Host Parallel Interface
53	NC		NC	117	D3	IA/OA	Host Parallel Interface
54	NC		NC	118	D4	IA/OA	Host Parallel Interface
55	TXA1	O(DD)	Line Interface	119	D5	IA/OA	Host Parallel Interface
56	TXA2	O(DD)	Line Interface	120	D6	IA/OA	Host Parallel Interface
57	GND4	GND	GND	121	D7	IA/OA	Host Parallel Interface
58	GND5	GND	GND	122	RS0	IA	Host Parallel Interface
59	VAA1	PWR	VAAOUT	123	RS1	IA	Host Parallel Interface
60	AGND1	GND	GND	124	NC		NC

Table 3b. MDP Pin Signals - 128-Pin TQFP (Cont'd)

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
61	VAA2	PWR	VAAOUT	125	NC		NC
62	AGND2	GND	GND	126	GND12	GND	GND
63	VC	MI	AGND through capacitors	127	GND13	GND	GND
64	RIN1	I(DA)	Line Interface	128	GND14	GND	GND

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB = Digital input.
   - OA, OB = Digital output.
   - I(DA)] = Analog input.
   - O(DD), O(DF) = Analog output.
2. NC = No external connection allowed. These pins may not be isolated internally. Do not use these pins for tie points.
3. Interface Legend:
   - DTE = Data Terminal Equipment.

Table 4. MDP Signal Definitions

Label	I/O Type	Signal/Definition
		OVERHEAD SIGNALS
XTLI, XTLO	I, O	**Crystal In and Crystal Out.** The modem must be connected to an external crystal circuit consisting of a 35.2512 MHz crystal, three capacitors, and an inductor, or to a square wave generator/sine wave oscillator.
~POR1, ~POR2	IA	**Power-On Reset.** ~POR1 and ~POR2 low hold the modem in the reset state. ~POR1 and ~POR2 must be held low for at least 3 µs. ~POR1 and ~POR2 going high initiate internal hardware normal operation (but not modem processing).
~RESOUT	OA	**Reset Output.** ~RESOUT high indicates internal hardware normal operation has been attained and initiates internal modem process using power turn-on (default) values. The modem is ready to use 500 ms after the low-to-high transition of ~RESOUT.
~RESIN	IA	**Reset Input.** Connect ~RESIN to ~RESOUT.
DETOUT	MI	**Detected Level Out.** No external connection.
DETIN	MI	**Detected Level In.** Connect to VCC (+5VDC).
VDDR	MI	**Digital Supply Voltage Regulated.** Connect to VCC (+5VDC).
GND	GND	**Digital Ground.** Connect to ground.
AGND	GND	**Analog Ground.** Connect to analog ground.
VDD1, VDD2	PWR	**DSP Digital Supply Voltage.** Connect to VCC (+5VDC).
DVDD	PWR	**IA Digital Circuits Power.** Connect to VCC (+5VDC).
AVDD1	PWR	**IA Digital Supply Voltage 1.** Connect to VCC (+5VDC).
AVDD2	PWR	**IA Digital Supply Voltage 2.** Connect to VCC (+5VDC) through RC filter.
VAAOUT	MI	**Analog Supply Voltage Output.** Connect to VAA1 and VAA2.
VAA1, VAA2	PWR	**Analog Supply Voltage.** Connect to VAAOUT. Connect to analog ground through 10 µF and 0.1 µF capacitors in parallel.
REGOUT	MI	**Regulator Out.** No external connection.
REGIN	MI	**Regulator In.** Connect to ground.
CAPP	MI	**Capacitor Plus Connection.** No external connection.
CAPN	MI	**Capacitor Negative Connection.** No external connection.

Table 4. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal/Definition
		MCU INTERFACE
		Address, data, control, and interrupt hardware interface signals allow modem connection to an 8086-compatible microprocessor bus. With the addition of external logic, the interface can be made compatible with a wide variety of other microprocessors such as the 6502, 8086 or 68000. The microprocessor interface allows a microprocessor to change modem configuration, read or write channel and diagnostic data, and supervise modem operation by writing control bits and reading status bits.
D0–D7	IA/OB	**Data Lines.** Eight bidirectional data lines (D0–D7) provide parallel transfer of data between the host and the modem. The most significant bit is D7. Data direction is controlled by the Read Enable and Write Enable signals.
RS0–RS4	IA	**Register Select Lines.** The five active high register select lines (RS0–RS4) address interface memory registers within the modem interface memory. These lines are typically connected to the five least significant lines (A0–A4) of the address bus. The modem decodes RS0 through RS4 to address one of 32 internal interface memory registers (00–1F). The most significant address bit is RS4, while the least significant address bit is RS0. The selected register can be read from or written into via the 8-bit parallel data bus (D0–D7). The most significant data bit is D7, while the least significant data bit is D0.
~CS	IA	**Chip Select.** ~CS selects the modem for microprocessor bus operation. ~CS is typically generated by decoding host address bus lines.
~READ	IA	**Read Enable.** During a read cycle (~READ asserted), data from the selected interface memory register is gated onto the data bus by means of three-state drivers in the modem. These drivers force the data lines high for a one bit, or low for a zero bit. When not being read, the three-state drivers assume their high-impedance (off) state.
~WRITE	IA	**Write Enable.** During a write cycle (~WRITE asserted), data from the data bus is copied into the selected modem interface memory register, with high and low bus levels representing one and zero bit states, respectively.
IRQ	OA	**Interrupt Request.** The modem IRQ output may be connected to the host processor interrupt request input in order to interrupt host program execution for immediate modem service. The IRQ output can be enabled in the modem interface memory to indicate immediate change of conditions. The use of IRQ is optional depending upon modem application. The IRQ output is driven by a TTL-compatible CMOS driver.
TXRQ	OA	**Transmitter Request.** When control bit DMAE in interface memory is set, this pin operates as the TXRQ output function rather than the ~RI function. TXRQ is a high active signal that follows the state of the TDBE bit. DMA operation is available in asynchronous, synchronous, and HDLC modes.
RXRQ	OA	**Receiver Request.** When control bit DMAE in interface memory is set, this pin operates as the RXRQ output function rather than the ~DSR function. RXRQ is a high active signal that follows the state of the RDBF bit. DMA operation is available in asynchronous, synchronous, and HDLC modes. (TPDM = 1.)

Table 4. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		DTE SERIAL INTERFACE
		Timing, data, control, and status signals provide a V.24-compatible serial interface. These signals are TTL compatible in order to drive the short wire lengths and circuits normally found within a printed circuit board, stand-alone modem enclosures, or equipment cabinets. For driving longer cables, these signals can be easily converted to EIA/TIA-232-E voltage levels.
TXD	IA	**Transmitted Data.** The modem obtains serial data to be transmitted from the local DTE on the Transmitted Data (TXD) input.
RXD	OA	**Received Data.** The modem presents received serial data to the local DTE on the Received Data (RXD) output.
~RTS	IA	**Request to Send.** Activating ~RTS causes the modem to transmit data on TXD when ~CTS becomes active. The ~RTS pin is logically ORed with the RTS bit.
~CTS	OA	**Clear To Send.** ~CTS active indicates to the local DTE that the modem will transmit any data present on TXD. CTS response times from an active condition of RTS are shown in Table 2.
~RLSD	OA	**Received Line Signal Detector.** ~RLSD active indicates to the local DTE that energy above the receive level threshold is present on the receiver input, and that the energy is not a training sequence. One of four ~RLSD receive level threshold options can be selected (RTH bits). A minimum hysteresis action of 2 dB exists between the actual off-to-on and on-to-off transition levels. The threshold level and hysteresis action are measured with a modulated signal applied to the Receiver Analog (RXA) input. Note that performance may be degraded when the received signal level is less than -43 dBm. The ~RLSD on and off thresholds are host programmable in DSP RAM.
~DTR	IA	**Data Terminal Ready.** In V.32 bis, V.32, V.22 bis, V.22, or Bell 212A configuration, activating ~DTR initiates the handshake sequence, provided that the DATA bit is a 1. If in answer mode, the modem immediately sends answer tone. In V.21, V.23, or Bell 103 configuration, activating ~DTR causes the modem to enter the data state provided that the DATA bit is a 1. If in answer mode, the modem immediately sends answer tone. In these modes, if controlled carrier is enabled, carrier is controlled by RTS. During the data mode, deactivating ~DTR causes the transmitter and receiver to turn off and return to the idle state. The ~DTR input and the DTR control bit are logically ORed.
~DSR	OA	**Data Set Ready.** ~DSR ON indicates that the modem is in the data transfer state. ~DSR OFF indicates that the DTE is to disregard all signals appearing on the interchange circuits except Ring Indicator (~RI). ~DSR is OFF when the modem is in a test mode (i.e., local analog or remote digital loopback). The DSR status bit reflects the state of the ~DSR output.
~RI	OA	**Ring Indicator.** ~RI output follows the ringing signal present on the line with a low level (0 V) during the ON time, and a high level (+5 V) during the OFF time coincident with the ringing signal. The RI status bit reflects the state of the ~RI output.
TDCLK	OA	**Transmit Data Clock.** The modem outputs a synchronous Transmit Data Clock (TDCLK) for USRT timing. The TDCLK frequency is the data rate (±0.01%) with a duty cycle of 50±1%. The TDCLK source can be internal, external (input on XTCLK), or slave (to ~RDCLK) as selected by TXCLK bits in interface memory.
XTCLK	IA	**External Transmit Clock.** In synchronous communication, an external transmit data clock can be connected to the modem XTCLK input. The clock supplied at XTCLK must exhibit the same characteristics as TDCLK. The XTCLK input is then reflected at the TDCLK output.
~RDCLK	OA	**Receive Data Clock.** The modem outputs a synchronous Receive Data Clock (~RDCLK) for USRT timing. The ~RDCLK frequency is the data rate (±0.01%) with a duty cycle of 50±1%. The ~RDCLK low-to-high transitions coincide with the center of the received data bits.

Table 4. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		TELEPHONE LINE INTERFACE
TXA1, TXA2	O(DF)	**Transmit Analog 1 and 2.** The TXA1 and TXA2 outputs are differential outputs 180 degrees out of phase with each other. Each output can drive a 300 Ω load.
RIN	I(DA)	**Receive Analog.** RIN is a single-ended receive data input from the telephone line interface or an optional external hybrid circuit.
RINGD	IA	**Ring Detect.** The RINGD input is monitored for pulses in the range of 15 Hz to 68 Hz. The frequency detection range may be changed by the host in DSP RAM. The circuit driving RINGD should be a 4N35 optoisolator or equivalent. The circuit driving RINGD should not respond to momentary bursts of ringing less than 125 ms in duration, or less than 40 VRMS (15 Hz to 68 Hz) across TIP and RING. Detected ring signals are reflected on the ~RI output signal as well as the RI bit.
~RLYA (~OHRC, CALLID)	OD	**Relay A Control.** The ~RLYA open collector output can directly drive a +5V reed relay coil with a minimum resistance of 360 ohms (13.9 mA max. @ 5.0V) and a must-operate voltage no greater than 4.0 VDC. A clamp diode, such as a 1N4148, should be installed across the relay coil. An external transistor can be used to drive heavier loads (e.g., electro-mechanical relays). ~RLYA is controlled by host setting/resetting of the RA bit. In a typical application, ~RLYA is connected to the normally open Off-Hook relay (~OHRC). In this case, ~RLYA active closes the relay to connect the modem to the telephone line. Alternatively, in a typical application, ~RLYA is connected to the normally open Caller ID relay (CALLID). When the modem detects a Calling Number Delivery (CND) message, the ~RLYA output is asserted to close the CALLID relay in order to AC couple the CND information to the modem RIN input (without closing the off-hook relay and allowing loop current flow which would indicate an off-hook condition).
~RLYB (~TALK)	OD	**Relay B Control.** The ~RLYB open collector output can directly drive a +5V reed relay coil with a minimum resistance of 360 ohms (13.9 mA max. @ 5.0V) and a must-operate voltage no greater than 4.0 VDC. A clamp diode, such as a 1N4148, should be installed across the relay coil. An external transistor can be used to drive heavier loads (e.g., electro-mechanical relays). ~RLYB is controlled by host setting/resetting of the RB bit. In a typical application, ~RLYB is connected to the normally closed Talk/Data relay (~TALK). In this case, ~RLYB active opens the relay to disconnect the handset from the telephone line.
		DIAGNOSTIC SIGNALS
		Three signals provide the timing and data necessary to create an oscilloscope quadrature eye pattern. The eye pattern is simply a display of the received baseband constellation. By observing this constellation, common line disturbances can usually be identified.
EYEXY	OA	**Serial Eye Pattern X/Y Output.** EYEXY is a serial output containing two 15-bit diagnostic words (EYEX and EYEY) for display on the oscilloscope X axis (EYEX) and Y axis (EYEY). EYEX is the first word clocked out; EYEY follows. Each word has 8-bits of significance. Each 15-bit data word is shifted out most significant bit first with the seven most significant bits set to zero. EYEXY is clocked by the rising edge of ~EYECLK. This serial digital data must be converted to parallel digital form by a serial-to-parallel converter, and then to analog form by two digital-to-analog (D/A) converters.
~EYECLK	OA	**Serial Eye Pattern Clock.** ~EYECLK is a 288 kHz output clock for use by the serial-to-parallel converters. The low-to-high transitions of ~RDCLK coincide with the low-to-high transitions of ~EYECLK. ~EYECLK, therefore, can be used as a receiver multiplexer clock.
EYESYNC	OA	**Serial Eye Pattern Strobe.** EYESYNC is a strobe for loading the D/A converters.
		SPEAKER INTERFACE
SPKR	O(DF)	**Speaker Analog Output.** The SPKR output reflects the received analog input signal. The SPKR on/off and three levels of attenuation are controlled by bits in DSP RAM. When the speaker is turned off, the SPKR output is clamped to the voltage at the VC pin. The SPKR output can drive an impedance as low as 300 ohms. In a typical application, the SPKR output is an input to an external LM386 audio power amplifier.

Table 4. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		REFERENCE SIGNALS AND MODEM INTERCONNECT
VC	MI	**Low Voltage Reference.** Connect to analog ground through 10 µF (polarized, + terminal to VC) and 0.1 µF (ceramic) in parallel.
VREF	MI	**High Voltage Reference.** Connect to VC through 10 µF (polarized, + terminal to VREF) and 0.1 µF (ceramic) in parallel.
~POR	MI	**Power-On-Reset**. Connect to ~RESET.
SR1IO	MI	**SR1IO.** Connect to RMODE and TMODE.
TMODE	MI	**Transmitter Mode.** Connect to SR1IO.
RMODE	MI	**Receiver Mode.** Connect to SR1IO.
SR3IN	MI	**SR3IN.** Connect to RXOUT.
RXOUT	MI	**Receive Data.** Connect to SR3IN.
SR4OUT	MI	**SR4OUT.** Connect to TXDAT.
TXDAT	MI	**Transmit Data.** Connect to SR4OUT.
PB0	MI	**PB0.** Connect to CLKIN.
CLKIN	MI	**Clock.** Connect to PB0.
IA1CLK	MI	**IA1CLK.** Connect to TSTROBE.
TSTROBE	MI	**Transmitter Strobe.** Connect to IA1CLK.
SA1CLK	MI	**SA1CLK.** Connect to TRESET.
TRESET	MI	**Transmitter Reset.** Connect to SA1CLK.
SLEEP	MI	**Sleep.** Connect to PF5.
PF5	MI	**PF5.** Connect to SLEEP.
DETIN	MI	**DETIN.** Connect to DETOUT.
DETOUT	MI	**DETOUT.** Connect to DETIN.
GP0	MI	**GP0.** Connect to EYESYNC.

Table 5. Digital Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Input High Voltage	V_{IH}				Vdc	
Type IA and IB		2.0	–	V_{CC}+0.3		
Type ID		0.7(V_{CC})	–	V_{CC}+0.3		
Input Low Voltage	V_{IL}	-0.3		0.8	VDC	
Input High Current	I_{IH}	–	–	40	µA	
Input Low Current	I_{IL}	–	–	400	µA	
Input Leakage Current	I_{IN}	–	–	±2.5	µADC	V_{IN} = 0 to +5V, V_{CC} = 5.25V
Output High Voltage	V_{OH}		–	–	VDC	
Type OA		3.5	–	-		I_{LOAD} = – 100 µA
Type OD		-	-	V_{CC}		I_{LOAD} = 0 mA
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
Three-State (Off) Current	I_{TSI}			±10	µADC	V_{IN} = 0.4 to V_{CC}-1

Note: VCC = 5.0 ± 5%, T_A = 0°C to +70°C (commercial temperature range) or -40°C to +85°C (extended temperature range).

Table 6. Analog Electrical Characteristics

Signal Name	Type	Characteristic	Value
RIN	I (DA)	Input Impedance	> 70K Ω
		AC Input Voltage Range	1.1 VP-P**
		Reference Voltage*	+2.5 VDC
TXA1, TXA2	O (DD)	Minimum Load	300 Ω
		Maximum Capacitive Load	0 µF
		Output Impedance	10 Ω
		AC Output Voltage Range	2.2 VP-P
		Reference Voltage	+2.5 VDC
		DC Offset Voltage	± 200 mV
SPKR	O (DF)	Minimum Load	300 Ω
		Maximum Capacitive Load	0 µF
		Output Impedance	10 Ω
		AC Output Voltage Range	1.1V VP-P
		Reference Voltage	+2.5 VDC
		DC Offset Voltage	± 20 mV

* Reference voltage provided internal to modem device.
** Corresponds to 2.2 VP-P at Tip and Ring.

Table 7. Current and Power Requirements

Mode	Current (ID)			Power (PD)		
	Typical @ 25° (mA)	Maximum @ 0°C (mA)	Maximum @ -40°C[1] (mA)	Typical @ 25°C (mW)	Maximum @ 0°C (mW)	Maximum @ -40°C[1] (mW)
Normal mode	45.0	54.0	68.0	225	285	355
Sleep mode	2.0	2.4	3.1	10.0	12.6	16.3

Notes:
1. Maximum power @ -40°C specified only for extended temperature range parts.
2. Test conditions: VCC = 5.0 VDC for typical values; VCC = 5.25 VDC for maximum values.
3. Input Ripple ≤ 0.1 Vpeak-peak.

Table 8. Absolute Maximum Ratings

Parameter	Symbol	Limits	Units
Supply Voltage (VCC = +5 V)	V_{CC}	-0.5 to +7.0	V
DC Input Voltage	V_{IN}	-0.5 to (VCC +0.5)	V
DC Output Voltage	V_O	-0.5 to (VCC +0.5)	V
Voltage Applied to Outputs in High Impedance (Off) State	V_{HZ}	-0.5 to (VCC + 0.5)	V
Analog Input Voltage	V_{IN}	-0.3 to (VAA + 0.3)	V
DC Input Clamp Current	I_{IK}	±20	mA
DC Output Clamp Current	I_{OK}	±20	mA
Static Discharge Voltage (25°C)	V_{ESD}	±2500	V
Latch-up Current (25°C)	I_{TRIG}	±200	mA
Operating Temperature Range	T_A		°C
Commercial		-0 to +70	
Extended		-40 to +85	
Storage Temperature Range	T_{STG}	-55 to +125	°C

SOFTWARE INTERFACE AND OPERATION

Modem functions are implemented in firmware executing in the MDP DSP.

INTERFACE MEMORY

The modem DSP communicates with the host processor by means of a dual-port, interface memory. The interface memory contains thirty-two 8-bit registers, labeled register 00 through 1F. Each register can be read from, or written into, by both the host and the DSP. The host communicates with the modem (DSP) interface memory via the microprocessor bus.

The host can control modem operation by writing control bits to DSP interface memory and writing parameter values to DSP RAM through the interface memory. The host can monitor modem operation by reading status bits from DSP interface memory and reading parameter values from DSP RAM through interface memory.

Interface Memory Signals

The interface memory signals (one or more bits) are identified in Figure 5 and defined in Table 11. Bits in the interface memory are referred to using the format Z:Q. The register number is specified by Z (00 through 1F) and the bit number by Q (0 through 7; 0 = LSB).

OPERATION AND CONNECTION

Configuration Selection

To enter a mode, the host must do the following:

1. Write the CONF code corresponding to the desired mode to the CONF register.
2. Set or reset any control bits to the state desired at the beginning of the selected mode.
3. Set the NEWC bit to initiate the new configuration.
4. Depending on the selected configuration, set the DTR bit to start the handshake for full-duplex modes or set the RTS bit to start training for half-duplex modes.

Transmitter Operation

Once in Data Mode, the host must do the following to transmit data in parallel data mode.

1. Ensure that the TPDM bit is set and the RTS bit is set.
2. Wait until the CTS bit is set and the TDBE bit is set.
3. Write the byte to transmit to TBUFFER.
4. Continue to load data in TBUFFER each time the TDBE bit is set until the data transfer is complete.

If DTR is cleared by the host, the modem terminates the connection and enters idle mode.

Receiver Operation

Once in Data Mode, the host must do the following to receive data in parallel data mode:

1. Wait until the RLSD bit is set and the RDBF bit is set.
2. Read the data byte in RBUFFER.
3. Once the receive process is activated, the modem enters acquisition mode. Received data may be read from RBUFFER when ever RDBF is set.

If DTR is cleared by the host, the modem terminates the connection and enters Idle mode.

Register	Bit 7	6	5	4	3	2	1	0
1F	NSIA	NCIA	—	NSIE	NEWS	NCIE	—	NEWC
1E	TDBIA	RDBIA	TDBIE	—	TDBE	RDBIE	—	RDBF
1D	MEACC	—	MEMW	MEMCR	Memory Access Address High B-8 (MEADDH)			
1C	Memory Access Address Low B7-B0 (MEADDL)							
1B	EDET	DTDET	OTS	DTMFD	DTMFW			
1A	SFRES	RIEN	RION	DMAE	—	SCOBF	SCIBE	SECEN
19	Memory Access Data MSB BF-B8 (MEDAM)							
18	Memory Access Data LSB B7-B0 (MEDAL)							
17	Secondary Transmit Data Buffer/Voice Transmit Buffer LSB(VBUFTL)							
16	Secondary Receive Data Buffer/Voice Receive Buffer LSB (VBUFRL)							
15	SLEEP	—	RDWK	HWRWK	AUTO	RREN	EXL3	EARC
14	ABCODE							
13	TLVL				RTH		TXCLK	
12	Configuration (CONF)							
11	BRKS	PARSL		TXV	RXV	V23HDX	TEOF	TXP
10	Transmit Data Buffer (TBUFFER)/Voice Transmit Buffer MSB(VBUFTM)							
0F	RLSD	FED	CTS	DSR	RI	TM	RTSDT	V54DT
0E	RTDET	BRKD	RREDT	V32BDT	SPEED			
0D	P2DET	PNDET	S1DET	SCR1	U1DET/	SADET	TXFNE	HKAB
0C	AADET	ACDET	CADET	CCDET	SDET	SNDET	RXFNE	RSEQ
0B	TONEA	TONEB	TONEC	ATV25	ATBEL	—	V32DET	EQMAT
0A	PNSUC	—	PE	FE	OE	CRCS/ VSYNC	FLAGS	SYNCD
09	NV25	CC	DTMF	ORG	LL	DATA	RRTSE	DTR
08	ASYN	TPDM	V21S	V54T	V54A	V54P	RTRN	RTS
07	RDLE	RDL	L2ACT	DDIS	L3ACT	L4ACT	RA	MHLD
06	RTDIS	EXOS	CF17	HDLC	PEN	STB	WDSZ/DECBITS	
05	ECFZ	ECSQ	FECSQ	TXSQ	CEQ	TTDIS	STOFF	LECEN
04	RB	EQT2	V32BS	FIFOEN	EQFZ	NRZIEN	TOD	STRN
03	EPT	SEPT	—	RLSDE	ARC	SDIS	GTE	GTS
02	TDE	SQDIS	S511	—	RTSDE	V54TE	V54AE	V54PE
			DCDEN	CDEN	SDCDE	SCDE	CODBITS	
01	VOLUME		VPAUSE	—	—	TXHF	RXHF	RXP
00	Receive Data Buffer (RBUFFER)/Voice Receive Data Buffer MSB (VBUFRM)							

Notes:
1. — in the "Bit" columns indicates reserved for modem use only.

Figure 5. Modem Interface Memory Map

Table 9. Interface Memory Bit Definitions

Mnemonic	Location	Default	Name/Description
AADET	0C:7	–	**AA Detector.** AADET indicates the V.32 bis/V.32 AA sequence detection status. (V.32 bis, V.32)
ABCODE	14:0–7	00	**Abort Code.** ABCODE contains a code indicating the point in the V.32 bis/V.32 handshake where the handshake failure occurred as indicated by status bit HKAB. (V.32 bis, V.32)
ACDET	0C:6	–	**AC Detector.** ACDET indicates the V.32 bis/V.32 AC sequence detection status. (V.32 bis, V.32)
ARC	03:3	1	**Automatic Rate Change Enable.** Control bit ARC is used to inform the modem to automatically condition itself to transmit data at the highest common rate negotiated during the V.32 bis/V.32 handshake. The host may specify the undefined bits in the rate sequence in DSP RAM. (V.32 bis, V.32) Control bit ARC is used to allow setting of the RTRN bit to cause the modem to send a rate change sequence rather than the normal retrain sequence. (V.22 bis) (See RTRN.)
ASYN	08:7	0	**Asynchronous/Synchronous.** Control bit ASYN selects either asynchronous or synchronous mode. (V.32 bis, V.32, V.22 bis, V.22, Bell 212A)
ATBEL	0B:3	–	**Bell Answer Tone Detector.** ATBEL indicates the modem receiver 2225 Hz answer tone detection status. ATBEL is active only when the DATA bit is a 0 and the modem is in originate mode. (Bell 212A, Bell 103)
ATV25	0B:4	–	**V25 Answer Tone Detector.** ATV25 indicates the modem receiver 2100 Hz answer tone detection status. ATV25 is only active when the DATA bit is a 0 and the modem is in originate mode. (V.32 bis, V.32, V.22 bis, V.22, V.23, V.21)
AUTO	15:3	0	**Automatic Mode Change Enable.** Control bit AUTO is used to enable the modem to automatically determine the communication standard of the remote modem and configure itself accordingly. The automode algorithm is based on the EIA/TIA PN-2330 specification. The possible operating modes are: V.32 bis, V.32, V.22 bis, V.22, Bell 212A, Bell 103, V.23 and V.21. (V.32 bis, V.32)
BRKD	0E:6	–	**Break Detected.** Status bit BRKD is used to indicate when the modem is receiving continuous space.
BRKS	11:7	0	**Break Sequence.** Control bit BRKS is used to enable sending of continuous space or sending of parallel data from the TBUFFER in parallel asynchronous mode (see TPDM).
CADET	0C:5	–	**CA Detector.** CADET indicates the V.32 bis/V.32 CA sequence detection status. (V.32 bis, V.32)
CC	09:6	0	**Controlled Carrier.** Control bit CC selects RTS controlled carrier or constant carrier operation. (V.22 bis, V.22, V.23, V.21, Bell 212A)
CCDET	0C:4	–	**CC Detector.** CCDET indicates the V.32 bis/V.32 CC sequence detection status. (V.32 bis, V.32)
CDEN	02:4	0	**Coder Enable.** When control bit CDEN is set in receive voice mode (CONF bits = 80, 81, 83, or 86, and RXV is set), the modem is in ADPCM receive mode and performs ADPCM coding. The coder output is placed into the Voice Receive Buffer, VBUFRM (MSB) and VBUFRL (LSB).
CEQ	05:3	1	**Compromise Equalizer Enable.** Control bit CEQ enables or disables insertion of the digital compromise equalizer into the transmit path. This bandpass equalizer has host programmable taps in DSP RAM.
CF17	06:5	0	**Carrier Frequency 1700 Hz.** Control bit CF17 selects 1700 Hz or 1800 Hz carrier frequency. The non-standard 1700 Hz option is provided for use with a secondary channel which is added at the high end of the band. (V.17)
CODBITS	02:0-1	–	**Coder No. of Bits.** Defines the number of bits per sample (2, 3, or 4) used by the ADPCM coder. (ADPCM receive mode only.)

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
CONF	12:0–7	76	**Modem Configuration.** The CONF control bits select the modem configuration from the following codes:

Mode	Data Rate	CONF (Hex)	
V.33 TCM	14400	31	
V.33 TCM	12000	32	
V.33 TCM	9600	34	
V.33 TCM	7200	38	
V.32 bis TCM	14400	76	
V.32 bis TCM	12000	72	
V.32 TCM	9600	74	
V.32	9600	75	
V.32 bis TCM	7200	78	
V.32	4800	71	
V.32 bis/V.32 clear down	-	70	See Note 1.
V.17 TCM	14400	B1	
V.17 TCM	12000	B2	
V.17 TCM	9600	B4	
V.17 TCM	7200	B8	
V.29	9600	14	
V.29	7200	12	
V.29	4800	11	
V.27 ter	4800	02	
V.27 ter	2400	01	
V.26 bis	2400	08	
V.26 bis	1200	04	
V.26 A	2400	0C	
V.22 bis	2400	84	
V.22 bis	1200	82	See Note 2.
V.22	1200	52	
V.22	600	51	
V.21	0-300	A0	
V.21 channel 2	300	A8	
Bell 212A	1200	62	
Bell 103	0-300	60	
V.23	1200 TX/75 RX	A4	
V.23	75 TX/1200 RX	A1	
Transmit Single Tone	—	80	See Notes 3 and 4.
Transmit Dual Tone	—	83	See Notes 3 and 4.
Dialing/Calling Tone	—	81	See Note 4.
DTMF Receiver	—	86	See Note 4.

NOTES:

1. Configuration 70h transmits a V.32 bis/V.32 GSTN clear-down sequence. This may be sent during a retrain or a rate renegotiation. The remote modem will automatically detect the clear-down sequence and both modems will drop carrier at the end of the retrain or rate renegotiation.
2. Configuration 82h allows for possible fall forward to 2400 bps.
3. When single tone or dual tone mode is selected, the modem transmits one or two tones, respectively. The tone frequencies and levels are host programmable in DSP RAM. Single tone transmit uses the Dual Tone 1 frequency and level.
4. Receive voice pass-through mode can run concurrently when RXV is set and CDEN is reset; transmit voice pass-through mode can run currehtly when TXV is set and DCDEN is reset. (See RXV and CDEN bits.)
   ADPCM receive mode can run concurrently when RXV is set and CDEN is set; transmit ADPCM mode can run concurrently when TXV is set and DCDEN is set. (See TXV and DCDEN bits.)

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
CRCS	0A:2	0	**CRC Sending.** Status bit CRCS is used to indicate that the transmitter is sending or not sending the CRC (2 bytes) in HDLC synchronous parallel mode.
CTS	0F:5	–	**Clear To Send.** Status bit CTS is used to indicate that the training sequence has been completed and any data present at TXD (serial mode) or in TBUFFER (parallel mode) will be transmitted. CTS response times from an RTS ON or OFF transition after the modem has completed a handshake are shown in Table 2. The CTS OFF-to-ON response time is programmable in DSP RAM.
DATA	09:2	1	**Data.** Control bit DATA is used to enable the modem to proceed with the handshake (start-up) sequence.
DCDEN	02:5	0	**Decoder Enable.** When control bit DCDEN is set in transmit voice mode (CONF bits = 80, 81, 83, or 86, and TXV is set), the modem is in ADPCM transmit mode and performs ADPCM decoding on the contents of the voice transmit buffer, VBUFTM (MSB) and VBUFTL (LSB).
DDIS	07:4	0	**Descrambler Disable.** Control bit DDIS is used to disable or enable the receiver's descrambler.
DECBITS	06:0-1	–	**Decoder No. of Bits.** DECBITS defines the number of bits per sample (2, 3, or 4) used by the ADPCM decoder. (ADPCM transmit mode only.)
DMAE	1A:4	0	**DMA Signals Enabled.** Control bit DMAE is used to enable DMA by assigning the ~RI and ~DSR output signals to TXRQ (Transmitter Request) and RXRQ (Receiver Request), respectively. TXRQ is an active high signal that follows the state of the TDBE bit and RXRQ is an active high signal that follows the state of the RDBF bit. DMA is available in asynchronous, synchronous, and HDLC modes (TPDM = 1)
DSR	0F:4	–	**Data Set Ready.** Status bit DSR is used to indicate that the modem is in the data transfer state. The DTE is to disregard all signals appearing on the interchange circuits except ~RI when DTR is OFF. DSR will switch to the OFF state when the modem is in a test mode.
DTDET	1B:6	–	**Dual Tone Detected.** When configured as a DTMF receiver, the modem sets status bit DTDET when a signal is received that satisfies all DTMF criteria except on-time, off-time, and cycle-time. The encoded DTMFW Output Word (1B:0-3) value is available when DTDET is set.
DTMF	09:5	1	**DTMF Select.** Control bit DTMF selects either DTMF or pulse dialing mode.
DTMFD	1B:4	–	**DTMF Signal Detected.** When configured as a DTMF receiver, the modem sets status bit DTMFD when a DTMF signal has been detected that satisfies all specified DTMF detect criteria.
DTMFW	1B:0-3	–	**DTMF Output Word.** When the modem is configured as a DTMF receiver and status bit DTDET is set by the modem, the encoded DTMF output is written into DTMFW.
DTR	09:0	0	**Data Terminal Ready.** In modes V.32 bis/V.32, V.22 bis/V.22, and Bell 212A, control bit DTR is used to initiate a handshake sequence in originate mode when the DATA bit is set, or to immediately send answer tone in answer mode. In modes V.21, V.23, and Bell 103, control bit DTR must be set for the modem to enter data state when DATA bit is set. If in answer mode, the transmitter will send answer tone. If controlled carrier is selected, the carrier is controlled by the ~RTS pin or RTS bit. During the data mode, setting DTR will cause the transmitter to turn off. The DTR bit parallels the operation of the hardware ~DTR control input. These inputs are ORed by the modem.
EARC	15:0	1	**Extended Automatic Rate Change.** Control bit EARC is used to enable automatic rate change during the V.32 bis/V.32 handshake. (See ARC) (V.32 bis, V.32).
ECFZ	05:7	0	**Echo Canceller Freeze.** Control bit ECFZ inhibits or enables updating of the echo canceller taps. (V.32 bis, V.32)
ECSQ	05:6	0	**Echo Canceller Squelch.** Control bit ECSQ is used to force the echo canceller output to zero. (V.32 bis, V.32)
EDET	1B:7	–	**DTMF Early Detection.** When configured as a DTMF receiver, the modem sets status bit EDET to indicate that the received signal is probably a DTMF signal.

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
EPT	03:7	0	**Echo Protector Tone Enable.** Control bit EPT is used to enable transmission of the echo protector tone prior to the transmission of the training sequence. (V.17, V.29, V.27 ter)
EQFZ	04:3	0	**Equalizer Freeze.** Control bit EQFZ inhibits or enables updating of the receiver's adaptive equalizer taps. (V.32 bis, V.32, V.22 bis, V.22, Bell 212A)
EQMAT	0B:0	0	**EQM Above Threshold.** Status bit EQMAT is used to indicate that the measured EQM is above the threshold value programmed in DSP RAM.
EQT2	04:6	1	**Equalizer T/2 Spacing Select.** Control bit EQT2 selects the receiver's adaptive equalizer spacing to be either T/2 fractionally spaced or T spaced (T = 1 baud time).
EXL3	15:1	0	**External Loop 3 Selector.** Control bit EXL3 selects either external or internal path during local analog test (loop 3). (See L3ACT.)
EXOS	06:6	0	**Extended Overspeed.** Control bit EXOS selects Extended or Normal Overspeed mode. (V.32 bis, V.32, V.22 bis, V.22, Bell 212A)
FE	0A:4	0	**Framing Error.** Status bit FE is used to indicate that more than 1 in 8 (or 1 in 4 for extended overspeed) characters were received without a Stop bit in asynchronous mode, or an ABORT sequence was detected in HDLC synchronous parallel mode.
FECSQ	05:5	0	**Far Echo Canceller Squelch.** Control bit FECSQ is used to force the output of the far-end echo canceller to zero. (V.32 bis, V.32)
FED	0F:6	–	**Fast Energy Detector.** Status bit FED is used to indicate energy in the passband above the selected receiver threshold has been detected (see RTH).
FIFOEN	04:4	0	**Transmit FIFO Enable.** Control bit FIFOEN is used to allow the host to input up to nine bytes of data through TBUFFER using the TDBE bit as a software interrupt or the TXRQ signal (DMAE = 1) as a DMA request. (TPDM = 1)
FLAGS	0A:1	0	**Flag Sequence.** Status bit FLAGS is used to indicate that the transmitter is sending the Flag sequence in HDLC mode, sending a constant mark in asynchronous parallel mode, or sending data.
GTE	03:1	0	**Guard Tone Enable.** Control bit GTE enables or disables transmission of guard tone by the answering modem as selected by the GTS bit. (V.22 bis, V.22)
GTS	03:0	0	**Guard Tone Select.** Control bit GTS selects the 550 Hz or 1800 Hz guard tone. (V.22 bis, V.22)
HDLC	06:4	0	**HDLC Select.** Control bit HDLC is used to enable HDLC operation in synchronous parallel data mode.
HKAB	0D:0	–	**Handshake Abort.** Status bit HKAB is used to indicate the V.32 bis/V.32 handshake has failed. Upon failure detection, the transmitter remains in an abort state for 1 second after which HKAB is reset and the transmitter returns to the idle mode.
HWRWK	15:4	1	**Host Write Wake up.** Control bit HWRWK is used to enable waking up of the modem from the sleep mode when the host writes to any register except 1D:0-7 (see SLEEP bit.)
L2ACT	07:5	0	**Loop 2 Activate.** Control bit L2ACT is used to cause the receiver's digital output to be connected to the transmitter's digital input (locally activated remote digital loopback) in accordance with V.54. (Not valid in FSK modes.)
L3ACT	07:3	0	**Loop 3 Activate.** Control bit L3ACT is used to cause the transmitter's analog output to be coupled internally to the receiver's analog input through an attenuator (local analog loopback) per V.54. The signal path for loop 3 can also be established externally to the modem (see EXL3).
L4ACT	07:2	0	**Loop 4 Activate.** Control bit L4ACT is used to cause the receiver's analog input to be connected internally to the transmitter's output (remote analog loopback) per V.54. (V.17, V29, V27).

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
LECEN	05:0	0	**Listener Echo Canceller Enable.** Control bit LECEN is used to enable the listener echo canceller in the receiver. Use of this bit improves V.32/V.32 bis performance over lines exhibiting listener echo. NEWC must be set after changing LECEN. (V.32, V.32 bis)
LL	09:3	0	**Leased Line.** Control bit LL selects leased or switched line operation. (V.22 bis, V.22)
MEACC	1D:7	0	**Memory Access Enable.** Control bit MEACC is used to enable modem accessing of the RAM associated with the address in MEADDH and MEADDL. The MEMW bit controls read or write.
MEADDL	1C:0–7	00	**Memory Access Address Low (7-0).** MEADDL contains the lower 8 bits (bits 7-0) of the address used to access modem RAM via the memory access data LSB (18) and MSB (19) registers.
MEADDH	1D:0–3	0	**Memory Access Address High (B-8).** MEADDH contains the upper 4 bits (bits B-8) of the address used to access modem RAM via the memory access data LSB (18) and MSB (19) registers.
MEDAL	18:0–7	00	**Memory Data LSB.** MEDAL is the least significant byte (bits 7-0) of the 16-bit data word used in reading or writing data locations in modem RAM.
MEDAM	19:0–7	00	**Memory Data MSB.** MEDAM is the most significant byte (bits F-8) of the 16-bit data word used in reading or writing data locations in modem RAM.
MEMCR	1D:4	0	**Memory Continuous Read.** Control bit MEMCR is used to enable continuous DSP RAM read.
MEMW	1D:5	0	**Memory Write.** When MEMW is set and MEACC is set, the modem copies data from interface memory data registers MEDAL (18) and MEDAM (19) to the memory location addressed by MEADDL and MEADDH. When control bit MEMW is reset and MEACC is set, the DSP copies data from the location addressed by MEADDL and MEADDH to MEDAL (18) and MEDAM (19).
MHLD	07:0	0	**Mark Hold.** Control bit MHLD is used to enable the transmitter to either clamp the digital input data to a mark or to take the input from TXD or TBUFFER (see TPDM).
NCIA	1F:6	–	**NEWC Interrupt Active Chip 0.** Status bit NCIA is used to indicate that NEWC caused IRQ to be asserted when enabled by the NCIE bit. (See NEWC and NCIE.)
NCIE	1F:2	0	**NEWC Interrupt Enable.** Control bit NCIE enables or disables assertion of IRQ and setting of NCIA when NCIA is set by the modem. (See NEWC and NCIA.)
NEWC	1F:0	0	**New Configuration.** Control bit NEWC must be set after the host changes the configuration mode code in the CONF register or changes any of the following control bits: CEQ, CF17, DTMF , EARC, EQT2, GTE, GTS, L3ACT, LECEN, LL, ORG, RTH, RXV, SFRES, SLEEP, TLVL, TXV, V21S, V23HDX, or V32BS. This informs the modem to implement the new configuration. The DSP resets the NEWC bit when the configuration change is implemented.
NEWS	1F:3	–	**New Status.** Status bit NEWS is used to indicate one or more status bits located in registers 0A– 0F, 01, 12, 1A, or 1B have changed state, or a DSP RAM read or write has been completed. The host may mask the effect of individual status bits upon NEWS by writing mask values to DSP RAM.
NRZIEN	04:2	0	**NRZI Enable.** Control bit NRZIEN is used to enable NRZI transmitter encoding and receiver decoding in synchronous and HDLC modes. When NRZIEN = 0, NRZ is used.
NSIA	1F:7	–	**NEWS Interrupt Active.** Status bit NSIA is used to indicate NEWS bit caused IRQ to be asserted when enabled by the NSIE bit. (See NEWS and NSIE.)
NSIE	1F:4	0	**NEWS Interrupt Enable.** Control bit NSIE enables or disables assertion of IRQ when NEWS is set by the modem. (See NEWS and NSIA.)
NV25	09:7	0	**No V.25 Answer Tone.** Control bit NV25 is used to disable transmission of the 2100 Hz ITU answer tone when a handshake sequence is initiated. (V.32 bis, V.32, V.22 bis, V.22, V.23, V.21)
OE	0A:3	0	**Overrun Error.** Status bit OE is used to indicate that the RBUFFER was loaded from the RXA input before the host read the old data from RBUFFER in asynchronous mode or HDLC synchronous parallel mode.

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
ORG	09:4	0	**Originate.** Control bit ORG selects either originate or answer mode.
OTS	1B:5	–	**DTMF On-Time Satisfied.** When configured as a DTMF receiver, the modem sets status bit OTS after the on-time criteria is satisfied. This bit is reset by the modem after DTMFD is set or if the received signal fails to satisfy the DTMF off-time criteria.
P2DET	0D:7	0	**P2 Sequence Detected.** Status bit P2DET is used to indicate the receiver is detecting the P2 portion of the training sequence. (V.17, V.29, V.27 ter)
PNSUC	0A:7	0	**PN Success.** Status bit PNSUC is used to indicate that the receiver has successfully trained at the end of the PN portion of the high speed training sequence. (V.17, V.29, V.27 ter)
PARSL	11:5, 6	00	**Parity Select.** Control bits PARSL select the method (stuff, space, even, or odd parity) by which parity is generated and checked during the asynchronous parallel data mode (ASYN = 1).
PE	0A:5	0	**Parity Error.** Status bit PE is used to indicate that a character with bad parity was received in the asynchronous mode or bad CRC was detected in the HDLC synchronous parallel mode.
PEN	06:3	0	**Parity Enable.** Control bit PEN enables or disables parity in asynchronous mode. (V.32 bis, V.32, V.22, V.22 bis, Bell 212A)
PNDET	0D:6	–	**PN Sequence Detected.** Status bit PNDET is used to indicate the receiver is detecting the PN portion of the training sequence. (V.17, V.29, V.27 ter)
RA	07:1	0	**Relay A Activate.** Control bit RA activates (turn on) or deactivates (turns off) the ~OHRC output.
RB	04:7	0	**Relay B Activate.** Control bit RB activates (turn on) or deactivates (turns off) the ~TALK output.
RBUFFER	00:0–7	–	**Receive Data Buffer.** The host obtains channel data from the modem receiver in the parallel data mode by reading data from the RBUFFER.
RDBF	1E:0	–	**Receive Data Buffer Full.** Status bit RDBF is used to signify that the receiver wrote valid data into RBUFFER. This condition can also cause IRQ to be asserted. (See RDBIE and RDBIA.)
RDBIA	1E:6	–	**Receive Data Buffer Interrupt Active.** When the receive data buffer interrupt is enabled (by RDBIE) and RBUFFER is written to by the modem (RDBF is set), the modem asserts IRQ and sets RDBIA to indicate that RDBF being set caused the interrupt. (See RDBF and RDBIE.)
RDBIE	1E:2	0	**Receive Data Buffer Interrupt Enable.** Control bit RDBIE is used to enable the modem to assert IRQ and set the RDBIA bit when RDBF is set by the modem. (See RDBF and RDBIA.)
RDL	07:6	0	**Remote Digital Loopback.** Control bit RDL is used to cause the modem to initiate a V.22 bis request for the remote modem to go into digital loopback. (V.22 bis, Bell 212A/1200)
RDLE	07:7	1	**Remote Digital Loopback Response Enable.** Control bit RDLE is used to enable the modem to respond to another modem's remote digital loopback request, thus going into loopback. (V.22 bis)
RDWK	15:5	1	**Ring Detect Wake up.** Control bit RDWK is used to enable the modem to wake up from sleep mode when incoming ring signal is detected on the RINGD pin. (See SLEEP bit.)
RI	0F:3	–	**Ring Indicator.** Status bit RI is used to indicate a ringing signal is being detected. Ringing is detected if pulses are present on the RINGD input in the 15 Hz–68 Hz frequency range. The decision bounds are host programmable in DSP RAM.
RIEN	1A:6	0	**RION Enable.** When control bit RIEN is a 1, the RI output will reflect the RION bit. When a 0, the RI output follows the ringing signal on the RINGD input.
RION	1A:5	0	**Ring Indicator On.** Control bit RION determines the state of the RI output when bit RIEN is set and the DATA bit is reset. When RION is a 1, the RI output is driven low and when RION is a 0, the RI output is driven high.
RLSD	0F:7	–	**Received Line Signal Detector.** Status bit RLSD is used to indicate that the receiver has completed receiving the training sequence or has detected energy above threshold, and is receiving data.

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
RLSDE	03:4	1	**RLSD Enable.** Control bit RLSDE is used to enable the ~RLSD pin to either reflect the RLSD bit state or to be clamped OFF regardless of the state of the RLSD bit.
RREDT	0E:5	–	**Rate Renegotiation Detected.** Status bit RREDT indicates V.32 bis rate renegotiation sequence detection status. (V.32 bis, V.32)
RREN	15:2	0	**Rate Renegotiation.** Control bit RREN is used to initiate a rate negotiation sequence when the modem is in V.32 bis data mode. (V.32 bis)
RRTSE	09:1	0	**Remote RTS Signaling Enable.** Control bit RRTSE is used to enable remote RTS signaling by sending either a pattern (idle pattern) produced by scrambling a binary 1 with the polynomial $1+x^{-3}+x^{-7}$ (RTS OFF) or a pattern of 8 bits (turn-on pattern) produced by scrambling a binary 0 with the polynomial $1+x^{-3}+x^{-7}$ (RTS ON) followed by the user data.
RSEQ	0C:0	0	**Rate Sequence Received.** Status bit RSEQ is used to indicate the 16-bit rate sequence included in the V.32 bis/V.32 start-up procedure has been received and the 16-bit rate sequence word is available in DSP RAM. (V.32 bis, V.32)
RTDET	0E:7	–	**Retrain Detector.** RTDET indicates the training sequence detection status. This bit parallels the operation of the ACDET, AADET, or S1DET bit. (V.32 bis, V.32, or V.22 bis).
RTDIS	06:7	0	**Receiver Training Disable.** Control bit RTDIS is used to prevent the receiver from recognizing a training sequence and entering the training state. (V.17, V.29, V.27 ter)
RTH	13:2,3	0	**Receiver Threshold.** The RTH control bits select the receiver energy detector threshold: **RTH** **RLSD ON** **RLSD OFF** 0 – 43 dBm – 48 dBm 1 – 33 dBm – 38 dBm 2 – 26 dBm – 31 dBm 3 – 16 dBm – 21 dBm
RTRN	08:1	0	**Retrain.** Control bit RTRN is used to initiate a retrain sequence. (V.32 bis, V.32 or V.22 bis)
RTS	08:0	0	**Request to Send.** Control bit RTS is used to enable the modem to transmit data present on TXD when CTS becomes active. The RTS bit parallels the operation of the ~RTS hardware control input. These inputs are ORed by the modem. (See CTS and DTR bits.) In V.22 bis, V.22, V.23, V.21, and Bell 103 constant carrier, and in V.32 bis/V.32 modes, RTS controls data transmission and DTR controls the carrier. In V.22 bis controlled carrier mode, RTS independently controls the carrier when DTR is ON. In V.21, V.23 and Bell 103 controlled carrier modes, RTS independently controls the carrier when DTR is ON. When RTS is turned ON, CTS is turned ON per Table 2.
RTSDE	02:3	0	**Remote RTS Pattern Detector Enable.** Control bit RTSDE enables or disables the remote RTS pattern detector in the receiver. (See RTSDT).
RTSDT	0F:1	–	**Remote RTS Pattern Detected.** Status bit RTSDT indicates the remote RTS signal is either ON or OFF. This status bit is valid only when RTSDE is set.
RXFNE	0C:1	-	**Receiver FIFO Not Empty.** Status bit RXFNE is used to indicate that the receiver FIFO contains one or more bytes of data. (TPDM = 1, FIFOEN = 1)
RXHF	01:1	0	**Receiver FIFO Half Full.** Status bit RXHF is used to indicate when there are 4 or more bytes in the receiver FIFO buffer.
RXP	01:0	0	**Received Parity Bit.** The RXP is used to indicate the received parity when parity is enabled and word size is set for 8 bits per character.
RXV	11:3	0	**Receive Voice.** Control bit RXV is used to enable the modem to provide voice samples in the Voice Receive Buffer (VBUFRM and VBUFRL). (Configuration codes 80, 81, 83, and 86)

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
S1DET	0D:5	–	**S1 Detector.** S1DET indicates the V.22 bis S1 sequence detection status. (V.22 bis)
S511	02:5	0	**Send 511.** Control bit S511 is used to instruct the modem to generate and transmit a 511 pattern in the current configuration. (Synchronous modes only.)
SADET	0D:2	–	**Scrambled Alternating Sequence Detector.** Status bit SADET is used to indicate that scrambled alternating data is being received during an automatic rate change sequence. (V.22 bis)
SCDE	02:2	0	**Silence Coder Enable.** When control bit SCDE is set and the ADPCM coder is enabled in ADPCM receive mode (see CDEN), the modem performs silence detection and deletion.
SCIBE	1A:1	–	**Secondary Channel Input Buffer Empty.** Status bit SCIBE is used to indicate that the secondary channel transmit buffer (SECTXB) is empty. (See SECEN.) (V.32 bis/V.32)
SCOBF	1A:2	–	**Secondary Channel Output Buffer Full.** Status bit SCOBF is used to indicate that the secondary channel receive buffer (SECRXB) is full. (See SECEN.) (V.32 bis, V.32)
SCR1	0D:4	–	**Scrambled Ones Detector.** SCR1 indicates the V.22 bis scrambled 1s detection status during handshake. (V.22 bis, V.22, Bell 212)
SDCDE	02:3	0	**Silence Decoder Enable.** When control bit SDCDE is set and the ADPCM decoder is enabled in ADPCM transmit mode (see DCDEN), the modem performs silence interpolation.
SDET	0C:3	–	**S Detector.** SDET indicates the V.32 bis/V.32 S sequence detection status. (V.32 bis, V.32)
SDIS	03:2	0	**Scrambler Disable.** Control bit SDIS disables or enables the transmitter scrambler circuit.
SECEN	1A:0	0	**Secondary Channel Enable.** Control bit SECEN enables or disables the secondary channel. (V.32 bis, V.32)
SECRXB	16:0-7	–	**Secondary Receive Buffer.** The host obtains secondary channel data from the modem receiver by reading a data byte from the SECRXB when bit SCOBF is set. (V.32 bis, V.32)
SECTXB	17:0-7	–	**Secondary Transmit Buffer.** The host conveys secondary channel output data to the transmitter by writing a data byte to the SECTXB when bit SCIBE is set. (V.32 bis, V.32)
SEPT	03:6	0	**Short Echo Protector Tone.** Control bit SEPT selects 30 ms or 185 ms echo protector tone. (V.17, V.29, V.27 ter)
SFRES	1A:7	0	**Soft Reset.** WHEN control bit SFRES is set, the modem will perform power-on reset processing. The NEWC bit will be reset to a 0 by the modem upon completion of the reset processing. NEWC must be set to initiate the reset. Wait for NEWC to clear before accessing the modem.
SLEEP	15:7	0	**Sleep Mode.** Control bit SLEEP is used to command the modem into sleep mode. If both RDWK and HWRWK are reset, only a power-on reset will bring the modem out of sleep mode.
SNDET	0C:2	–	**S Negative Detector.** SNDET indicates the ~S sequence detection status. (V.32 bis, V.32)
SPEED	0E:0–3	–	**Speed Indication.** The SPEED bits contain a code indicating the receiver's data rate at the completion of a handshake.
SQDIS	02:6	0	**Squarer Disable (Tone Detector C).** Control bit SQDIS is used to disable the squarer in front of tone detector C thus cascading prefilter and filter C to create an 8th-order filter.
STB	06:2	0	**Stop Bit Number.** Control bit STB selects one or two stop bits in asynchronous mode. (V.32 bis, V.32, V.22, V.22 bis, Bell 212A)
STOFF	05:1	0	**Soft Turn Off.** Control bit STOFF is used to enable the transmitter to send one of the following mark frequency turn-off tones at the end of a transmission.

Configuration	Frequency (Hz)	Duration (ms)
V.23/1200	900	7
V.21 Originate	880	30
V.21 Answer	1550	30
Bell 103 Originate	1370	30
Bell 103 Answer	2325	30

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
STRN	04:0	0	**Short Train Select.** Control bit STRN selects long or short training mode. (V.17, V.27 ter)
SYNCD	0A:0	0	**Sync Pattern Detected.** Status bit SYNCD is used to indicate that HDLC flags (7E pattern) are being detected in HDLC synchronous parallel mode.
TBUFFER	10:0–7	00	**Transmit Data Buffer.** The host conveys output data to the transmitter in the parallel mode by writing data to the TBUFFER. Parallel data mode is available in both synchronous and asynchronous modes. The data is transmitted bit 0 first.
TDE	02:7	1	**Tone Detectors Enable.** Control bit TDE enables or disables tone detectors A, B, and C.
TDBE	1E:3	–	**Transmit Data Buffer Empty.** Status bit TDBE is used to signify that the transmitter has read TBUFFER and the host can write new data into TBUFFER. This condition can also cause IRQ to be asserted. The host writing to TBUFFER resets the TDBE and TDBIA bits.
TDBIA	1E:7	–	**Transmit Data Buffer Interrupt Active.** When the transmit data buffer interrupt is enabled (TDBIE is set) and register 10 is empty (TDBE is set), the modem asserts IRQ and sets status bit TDBIA to indicate that TDBE being set caused the interrupt. The host writing to register 10 resets the TDBIA bit and clears the interrupt request due to TDBE. (See TDBIE and TDBE.)
TDBIE	1E:5	0	**Transmit Data Buffer Interrupt Enable.** When control bit TDBIE is set (interrupt enabled), the modem will assert IRQ and set the TDBIA bit when TDBE is set by the modem. When TDBIE is reset (interrupt disabled), TDBE has no effect on IRQ or TDBIA. (See TDBE and TDBIA.)
TEOF	11:1	0	**HDLC Transmit End of Frame.** Control bit TEOF is used to inform the modem of the last data byte in the frame. (HDLC = 1, TPDM = 1, FIFOEN = 1)
TLVL	13:4–7	9	**Transmit Level.** The TLVL code selects the transmitter analog output level at TXA. The output can vary from 0 ±0.5 dBm (TLVL = 0) to -15 ±0.5 dBm (TLVL = F) in steps of 1 dB. The host can fine tune the transmit level within a 1 dB step by changing a value in DSP RAM.
TM	0F:2	–	**Test Mode.** Status bit TM is used to indicate that the modem has completed the handshake and is in RDL test mode. (V.22 bis, V.22, Bell 212A)
TOD	04:1	0	**Train On Data.** Control bit TOD is used to enable the train-on-data algorithm to converge the equalizer if the signal quality degrades to a BER of 10^{-3} for 0.5 seconds. (V.27)
TONEA	0B:7	–	**Tone A Detected.** Status bit TONEA is used to indicate that energy is present on the line within the tone detector A passband and above its threshold. The tone A, B, and C bandpass filter coefficients are host programmable in DSP RAM.
TONEB	0B:6	–	**Tone B Detected.** Status bit TONEB is used to indicate that energy is present on the line within the tone detector B passband and above its threshold.
TONEC	0B:5	–	**Tone C Detected.** Status bit TONEC is used to indicate that energy is present on the line within the tone detector C passband and above its threshold.
TPDM	08:6	0	**Transmitter Parallel Data Mode.** Control bit TPDM is used to select transmitter parallel data mode in which the modem accepts data for transmission from the TBUFFER (register 10) rather than the TXD input. (See TDBE.)
TTDIS	05:2	0	**Transmitter Training Disable.** Control bit TTDIS is used to inhibit the modem transmitter from generating the training sequence at the start of transmission. (V.17, V.29, V.27 ter)
TXCLK	13:0,1	0	**Transmit Clock Select.** The TXCLK control bits designate the origin of the transmitter data clock to be internal, external (XTCLK), or slave (~RDCLK).
TXFNE	0D:1	-	**Transmitter FIFO Not Empty.** Status bit TXFNE is used to indicate that the transmitter FIFO contains one or more bytes of data. (TPDM = 1, FIFOEN = 1)
TXHF	01:2	0	**Transmitter FIFO Half Full.** Status bit TXHF is used to indicate that there are 4 or more bytes in the transmitter FIFO buffer.
TXP	11:0	0	**Transmit Parity Bit (or 9th Data Bit).** The TXP contains the stuffed parity bit (or 9th data bit) for transmission when parity is enabled, stuff parity is selected, and word size is set for 8 bits per character (see PEN, PARSL, and WDSZ bits).

Table 9. Interface Memory Bit Definitions (Cont'd)

Mnemonic	Location	Default	Name/Description
TXV	11:4	0	**Transmit Voice.** Control bit TXV is used to enable the modem to accept voice samples from the Voice Transmit Buffer (VBUFTM and VBUFTL). (Configuration codes 80, 81, 83, and 86)
TXSQ	05:4	0	**Transmitter Squelch.** Control bit TXSQ enables or disables squelching of the transmitter output.
U1DET	0D:3	–	**Unscrambled 1s Detector.** U1DET indicates the V.22 bis unscrambled 1s sequence detection status. (V.22 bis)
V21S	08:5	0	**V21 Synchronous.** Control bit V21S selects synchronous or asynchronous mode in V.21.
V23HDX	11:2	0	**V.23 Half Duplex.** Control bit V23HDX selects half-duplex or full-duplex operation in V.23.
V32BDT	0E:4	–	**V.32 bis Rate Sequence Detected.** V32BDT indicates the V.32 bis rate sequence detection status. (V.32 bis, V.32)
V32BS	04:5	1	**V.32 bis Select.** Control bit V32BS selects V.32 bis or V.32 operation. (V.32 bis)
V32DIS	0B:1	–	**V.32 Disconnect Detect.** Status bit V32DIS is used to indicate that a line disconnection has occurred and the modem has synchronized on its own transmit signal. (V.32 bis, V.32)
V54A	08:3	0	**V.54 Acknowledgment Signaling.** Control bit V54A is used to enable sending of a pattern of 1948 bits produced by scrambling a binary 1 with the polynomial $1+x^{-4}+x^{-7}$ per V.54 at the modem data signaling rate. (Not valid in FSK modes.)
V54AE	02:1	0	**V.54 Acknowledgment Phase Detector Enable.** Control bit V54AE enables or disables the V.54 acknowledgment phase detector in the receiver. (See V54DT). (Not valid in FSK modes.)
V54DT	0F:0	0	**V.54 Pattern Detected.** Status bit V54DT is used to indicate that one of the three V.54 patterns is being detected. (Not valid in FSK modes.)
V54P	08:2	0	**V.54 Preparatory Signaling.** Control bit V54P is used to enable the sending of a pattern of 2048 bits produced by scrambling a binary 0 with the polynomial $1+x^{-4}+x^{-7}$ per V.54 at the modem data signaling rate. (Not valid in FSK modes.)
V54PE	02:0	0	**V.54 Preparatory Phase Detector Enable.** Control bit V54PE enables or disables the V.54 preparatory phase detector in the receiver. (Not valid in FSK modes.)
V54T	08:4	0	**V.54 Termination Signaling.** Control bit V54T is used to enable the sending of a pattern of 8192 bits produced by scrambling a binary 1 with the polynomial $1+x^{-4}+x^{-7}$ followed by 64 binary 1s per V.54 at the modem signaling rate. (Not valid in FSK modes.)
V54TE	02:2	0	**V.54 Termination Phase Detector Enable.** Control bit V54TE enables or disables the V.54 termination phase detector in the receiver. (See V54DT). (Not valid in FSK modes.)
VBUFTL	17:0-7	–	**Voice Buffer Transmit Least Significant Byte (LSB).** VBUFTL is the least significant byte of the 16-bit ADPCM decoder input buffer. (Voice transmit only.)
VBUFTM	10:0-7	–	**Voice Buffer Transmit Most Significant Byte (MSB).** VBUFTM is the most significant byte of the 16-bit ADPCM decoder input buffer. (Voice transmit only.)
VBUFRL	16:0-7	–	**Voice Buffer Receive Least Significant Byte (LSB).** VBUFRL is the least significant byte of the 16-bit ADPCM coder output buffer. (Voice receive only.)
VBUFRM	00:0-7	–	**Voice Buffer Receive Most Significant Byte (MSB).** VBUFRM is the most significant byte of the 16-bit ADPCM coder output buffer. (Voice receive only.)
VOLUME	01:6,7	0	**Volume Control.** Two-bit encoded speaker volume field selects volume off or one of three volume on levels.
VPAUSE	01:5	0	**Voice Pause.** Control bit VPAUSE enables or disables the voice "pause." When VPAUSE is enabled, voice data is not output to the host.
VSYNC	0A:2	0	**Voice Sync.** Status bit VSYNC is used in conjunction with RDBF to indicate that the first received ADPCM voice sample is available in VBUFRM and VBUFRL. (Voice receive only.)
WDSZ	06:0,1	0	**Data Word Size.** The WDSZ bits select a word size of 5, 6, 7, or 8 data bits per character in asynchronous mode. (V.32 bis, V.32, V.22, V.22 bis, Bell 212A)

MODEM INTERFACE CIRCUIT

Recommended modem interface connections are shown in Figure 4.

Typical external circuits for connection to the telephone line are shown in Figure 5 (no external hybrid, transmit level to -7 dBm) and Figure 6 (external; hybrid, transmit level to 0 dBm).

A typical external speaker circuit is shown in Figure 7.

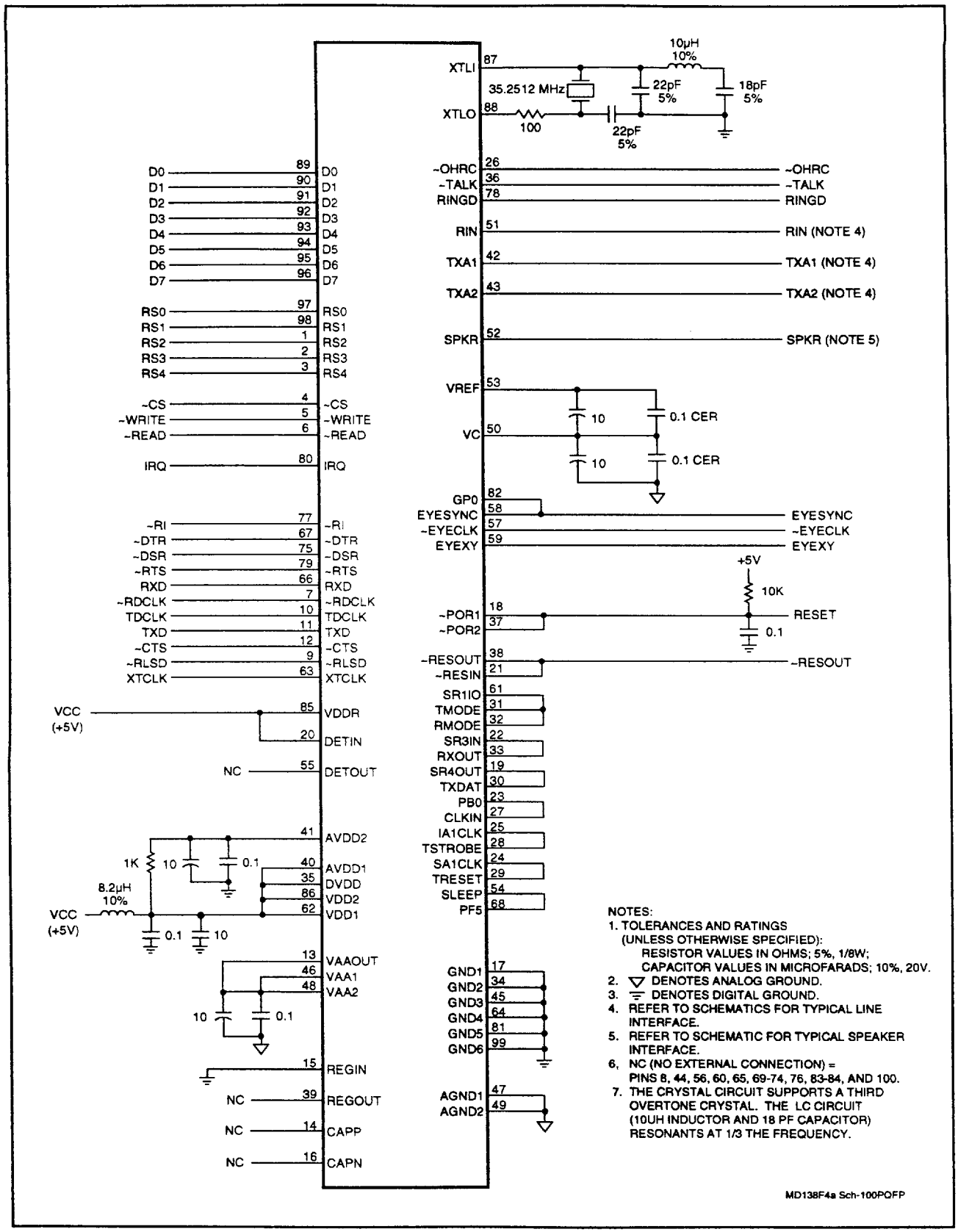


Figure 4a. Typical Modem Interface - 100-Pin PQFP

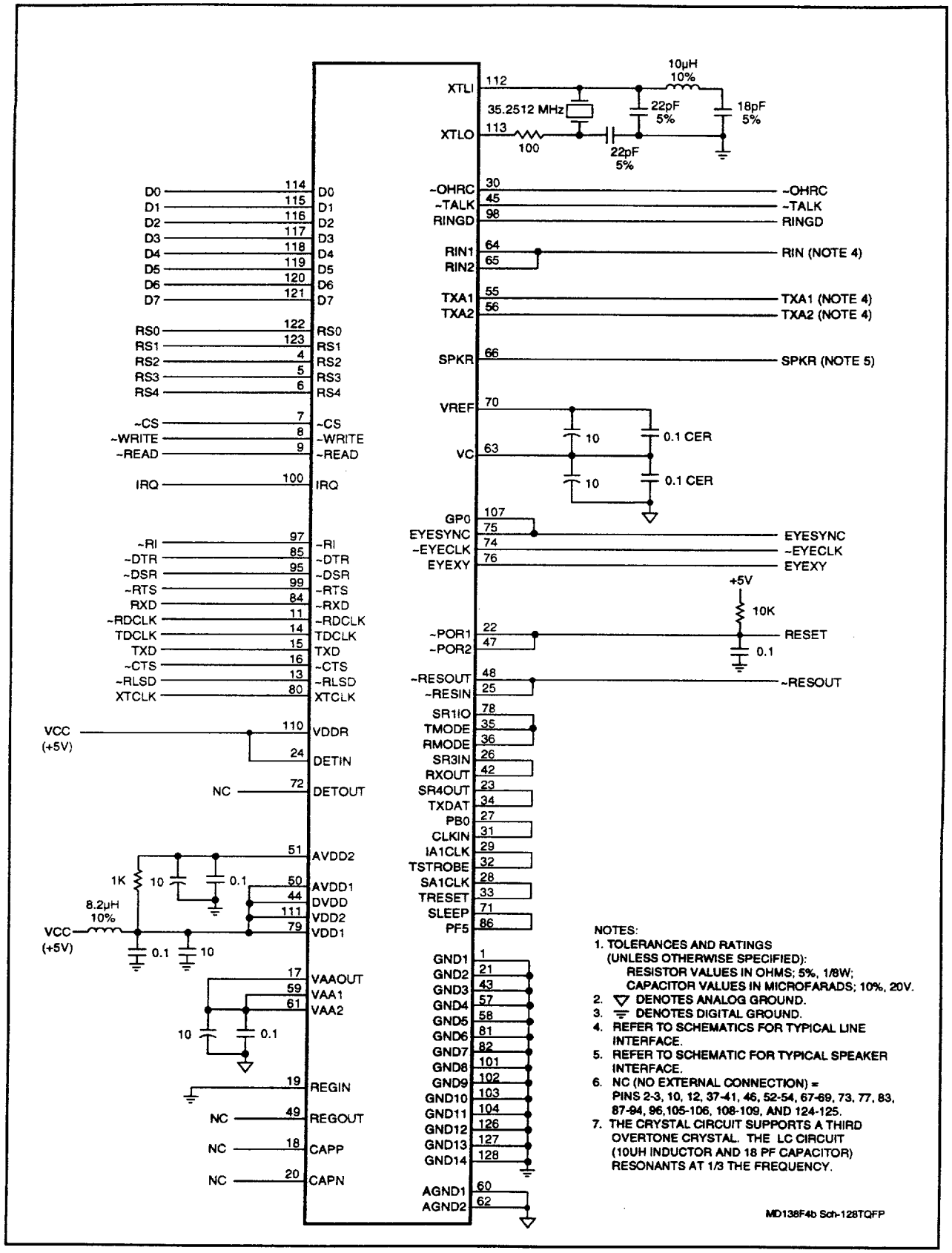


Figure 4b. Typical Modem Interface - 128-Pin TQFP

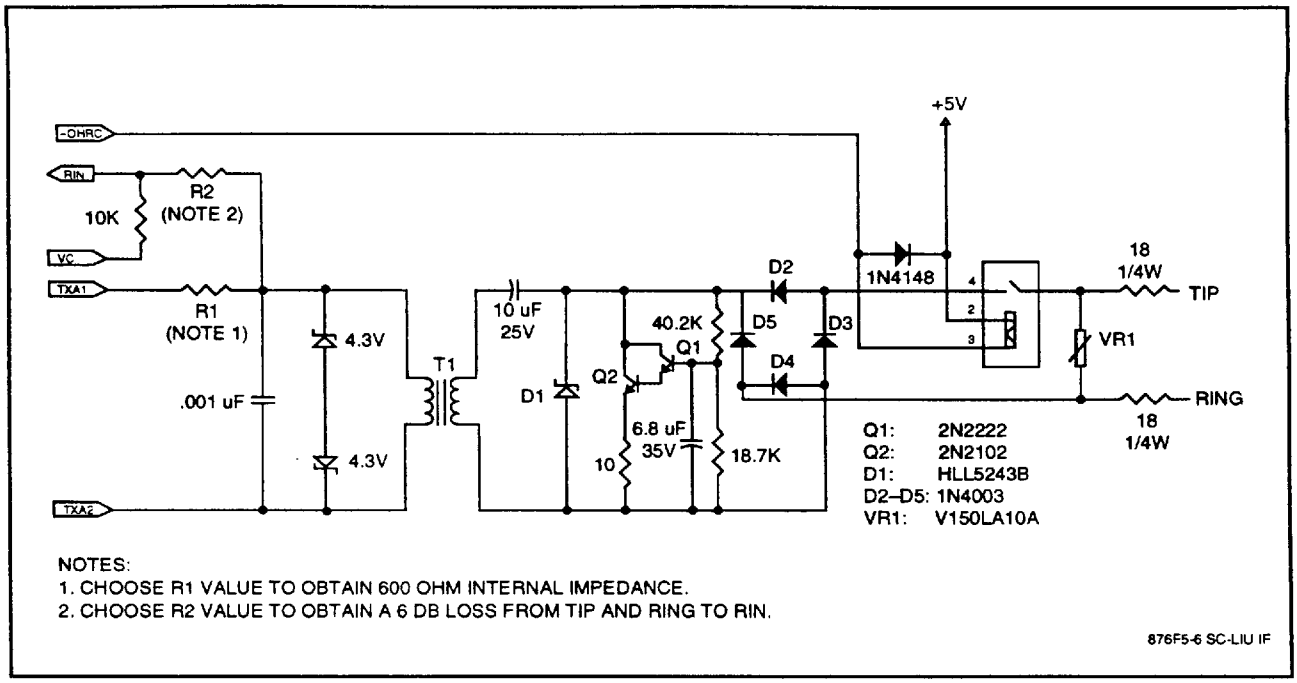


Figure 5. Typical Line Interface

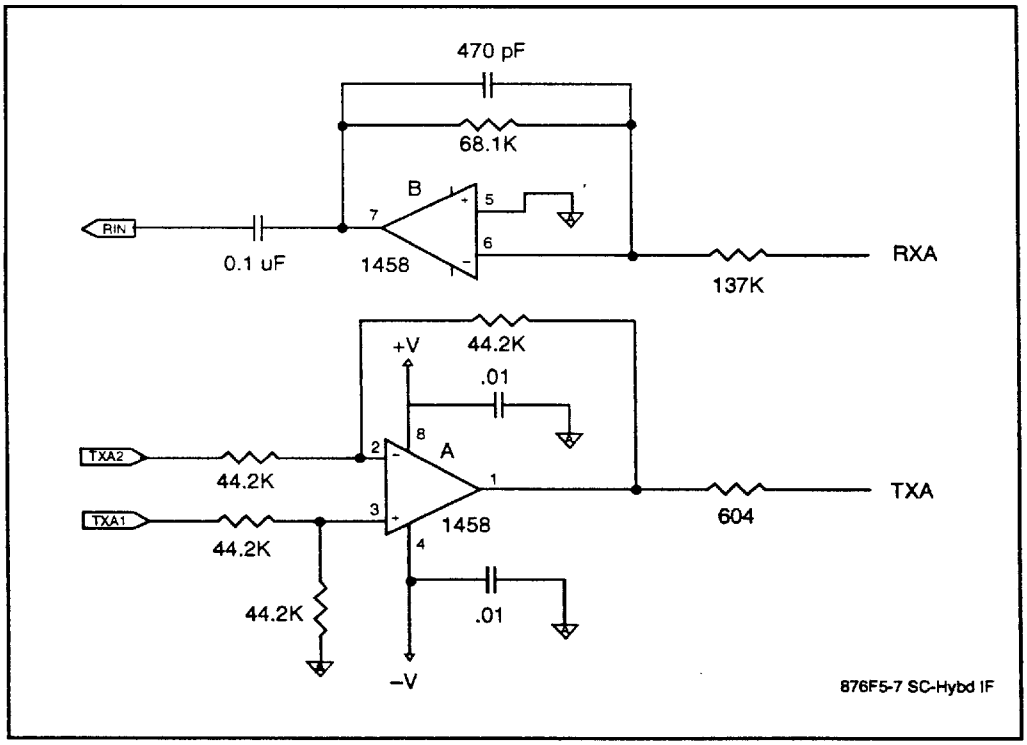


Figure 6. Typical Interface to External Hybrid

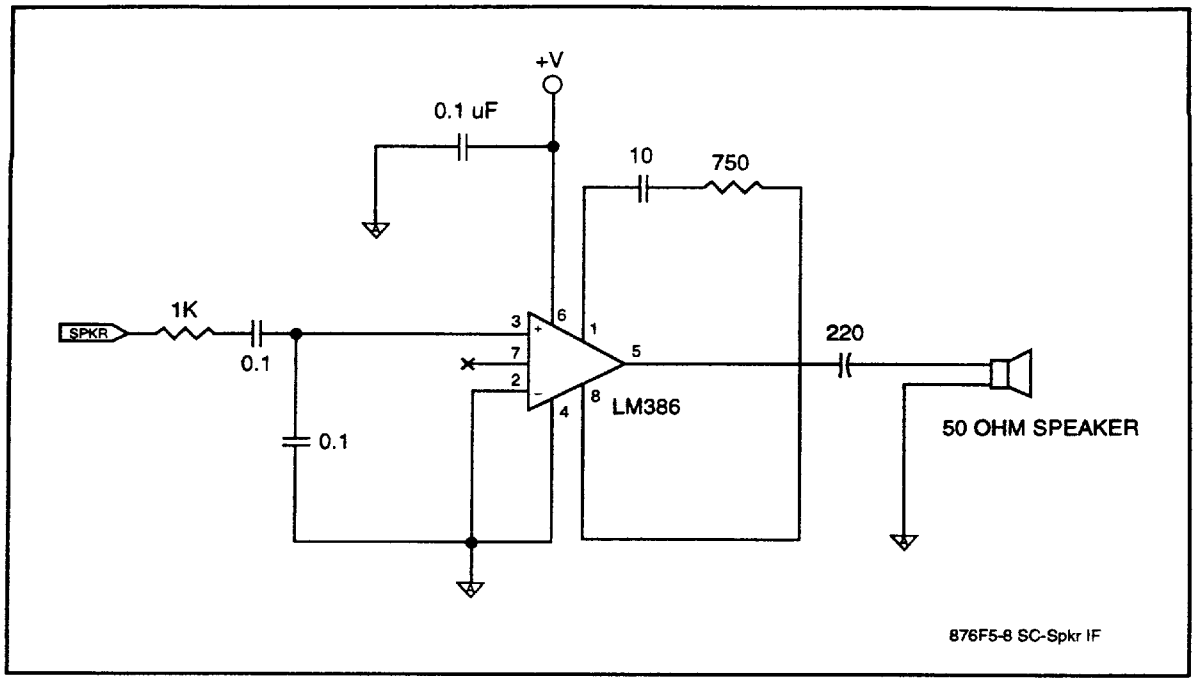
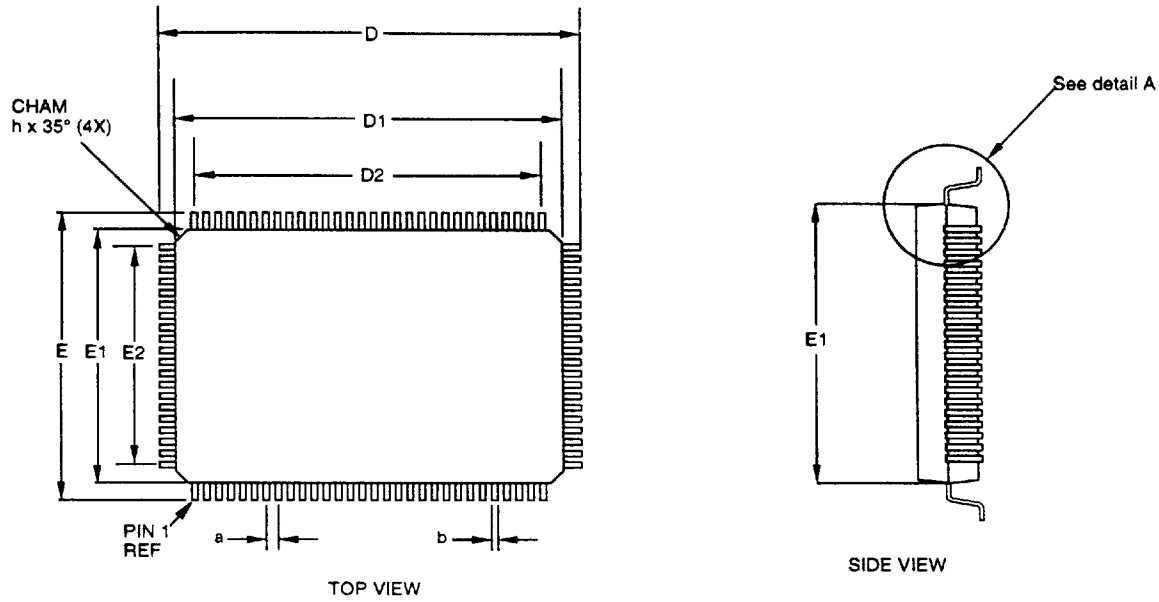
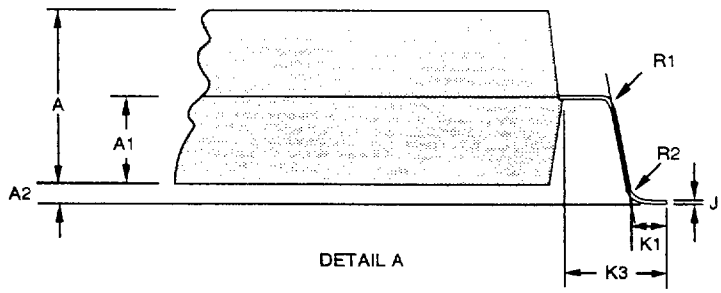


Figure 7. Typical External Speaker Circuit

PACKAGE DIMENSIONS

Package dimensions are shown in Figure 8.





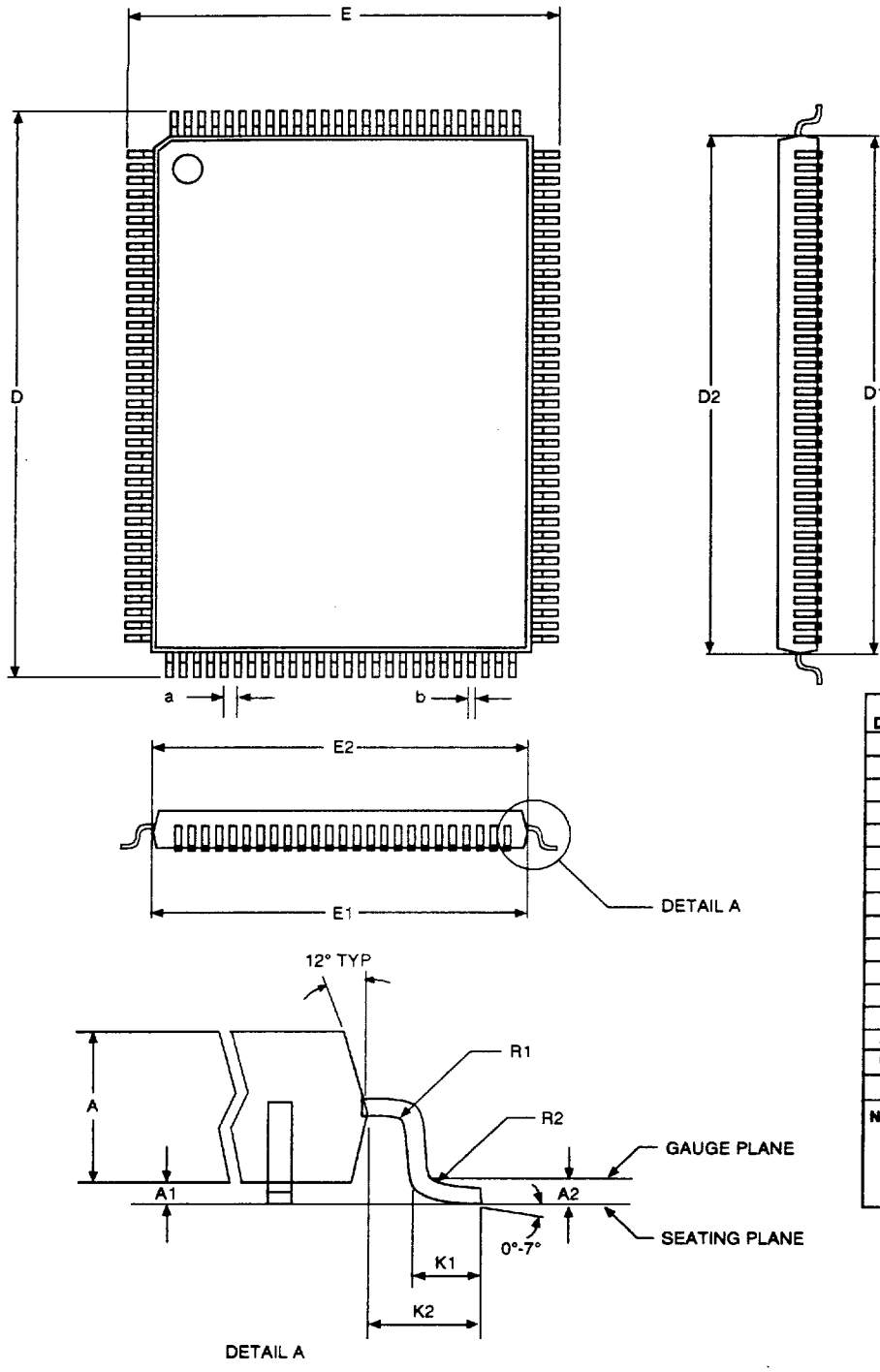
Dim.	Millimeters Min.	Millimeters Max.	Inches* Min.	Inches* Max.
A	1.95	2.05	0.077	0.081
A1	0.95	1.05	0.037	0.041
A2	0.25 REF		0.0098	
D	23.05	23.35	0.907	0.919
D1	19.95	20.05	0.785	0.789
D2	18.85 REF		0.7421	
E	17.05	17.35	0.671	0.683
E1	13.95	14.05	0.549	0.553
E2	12.35 REF		0.4862	
K1	0.70	0.90	0.028	0.035
K3	1.60 REF		0.0630	
R1	0.23	--	0.009	--
R2	0.15	0.25	0.006	0.010
a	0.65 REF		0.0256	
b	0.30 REF		0.0118	
h	--	0.50	--	0.020
J	0.1524 REF		0.0060	

Ref: GP00-D234-5/92 (091393)

Note: * Metric values (millimeters) should be used for PCB layout. English values (inches) are converted from metric values and may include round-off errors.

PD-PQFP-100

Figure 8a. Package Dimensions - 100-Pin PQFP



Dim.	Millimeters Min.	Millimeters Max.	Inches* Min.	Inches* Max.
A	1.35	1.45	0.053	0.057
A1	0.05	0.15	0.002	0.006
A2	0.25 REF		0.0098	
D	21.85	22.15	0.860	0.872
D1	19.95	20.05	0.785	0.789
D2	19.82	19.92	0.780	0.784
E	15.85	16.15	0.624	0.636
E1	13.95	14.05	0.549	0.553
E2	13.82	13.92	0.544	0.548
K1	0.50	0.75	0.020	0.030
K2	1.00 REF		0.039	
R1	0.20 TYP		0.008TYP	
R2	0.20TYP		0.008TYP	
a	0.50 REF		0.020 REF	
b	0.22 REF		0.009 REF	

Ref: GP00-D264-A 11/19/93 (102594)

Note: * Metric values (millimeters) should be used for PCB layout. English values (inches) are converted from metric values and may include round-off errors.

Figure 8b. Package Dimensions - 128-Pin TQFP