RC224ATL/224ATLV

EmbeddedModem Family

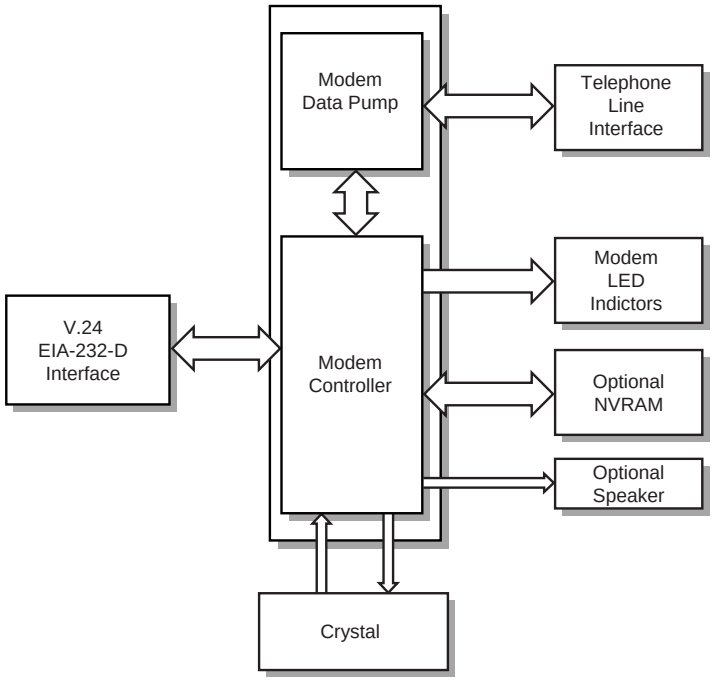
The new Conexant RC224ATL utilizes a new integrated data pump/controller to allow the device to directly connect to host processors that are 3.3 V I/O capable. The codec used in the new part is the same as the codec used in the existing RC224ATL. The new device is form, fit, and function compatible with the existing device. This means there are no hardware and software differences between the existing and the new part, with one exception. The 3.3 V I/O capable part incorporates 3.3 V compatible digital I/O buffers, hence requiring 3.3 V digital supply instead of 5 V digital supply.

In addition, unlike the current version of RC224ATL, the new part provides both data and fax capabilities.

Data modes, controlled by an industry standard 2400 AT command set, can transmit and receive up to 2400 bps.

Fax modes, controlled by a built-in EIA-578 Class 1 command interface, provide Group 3 transmit and receive functions.

Functional Block Diagram



Distinguishing Features

- Data modes
  - CCITT V.22 bis (2400 bps), V.22 (1200 bps)
  - Bell 212A (1200 bps) and 103 (300 bps)
  - Enhanced AT commands
- Group 3 fax modes
  - V.29 (9600/7200 bps) transmit
  - V.27 ter (4800/2400 bps) transmit and receive
  - V.21 Channel 2 (300 bps) transmit and receive
- EIA-578 Service Class 1 commands
- V.42/MNP2-4 and V.42 bis/MNP 5 can be supported through host software without additional hardware
- Data/fax discriminator and auto answering
- Communications software compatible
- Integrated call progress and dialing
- No external microcomputer or memory required
- Parallel or serial asynchronous DTE interface
- A/A1 relay control
- NVRAM interface allows storage of two user configurations and four 36-digit dial strings
- Automatic adaptive/fixed compromise equalization
- Programmable sleep mode and wake-up
- Full-duplex data mode test capabilities: Analog loop, local digital loop, and remote digital loop
- Half-duplex fax mode test capabilities
- Automatic format/speed sensing
- Low power consumption (typical)
  - Operating: 100 mW
  - Sleep—Idle: 25 mW
  - Sleep—Stop: 5 mW
- Single +5 V power supply or Dual + 3.3 VDD and + 5 VAA power supplies
- Package options:
  - 68-pin plastic leaded chip carrier (PLCC)
  - 100-pin plastic quad flat pack (PQFP)

Ordering Information

Marketing Number	Manufacturing Number	DSP Die Number	I/O & VDD	VAA/Codec	Package
RC224ATL	R6781-11	L2501	5V	5V	68 PLCC
RC224ATL	R6781-12	L2501	5V	5V	100 PQFP
RC224ATL	R6781-13	L2503	5V	5V	68 PLCC
RC224ATL	R6781-14	L2503	5V	5V	100 PQFP
RC224ATLV	R6781-21	L2531	3V	5V	68 PLCC
RC224ATLV	R6781-22	L2531	3V	5V	100 PQFP

Replacement Matrix

Marketing Number	Manufacturing Number	Package	Replaces
RC224ATL	R6781-11	68 PLCC	RC224ATL/V (R6641-14), RC224ATL (R6641-15), RC224ATL/VN (R6641-16), RC224ATLN (R6641-17), RC224ATL/VE (R6641-24), RC224ATLE (R6641-25)
RC224ATL	R6781-12	100 PQFP	RC224ATL/V (R6641-18), RC224ATL (R6641-19), RC224ATL/VN (R6641-20), RC224ATLN (R6641-21), RC224ATL/VE (R6641-26), RC224ATLE (R6641-27)
RC224ATL	R6781-13	68 PLCC	RC224ATL/VN (R6641-36), RC224ATL/V (R6641-37), RC224ATLN (R6641-38), RC224ATL (R6641-39)
RC224ATL	R6781-14	100 PQFP	RC224ATL/VN (R6641-40), RC224ATATL/V (R6641-41), RC224ATL (R6641-43)
RC224ATLV	R6781-21	68 PLCC	N/A: New 3.3 V Digital I/O
RC224ATLV	R6781-22	100 PQFP	N/A: New 3.3 V Digital I/O

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1.0 Functional Description

1.1 Overview

The Rockwell RC224ATL/V is a combination V.22 bis data and Group 3 facsimile (fax) CMOS modem in a single VLSI package and is identical to the RC224ATL/V. The RC224ATL/V integrated data/fax modem is available in either a 68-pin plastic leaded chip carrier (PLCC) or a 100-pin plastic quad flat pack (PQFP).

Full error correction (V.42 LAPM, MNP2-4) and data compression (V.42 bis, MNP 5) capabilities can be supported in the RC224ATL/V using the host communication software.

The modem has a selectable parallel or serial interface to the host (DTE). When parallel mode is selected, a 16C450-compatible interface allows direct connection to a notebook, laptop, or PC-compatible bus without an external UART. When serial mode is selected, a CCITT V.24 logic-compatible interface with TTL levels is supplied along with indicator outputs.

The RC224ATL/V Designer's Guide (Order No. 821) provides detailed interface, AT command, and S register information.

1.2 Technical Specifications

1.2.1 General

The RC224ATL/V modem is a full-featured, self-contained data/fax solution. No external microcontroller for data or fax control functions is required. Dialing, call progress, and telephone line interface functions are fully supported and controlled through the AT command set.

Data modes perform complete handshake and data rate negotiations. All tone and pattern detection required by the applicable CCITT or Bell standard are supported.

Fax modes support Group 3 fax requirements. Fax data and fax control (V.21 300 bps) performed by the modem is controlled and monitored through the fax EIA-578 Class 1 command interface. Full HDLC formatting, flag insertion/deletion, and CRC generation/checking is provided.

Both transmit and receive fax data is buffered within the modem. Fax data transfer to and from the DTE is flow controlled by XON/XOFF.

1.2.2 Configurations and Rates

The supported modem configurations and signaling rates are listed in Table 1-2. In data modes with serial interface selected, DTE rate offsets of +1%, -2.5% are accommodated by adding/deleting stop bits as required. In fax modes, the DTE rate is 19200 bps.

1.2.3 Operation

Modem operation is controlled by AT commands, fax service class 1 commands, and supporting S registers.

1.2.3.1 Data Modes

Data rate selection is determined by the speed of the originating and answering modems:

Table 1-1. Connect Speeds

Originate Modem Rate (bps)	Connect Speed Based on Answer Modem Rate (bps)		
	300	1200	2400
300	300	300	300
1200	300	1200	1200
2400	300	1200	2400

1.2.3.2 Fax Modes

Fax modes are negotiated as defined in T.30 and are implemented by AT+F commands. The AT+FCLASS=1 command causes entry into the fax mode from the data mode. Most other fax class 1 commands, which start with the AT+F prefix, are valid only in the fax mode. All data commands are valid in the fax mode except A/, On, &Tn, and the escape sequence (+++). The AT+FCLASS=0 command terminates the fax mode and causes entry into the data mode.

Table 1-2. Configurations and Rates

Configuration	Modulation	Transmitter Carrier Frequency (Hz) ±0.01%		Data Rate (bps)	Baud (Symbols/Sec.)	Bits Per Symbol	Constellation Points
Data Mode		Answer	Originate				
V.22bis	QAM	2400	1200	2400	600	4	16
V.22	DPSK	2400	1200	1200	600	2	4
Bell 212A	DPSK	2400	1200	1200	600	2	4
Bell 103	FSK	2225 M 2025 S	1270 M 1070 S	300	300	1	1
Fax Mode		Receive	Transmit				
V.29	QAM	N/A	1700	9600	2400	4	16
	QAM	N/A	1700	7200	2400	3	8
V.27ter	DPSK	1800	1800	4800	1600	3	8
	DPSK	1800	1800	2400	1200	2	4
V.21	FSK	1650 M 1850 S	1650 M 1850 S	300	300	1	1

Notes:

Legend:
QAM = Quadrature Amplitude Modulation
DPSK = Differential Phase Shift Keying
FSK = Frequency Shift Keying
M = Mark condition
S = Space Condition
N/A = Not Applicable

1.2.4 Data/Fax Auto Answering

The modem can automatically determine if the incoming call is from a data or fax modem, make the appropriate connection, and inform the DTE of the connection type.

1.2.5 Data Modulation

The data modulation conforms to V.29, V.27 ter, V.22 bis, V.22, V.21, Bell 212A, or Bell 103, depending on the selected configuration. Transmitter and receiver spectrum shaping is provided in accordance with the applicable standard.

1.2.6 Equalization

Automatic adaptive equalization as well as fixed compromised equalization is provided to compensate for line distortions and to minimize the effects of intersymbol interference.

1.2.7 Scrambler/Descrambler

The modem incorporates a self-synchronizing scrambler/descrambler satisfying the applicable CCITT or Bell requirements.

1.2.8 Transmit Level

The transmit level is -10 dBm ±1 dB (at TIP and RING) and can be obtained using the circuits shown in Appendix A. Carrier and DTMF transmit levels can be further attenuated using AT%Ln + AT%Dn commands, respectively. If a higher transmit level is required, an external op amp can be added.

1.2.9 Transmit Tones

Answer Tone An answer tone of 2100 Hz (V.22 bis, V.22, or T.30) or 2225 Hz (Bell 212A or 103) is generated.

Guard Tone An 1800 Hz guard tone can be generated in all data modes.

Calling Tone An 1100 Hz (0.5 seconds on, 3 seconds off) calling tone (T.30) is generated in the originate fax mode.

1.2.10 Receive Level

The receiver satisfies performance requirements for a received signal from -9 dBm to -43 dBm. The carrier detect is ON at -43 dBm and OFF at -48 dBm with a minimum of 2 dB hysteresis.

1.2.11 Receiver Tracking

The modem can accommodate carrier frequency offset up to ±7 Hz, and a transmit timing error of ±0.01% (V.22 bis or V.27 ter) or ±0.02% (V.22 or Bell 212A).

DTMF Dialing

Standard DTMF (dual tone multi-frequency) tones (digits 0-9, A, B, C, D, *, and #) or pulses (digits 0-9) can be generated. See Table 1-3.

Ring Detection

RING signal is detected from valid high to low transitions on the RING input line at frequencies of 15.3 Hz to 63 Hz. A RING is valid if the RING ON time is greater than 0.125 seconds and is followed by a RING OFF time greater than 0.5 seconds.

Table 1-3. Dial Digits/Tone Pairs

Dial Digit	Tone 1 Frequency (Hz)	Tone 2 Frequency (Hz)
0	941	1336
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
*	941	1209
#	941	1477
A	697	1633
B	770	1633
C	852	1633
D	941	1633

1.2.12 Low Power Sleep Mode

To conserve power, theRC224ATL/V has two selectable sleep (power down) modes - Idle and Stop. If enabled by the IDLENO and IDLN1 inputs, the selective sleep mode is entered whenever the modem is active. The sleep mode indicator output, $\overline{\text{SLEEP}}$, is provided to allow external circuits to be powered down when the modem is in Idle or Stop mode.

The Idle mode allows reduced power consumption with automatic recovery without additional circuitry. If Idle mode is selected, the modem exits Idle mode and returns to full operation whenever a ring signal occurs, the DTE writes to the modem (parallel interface), or $\overline{\text{WAKEUP}}$ input, normally tied to $\overline{\text{DTR}}$ or $\overline{\text{TXD}}$, is asserted (serial interface).

The Stop mode further reduces power consumption.

Table 1-4. Current and Power Requirements

Mode	Current (ID)		Power (PD)	
	Typical Current @ 25°C	Maximum Current @ 0°C	Typical Power @ 25°C	Maximum Power @ 0°C
Operating	21 mA	22 mA	100 mW	110 mW
Sleep - Idle	5 mA	6 mA	25 mW	30 mW
Sleep - Stop	1 mA	1 mA	5 mW	5 mW

Notes:
1. Test conditions: VDD = 5.0 VDC for typical values; VDD = 5.25 VDC for maximum values.
2. Test conditions: VDD = 3.3 VDC for typical values; VDD = 3.6 VDC for maximum values.

1.3 Low Power Modes

1.3.1 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 EmbeddedModem 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 a ring signal occurs, or the host write to the modem.

Wake-up - Serial Interface Configuration Wake-up occurs when a ring signal occurs, or the DTE sends a character to the modem.

2.0 Hardware Interface

The RC224ATL/V hardware interface signals are shown for the parallel interface in Figure 2-1, and for the serial interface in Figure 2-2.

The RC224ATL/V hardware interface signals are described in Table 3-5.

The parallel interface registers are identified in Table 2-1.

Figure 2-1. RC224ATL/V Signals - Parallel Interface

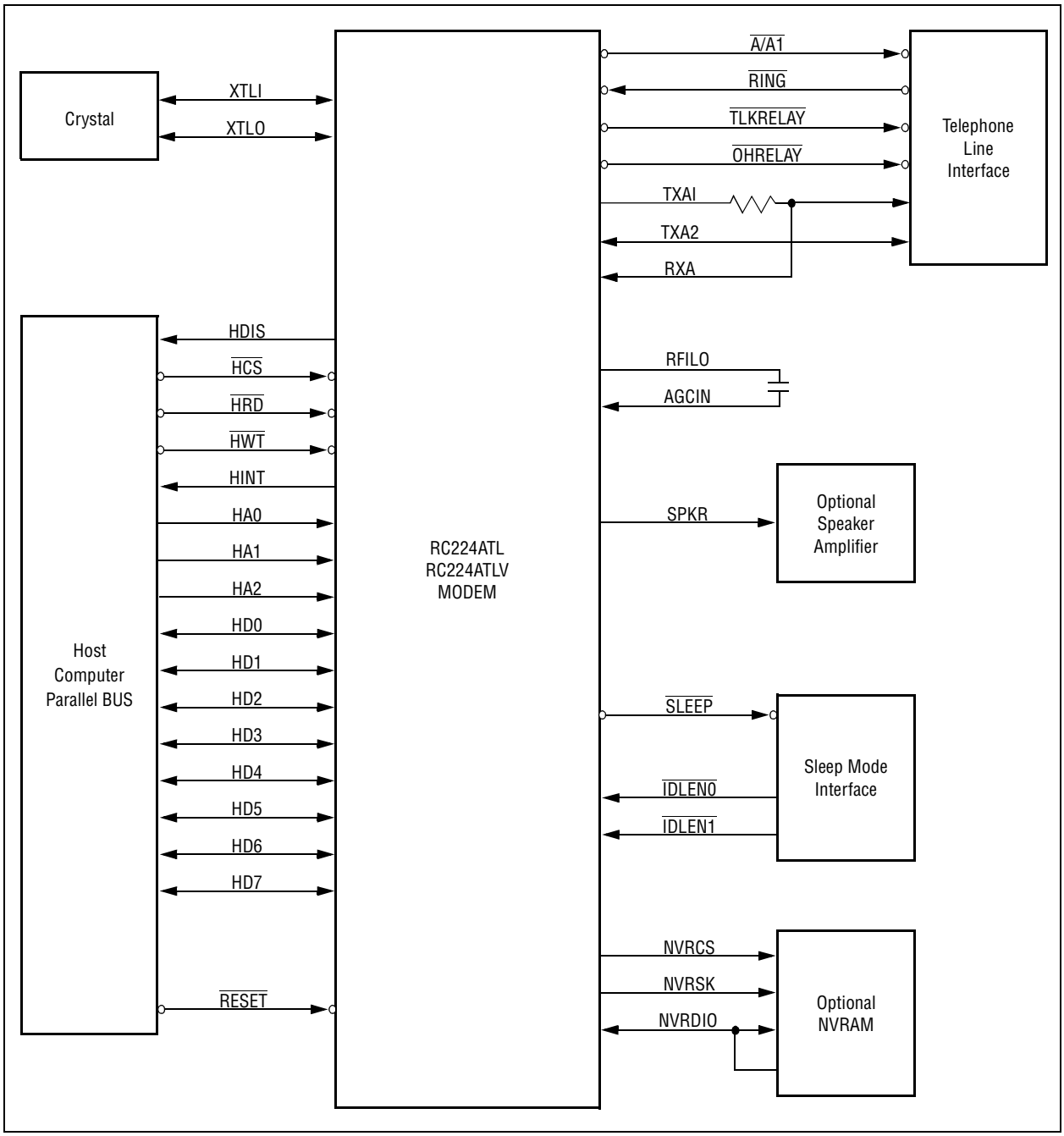
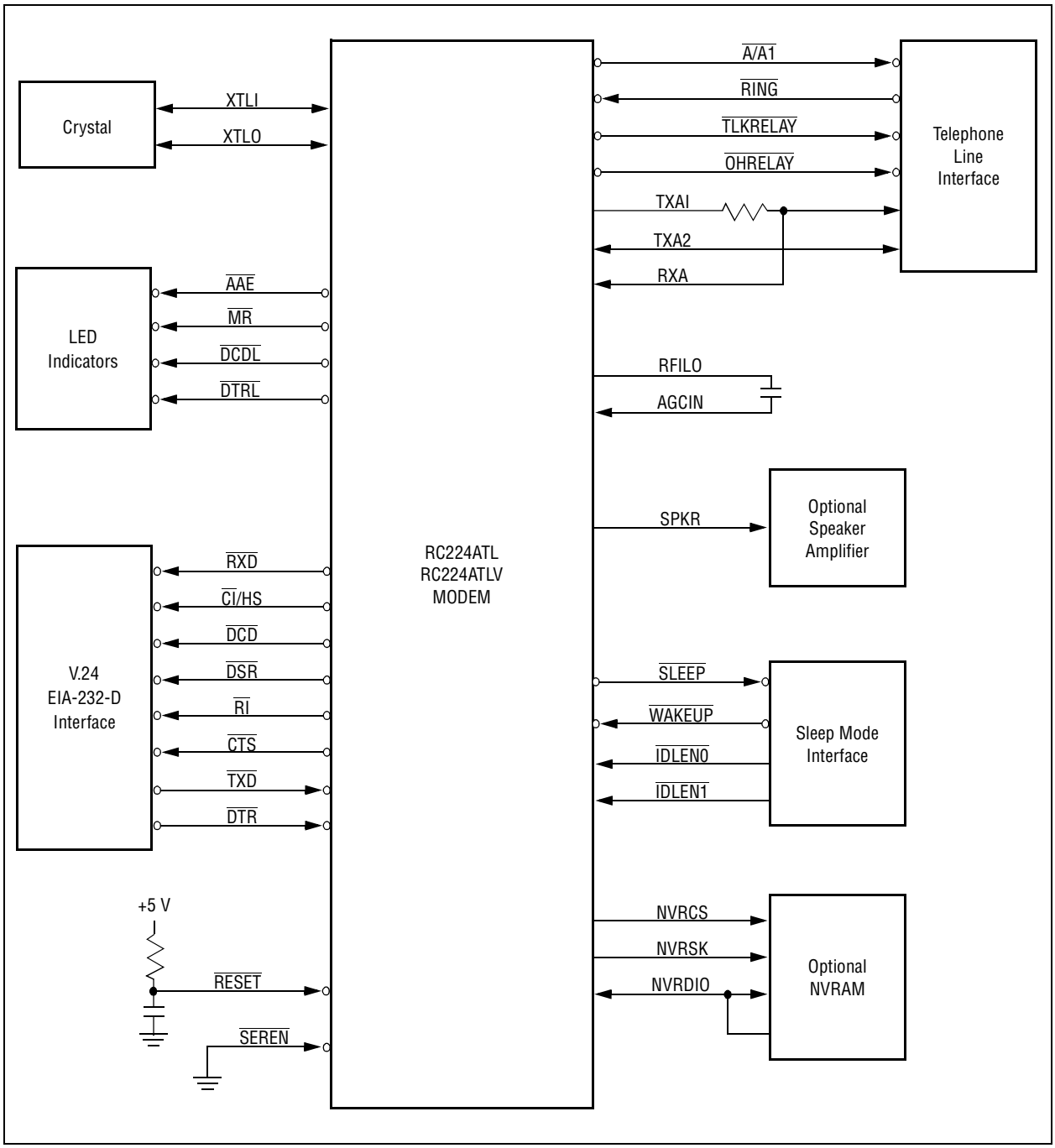


Figure 2-2. RC224ATL/V Signals - Serial Interface



2.1 Interface Timing and Waveforms

Table 2-6 lists the host bus interface timing parameters. Figure 2-4 illustrates the interface waveforms.

Table 2-1. Parallel Interface Registers

Register Number	Register Name	Bit Number							
		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)	0	Transmitter Empty (TEMT)	Transmitter Holding Register (THRE)	Break Interrupt (BI)	Framing Error (FE)	Parity Error (PE)	Overrun Error (OE)	Receiver Data (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)	0	0	0	0	0	Pending Interrupt ID Bit 1	Pending Interrupt ID Bit 0	“0” if Interrupt Pending
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)

Table 2-1. Parallel Interface Registers (Continued)

Register Number	Register Name	Bit Number							
		7	6	5	4	3	2	1	0
0 DLAB = 0	Transmitter Holding Register (THR)	Transmitter Holding Register (Write Only)							
0 DLAB = 0	Receiver Buffer Register (RBR)	Receiver Buffer Register (Read Only)							
1 DLAB = 1	Divisor Latch MSB Register (DLM)	Divisor Latch (MS)							
0 DLAB = 1	Divisor Latch LSB Register (DLL)	Divisor Latch (LS)							

2.2 Hardware Interface

2.2.1 Parallel Interface

A 16450 UART-compatible parallel interface is provided.

Host Buss Interface Eight data lines, three address lines, and four control lines are supported.

2.2.2 Serial/Indicator Interface

A DTE serial interface and indicator outputs are supported.

Serial Interface An 8-line V.24/EIA-232-D or TTL logic serial interface to the DTE is supported.

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

2.2.3 Speaker Interface.

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

2.2.4 Line Interface

The EmbeddedModem connects to the line interface circuitry via a receive analog input, two transmit analog outputs, and a ring signal input.

The EmbeddedModem provides three relay control outputs to the line interface. These outputs may be used to control relays such as off-hook, A/A1, and talk/data.

2.3 Low Power Modes

2.3.1 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 EmbeddedModem 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 a ring signal occurs, or the host writes to the modem.

Wake-up - Serial Interface Configuration Wake-up occurs when a ring signal occurs, or the DTE sends a character to the modem.

2.4 Additional Information

Additional Information is described in the RC224ATL/V Modem Designer's Guide (Order No. 821).

3.0 Pin Descriptions

The RC224ATL/V packaged in a 68-pin PLCC is shown in Figure 3-1 and Figure 3-2. The RC224ATL/V packaged in a 100-pin PQFP is shown in Figures 3-3 and Figure 3-4.

The RC224ATL/V 68-pin PLCC pinout diagrams are provided as Figure 3-1 and Figure 3-2 for serial and parallel interface implementations, respectively. The 100-pin PQFP pinout diagrams are provided as Figure 3-3 and Figure 3-4 for serial and parallel interface implementations, respectively.

RC224ATL/V 68-pin PLCC pin assignments are given in 3-1 and 3-2 for serial and parallel interface implementations, respectively. The 100-pin PQFP pinout diagrams are provided as 3-3 and 3-4 for serial and parallel interface implementations, respectively.

Figure 3-1. 68-Pin PLCC Package — Serial

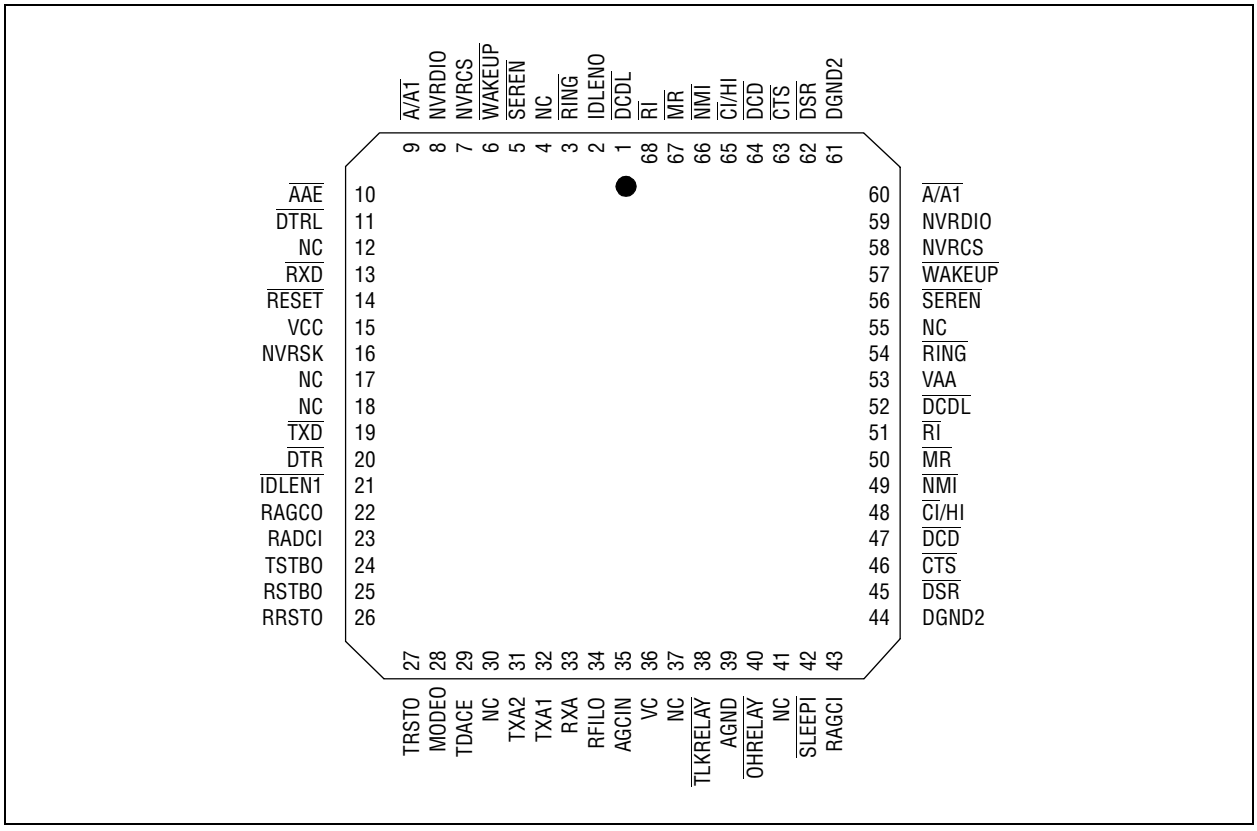


Figure 3-2. 68-Pin PLCC Package — Parallel

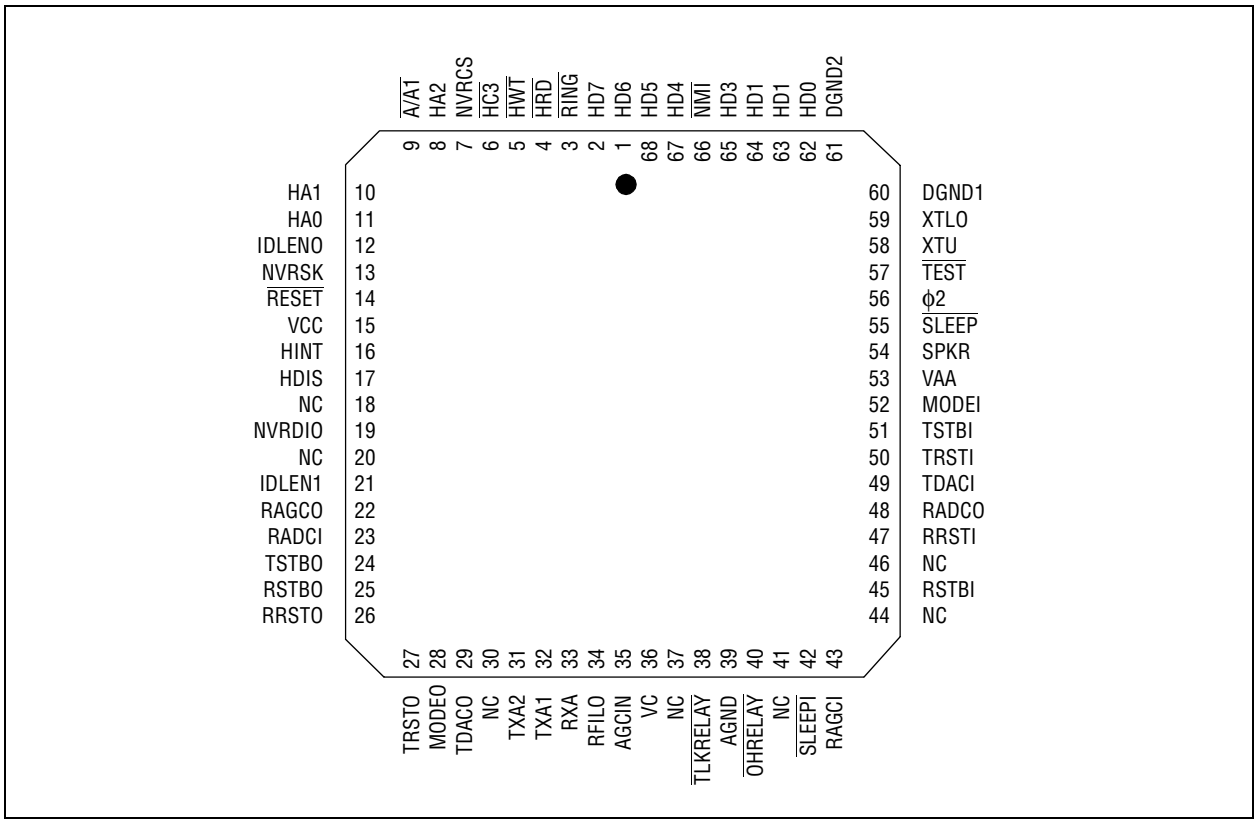


Figure 3-3. 100-Pin PQFP Package — Serial

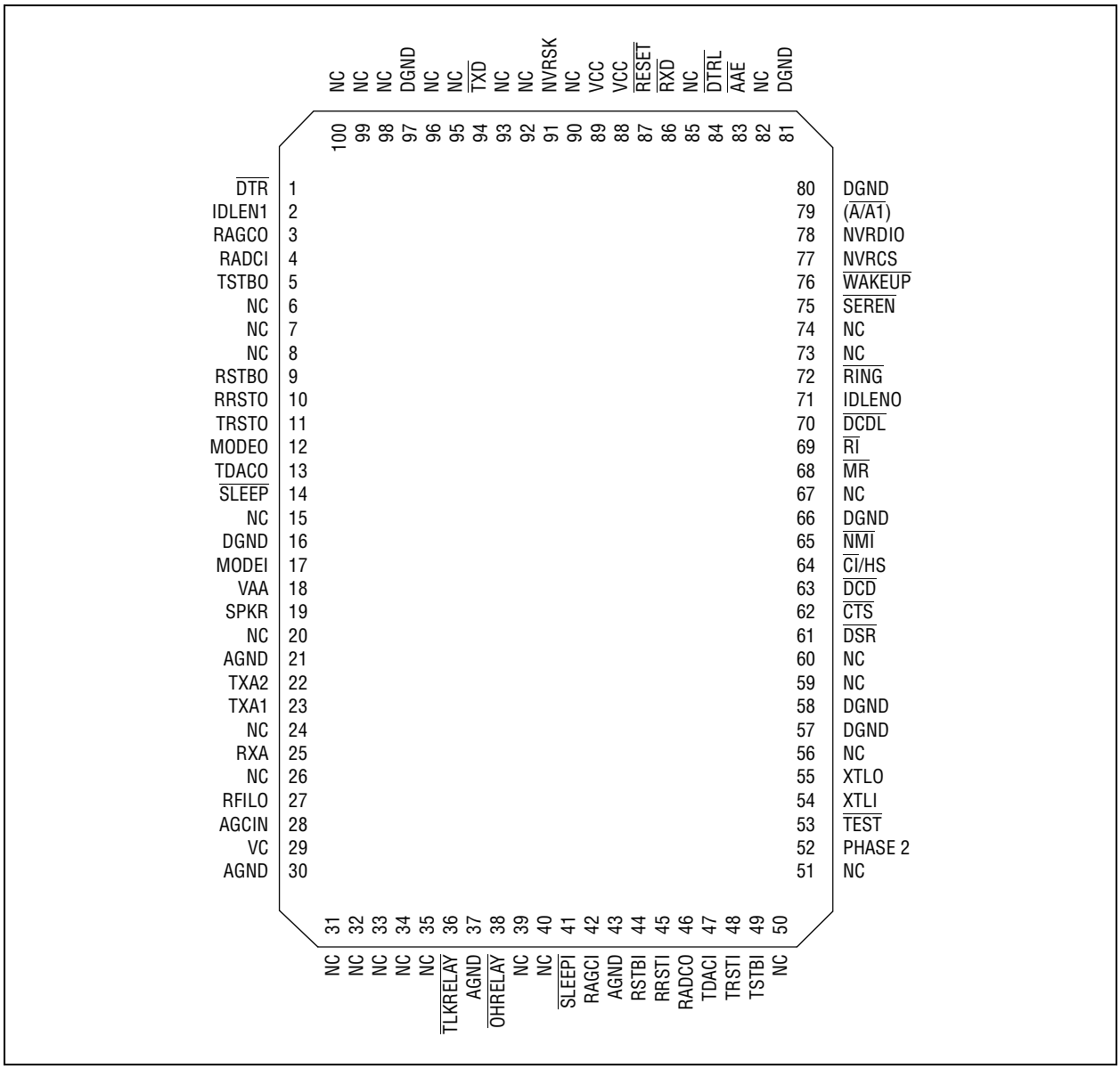


Figure 3-4. 100-Pin PQFP Package — Parallel

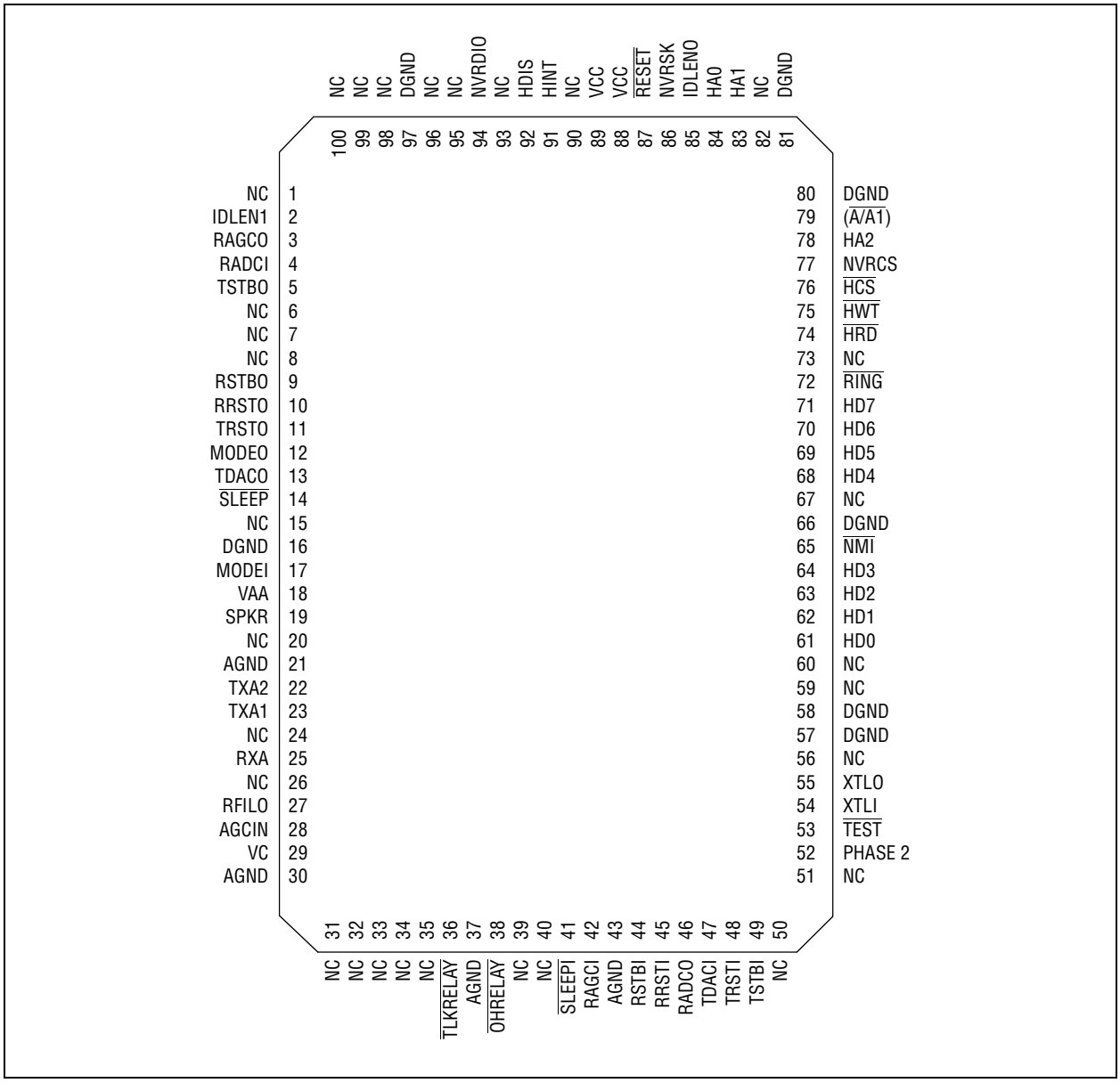


Table 3-1. RC224ATL/224ATLV PLCC Pin Assignments - Serial Mode

Pin Number	Signal Label	I/O Type
1	DCDL	DO
2	IDLEN0	DI
3	RING	DI
4	NC	
5	SEREN	DI
6	WAKEUP	DI

Pin Number	Signal Label	I/O Type
35	AGCIN	
36	VC	
37	NC	
38	TLKRELAY	OD
39	AGND	
40	OHRELAY	OD

Table 3-1. RC224ATL/224ATLV PLCC Pin Assignments - Serial Mode (Continued)

Pin Number	Signal Label	I/O Type
7	NVRCS	DO
8	NVRDIO	DI
9	$\overline{A}$/A1	DO
10	$\overline{AAE}$	DO
11	$\overline{DTRL}$	DO
12	NC	
13	$\overline{RXD}$	DO
14	$\overline{RESET}$	DI
15	VCC	
16	NVRSK	DO
17	NC	
18	NC	
19	$\overline{TXD}$	DI
20	$\overline{DTR}$	DI
21	IDLEN1	DI
22	RAGCO	MI TO RAGCI
23	RADCI	MI TO RADCO
24	TSBO	MI TO TSTBI
25	RSTBO	MI TO RSTBI
26	RRSTO	MI TO RRSTI
27	TRSTO	MI TO TRSTI
28	MODEO	MI TO MODEI
29	TDACO	MI TO TDACI
30	NC	
31	TXA2	O (DD)
32	TXA1	O(DD)
33	RXA	I(DA)
34	RFILO	

Pin Number	Signal Label	I/O Type
41	NC	
42	SLEEP1	DI
43	RAGCI	MI TO RAGCO
44	NC	
45	RSTBI	MI TO RSTBO
46	NC	
47	RRSTI	MI TO RRSTO
48	RADCO	RADCO
49	TDACI	MI TO TADCO
50	TRSTI	MI TO TRSTO
51	TSTBI	MI TO TSTBO
52	MODEI	MI TO MODEO
53	VAA	
54	SPKR	O(DF)
55	$\overline{SLEEP}$	DO
56	02	DO
57	$\overline{TEST}$	DI 4.7K TO VCC
58	XTLI	IE
59	XTLO	OE
60	DGND1	
61	DGND2	
62	$\overline{DSR}$	DO
63	$\overline{CTS}$	DO
64	$\overline{DCD}$	DO
65	$\overline{CI}$/HS	DO
66	$\overline{NMI}$	DI
67	$\overline{MR}$	DO
68	$\overline{RI}$	DO

Table 3-2. RC224ATLV PLCC Pin Assignments - Parallel Mode

Pin Number	Signal Label	I/O Type
1	HD6	DIO
2	HD7	DIO
3	$\overline{\text{RING}}$	DI
4	$\overline{\text{HRD}}$	DI
5	$\overline{\text{HWT}}$	DI
6	$\overline{\text{HCS}}$	DI
7	NVRCS	DO
8	HA2	DI
9	$\overline{\text{A}}$/A1	DO
10	HA1	DI
11	HA0	DI
12	IDLEN0	
13	NSRSK	DO
14	$\overline{\text{RESET}}$	DI
15	VCC	
16	HINT	DO
17	HDIS	DO
18	NC	
19	NVRDIO	DIO
20	NC	
21	IDLEN1	DI
22	RAGCO	MI TO RAGCI
23	RADCI	MI TO RADCO
24	TSBO	MI TO TSTBI
25	RSTBO	MI TO RSTBI
26	RRSTO	MI TO RRSTI
27	TRSTO	MI TO TRSTI
28	MODEO	MI TO MODEI

Pin Number	Signal Label	I/O Type
35	AGCIN	
36	VC	
37	NC	
38	$\overline{\text{TLKRELAY}}$	OD
39	AGND	
40	$\overline{\text{OHRELAY}}$	OD
41	NC	
42	$\overline{\text{SLEEPI}}$	DI
43	RAGCI	MI TO RAGCO
44	NC	
45	RSTBI	MI TO RSTBO
46	NC	
47	RRSTI	MI TO RRSTO
48	RADCO	RADCO
49	TDACI	MI TO TADCO
50	TRSTI	MI TO TRSTO
51	TSTBI	MI TO TSTBO
52	MODEI	MI TO MODEO
53	VAA	
54	SPKR	O(DF)
55	$\overline{\text{SLEEP}}$	OA
56	02	OA
57	$\overline{\text{TEST}}$	4.7K TO VCC
58	XTLI	IE
59	XTLO	OE
60	DGND1	
61	DGND2	
62	HD0	DIO

Table 3-2. RC224ATLV PLCC Pin Assignments - Parallel Mode (Continued)

Pin Number	Signal Label	I/O Type
29	TDACO	MI TO TDACI
30	NC	
31	TXA2	O (DD)
32	TXA1	O(DD)
33	RXA	I(DA)
34	RFILO	

Pin Number	Signal Label	I/O Type
63	HD1	DIO
64	HD3	DIO
65	HD3	DIO
66	$\overline{\text{NMI}}$	DI
67	HD4	DIO
68	HD5	DIO

Table 3-3. RC224ATL/224ATLV PQFP Pin Assignments - Serial

Pin Number	Signal Label	I/O Type
1	$\overline{\text{DTR}}$	DI
2	IDLEN1	DI
3	RAGCO	MI to RAGCI
4	RADCI	MI to RADCO
5	TSTBO	MI to TSTBI
6	NC	
7	NC	
8	NC	
9	RSTBO	MI to RSTBI
10	RRSTO	MI to RRSTI
11	TRSTO	MI to TRSTI
12	MODEO	MI to MODEI
13	TDACO	MI to TDACI
14	$\overline{\text{SLEEP}}$	DO
15	NC	
16	DGND	DGND
17	MODEI	MI to MODEO
18	+5VA	
19	SPKR	O(DF)

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω.
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-3. RC224ATL/224ATLV PQFP Pin Assignments - Serial (Continued)

Pin Number	Signal Label	I/O Type
20	NC	
21	AGND	AGND
22	TXA2	O(DD)
23	TXA1	O(DD)
24	NC	
25	RXA	I(DA)
26	NC	
27	RFILO	
28	AGCIN	
29	VC	
30	AGND	AGND
31	NC	
32	NC	
33	NC	
34	NC	
35	NC	
36	$\overline{\text{TLKRELAY}}$	OD
37	AGND	AGND
38	$\overline{\text{OHRELAY}}$	OD
39	NC	
40	NC	
41	$\overline{\text{SLEEPI}}$	DI
42	RAGCI	MI to RAGCO
43	AGND	AGND
44	RSTBI	MI to RSTBO
45	RRSTI	MI to RRSTO
46	RADCO	MI to RADCI
47	TDACI	MI to TDACO

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω.
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-3. RC224ATL/224ATLV PQFP Pin Assignments - Serial (Continued)

Pin Number	Signal Label	I/O Type
48	TRSTI	MI to TRSTO
49	TSTBI	MI to TSTBO
50	NC	
51	NC	
52	PHASE 2	DO
53	$\overline{\text{TEST}}$	Note 4
54	XTLI	IE
55	XTLO	OE
56	NC	
57	DGND	DGND
58	DGND	DGND
59	NC	
60	NC	
61	$\overline{\text{DSR}}$	DO
62	$\overline{\text{CTS}}$	DO
63	$\overline{\text{DCD}}$	DO
64	$\overline{\text{CI}}$/HS	DO
65	$\overline{\text{NMI}}$	Note 5
66	DGND	DGND
67	NC	
68	$\overline{\text{MR}}$	DO
69	$\overline{\text{RI}}$	DO
70	$\overline{\text{DCDL}}$	DO
71	IDLENO	DI
72	$\overline{\text{RING}}$	DI
73	NC	
74	NC	
75	$\overline{\text{SEREN}}$	DI

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-3. RC224ATL/224ATLV PQFP Pin Assignments - Serial (Continued)

Pin Number	Signal Label	I/O Type
76	$\overline{\text{WAKEUP}}$	DI
77	NVRCS	DO
78	NVRDIO	DIO
79	$\overline{\text{(A/A1)}}$	DO
80	DGND	DGND
81	DGND	DGND
82	NC	
83	$\overline{\text{AAE}}$	DO
84	$\overline{\text{DTRL}}$	DO
85	NC	
86	$\overline{\text{RXD}}$	DO
87	$\overline{\text{RESET}}$	IC
88	VCC	Note 5
89	VCC	Note 5
90	NC	
91	NVRSK	DO
92	NC	
93	NC	
94	$\overline{\text{TXD}}$	DI
95	NC	
96	NC	
97	DGND	DGND
98	NC	
99	NC	
100	NC	

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω.
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-4. RC224ATL/224ATLV PQFP Pin Assignments - Parallel

Pin Number	Signal Label	I/O Type
1	NC	
2	IDLEN1	DI
3	RAGCO	MI to RAGCI
4	RADCI	MI to RADCO
5	TSTBO	MI to TSTBI
6	NC	
7	NC	
8	NC	
9	RSTBO	MI to RSTBI
10	RRSTO	MI to RRSTI
11	TRSTO	MI to TRSTI
12	MODEO	MI to MODEI
13	TDACO	MI to TDACI
14	$\overline{\text{SLEEP}}$	DO
15	NC	
16	DGND	DGND
17	MODEI	MI to MODEO
18	+5VAA	
19	SPKR	O(DF)
20	NC	
21	AGND	AGND
22	TXA2	O(DD)
23	TXA1	O(DD)
24	NC	
25	RXA	I(DA)
26	NC	
27	RFILO	
28	AGCIN	

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω.
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-4. RC224ATL/224ATLV PQFP Pin Assignments - Parallel (Continued)

Pin Number	Signal Label	I/O Type
29	VC	
30	AGND	AGND
31	NC	
32	NC	
33	NC	
34	NC	
35	NC	
36	$\overline{\text{TLKRELAY}}$	DO
37	AGND	AGND
38	$\overline{\text{OHRELAY}}$	DO
39	NC	
40	NC	
41	$\overline{\text{SLEEPI}}$	DI
42	RAGCI	MI to RAGCO
43	AGND	AGND
44	RSTBI	MI to RSTBO
45	RRSTI	MI to RRSTO
46	RADCO	MI to RADCI
47	TDACI	MI to TDACO
48	TRSTI	MI to TRSTO
49	TSTBI	MI to TSTBO
50	NC	
51	NC	
52	02	DI
53	$\overline{\text{TEST}}$	Note 4
54	XTLI	IE
55	XTLO	OE
56	NC	

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-4. RC224ATL/224ATLV PQFP Pin Assignments - Parallel (Continued)

Pin Number	Signal Label	I/O Type
57	DGND	DGND
58	DGND	DGND
59	NC	
60	NC	
61	HD0	DIO
62	HD1	DIO
63	HD2	DIO
64	CI/HD3	DIO
65	$\overline{\text{NMI}}$	Note 5
66	DGND	DGND
67	NC	
68	HD4	DIO
69	HD5	DIO
70	HD6	DIO
71	HD7	DIO
72	$\overline{\text{RING}}$	DI
73	NC	
74	$\overline{\text{HRD}}$	DI
75	$\overline{\text{HWT}}$	DI
76	HCS	DI
77	NVRCS	DO
78	HA2	DI
79	$\overline{\text{(A/A1)}}$	DO
80	DGND	DGND
81	DGND	DGND
82	NC	
83	HA1	DI
84	HA0	DI

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-4. RC224ATL/224ATLV PQFP Pin Assignments - Parallel (Continued)

Pin Number	Signal Label	I/O Type
85	IDLENO	DI
86	NVRSK	DO
87	$\overline{\text{RESET}}$	IC
88	+5VCC	Note 5
89	+5VCC	Note 5
90	NC	
91	HINT	DO
92	HDIS	DO
93	NC	
94	NVRDIO	DIO
95	NC	
96	NC	
97	DGND	DGND
98	NC	
99	NC	
100	NC	

Notes: 1. MI = Modem Interconnection
2. NC = No external connection (may have internal connection, leave pin disconnected (open)).
3. I/O Types are described in Table 10 (digital signals) and Table 11 (analog signals).
4. Connect to +5 VCC through 4.7K Ω
5. Connect to +5 VCC.
6. AGND is analog ground and DGND is digital ground.

Table 3-5. Hardware Interface Signal Definitions

Label	I/O Type	Signal Name/Description
		System Signals
XTLI XTLO	IE OE	**Crystal/Clock In and Crystal Out.** The modem must be connected to an external crystal circuit consisting of a 16.000312 MHz crystal and two capacitors. Alternatively, XTLI may be driven with a buffered clock; in this case, XTLO should be left open.
$\overline{\text{RESET}}$	IC	**Reset.** The active low $\overline{\text{RESET}}$ input resets the internal modem logic. Upon $\overline{\text{RESET}}$ transitioning from high to low, modem operation returns to the state controlled by factory default values and stored values in NVRAM. During modem power turn-on, $\overline{\text{RESET}}$ must be held low for at least 5 ms after +5VD and +5VA operating voltage (see TSVD and +5VA below) is attained for the modem top stabilize. When the serial interface is selected, $\overline{\text{RESET}}$ can be connected to an external RC network to cause the modem to reset upon power turn on. When the parallel interface is selected, $\overline{\text{RESET}}$ should be connected to the hose bus reset line.
$\overline{\text{SEREN}}$	DI	**Serial Interface Enable.** When the $\overline{\text{SEREN}}$ input is low, serial interface is selected upon reset. In this case, the serial interface signals should be connected to the V.24 (EIA-232-D) interface and LED indicators.
VCC VAA	PWR	**Digital Supply.** +5V/3.3V ATLV ±5% is required. **Analog Supply.** +5V ±5% is required.
DGND AGND	GND	**Digital and Analog Grounds.**
		Sleep Mode Signals
IDLEN0 IDLEN1	DI DI	**Idle Enable 0 and Idle Enable 1.** Encoded inputs enable or disable the sleep modes as follows: **IDLN1 IDLEN0 Mode** L L Idle mode disabled L H Idle mode enabled H L Stop mode disabled H H Stop mode enabled If Idle option is enabled, the modem will enter idle mode after 5 seconds of inactivity ($\overline{\text{WAKEUP}}$ must also be high for the serial interface). The modem will wakeup upon DTE activity (RXD for parallel mode and low on $\overline{\text{WAKEUP}}$ for serial mode) or the presence of RING. If Stop option is selected, the $\overline{\text{RING}}$ input becomes RING (i.e., the $\overline{\text{RING}}$ signal must be inverted). The modem will enter stop mode after 5 seconds of inactivity (and if $\overline{\text{WAKEUP}}$ is high for the serial interface). Only a 4 ms or longer pulse on the RING pin can wake up the modem from stop mode.
$\overline{\text{SLEEP}}$	DO	**Sleep Mode.** $\overline{\text{SLEEP}}$ output high indicates the modem is operating in its normal mode. $\overline{\text{SLEEP}}$ low indicates that the modem is in the sleep mode. The $\overline{\text{SLEEP}}$ output can also be used to control power to other devices.
$\overline{\text{SLEEPI}}$	DI	**Sleep Mode.** $\overline{\text{SLEEP}}$ input low causes the integrated Analog (IA) to enter low power sleep mode.

Table 3-5. Hardware Interface Signal Definitions (Continued)

Label	I/O Type	Signal Name/Description
$\overline{\text{WAKEUP}}$	DI	**Wake Up.** For serial interfaces only, $\overline{\text{WAKEUP}}$ input low removes the modem from the sleep mode (if in the sleep mode), or prevents the modem from entering the sleep mode (if not in the sleep mode). $\overline{\text{WAKEUP}}$ high allows the modem to enter sleep mode after 5 seconds of modem inactivity. $\overline{\text{WAKEUP}}$ is typically connected to DTR or TXD.
NVRAM Interface		
NVRCS	DO	**NVRAM Chip Select.** NVRCS output high enables the NVRAM.
NVRSK	DO	**NVRAM Shift Clock.** The NVRSK output is used to shift data to or from the NVRAM.
NVRDIO	DIO	**NVRAM Data In/NVRAM Data Out.** NVRDIO is a bidirectional signal that carries both the serial input data from the NVRAM and the serial output data to the NVRAM. Depending on the specific NVRAM used, a resistor may be required between the NVRAM DO output pin and the modem NVRDIO bidirectional line. (Refer to the NVRAM data sheet and Figure 3-5.)
Speaker Interface		
SPKR	O(DF)	**Speaker Analog Output.** The SPKR output reflects the output of the receive analog signal. The SPKR output is turned on or off by the Speaker Control Option (Mn command) and the gain is controlled by the Speaker Volume Option (Ln command). When the speaker is turned off, the SPKR output is clamped to the voltage at the VC pin. The SPKR output can drive a load as low as 300 Ω. Typically, the SPKR output is an input to an external LM386 audio power amplifier.
Asynchronous Serial Interface (Serial Interface Only; $\overline{\text{SEREN}}$ = Low)		
$\overline{\text{RXD}}$	DO	**Received Data.** The modem presents received serial data to the $\overline{\text{RXD}}$ output pin.
$\overline{\text{TXD}}$	DI	**Transmitted Data.** The modem obtains serial data to be transmitted from the $\overline{\text{TXD}}$ pin.
$\overline{\text{DTR}}$	DI	**Data Terminal Ready.** $\overline{\text{DTR}}$ input ON (low) indicates that the DTE is ready to operate. $\overline{\text{DTR}}$ input OFF (high) indicates that the DTE is not ready to operate.
$\overline{\text{CTS}}$	DO	**Clear to Send.** In data modes, the $\overline{\text{CTS}}$ output is ON; in fax modes, $\overline{\text{CTS}}$ is optionally used for flow control.
$\overline{\text{DSR}}$	DO	**Data Set Ready.** The $\overline{\text{DSR}}$ output is controlled by the AT&Sn command.
$\overline{\text{DCD}}$	DO	**Data Carrier Detected.** The $\overline{\text{DCD}}$ output is controlled by the AT&C command.
$\overline{\text{CI}}$/HS	DO	**Calling Indicator/High Speed Indicator.** $\overline{\text{CI}}$/HS output ON (low) indicates modem connection at 2400 bps.
$\overline{\text{RI}}$	DO	**Ring Indicator.** $\overline{\text{RI}}$ output ON (low) indicates the presence of an ON segment of a ring signal on the telephone line. (The ring signal cycle is typically two seconds ON, four seconds OFF.) The OFF (high) condition of the $\overline{\text{RI}}$ output is maintained during the OFF segment of the ring cycle (between rings) and at all other times when ringing is not being received.
Serial Indicator Interface (Serial Interface Only; $\overline{\text{SEREN}}$ = Low)		
$\overline{\text{AAE}}$	DO	**Auto Answer Enable.** $\overline{\text{AAE}}$ output ON (low) indicates that modem auto answer mode has been enabled with the S0 = command. $\overline{\text{AAE}}$ high indicates auto answer has been disabled. The $\overline{\text{AAE}}$ output also indicates the status of the $\overline{\text{RI}}$ output.
$\overline{\text{MR}}$	DO	**Modem Ready.** $\overline{\text{MR}}$ output ON (low) indicates that the modem is ready, i.e., modem power is on and a test mode is not selected. In a test mode, the $\overline{\text{MR}}$ output pulses to indicate a test is in process.

Table 3-5. Hardware Interface Signal Definitions (Continued)

Label	I/O Type	Signal Name/Description
$\overline{\text{DCDL}}$	DO	**DCD Indicator.** The $\overline{\text{DCDL}}$ output is controlled by the AT&C command.
$\overline{\text{DTRL}}$	DO	**DTR Indicator.** The $\overline{\text{DTRL}}$ output is controlled by the AT&D command.
Parallel Host Interface (Parallel Interface Only)		
		When the $\overline{\text{HWT}}$ input signal is connected to the host bus write line, the parallel interface is selected upon reset. (See Order No. 821 for waveform and timing information.) The parallel interface emulates a 16C450 UART, Table 13 identifies the parallel interface registers. Parallel interface operation is equivalent to 16C450 operation with CS0 and CS1 inputs high and DISTR, DOSTR, and $\overline{\text{ADS}}$ inputs low. The corresponding RC224ATL/V and 16C450 signals are shown below. 16C450 signals not required for RC224ATL/V host computer operation are not shown. **16C450 Signal RC224ATL/V Signal** A0 - A2 HA0 - HA2 D0 - D7 HD0 - HD7 MR $\overline{\text{RESET}}$ (Active low) $\overline{\text{CS2}}$ $\overline{\text{HCS}}$ DISTR $\overline{\text{HWT}}$ $\overline{\text{DOSTR}}$ $\overline{\text{HRD}}$ INTRPT HINT $\overline{\text{DDIS}}$ HDIS $\overline{\text{OUT2}}$ None (Implemented internally in RC224ATL/V)
HA0-HA2	DI	**Host Bus Address Lines 0-2.** During a host read or write operation, HA0-HA2 select an internal register. The state of the divisor latch access bit (DLAB) affects the selection of certain registers. The register addresses are:
HD0-HD7	DIO	**Host Bus Data Lines 0-7.** HD0-HD7 are comprised of eight tri-state input/output lines providing bidirectional communication between the host and the modem. Data, control words, and status information are transferred through HD0-HD7.

DLAB	HA2	HA1	HA0	Register
0	0	0	0	Receive Buffer Register (Read), Transmitter Holding Register (Write)
0	0	0	1	Interrupt Enable Register
X	0	1	0	Interrupt Identification Register (Read Only)
X	0	1	1	Line Control Register
X	1	0	0	Modem Control Register
X	1	0	1	Line Status Register (Read Only)
X	1	1	1	Scratch Register
1	0	0	0	Divisor Latch Register (Least Significant Byte)
1	0	0	1	Divisor Latch Register (Most Significant Byte)

$\overline{\text{HCS}}$	DI	**Host Bus Chip Select**. $\overline{\text{HCS}}$ input low enables reading from or writing to the modem using the parallel bus.
$\overline{\text{HRD}}$	DI	**Host Bus Read.** $\overline{\text{HRD}}$ is an active low read control input. When the modem is selected with $\overline{\text{HCS}}$, $\overline{\text{HRD}}$ low allows status or data words to be read from an addressed register.
$\overline{\text{HWT}}$	DI	**Host Bus Write.** $\overline{\text{HWT}}$ is an active low write control input. When the modem is selected with $\overline{\text{HCS}}$, $\overline{\text{HWT}}$ low allows data or control words to be written to an addressed register.

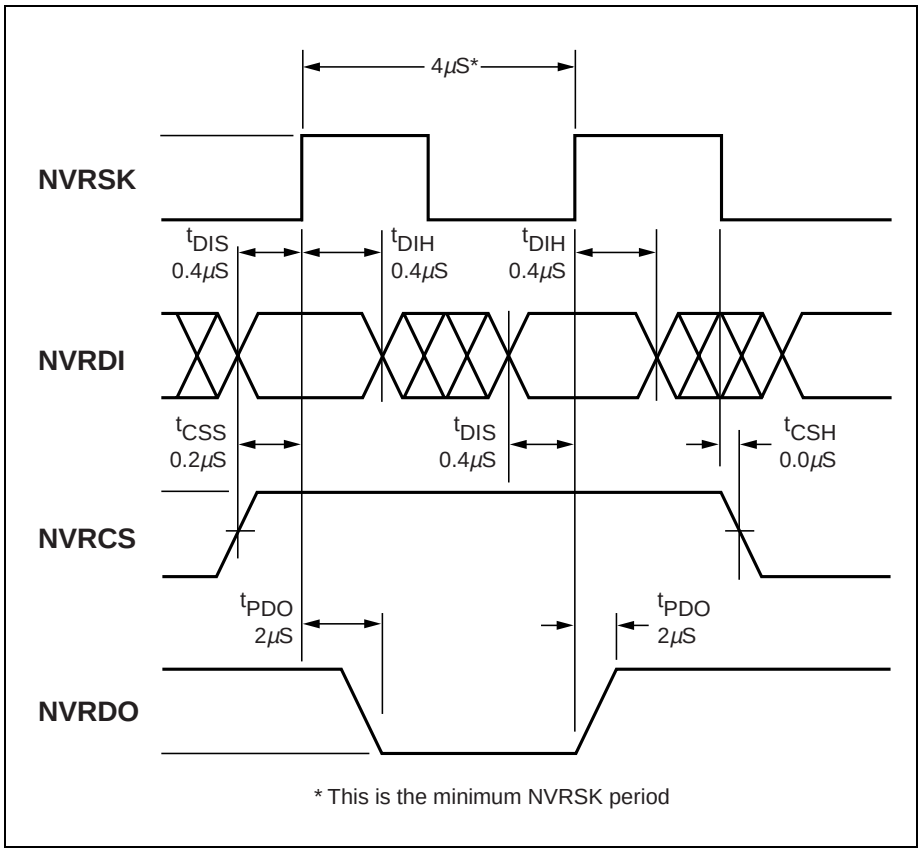
Table 3-5. Hardware Interface Signal Definitions (Continued)

Label	I/O Type	Signal Name/Description
HDIS	DO	**Host Bus Driver Disable.** HDIS output is low when the host is reading data from the modem over the host data bus (both $\overline{HRD}$ and $\overline{HCS}$ are low). HDIS is also used to disable the external transceiver drivers whenever data is not being read from the modem.
HINT	DO	**Host Bus Interrupt.** HINT output is 16C450-compatible output indicating interrupt status and is enabled by the OUT2 bit set to a 1 in the Modem Control Register (MCR).
Telephone Line Interface		
TXA1 TXA2	O(DF)	**Transmit Analog 1 and 2.** The TXA1 and TXA2 outputs are differential outputs. A 600 Ω telephone coupling transformer may be driven directly without the need for external discrete buffer amplifiers. Both TXA1 and TXA2 outputs are turned off when the transmitter is disabled or during local analog loopback.
RXA	I(DA)	**Receive Analog.** RXA is a single-ended receive data input from the telephone line interface.
VC	OA	**Centerpoint Voltage.** A +2.5 VDC centerpoint voltage derived from an internal reference voltage. The TXA1 and TXA2 outputs are biased at VC.
$\overline{TLKRELAY}$	DO	**Talk/Data Relay Driver.** $\overline{TLKRELAY}$ is an open drain output which can directly drive a relay with greater than 360 Ω coil resistance and having a “must operate” voltage of no greater than 4.0 VDC. A heavier load, such as an electro-mechanical relay, requires the use of an external transistor. An external diode should be provided across the relay coil. The $\overline{TLKRELAY}$ output is clamped off during power-on reset or the sleep mode. The $\overline{TLKRELAY}$ output is activated and deactivated at the same time as the $\overline{OHRELAY}$ output. In a typical application, $\overline{TLKRELAY}$ ON opens the normally closed Talk/Data relay and disconnects the handset from the telephone line.
OHRELAY	DO	**Off-Hook Relay Driver.** OHRELAY is an open drain output which can directly drive a relay with greater than 360 Ω coil resistance and having a “must operate” voltage of no greater than 4.0 FDC. A heavier load, such as an electro-mechanical relay, requires the use of an external transistor. An external diode should be provided across the relay coil. The $\overline{OHRELAY}$ output is clamped off during power-on reset or the sleep mode. In a typical application, $\overline{OHRELAY}$ ON closes the normally open Off-Hook relay and connects the modem to the telephone line (off-hook).
$\overline{RING}$	DI	**Ring Detector**. $\overline{RING}$ is a TTL-compatible input used to indicate to the modem that a 15.3 Hz to 63 Hz ringing signal is present. The signal (a 4N35 optoisolator compatible output) into the $\overline{RING}$ input should not respond to a voltage less than 40 VRMS, 15 Hz to 68 Hz, appearing across TIP and RING with respect to ground. A low-going edge on the $\overline{RING}$ input also removed the modem from the sleep mode.
$\overline{A/A1}$	DO	**Key Telephone Hold Indicator.** $\overline{A/A1}$ output low indicates that the telephone line is in use when used on multi-line key telephones.
Modem Interconnect		
RFILO	MI	**Receive Filter Output.** RFILO is the output of the internal receive anti-aliasing filter which must be connected to AGCIN through a 0.1 µF, 20%, DC decoupling capacitor. The 1000 pF capacitor to ground provides noise immunity at low noise levels.
AGCIN	MI	**Receive AGC Gain Amplifier Input.** See RFILO.
MODEO (DSP), MODEI (IA)	MI	**Mode Control.** Direct modem interconnect line.

Table 3-5. Hardware Interface Signal Definitions (Continued)

Label	I/O Type	Signal Name/Description
TDACO (DSP), TDACI (IA)	MI	**Transmitter DAC Signal.** Serial digital DAC signal. Direct modem interconnect line.
TSTBO (DSP), TSTBI (IA)	MI	**Transmitter Strobe.** 576 kHz digital transmitter timing reference. Direct modem interconnect line.
TRSTO (DSP), TRSTI (IA)	MI	**Transmitter Reset.** 9.6 kHz, 8228.57 Hz, or 7.2 kHz digital transmitter timing reference. Direct modem interconnect line. Direct modem interconnect line.
RADCI (DSP), RADCO (IA)	MI	**Receiver ADC Signal.** Serial digital ADC signal. Direct modem interconnect line.
RAGCO (DSP), RAGCI (IA)	MI	**Receiver AGC Signal.** Serial digital AGC signal. Direct modem interconnect line.
RRSTO (DPS), RRSTI (IA)	MI	**Receiver Reset.** 9.6 kHz, 8228.57 Hz, or 7.2 kHz digital receiver timing reference. Direct modem interconnect line.
RSTBO (DSP), RSTBI (IA)	MI	**Receiver Strobe.** 576 kHz digital receiver timing reference. Direct modem interconnect line.

Figure 3-5. NVRAM Timing



4.0 AT Commands

4.1 AT Command Format

Each command line must start with the AT prefix and be terminated with a carriage return (CR). Several commands may be included on one command line. A command line may contain up to 40 characters excluding the AT prefix and the terminating CR. A separator is not required between data commands. A semicolon (;) separator is required between fax commands.

AT commands are composed of 10-bit ASCII encoded asynchronous characters. The character format in data mode is 8 data bits with no parity, or 7 data bits with even, odd, or no (two stop bits) parity, at a data rate of 19200, 2400, 1200, or 300 bps. The character format in fax mode is 8 data bits with no parity at 19200 bps.

Table 4-1. Result Codes and Messages

Digital Code	Word Code	Meaning
0	OK	Command line executed without errors
1	CONNECT	Connection at 300 bps
2	RING	Ringing signal detected
3	NO CARRIER	Carrier lost or never present
4	ERROR	Invalid command, checksum, error in command line, or command line exceeds 40 characters
5	CONNECT 1200	Connection at 1200 bps
6	NO DIALTONE	No dialtone detected
7	BUSY	Busy signal detected
8	NO ANSWER	No silence detected when dialing a system not providing a dialtone
10	CONNECT 2400	Connection at 2400 bps
+F4	+FCERROR	Fax carrier error
13	DATA	Connected as data modem during auto answer
15	FAX	Connected as fax modem during auto answer

Table 4-2. "AT" Command Set Summary

Command	Function	Default	Parameters/Description
A/	Re-execute command		
A	Answer a call		
AT	Command line prefix Parameters: none		Attention Code. Precedes the command line except for +++ (escape) and A/ (repeat) commands.
Bn	Select CCITT or Bell Mode Parameters: n=0,1	n=1	**n=0** Selects CCITT operation at 300 or 1200 bps during Call Establishment and a subsequent connection. **n=1** Selects BELL operation at 300 or 1200 bps during Call Establishment and a subsequent connection.
Cn	Carrier control Parameters: n=0,1	n=1	
D			Dial Command. D causes the modem to dial the number which follows the D in the command line. Valid dial characteristics are 0 to 9, A to D, #, and *. Other valid dial modifier characters are: "," P, R, S=n, T, W, ";", @, and !.
Dn	Dial modifier		
En	Command echo Parameters: n=0,1	n=1	**n=0** Disables command echo. **n=1** Enables command echo.
Fn	On-line character echo option Parameters: n=0,1	n=1	**n=0** Returns **ERROR** result code **n=1** Returns OK result code
Hn	Disconnect (hang-up) Parameters: n=0,1	n=0	**n=0** Modem on-hook (relay open) **n=1** Modem off-hook (relay closed)
In	Identification Parameters: n=0,1,2,3	n=0	**n=0** Reports product identification code **n=1** Calculates the ROM checksum **n=2** Calculates the ROM checksum and compares it with the prestored checksum. Reports "OK" if the calculated checksum equals the prestored checksum or if the prestored checksum value is FFh; otherwise reports "ERROR". **n=3** Reports the firmware version and ROM part number
Ln	Speaker volume Parameters: n=0,1,2,3	n=2	**n=0** Low volume. **n=1** Low volume. **n=2** Medium volume. **n=3** High volume.

Table 4-2. "AT" Command Set Summary (Continued)

Command	Function	Default	Parameters/Description
Mn	Speaker control Parameters: n=0,1,2,3	n=1	**n=0** Speaker is always off. **n=1** Speaker is on during call establishment, but off when receiving carrier. **n=2** Speaker is always on. **n=3** Speaker is on after dialing, until carrier is detected
On	Go on-line Parameters: n=0,1		**n=0** On-line state **n=1** On-line state with equalizer retrain.
P	Force pulse dialing		
Qn	Quiet Result codes control	n=0	**n=0** Enables result codes to the DTE. **n=1** Disables result codes to the DTE.
Sn	Select S register as default Range: n=0-27		n Establishes S-Register n as the last register accessed. n=v Sets S-Register n to the value v. n? Reports the value of S-Register n.
Sn=	Parameters: none Range:n=0-27 (register no.) x=0-255 (value)		Write to an S Register. Sr=x sets register "n" to the value "x". Configuration registers are provided to retain modem configuration parameters. The contents of these registers can be modified with this command.
Sn?	Parameters: none Range: n=0-27		Read an S register. Sn? causes the contents stored in register "n" to be returned.
T	Force DTMF dialing		
Vn	Report codes form	n=1	**n=0** Result code is sent as a digit **n=1** Result code is send a ASCII text
Xn	Extended result codes	n=4	**n=0** Basic set of result codes 0-4 are enabled. The modem blind dials and sends the appropriate connect result code once a satisfactory connection is established. Dial tone and busy are not recognized. **n=1** Result codes 0-5 and 10 are enabled. The modem blind dials and sends the appropriate connect result code once a satisfactory connection is established. Dial tone and busy are not recognized. **n=2** Result codes 0-6 and 10 are enabled; dial tone detected. The modem waits for a dial tone before dialing, then send the appropriate result code once a satisfactory connection is established. The busy result code is sent if a busy signal is detected. **n=3** Result codes 0-5, 7 and 10 are enabled; busy signal detected; dial tone not detected. The modem blind dials and sends the appropriate connect result code once a satisfactory connection is established. The busy result code is sent if a busy signal is detected. **n=4** Result codes 0-7 and 10 are enabled; busy signal and dial tone detected. The modem waits for a dial tone before dialing, then send the appropriate result code once a satisfactory connection is established. The NO DIALTONE result code is sent if the dial tone is not detected within 5 seconds. The BUSY result code is sent if a busy signal is detected.

Table 4-2. "AT" Command Set Summary (Continued)

Command	Function	Default	Parameters/Description
Yn	Long space disconnect	n=0	**n=0** Disables long space disconnect. **n=1** Enables long space disconnect
Zn	Soft reset and restore profile	n=0	**n=0** Soft reset and restore stored profile 0. **n=1** Soft reset and restore stored profile 1.
&Cn	RLSD (DCD) option	n=0	**n=0** RLSD remains ON at all times. **n=1** RLSD follows the state of the carrier.
&Dn	DTR option	n=0	**n=0** Modem ignores DTR **n=1** Modem assumes command state when ON-to-OFF transition is detected on DTR **n=2** Modem hangs up, assumes command state and disables auto-answer upon detecting ON-toOFF transition on DTR **n=3** Modem assumes software reset state upon detecting ON-to-OFF transition on DTR
&F	Recall (restore) factory profile		S Registers: S0=1, S1=0, S2=43. S3=13, S4=10, S5=8, S6=0, S7=30, S8=2, S9=5, S10=14, S11=95, S12=50, S18=0, S25=5, S26=1 Commands: B1, C1, E1, F1, L2, M1, P, Q0, V1, Y0, X4, &C0, &D0, &G0, &J0, &M0/&G0, &P0, &R0, &S0, &T4, &X0
&Gn	Select guard tone	n=0	**n=0** No guard tone. **n=1** 550 Hz guard tone. **n=2** 1800 Hz guard tone.
&Jn	Telephone jack control	n=0	**n=0** Suitable for RJ11, RJ41S. or RJ45S type phone jack. **n=1** Suitable for RJ12 or RJ13 type phone jack; the A lead ia connected to A1 lead while the modem is off-hook.
&L0	Dial-up line operation	n=0	**n=0** Requests dial-up operation.
&Mn	Asynchronous mode	n=0	**n=0** Asynchronous operation. **n=1** Reserved **n=2** Reserved **n=3** Reserved
&Pn	Pulse dial make/break ratio	n=0	**n=0** Selects 39%-61% make/break ratio at 10 pulses per second. (USA/Canada) **n=1** Selects 33%-67% make/break ratio at 10 pulses per second. (UK/HK)

Table 4-2. "AT" Command Set Summary (Continued)

Command	Function	Default	Parameters/Description
&Q0	Asynchronous mode	n=0	Idle State / On-line State **n=0** Normal / asynchronous. **n=1** Reserved / Reserved **n=2** Reserved / Reserved **n=3** Reserved / Reserved
&Sn	DSR override	n=0	**n=0** DSR will remain ON at all times. **n=1** DSR will become active after answer tone has been detected and inactive after the carrier has been lost. DSR if OFF when the modem is in test mode or idle state.
&Tn	Test and diagnostic	n=4	**n=0** Terminates test in progress. **n=1** Initiates local analog loopback. **n=2** Returns ERROR. **n=3** Initiates local digital loopback. **n=4** Enables digital loopback acknowledgment from remote modem for RDL **n=5** Disables digital loopback acknowledgment from remote modem for RDL **n=6** Initiate remote digital loopback. * **n=7** Initiate remote digital loopback with self test. * **n=8** Initiate remote analog loopback with self test. * * . Not available for 300 bps
&V	Display current configurations		Example: AT&V ACTIVE PROFILE: B0 E1 L1 M1 QO T V1 Y0 &C0 &D0 &G2 &J0 &L0 &P0 &Q0 &R0 &S0 &X0 &Y0 S00:000 S01:000 S02:043 S03:013 S04:010 S05:008 S06:002 S07:030 S08:002 S09:006 S10:014 S12:050 S14:AAH S16:00H S18:000 S21:00H S22:76H S23:17H S25:005 S26:001 S27:40H STORED PROFILE 0: B1 E1 L2 QO V1 X4 Y0 &C0 &D0 &G0 &J0 &L0 &P0 &Q0 &R0 &S0 &X0 S00:000 S14:AAH S18:000 S21:00H S22:76H S23:17H S25:005 S26:001 S27:40H STORED PROFILE 1: B1 E1 L2 QO V1 X4 Y0 &C0 &D0 &G0 &J0 &L0 &P0 &Q0 &R0 &S0 &X0 S00:000 S14:AAH S18:000 S21:00H S22:76H S23:17H S25:005 S26:001 S27:40H TELEPHONE NUMBERS: &Z0= 5551212 &Z1= &Z2= &Z3=

Table 4-2. "AT" Command Set Summary (Continued)

Command	Function	Default	Parameters/Description
&Wn	Store current configuration	n=0	Commands: Bn, En, Ln, Mn, P or T, Qn, Vn, Yn, &Cn &Dn, &Gn, &Jn, &Ln, &Pn, &Qn, &Rn, &Sn &Xn &Yn Registers: S0, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S12, S14, S16, S18, S21, S22, S23, S25, S26, S27 **n=0** Store active profile in location 0 **n=1** Store active profile in location 1
&X0	Asynchronous data transmission	n=0	**n=0** Reserved **n=1** Reserved **n=2** Reserved
&Yn	Select default profile		**n=0** The modem will use profile 0 on powerup **n=1** The modem will use profile 1 on powerup
&Zn=x	Store dial string to location n		&Zn=x n=0 to 3 and x = dial string. (up to 36 characters)
%Dn	DTMF Level Attenuation		
%J	Load Secondary Defaults		
%Ln	Transmit Level Attenuation		
Dial Modifier	**Function**		
P	Pulse Dial Parameters: none		
R	Originate Call in Answer Mode Parameters: none		
S=n	Dial Stored Number Parameters: n=0, 1, 2, 3 S<CR> S=<CR> S=n<CR> where n=0-3		
T	Tone Dial Parameters: none		

Table 4-2. "AT" Command Set Summary (Continued)

Command	Function	Default	Parameters/Description
W	Wait for Dial Tone Parameters: none		
;	Return to Idle State Parameters: none		
@	Wait for Quiet Answer Command Parameters: none		
!	Flash Hook Parameters: none		
, (comma)	Pause Parameters: none		
0-9, A, B, C, D, #, *	Dial Digits/Characters Parameters: none		

Table 4-3. Fax Command Set Summary

Fax Command	Function	Default	Parameters/Description
+FCLASS=n	Service class	n=0	Select Service Class. +FCLASS=n command sets the active service class. +FCLASS=0 Return to data mode +FCLASS=1 Fax Class 1 +FCLASS=2 Fax Class 2 (Not supported) +FCLASS=3 Fax Class 3 (Not supported)
+F<command>?	Report Active Configuration		Report Active Configuration. +F<command>? interrogates the modem to determine the active configuration. The responses are: +FAA? 0 if auto answer is disabled; 1 if auto answer is enabled +FCLASS 0 ifin data mode; 1 if in fax class 1 +FF? 0 if flow control off; 1 if flow control on
+F<command>=?	Report Operating Capabilities		Report Operating Capabilities. +F<commands>=? can be used to determine the operating capabilities of the modem. The responses are: +FAA=? 0, 1 +FCLASS=?0, 1 +FTM=? 24, 48, 72, 96 +FTM=? 24, 48 +FTH=? 3 +FTH=? 3 +FF=? 0,1
+FAA=n	Data/Fax Auto Answer	n=0	Data/Fax Auto Answer. +FAA command configures the modem to automatically detect whether an incoming call is from a data modem or a fax modem. This command is valid in both data and fax modes. **n=0** Disable data/fax auto answer mode (default) **n=1** Enable data/fax auto answer mode. The modem determines calling type and issues DATA result code (13) if caller is a data modem or issues FAX result code (15) in the caller is a fax modem
+FF	Enhanced Flow Control	n=0	Enhanced Flow Control. +FF=n command enables an enhanced flow control mode for data transfer between the DTE and DCE. **n=0** Disable enhanced flow control interface. In this mode, data transfer is compatible with the EIA-578 standard **n=1** Enable enhanced flow control

Table 4-3. Fax Command Set Summary (Continued)

Fax Command	Function	Default	Parameters/Description
+FTS=n	Stop Transmission and Wait	n=0	Stop Transmission and Wait. +FTS=n causes the modem to terminate a transmission. After temination the modem waits for n 10 millisecond intervals before responding with the OK result code. An ERROR response code results if this command is issued while the modem is on-hook.
+FRS=n	Receive Silence	n=0	Receive Silence. +FRS=n causes the modem to report back to the DTE with an OK result code after n 10 millisecond intervals of silence have been detected on the line. This command is aborted if any command character is received. The modem discards the aborting character and issues an OK result code. An ERROR response code results if this command is issued while the modem is on-hook.
+FTM=n	Transmit Data	n=48	Transmit Data. +FTM=n causes the modem to transmit data using the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook. +FTM=24 V.27 ter 2400 bps +FTM=48 V.27 ter 4800 bps +FTM=72 V.29 7200 bps +FTM=96 V.29 9600 bps
+FRM=n	Receive Data	n=48	Receive Data. +FRM=n causes the modem to enter the receiver mode using the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook. +FRM=24 V.27 ter 2400 bps +FRM=48 V.27 ter 4800 bps +FRM=72 V.29 7200 bps (Not supported*) +FRM=96 V.29 9600 bps (Not supported*) * Modem will respond with ERROR result code.
+FTH=n	Transmit Data with HDLC Framing	n=3	Transmit Data with HDLC Framing. +FTH=n causes the modem to transmit data framed in HDLC protocol using the modulation defined below. An ERROR response code results if this command is issued while the modem is on-hook. +FTH=3 V.21 Channel 2300 bps

Table 4-3. Fax Command Set Summary (Continued)

Fax Command	Function	Default	Parameters/Description
+FRH=n	Receive Data with HDLC Framing	n=0	Receive Data with HDLC Framing. +FRH=n causes the modem to receive frames in HDLC protocal using the modulation defined below. An ERROR response code results if the command is issued while the modem is on-hook. +FRH=3 V.21 Channel 2300 bps
+FRTn	Receive Test Data	n=48	Receive Test Data. +FRTn causes the modem to go off-hook and begin demodulating received data at the specified rate. **n ConFiguration/Data Rate** **n=24** V.27 ter 2400 bps **n=48** V.27 ter 4800 bps
+FTTn=m	Transmit Test Data	n=96, m=0	Transmit Test Data. +FTTn=m causes the modem to transmit a continuous test pattern at the specified rate. The transmission will terminate by a DTE abort (i.e. any character recognized at the DTE interface). **n ConFiguration/Data Rate** **n=24** V.27 ter 2400 bps **n=48** V.27 ter 4800 bps **n=72** V.29 7200 bps **n=96** V.29 9600 bps **m Test Pattern** **m=0** ASCII data (20h - 7Fh sequential) **m=1** All zeros **m=2** All ones **m=3** Alternate 10 **m=4** Sliding 0 (01111) **m=5** Sliding 1 (00001)
+Hn	Rockwell Protocol Interface (RPI) Enable	n=0 Parameters: n=0, 1	RPI Enable. The +Hn command enables or disables the Rockwell Protocol Interface (RPI), and works in conjunction with S19. **n=0** RPI disabled **n=1** RPI enabled

5.0 S Registers

The S register commands are summarized in Table 5-2. The range of possible values along with the factory default value for each S register are also shown. The factory default values are used whenever the &F command is received or a parity error is detected in the NVRAM upon modem power turn-on.

The user-defined S registered default values are used at modem power turn-on or when a modem reset is received. If the NVRAM is not available or contains a parity error, the factory default S register values are used.

The S registers are described in Table 5-1.

Reading an S Register

The command Sn? reads the current value of an S register, where "n" is the decimal number of the register.

Example: Read the current value in register S0 (Ring to Answer On) and S7 (Wait Time for Data Carrier), perform the following:

Enter: AT S0? S7? (Value in register S0? Value in register S7?)

A typical response to the might be:

Result: 001 (modem will answer on first ring)

Result: 030 (modem will wait 30 seconds for a carrier)

Result: OK (command completed)

Table 5-1. S Register Description

Register	Default	Range	Units	Description
S0	00	0-255	rings	Ring to Answer On. Assigning S0 a value from 1 to 255 places the modem in auto-answer mode. The modem will auto answer after the specified number of rings has occurred. Setting S0 to 0 disables auto-answer
S1	00	0-255	rings	Ring Count. S1 is incremented each time a ring is detected. It will be cleared if no rings occurs within 8 seconds after the last ring.
S2	43	0-127	ASCII	Escape Code Character. S2 holds the ASCII value used for the escape code. The + character responds to the factory default value. values greater than 127 disables the escape code operation. To enter the command mode when the escape code is disabled, a loss of carrier must occur to DTR must be set to a 0 (dependent on &D command).
S3	13	0-127	ASCII	Carriage Return Character. S3 holds the ASCII value for the carriage return. 13 is the standard value. The character in S3 is both the command line terminator and the result code terminator.

Table 5-1. S Register Description (Continued)

Register	Default	Range	Units	Description
S4	10	0-127	ASCII	Line Feed Character. S4 holds the ASCII value for the line feed. The line feed character is output after the carriage return only when English word result codes have been selected (V1). If a line feed character is not desired, it may be changed to a null, but it cannot be totally disabled.
S5	08	0-32, 127	ASCII	Backspace Character. S5 holds the ASCII value for the backspace character. This character is both the backspace key and the character echoed to move the cursor back one position. Normally a value of 8 is used. The backspace character must not be set to a value corresponding to a printable ASCII character (i.e. between 33 and 126) or to a value greater than 127. A backspace is used as follows: The keystroke is echoed back to the terminal and the cursor moved back over the last character entered. The last character in the command buffer deleted.
S6	02	2-255	seconds	Wait for Dial Tone. S6 specifies the wait time before dialing. The delay allows time for the dial tone to occur on the telephone line. The minimum time is two seconds. Values greater than two seconds may be necessary if trouble is encountered getting dial tones.
S7	30	1-255	seconds	Wait for Carrier After Dial. S7 specifies the delay time that the modem waits for the carrier signal from the remote modem before hanging up. Typically, a delay time of 30 seconds is enough but it can be extended to 255 seconds. If the carrier is not detected within the specified time period, the modem hangs up and sends the NO CARRIER result code. If carrier is detected, the modem returns the CONNECT result code and goes on-line.
S8	02	0-255	seconds	Pause Time for the Comma Dial Modifiers. S8 sets the pause time for the comma dial modifier. The comma is used during dialing when it is necessary to dial through a PBX and wait for a second dial tone. A two second delay is usually enough. S8 can be changed or multiple commas used to lengthen the delay.
S9	06	1-255	1/10 seconds	Carrier Detect Response Time. S9 sets the carrier detect response time.
S10	14	1-255	1/10 seconds	Lost Carrier to Hang Up Delay. S10 sets the delay time between loss of carrier and hang-up. The modem will not hang-up due to loss of carrier if the value of S10 is 255.
S11	95	50-255	ms	DTMF Dialing Speed. S11 sets the duration and inter-digit delay of the touch-tones.
S12	50	0-255	1/50 seconds	Escape Code Guard Time. S12 sets the escape code guard time.
S13				Reserved.

Table 5-1. S Register Description (Continued)

Register	Default	Range	Units	Description
S14	AAh	Bit Mapped	None	S14 is the modem option register with the following bit funcitons. Bit 0 Reserved Bit 1 Command Echo (See E command) 0 E0 - No echo 1 E1 - Echo (factory default) Bit 2 Results Code (See Q command) 0 Q0 - Enabled (factory default) 1 Q1 - Disabled Bit 3 Verbose Command (See V command) 0 V0 - Digits 1 V1 - Words (factory default) Bit 4 Reserved Bit 5* Dial Method (See T and P commands) 0 T - Tone dial 1 P - Pulse dial (factory default) Bit 6 Reserved Bit 7 Originate/Answer (See A, D, and R commands, and register S0) 0 Answer 1 Originate (factory default) *Bit 5 is set or reset if the dial command string contains a P (pulse dial) or T (tone dial), respectively. If a subsequent dial command string is used with a P or T, the modem uses the option specified by this bit.
S15				Reserved.
S16	00		None	Modem Test Option. Controls the diagnostic modes as follows: Bit 0 Local Analog Loopback L3 (See &T1 command) 0 Disabled (factory default) 1 &T1 - Enabled Bit 1 Reserved Bit 2 Local Digital Loopback (See &T3 command) 0 Disabled (factory default) 1 &T3 - Enabled Bit 3 Remote Digital Loopback L2 (See &T6 command) 0 Disabled (factory default) 1 &T6 - Enabled

Table 5-2. S Register Summary

Register	Range	Units	Default	Description
S0*	0-255	rings	00	Rings to Auto-Answer
S1	0-255	rings	00	Ring Counter
S2	0-127	ASCII	43	Escape Character
S3	0-127	ASCII	13	Carriage Return Character
S4	0-127	ASCII	10	Line Feed Character
S5	0-32, 127	ASCII	08	Backspace Character
S6	2-255	seconds	02	Maximum time to Wait for Dial Tone
S7	1-255	seconds	30	Wait for Carrier
S8	0-255	seconds	02	Pause Time for Comma
S9	1-255	1/10 seconds	06	Carrier Detect Response Time
S10	1-255	1/10 seconds	14	Carrier Loss Disconnect Time
S11	50-255	ms	95	DTMF Dialing Speed
S12	0-255	1/50 seconds	50	Escape Prompt Delay
S14*	Bit Mapped	none	AA hex	General Bit Mapped Options
S16	Bit Mapped	none	00	Test Mode Bit Mapped Options (&T)
S17	0-250	4 ms increments	00	Fax Mode Null Byte Timer
S18*	0-255	seconds	00	Test Timer
S19	0-1	none	00	Rockwell Protocol Interface Speed
S20	0-127	seconds	00	Fax Mode Inactivity Timer
S21*	Bit Mapped	none	00	General Bit Mapped Options
S22*	Bit Mapped	none	76 hex	General Bit Mapped Options
S23*	Bit Mapped	none	07	General Bit Mapped Options
S24	0-255	seconds	00	Sleep Inactivity Timer
S25*	0-255	0.1 or 1 seconds	05	Delay to DTR Off
S26*	0-255	0.01 seconds	1	RTS-to-CTS Delay
S27*	Bit Mapped	none	40 hex	General Bit Mapped Options
S28*	Bit Mapped	none	00	General Bit-Mapped Options
* Register value may be stored in one of two user profiles with the AT&W command.				

6.0 Operation

Modem operation supports data modem processing, fax modem processing and common call progress processing.

The AT+FCLASS command allows the operator to select either data or fax operation.

AT+FCLASS=0 Data mode

AT+FCLASS=1 Fax mode Class 1

6.1 Data Modes

6.1.1 Data Mode Selection

Data mode operation is defined by the AT commands and S register settings described in Sections 3 and 4. Data rate selection is determined by the speed of the originating and answering modems as follows:

Answer Mode	Originate Mode		
	300	1200	2400
300	300	1200	1200
1200	300	1200	1200
2400	300	1200	2400

6.1.2 Data Modem Processing

Data modem processing is explicitly defined in CCITT V.22 bis, CCITT V.22, Bell 212A, and Bell 103 documentation. All modulation, waveform spectrum, and data processing functions conform to the appropriate specifications with the following exceptions:

1. CTS is ON all the time and does not go OFF during handshake.
2. DSR is always ON in parallel mode operation.
3. The rate change request option is not supported for V.22 bis.
4. V.22 operation supports only Alternative B, mode ii (1200 bps asynchronous, 10 bit characters)

6.1.3 Call Origination

Automatic and manual origination of calls is supported. Automatic call origination is supported by the ATDS command. The modem automatically enters the data handshaking mode upon completion of the dial function.

6.1.4 Call Answering

Automatic and manual answering of calls is supported. Incoming ring signals are detected by the modem and indicated by the RING result code. Answering can be performed by the DTE acknowledging the RING result code and issuing the ATA command or by having the modem automatically go off-hook after N rings are detected. The number of rings, N, is determined by the setting of theS0 register. Upon going off-hook, the DCE will transmit 2100 Hz (or 2225 Hz for Bell modes) for a duration of not less than 2.6 seconds and not more than 4.0 seconds.

6.1.5 Call Termination

A call is terminated by the DTE sending the ATH command to the modem. Rockwell Protocol Interface (RPI)

The Rockwell Protocol Interface is an RC224ATLV feature, which when enabled by the AT+H1 command prior to establishing a modem to modem data connection, allows Data Applications Protocol Interface (DAPI) host software to provide full error correction (V.42 LAPM, MNP2-4) and data compression (V.42 bis, MNP5) processing for the modem. (Only host communication software packages including DAPI will support the RPI.)

Data from the DTE is sent asynchronously at 19,200 bps (see S19), and the RPI takes the asynchronous characters (8N1 format) and converts them to synchronous data.

6.2 Fax Modes

6.2.1 Fax Mode Selection

Fax modes and rates are determined by the AT+F commands are defined in “AT Commands,” in Chapter 4.

6.2.2 Fax Mode Processing

Fax modem processing is explicitly defined in CCITT V.29, CCITT V.27 ter, and CCITT V.21 recommendations. All modulation, waveform spectrum, and data processing functions conform to the appropriate specifications with the following exceptions:

1. V.29 receive functions are not supported.
2. V.29 4800 bps is not supported; V.27 ter 4800 bps is used instead.
3. V.29 half-duplex continuous carrier mode only is supported.
4. V.29 channel multiplexer option is not supported.
5. V.27 ter 75 baud backward channel option is not supported.
6. V.27 ter short train mode is not supported.

6.2.3 Fax Origination

Automatic origination of fax call is supported by the ATDS command. Upon completion of the dial function, a calling tone at 1100 Hz (± 38 Hz) with an ON duration of 0.5 sections (±75 ms) and OFF duration of 3 seconds (± 450 ms) is transmitted.

6.2.4 Fax Answering

Answering of fax calls is identical to answering of data calls with the exception that the DCE enters the fax handshaking mode instead of the data handshaking mode after going off-hook.

6.2.5 Fax Data Transmission

Fax data transmission is initiated by the +FTM command. Upon recognition of the command, the modem initiates the selected modulation mode and issues the CONNECT result code. The proper training sequence for the selected mode is transmitted, followed by constant 1 bits, until data is received from the DTE. DTE data is buffered and processed prior to being transmitted. The transmission is terminated when the transmit buffer becomes empty and the last transmitted character was not a NUL character. The modem then turns off the carrier and issues the OK result code. If the last character was a NUL character (00), the modem continues to transmit NUL characters until more data is received by the DTE or until 5 seconds have elapsed. After 5 seconds, the modem turns off the carrier and issues the ERROR result code.

6.2.6 Fax Data Reception

Fax data reception is initiated by the +FRM command. Upon recognition of the command, the modem initiates the selected demodulation mode and looks for the proper carrier. The modem issues the CONNECT result code when the selected carrier is detected. An +FCERROR result code will be issued and the modem will return to the command state if a signal other than the selected carrier is detected. Demodulated data is stored in an output buffer for additional I/O processing and eventual output to the DTE. Detection of loss of carrier will cause the modem to issue the NO CARRIER result code and will cause the modem to return to the command state. Any character other than flow control characters issued while the receiver is outputting data will cause the receiver to abort and return to the command state.

6.2.7 Fax Control Transmission

Fax control transmission is initiated by the +FTH command or after answering a call. The modem initiates the selected modulation mode, issues the CONNECT result code, transmits one second of flags, then transmits data sent by the DTE. DTE data is buffered and processed prior to transmission.

Processed I/O data is grouped into frames and encoded with a Cyclic Redundancy Check (CRC) generator. The generator polynomial is $X^{16} + X^{12} + X^5 + 1$. The CRC parity or Frame Check Sequence (FCS) is appended to the end of the frame. The end of the frame is indicated by an empty I/O buffer. Transmission frames begin and end with a flag sequence (7Eh). The ending flag may serve as the beginning flag for the next frame. To prevent data from looking like flags, a zero is inserted into the data stream after 5 consecutive ones are detected.

Each frame is checked to see if the current frame is the last frame of the transmission. If the final frame bit (5th received bit of the second byte of the frame) is 1, indicating that the current frame is the final frame, the modem completes the frame transmission, Issues the OK result code, and returns to the command state. If the final frame bit is a 0, the modem issues the CONNECT result code continues to transmit flags until one of the following actions is taken by the DTE:

1. If additional data is sent by the DTE, the modem transmits another frame.
2. If the transmission is terminated by the <DLE> ETX> string, the modem turns off the carrier and issues the OK result code.
3. If no data is sent by the DTE within 5 seconds of receiving the CONNECT message, the modem turns off the carrier and issues the ERROR result code.

6.2.8 Fax Control Reception

Fax control reception is initiated by the +FRH command or after dialing. Upon recognition of the command, the modem initiates the selected demodulation mode and looks for the proper carrier. When the selected carrier is detected, the modem issues the CONNECT result code. If a signal other than the selected carrier is detected, the modem issues an +FCERROR result code and returns to the command state.

The modem removes the flags, removes transmitter inserted zero bits (a zero following 5 consecutive ones), performs the CRC error checking, and stores the data in the internal I/O buffer for further processing and eventual passing to the DTE.

The modem indicates end of a frame by issuing the <DLE> <ETX> characters and an OK result code if the frame was received correctly, or by issuing an ERROR result code if one or more errors were detected in the frame. The first frame received is stripped of flags (CONNECT result code indicates that a valid flag has been received) and output to the DTE. Subsequent frames are buffered and output to the DTE when additional +FRH commands are received.

Any characters other than flow control that are received while demodulating data and prior to issuance of the status result code will result in the receive process being aborted, an OK result code being issued and the modem returning to the command state. After the status result code is issued, the modem continues to demodulate data. Additional +FRH commands specifying the same modulation rate will result in the issuance of a CONNECT result code, output of the next data frame, and continuation of normal demodulation. Any other commands will result in the receive process being aborted, buffered data being discarded, and the command being implemented.

Detection of loss of carrier will result in the modem issuing the NO CARRIER result code and returning to the command state.

6.2.9 Fax I/O Processing

The fax I/O interface supports asynchronous serial and parallel interfaces. The interface rate is 19.2 kbps. Start and stop elements are removed from the incoming serial data stream and are added to the outgoing serial data (receive). Both transmit and receive data is buffered. Flow control using XON/XOFF (DC1/DC3) is provided.

Unique control character strings are identified, filtered, or reinserted into the I/O data stream. These control characters and their resultant action are shown below.

DTE to Modem Transmit Data Stream

<DLE> <data>	Delete <DLE> <data> characters
<DLE> <ETX>	Recognize as a string terminator and take appropriate action.
<DLE> <DLE>	Replace with single <DLE> character.

Modem to DTE Receive Data Stream

<DLE>	Insert extra <DLE> ahead of <DLE>

The modem also identifies the end of a frame by inserting <DLE> <ETX> into the data stream after the FCS bytes.

6.3 FAX ENHANCED FLOW CONTROL

The fax Class 1 standard provides for bidirectional XON/XOFF flow control. However, in multitasking “windowing” environments, the DTE communication package can be suspended long enough to miss a 19200 bps serial async character sent by the DCE (520.83 μs). XON/XOFF flow control will not solve this problem because the DTE software does not always know when its going to be suspended. To solve this problem, a new enhanced flow control mechanism is provided. This mechanism is enabled/disabled by issuing an AT+FF=1/0 command.

6.3.1 Parallel/Serial Interface Selection

For parallel host interface operation, the enhanced flow control takes advantage of the fact that the DCE hardware knows if the DTE has read the last character. The DCE will not send a new character until the DTE reads the previous one. The

modem fax receiver has an internal 223-byte buffer. Therefore, the DTE can stop reading characters for 371 ms (4800 bps receive) before any data is lost.

For serial interface operation. the enhanced flow control mechanism utilizes the fact that the Fax Class 1 serial interface is only required to operate half duplex. The scheme involves sending characters to the DTE and waiting for the DTE to send an acknowledgment (if the DTE reads the character OK) or a request for re-transmission (if the DTE misses a character and detects an overrun). The required DTE operation using the enhanced flow control mechanism is defined below.

6.3.2 Fax V.42 Buffer Sizes

Fax V.42 buffer sizes are shown below.

Buffer Type	Size in Bytes
Fax V.27/V.29 Tx	255 (9600:212 ms)
Fax V.21 (HDLC) Tx	255 (300:6.8 sec)
RPI (HDLC) Tx	238 (2400:793 ms)
Fax V.27 Rx	223 (4800:371 ms)
Fax V.21 (HDLC) Rx	255 (300:6.8 sec)

6.3.3 DTE Flow Control Operation

Normal operation: DTE does not miss character. The DTE reads the serial character sent by the DCE. The DTE checks serial hardware overrun status and determines that an overrun did not occur. The DTE can therefore use the character. The DTE must send the following acknowledgment character back to the DTE.

11111110 (FEh)

Overrun Operation: DTE Misses Character. The DTE returns after being suspended and reads the serial character sent by the DCE. The DTE checks serial hardware overrun status and determines that an overrun occurred. The DTE does not use the received character. The DTE then sends the following re-transmission request character back to the DCE.

11110000 (F0h)

6.4 Data/Fax Auto Answering

Data/fax auto answering, when used with appropriate DTE host software, will automatically recognize whether an incoming call is a data or fax modem. This mechanism can be used with an integrated data/fax communication package or with separate data/fax communication packages operating together in a foreground/background configuration.

Table 6-3 describes a procedure to configure a terminal being called by a 1200 bps data modem. Table 6-4 describes a procedure to configure a terminal being called by a fax machine with or without calling tone.

The auto answering mechanism is structured such that the DTE is initially operating in the fax mode. The DTE enables auto answering using the AT+FAA=1 command (saved in NVRAM under S27). This command should be issued while AT+FCLASS=1. The DTE will then change its communication rate from 19200 bps (fax class 1 rate) to the rate expected in data mode (2400, 1200, or 300 bps).

The DCE will attempt to establish a connection with the incoming call as a data modem. If the incoming call is a fax, the DCE will switch to the fax mode and establish the connection. To minimize incompatibilities with various fax and data modems, the 59 register is used to define the length of time that the DCE has to establish a data connection.

S9 (Range: 0-255; Default: 06). Defines the time (in seconds) after going off-hook that the DCE waits for the entire data mode handshaking process to complete before switching to fax mode.

When a call is received (DCE sends RING result code), the DTE can Initiate the answer manually by sending an ATA command. Alternatively, the DTE can allow the DCE to answer automatically by setting S0 = non-zero value. After the DCE goes off-hook, It will automatically determine the caller type (data or fax), establish the appropriate connection, and inform the DTE of the caller type with the following result codes:

Numeric	Verbose	Description
13 (0Dh)	DATA	DCE sends this result code only during auto answering or when DCE has connected as a data modem.
15 (0Fh)	FAX	DCE sends this result code only during auto answer mode when DCE has connected as a fax modem.

It is assumed initially for auto answer operation that the DTE is running the fax communication package.

It is impractical to force the fax package to use the same options selected by the data package. Therefore, some method must be provided to allow the DTE fax package to restore the DCEs registers after the DCE has connected as a data modem. The DCE accommodates this by automatically entering on-line command mode after connecting. After the DTE receives the DATA result code, it can then send any necessary AT commands to the DCE. The DCE will wait in the on-line command mode and delay sending the “data” connect message until the DTE sends an ATO command. After sending the ATO command, the DTE then transfers control to the data communication package.

For DTEs running separate data and fax packages in a foreground/background configuration, a method is provided to allow the fax package to regain control after the data connection has terminated during auto answer mode without requiring changes to existing data packages. The RC224ATLV accommodates this through the use of the data carrier detect (DCD) indicator. Initially, in auto answer mode, DCD will be off. When connected in data mode, the DCE will turn

DCD on. When the data connection is terminated, the DCE will turn DCD off again. The fax package, running in the background, can poll DCD (160450 modem status register bit 7) to ascertain the data connection status. The DTE must send AT&C1 to cause DCD to operate in this manner.

During auto answer mode, when the caller is a fax machine, the DCE will behave as a normal fax DCE (as defined by +FCLASS=1) with the following exceptions:

1. The transmission of the fax 2100 Hz answer tone will be delayed by the time needed to determine that the caller is a fax machine (S9 seconds).
2. The DCE sends FAX message at the data mode DTE rate (as defined by the previous AT command autobaud rate) and automatically sets +FCLASS=1 after detecting caller is a fax.
3. After the answer tone is sent and the DCE enters the V.21 transmit mode, the CONNECT result code will be sent at 19200.

During auto answer mode, if the DCE determines that the caller is not a data modem nor a fax machine, then DCE will send the NO CARRIER result code, go on-hook and remain in data mode.

6.5 Call Progress

6.5.1 Call Progress Algorithms

Data call progress algorithms measure the power and/or relative power of the highband and lowband channels and determine signal presence and cadence correlations. Highband channel signals include 2100 and 2225 Hz signalling tones. Lowband channel signals include dial tones, busy tones, ringback tones and voice ranging in frequency from 120 to 620 Hz.

Characteristics of the tones detected by the RC224ATLV are listed below.

Tone	Cadence	Frequency
Dial Tone	Continuous	350 + 440
Old Dial Tone	Continuous	600+120/133
Busy	0.5 sec ON 0.5 sec OFF	480 + 620 480 + 620
Old Busy	0.5 sec ON 0.5 sec OFF	600 + 120 600 + 120
Precision Reorder	0.3 sec ON 0.2 sec OFF	480 + 620 480 + 620
Old Reorder (local)	0.25 sec ON 0.25 sec OFF	600 + 120 600 + 120
Old Reorder (toll)	0.2 sec ON 0.3 sec OFF	600 + 120 600 + 120
Ringback	0.8-1.2 sec ON 2.7-3.3 OFF	440 + 480 440 + 480
Old Ringback	2 sec ON 4 sec OFF	420 + 40 420 + 40
Double Ringback	0.8 sec ON 0.3 sec OFF 0.8 sec ON 4 sec OFF	440 + 480 440 + 480 440 + 480 440 + 480

Fax answertone detection requirements include 2100 and 1100 Hz. The call progress detection requirements are identical to the lowband data signals identified above.

6.5.2 Ring Detection

Ring detection is based on a digital input to the modem. External circuitry not part of the modem is required to convert the analog 40 to 150 VRMS ring signal to a digital single-bit data stream representation. Valid ring frequencies of 15.3 to 68 Hz are detected. Detection is achieved by counting valid high to low ring signal transitions. Valid transitions consist of a high state of 2 to 34 ms followed

by a low state of 2 to 42 ms. Ring signals that have transition counts less than the nominal value are discarded.

In addition to valid high to low transitions, ring detection depends on the cadence of the ring ON time (valid transitions occurring) and ring OFF time (no valid transitions). Ring OFF times must be greater than 0.5 seconds. Ring ON times must be greater than 125 ms at 20Hz (100 ms at 68Hz).

Ring detection is integrated over 8 seconds. All counters and timers are reset at 8 second intervals. The modem will answer the ring after N valid ON/OFF ring cycles. N is programmable via the SO register. Upon detecting N rings, the modem verifies that the current ring state has been in the OFF state for 0.5 seconds before seizing the line.

Table 6-1. Fax Class 1 Calling Sequence

DTE Commands (Host)	DCE Responses (Modem)	Remote Fax	Notes
(1) AT+FCLASS=1	(2) OK		Set to Class 1
PHASE A			
(3) ATDT6163	(4) dials (6) CONNECT	(5) answers (7) Send HDLC flags	+FRH=3 implied by Dialing
PHASE B			
		(8) Send NSF Frame	
	(9)	<NSF>, OK	
(10) AT+FRH=3	(11) CONNECT		
		(12) Send CSI frame	
	(13) <CIS>, OK		
(14) AT+FRH=3	(15) CONNECT		
		(16) Send DIS frame	last frame bit = 1
	(17) <DIS>, OK	(18) Drop carrier	
(19) AT+FTH=3	(20) send HDLC flags	(21) Receive flags	
	(21) CONNECT		
(22) <TSI>	(23) Send TSI frame	(24) Receive TSI	last frame bit = 0
	(25) CONNECT		
(26) <DCS>	(27) send DCS frame	(28) Received DCS	last frame bit = 1
	(29) detect last frame bit		
	(30) OK, drop carrier		

Table 6-1. Fax Class 1 Calling Sequence (Continued)

DTE Commands (Host)	DCE Responses (Modem)	Remote Fax	Notes
(31) AT+FTS=8	(32) OK, wait 80 ms		
(33) AT+FTM=96	(34) send F.29		
	(35) CONNECT		
(36) <TCF>	(37) send TCF data	(38) Receive and check	
	(39) OK		
(40) AT+FRH=3	(41) CONNECT		
		(42) send CFR frame	last frame bit = 1
	(43) <CFR>, OK	(44) drop carrier	
	(45) OK		
PHASE C			
(46) AT+FRM=06	(47) send V.29		
	(48) CONNECT		
(49) Page data	(50) send page data	(51) receive data	
	(52) OK		
(53) AT+FTH=3	(54) send HDLC flags	(55) receive flags	
	(56) CONNECT		
PHASE D			
(57) <EOP>	(58) send EOP frame	(59) receive EOP	last frame bit = 1
	(60) OK, drop carrier		
(61) AT+FRH=3	(62) CONNECT		
		(63) send MCF frame	last frame bit = 1
	(64) <MCF>,OK		
(65) AT+FTH=3	(66) send HDLC flags	(67) receive flags	
	(68) CONNECT		
(69) <DCN>	(70) send DCN frame	(71) receive DCN	last frame bit = 1
	(72) OK, drop carrier		
PHASE E			
(73) ATH0	(74) OK, hang up	(75) hang up	

Table 6-2. Fax Class 1 Answering Sequence

DTE Commands (Host)	DCE Responses (Modem)	Remote Fax	Notes
(1) AT+FCLASS=1	(2) OK		Set to Class 1
(2b) AT+FRM=?	24,48		
	OK		
PHASE A			
		(3) FAX machine dials	
	(4) RING		
(5) ATA	(6) modem answers		
	(7) Send HDLC flags	(8) Receive flags	+FTH=3 implied by answering
	(9) CONNECT		
PHASE B			
(10) <NSF>	(11) send NSF frame	(12) Receive NSF	last frame bit = 0
	(13) CONNECT		
(14) <CSI>	(15) send CSI frame	(16) Receive CSI	last frame bit = 0
	(17) CONNECT		
(18) <DSI>	(19) send DSI frame	(20) Receive DSI	last frame bit = 1
	(21) OK, drop carrier		
(22) AT + FRH=3	(23) CONNECT		
		(24) Send TSI frame	last frame bit = 0
	(25) <TSI>,OK		
(26) AT+FRH=3	(27) CONNECT		
		(28) send DCS frame	last frame bit = 1
	(29) <DCS>,OK	(30) Drop Carrier	
(31) AT+FTH=3			
		(32) Send V.27 (4800)	
	(33) CONNECT	(34) Send TCF frame	
	(35) <TCF>	(36) Drop Carrier	
	(37) NO CARRIER		
(38) AT+FRM=48	(39) CONNECT		

Table 6-2. Fax Class 1 Answering Sequence (Continued)

DTE Commands (Host)	DCE Responses (Modem)	Remote Fax	Notes
(40) <CFR>	(41) Send CFR frame	(42) Receive CFR	last frame bit = 1
	(43) OK, drop carrier		
PHASE C			
(44) AT+FRM-48			
		(45) Send page data	
	(46) <page data>	(47) Drop carrier	
	(48) NO CARRIER		
PHASE D			
(49) AT+FRH=3	(50) CONNECT		
		(51) Send EOP frame	last frame bit = 1
	(52) <EOP>, OK		
(53) AT+FTH=3	(54) CONNECT		
(55) <MCF>	(56) Send MCF frame	(57) Receive MCF	last frame bit = 1
	(58) OK, drop carrier		
(59) AT+FRH=3	(60) CONNECT		
		(61) Send DCN frame	last frame bit = 1
	(62) <DCN>, OK		
PHASE E			
(73) ATH0	(74) OK, hang up	(75) hang up	

Table 6-3. Terminal Called by a 1200 bps Data Modem

DTE COMMAND	DCE RESPONSE	COMMENTS
		Assume DCE in fax mode (FCLASS = 1), DTE running fax communication package, and DCD is off.
AT&C1	OK	DTE commands DCD to follow data carrier
ATS9=n	OK	DTE defines the data mode connection time.
AT+FAA=1	OK	DTE enables data/fax auto answer mode
		DTE sets the communication rate to the data modem rate (e.g., 2400 bps) **prior to an incoming call.**
	RING	Terminal is being called.
ATA		DTE commands DCE to go off-hook and start auto answer.
		DCE determines caller as data modem and establishes connection with caller.
		DCE turns on DCD to indicate data connection is established.
		DCE then waits in on-line command mode.
	DATA	DCE indicates data modem connection is established.
AT commands	OK	DTE optionally sends any commands to DCE to restore conditions required by data modem communications package.
ATO	CONNECT 1200	DTE instructs DCE to switch from on-line command to data state.
		DTE then transfers control to data modem package.
		Fax package remains in background polling DCD to check connection status.
		DCE response will then be read by data modem communication rate to 1200 bps.
	“Callers data”	DTE sends/receives data.
		Caller hangs up. DTE detects carrier loss and turns off DCD.
	NO CARRIER	DCE indicates connection with caller has terminated.
		DTE fax communications software, running in background, sees DCD turn off, and regains control from data modem package.

Table 6-4. Terminal Called by a Fax Machine

DTE Command	DCE Response	Comments
		Assume DCE in fax mode (FCLASS = 1), DTE is running fax communication package, and DCD is off.
AT&C1	OK	DTE commands DCD to follow data carrier.
ATS9=n	OK	DTE defines the data mode connection time.
AT+FAA=1	OK	DTE enables data/fax auto answer mode.
		DTE sets the communication rate to the data modem rate (e.g., 2400 bps) **prior to an incoming call.**
	RING	Terminal is being called.
ATA		DTE commands DCE to go off-hook and start auto answer.
		DCE starts data modem handshaking. If receive data signal is not detected within S9 seconds from going off-hook, DCE switches to fax mode and automatically sets FCLASS=1.
	FAX	DCE switches to fax mode handshaking and sends “FAX” message at the data modem rate (e.g., 2400 bps).
		DCE sends 3 seconds of 2100 Hz answer tone, enters V.21 transmit mode, and sends HDLC flags.
	CONNECT	DCE ends CONNECT response at the fax rate (i.e., 19200 bps).

7.0 Electrical/Mechanical Specifications

7.1 Interfacing the RC224ATLV

7.1.1 Interfacing the RC224ATLV 3.3 V Digital Logic with External 5.0 V Digital Logic

The RC224ATLV is not 5.0 Volt I/O logic tolerant. It is recommended to add a series resistor of 150 ohms to current limit the digital inputs to the RC224ATLV when interfacing to +5.0 volt logic output lines. The digital outputs of the RC224ATLV should not go to resistor pull-ups that are connected to the +5 volt power supply. These precautions will help prevent the modem chip from going into latch-up due to raising any input or output pin level more than +0.3 volts above the +3.3 volt power rail of the RC224ATLV.

7.2 Environmental Requirements

The environmental specifications are listed in Table 7-1.

Table 7-1. Environmental Specifications

Parameter	Specification
Operating Temperature	0°C to +70°C (32°F to 158°F)
Storage Temperature	-55°C to +125°C (-67°F to +257°F)
Relative Humidity	Up to 90% noncondensing, or a wet bulb temperature up to 35°C, whichever is less.

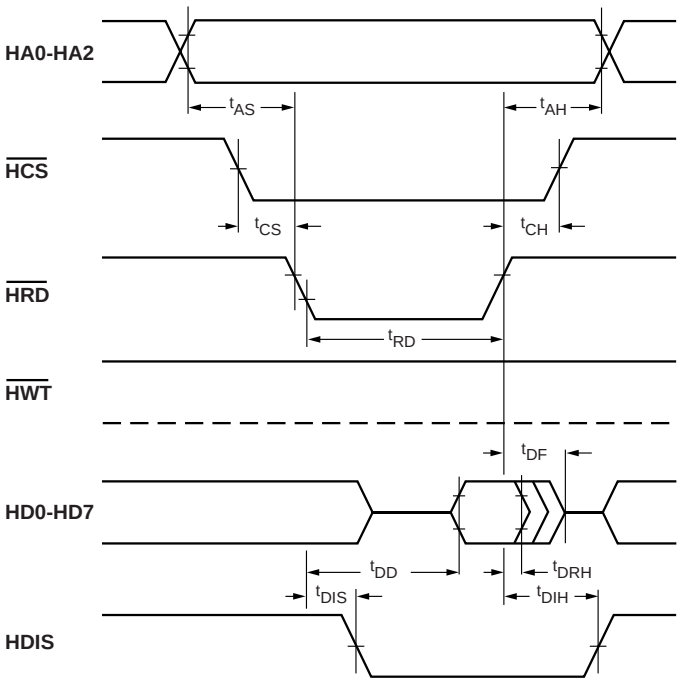
7.3 Interface Timing and Waveforms

Table 7-2 lists the host bus interface timing parameters. illustrates the interface waveforms.

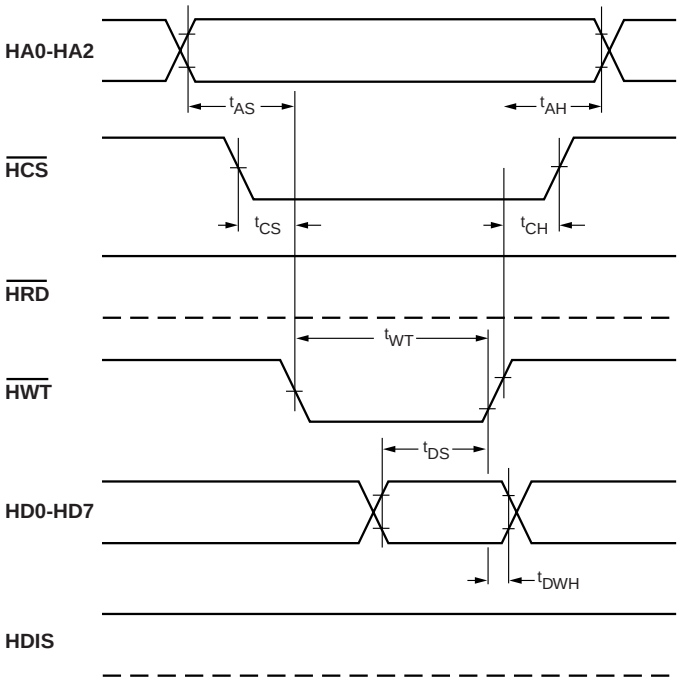
Table 7-2. Timing - Host Bus Interface

Symbol	Parameter	Min	Max	Units
tAS	Address Setup	25	-	ns
tAH	Address Hold	0	-	ns
tCS	Chip Select Setup	10	-	ns
tCH	Chip Select Hold	0	-	ns
tRD	Read Strobe Width	100	-	ns
tDD	Delay HRD to Data	-	75	ns
tDRH	$\overline{\text{HRD}}$ to Data Hold	10	-	ns
tWT	Write Strobe Width	75	-	ns
tDS	Write Data Setup	30	-	ns
tDWH	Write Data Hold	10	-	ns
tDF	$\overline{\text{HRD}}$ to Driver Off	-	30	ns
tDIS	HDIS Enable	-	40	ns
tDIH	HDIS Hold	40	-	ns
tINH	Interrupt Hold	-	100	ns

Figure 7-1. Timing Waveform



a. Host Read



b. Host Write

Table 7-3. Current and Power Requirements

Mode	Current (ID)		Power (PD)	
	Typical Current @ 25°C	Maximum Current @ 0°C	Typical Power @ 25°C	Maximum Power @ 0°C
Operating	31 mA	33 mA	155 mW	165 mW
Sleep - Idle	7 mA	9 mA	35 mW	45 mW
Sleep - Stop	2 mA	2 mA	10 mW	10 mW

Notes:
1. Test conditions: VDD = 5.0 VDC for typical values; VDD = 5.25 VDC for maximum values.
2. Test conditions: VDD = 3.3 VDC for typical values; VDD = 3.6 VDC for maximum values.

Table 7-4. Absolute Maximum Ratings

Parameter	Symbol	Limits	Units
Supply Voltage	V_{DD}	-0.5 to +7.0	V
Input Voltage	V_{IN}	-0.5 to VDd + 0.5	V
Analog Inputs	V_{IN}	-0.3 to +5VAa + 0.3	V
Voltage Applied to Outputs in High Z State	V_{HZ}	-0.5 to +5VDD + 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}	-40 to +80	C

Table 7-5. 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 DIO		2.4	-	V_{CC}		
Type IH		-30	-	30		
Input Low Voltage	V_{IL}				Vdc	
Type IA, IC, and DO		-0.3	-	0.8		
Input Low Voltage	V_{IL}				Vrms	
Type IF		38	-	-		Note 3
Input Leakage Current	I_{IN}				Adc	V_{IN} = 0 to V_{CC}
IA and IC		-	-	10		
Output High Voltage	V_{OH}				Vdc	
Type OA		2.4	-	-		I_{LOAD} = -100A
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_{TS}			25	Adc	V_{IN} = 0.8 V to 4.5V

Notes:
1. Test Conditions: V_{CC} = 5V 5%, T_A= 0°C to 70°C (unless otherwise stated). (RC224ATL)
2. Test Conditions: V_{CC} = 3.3V 5%, T_A= 0°C to 70°C (unless otherwise stated). (RC224ATLV)
   Output loads: 50 pF + one TTL.
3. AC V_{rms} voltage between Tip and Ring, using the on-board modular DAA.

Table 7-6. Analog Interface Characteristics

Name	Type	Characteristic	Value
RXA	I (DA)	Input Impedance:	>50K Ω
		Voltage Range:	2.5**1.6V
TXA1, TXA2	O (DD)	Minimum Load:	300 Ω
		Maximum Capacitive Load:	0.01 **F
		Output Impedance:	10 Ω
		Output Voltage:	2.5**1.6V
		D.C. Offset:	<200 mV[1]
SPKR	O (DF)	Minimum Load:	300 Ω
		Maximum Capacitive Load:	0.01 **F
		Output Impedance:	10 Ω
		Output Voltage:	2.5**1.6V
		D.C. Offset:	<20 mV[1]
Note: 1. With Reference to VC (2.5 V nominal).			

Figure 7-2. 68-Pin PLCC

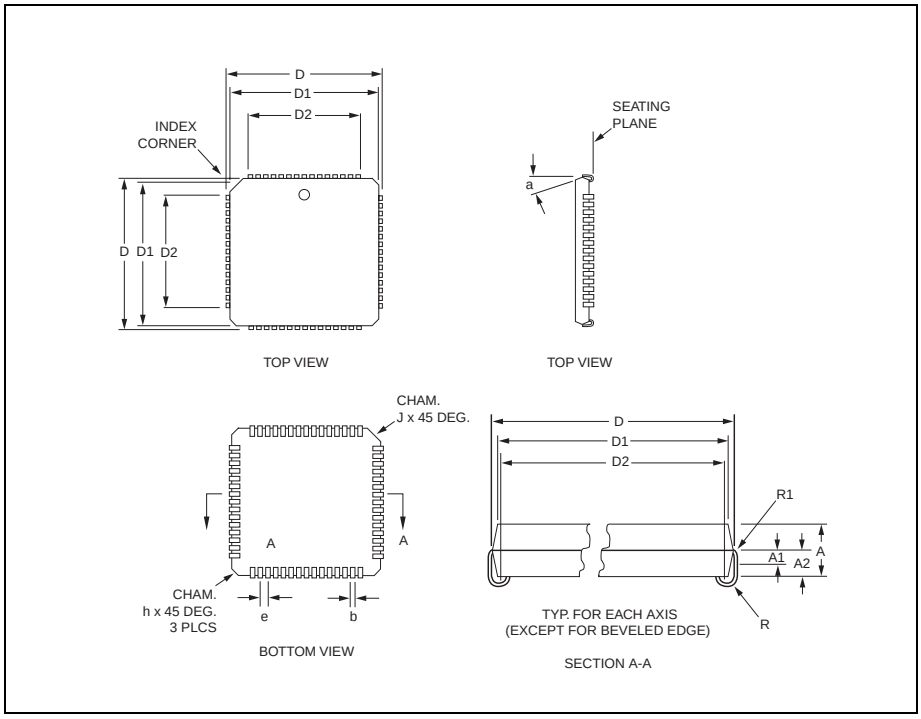


Table 7-7. 68-Pin PLCC Dimensions

Dim	Millimeters		Inches	
	Min	**Max**	**Min**	**Max**
A	4.14	4.39	0.163	0.173
A1	1.37	1.47	0.054	0.058
A2	2.31	2.46	0.091	0.097
b	0.457 TYP		0.018 TYP	
D	25.02	25.27	0.985	0.995
D1	24.00	24.26	0.945	0.955
D2	20.19	20.45	0.795	0.805
D3	23.24	23.5	0.915	0.925
e	1.27 BSC		0.050 BSC	

Table 7-7. 68-Pin PLCC Dimensions (Continued)

Dim	Millimeters		Inches	
	Min	Max	Min	Max
h	0.254 TYP		0.010 TYP	
j	1.15 TYP		0.045 TYP	
a	45° TYP		45° TYP	
R	0.89 TYP		0.035 TYP	
R1	0.254 TYP		0.010 TYP	
Ref: PD68J/GP00-D164				

Figure 7-3. 100-Pin PQFP

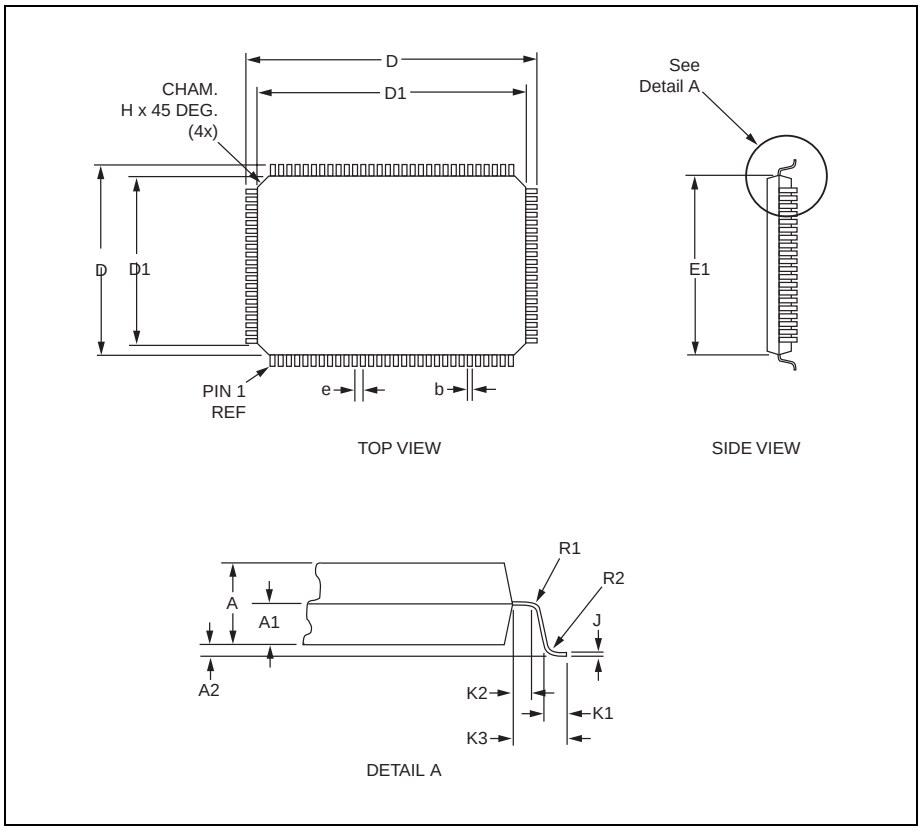


Table 7-8. 100-Pin PQFP Dimensions

Dim	Millimeters		Inches	
	Min	Max	Min	Max
A	1.95	2.05	0.077	0.081
A1	0.95	1.05	0.037	0.041
A2	0.15	0.25	0.006	0.010
D	22.96	23.44	0.904	0.923
D1	19.89	20.09	0.783	0.791
E	16.94	17.45	0.667	0.687
E1	13.89	14.10	0.547	0.555
K1	0.70	0.90	0.028	0.035
K2	0.40	–	0.016	–
K3	1.60 REF		0.083 REF	
R1	0.13	–	0.005	–

Table 7-8. 100-Pin PQFP Dimensions (Continued)

Dim	Millimeters		Inches	
	Min	Max	Min	Max
R2	0.15	0.25	0.008	0.010
a	0.60	0.70	0.024	0.028
b	0.26	0.36	0.010	0.014
h	–	0.25	–	0.010
j	0.13	0.17	0.005	0.007
Ref: GP00-D234				

Appendix A. Modem Designs

A.1 RC224ATF Modem Designs

This appendix describes two modem design examples. The schematics and parts lists are provided for designs incorporating the RC224ATF packaged in a 68-pin PLCC and implemented with either a parallel or serial interface.

A.1.1 RC224ATF 68-Pin PLCC Design for Serial Interface

Figure A-1 and Table A-1 are the schematic and parts list, respectfully, of an RC224ATF 68-pin PLCC serial interface board design.

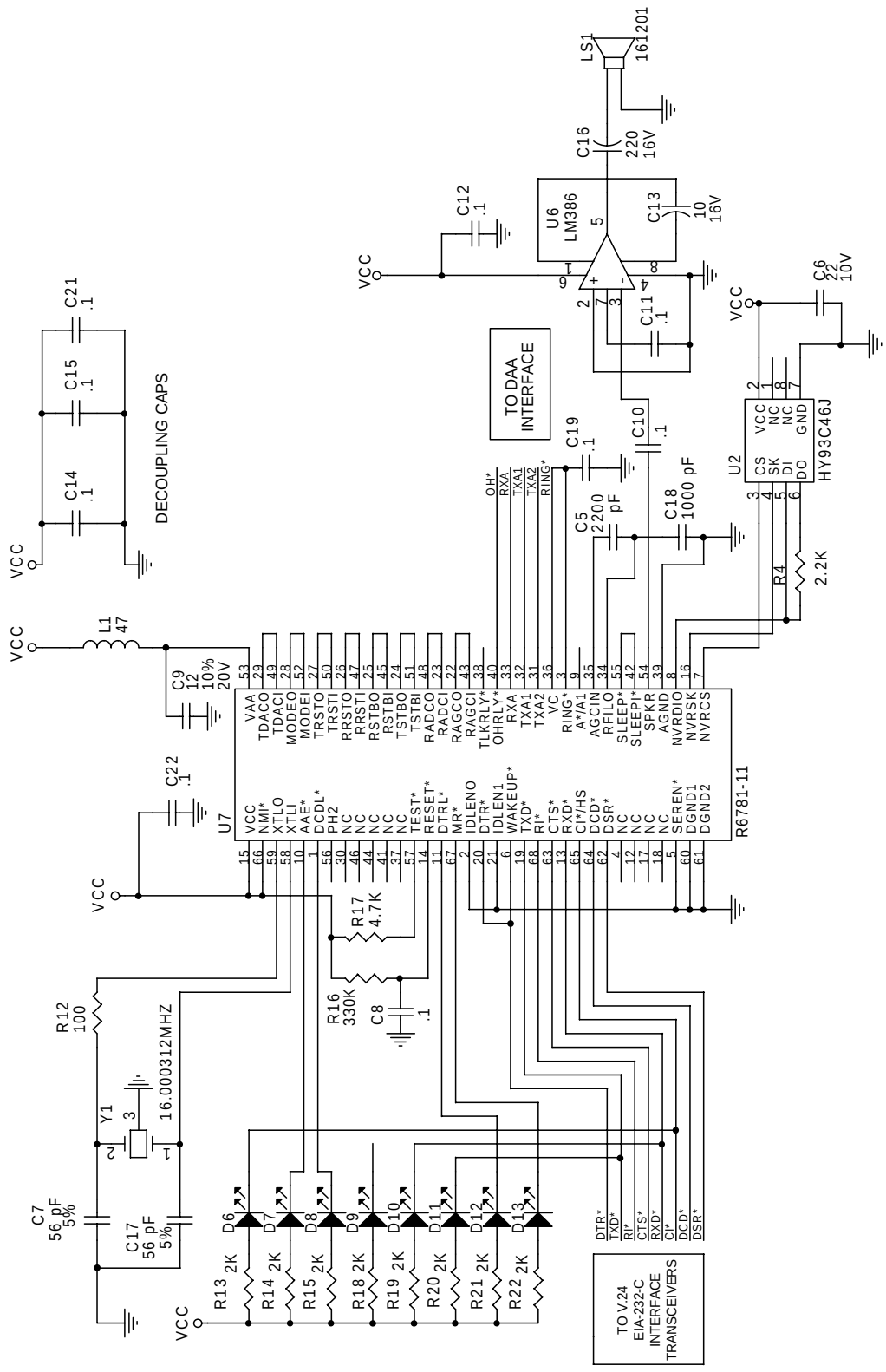


Figure A-1. Serial Interface Design

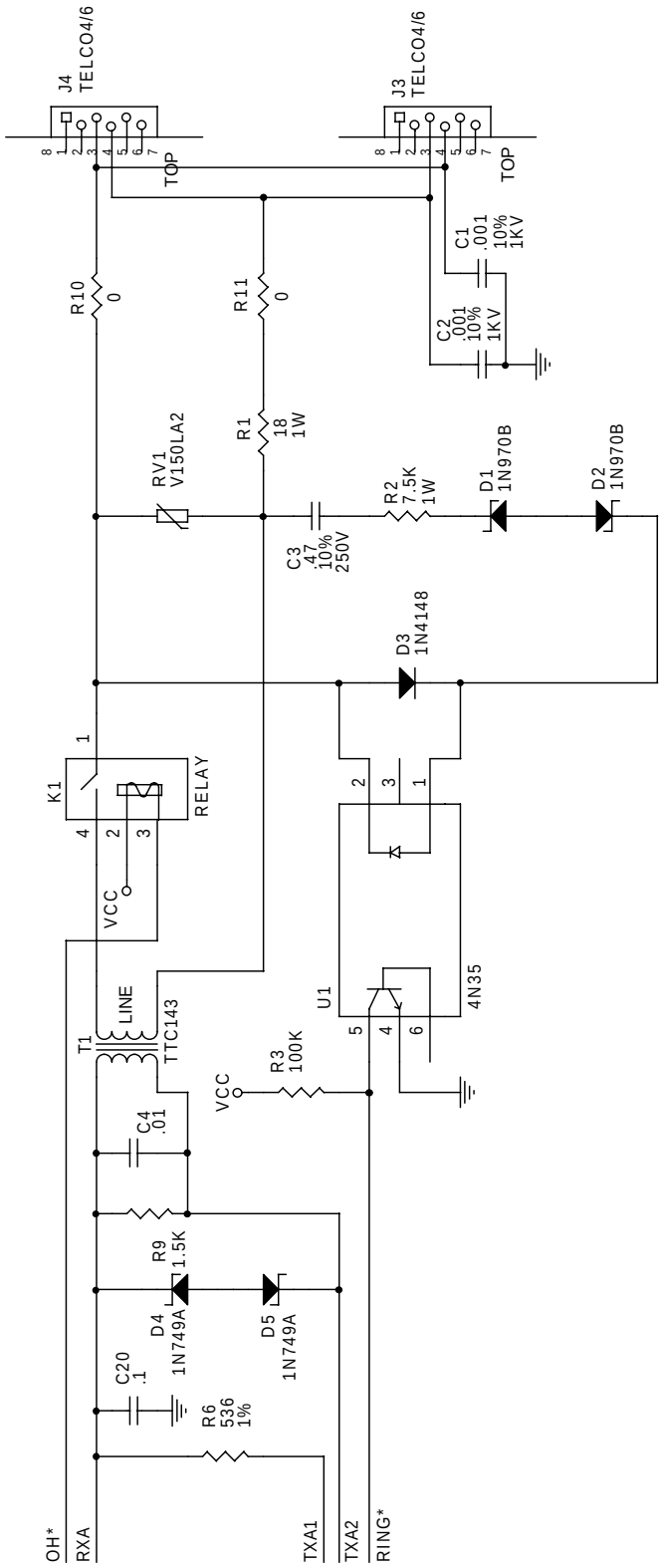


Figure A-2. Serial Interface Design DAA

A.1.2 Serial Bill Of Materials

Table A-1. Serial Bill of Materials

Item	Quantity	Reference	Part
1	2	C2,C1	.001
2	1	C3	.47
3	1	C4	.01
4	1	C5	2200 pF
5	1	C6	22
6	2	C7,C17	56 pF
7	9	C8,C10,C11,C12,C14,C15,	.1
		C19,C20,C21	
8	1	C9	12
9	1	C13	10
10	1	C16	220
11	1	C18	1000 pF
12	2	D1,D2	1N970B
13	1	D3	1N4148
14	2	D5,D4	1N749A
15	8	D6,D7,D8,D9,D10,D11,D12,	
		D13	
16	2	J4,J3	TELCO4/6
17	1	K1	RELAY
18	1	LS1	161201
19	1	L1	47
20	1	RV1	V150LA2
21	1	R1	18
22	1	R2	7.5K
23	1	R3	100K
24	1	R4	2.2K
25	1	R6	536
26	1	R9	1.5K

Table A-1. Serial Bill of Materials (Continued)

Item	Quantity	Reference	Part
27	2	R11,R10	0
28	1	R12	100
29	8	R13,R14,R15,R18,R19,R20,	2K
		R21,R22	
30	1	R16	330K
31	1	R17	4.7K
32	1	T1	TTC143
33	1	U1	4N35
34	1	U2	HY93C46J
35	1	U6	LM386
36	1	U7	R6781-11
37	1	Y1	16.000312MHZ

A.2 RC224ATF 68-Pin PLCC Design for Parallel Interface

Figure A-3 and Table A-2 are the schematic and parts list, respectfully, of an RC224ATF 68-pin PLCC parallel interface board design.

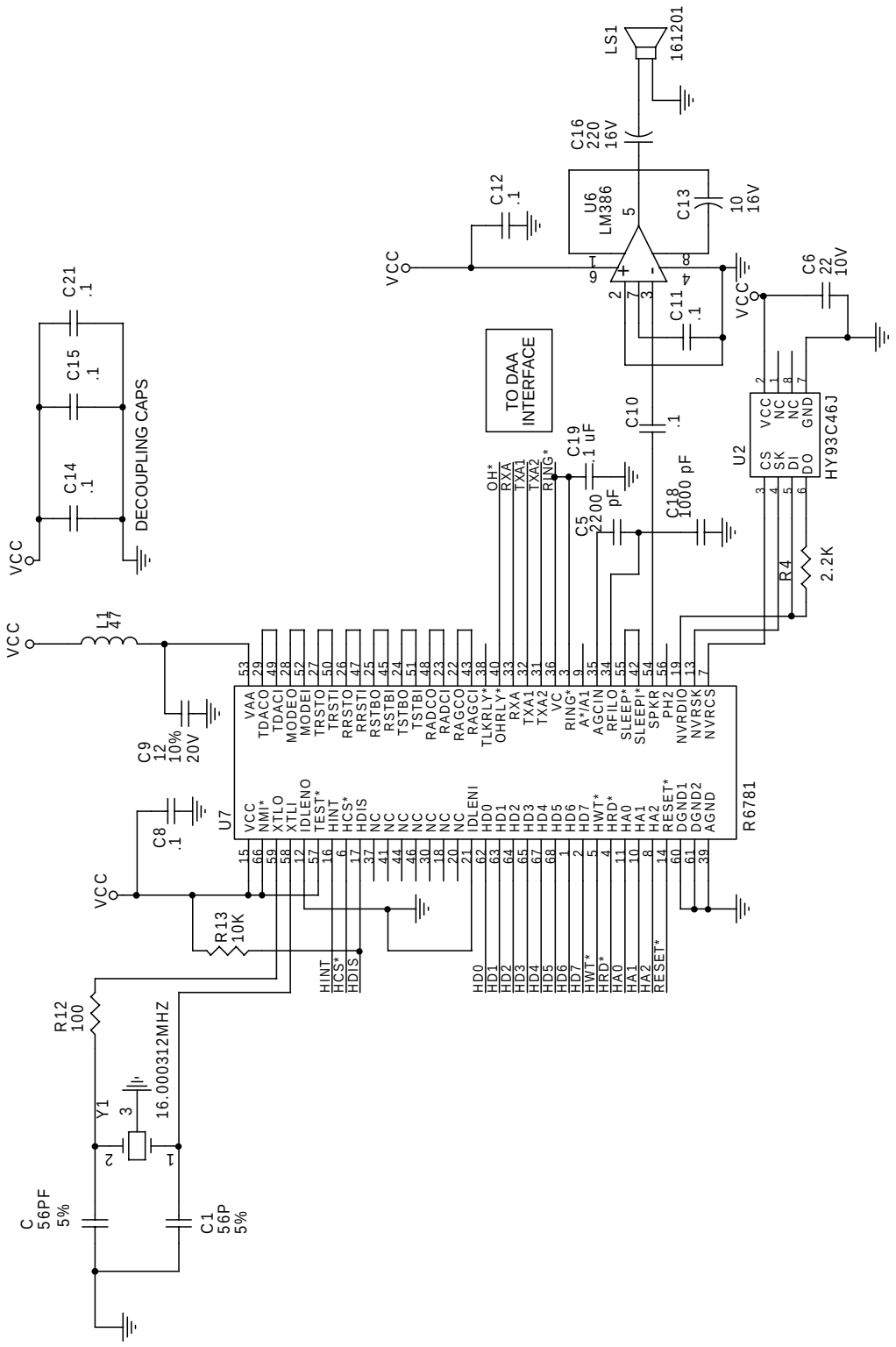


Figure A-3. Parallel Interface Design

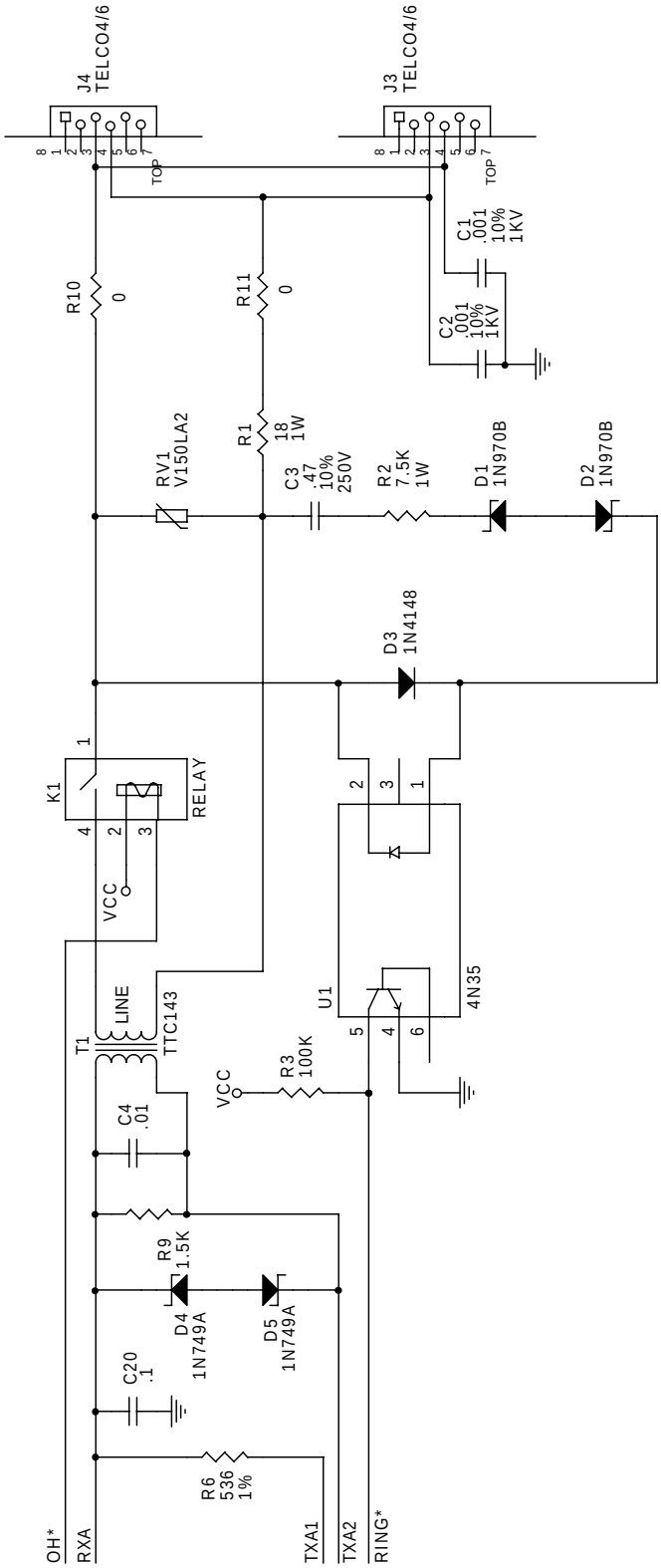


Figure A-4. Parallel Interface Design DAA

A.2.1 Parallel Bill Of Materials

Table A-2. Parallel Billing Materials

Item	Quantity	Reference	Part
1	2	C2,C1	.001
2	1	C3	.47
3	1	C4	.01
4	1	C5	2200 pF
5	1	C6	22
6	2	C7,C17	56PF
7	8	C8,C10,C11,C12,C14,C15,	.1
		C20,C21	
8	1	C9	12
9	1	C13	10
10	1	C16	220
11	1	C18	1000 pF
12	1	C19	.1 uF
13	2	D1,D2	1N970B
14	1	D3	1N4148
15	2	D5,D4	1N749A
16	2	J4,J3	TELCO4/6
17	1	K1	RELAY
18	1	LS1	161201
19	1	L1	47
20	1	RV1	V150LA2
21	1	R1	18
22	1	R2	7.5K
23	1	R3	100K
24	1	R4	2.2K
25	1	R6	536
26	1	R9	1.5K
27	2	R11,R10	0

Table A-2. Parallel Billing Materials (Continued)

Item	Quantity	Reference	Part
28	1	R12	100
29	1	R13	10K
30	1	T1	TTC143
31	1	U1	4N35
32	1	U2	HY93C46J
33	1	U6	LM386
34	1	U7	R6781
35	1	Y1	16.000312MHZ