RC96V24AC and RC14V24AC
Low Power Integrated Low Speed Data/Fax/Voice Modem Device Set

INTRODUCTION

The Rockwell RC96V24AC/RC14V24AC integrated data/fax/voice modem device set family supports low speed data, high speed fax, and voice operation. It consists of data/fax/voice modem data pump and controller devices with supporting firmware. The modem supports data throughput to 9600 bps, fax operation up to 14400 bps (RC14V24AC) or 9600 bps (RC96V24AC), and voice functions. Extended "AT" commands provide data, fax class 1 and class 2, MNP 10, voice, and world-class functions to meet world-wide requirements while using minimal external ROM, RAM, and optional NVRAM. Models supporting US/Canada, single country, and multiple countries with different memory requirements are available (Table 1).

As a data modem, the modem operates at line speeds up to 2400 bps. Error correction (V.42/MNP 2–4) and data compression (V.42 bis/MNP 5) maximize data transfer integrity and boost average throughput up to 9.6 kbps. The modem also operates in non-error-correcting mode.

As a fax modem, the modem supports Group 3 send and receive rates up to 14400 bps (RC14V24AC) or 9600 bps (RC96V24AC) and supports T.30 protocol.

The modem operates over dial-up or leased lines, can auto-dial and auto-answer, and can operate in both synchronous and asynchronous modes. Configuration information can be stored in non-volatile memory.

The modem uses enhanced Adaptive Differential Pulse Coded Modulation (ADPCM) coding and decoding to support efficient digital storage of voice messages, as well as optional coder silence deletion and decoder silence interpolation to significantly increase compression rates.

A PC-based "ConfigurACE™" utility program can be used to customize the MCU firmware to specific application and country requirements.

With its small size and extremely low power consumption, this modem device set is ideal for laptop, notebook, and palmtop applications.

Accelerator kits are available to minimize application design time and costs.

PCMCIA PC Card designs are supported with a Rockwell PCMCIA Interface Controller Adapter (PICA) device.

FEATURES

- Data modem throughput to 9.6 kbps
  - —V.22 bis, V.22A/B, V.23, and V.21
  - —Bell 212A and 103
  - —V.42 LAPM and MNP 2-4 error correction
  - —V.42 bis and MNP 5 data compression
- Fax modem send and receive rates up to 14,400 bps
  - —V.17 (RC14V24AC) V.29, V.27 ter, and V.21 ch 2
- MNP 10 data throughput enhancement
- Voice mode (option)
  - —Enhanced ADPCM compression/decompression
  - —Tone detection/generation and call discrimination
  - —Concurrent DTMF detection
- World-class operation (option)
  - —V.25 bis commands
  - —Call progress and blacklisting parameters
  - —Multiple country support
- Expanded functions (option)
  - —Callback security; remote configuration and access
  - —Hayes AutoSync
- ConfigurACE utility program
- Communication software compatible command sets
  - —AT, fax class 1 and 2, and voice commands
  - —S registers
- Built-in DTE interfaces
  - —DTE speed to 19.2 kbps (data) or 38.4 kbps (voice)
  - —Parallel 16450 or 16450/16550A UART interface
  - —Serial CCITT V.24 (EIA-232-D)
- Line quality monitoring and auto retrain
- NVRAM directory and stored profiles
- Flow control and speed buffering
- Automatic format/speed sensing to 19.2 kbps
- Serial synchronous and asynchronous data
- Parallel asynchronous data
- Auto dial and auto answer
- Tone, pulse, and adaptive dialing
- Calling Number Delivery (Caller ID) detect
- Diagnostics
- Extended operating temperature models available
- +5V operation; typical low power consumption:

	RC96V24AC	RC14V24AC
Operating	250 mW	315 mW
Sleep mode (C29)	17.0 mW	12.0 mW
Sleep mode (C39)	14.5 mW	9.5 mW
Stop mode (C39)	10.8 mW	5.8 mW

- Two CMOS VLSI devices
  - —MCU: One 80-pin PQFP or one 84-pin PLCC
  - —MDP: One 100-pin PQFP or one 68-pin PLCC

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Table 1. Modem Models, Functions, and Memory Requirements

Model[1]	Supported Functions[2]							Memory (Bytes)		
	Fax	MNP10	W-Class	V.42 bis	AutoSync	Voice	Country	ROM	RAM	NVRAM
RC14V24AC/U	V.17	S	–	S	S	S	US/Can	128k	32k	128/256
RC96V24AC/U	V.29	S	–	S	S	S	US/Can	128k	32k	128/256
RC1424AC2(/U)	V.17	S	–	S	S	–	US/Can	128k	32k	128/256
RC9624AC2(/U)	V.29	S	–	S	S	–	US/Can	128k	32k	128/256
RC2324AC2(/U)	No fax	S	–	S	S	–	US/Can	128k	32k	128/256
RC14V24AC/U	V.17	–	–	S	–	S	US/Can	64k	32k	128/256
RC96V24AC/U	V.29	–	–	S	–	S	US/Can	64k	32k	128/256
RC1424AC2(/U)	V.17	–	–	S	–	–	US/Can	64k	32k	128/256
RC9624AC2(/U)	V.29	–	–	S	–	–	US/Can	64k	32k	128/256
RC2324AC2(/U)	No fax	–	–	S	–	–	US/Can	64k	32k	128/256
RC14V24AT/U	V.17	–	–	–	–	S	US/Can	32k	0k	128/256
RC96V24AT/U	V.29	–	–	–	–	S	US/Can	32k	0k	128/256
RC1424AT2(/U)	V.17	–	–	–	–	–	US/Can	32k	0k	128/256
RC9624AT2(/U)	V.29	–	–	–	–	–	US/Can	32k	0k	128/256
RC14V24ACW(E)/U	V.17	S	S	S	S	S	Multiple	128k	32k	2k
RC96V24ACW(E)/U	V.29	S	S	S	S	S	Multiple	128k	32k	2k
RC1424AC2W(/U)	V.17	S	S	S	S	–	Multiple	128k	32k	2k
RC9624AC2W(/U)	V.29	S	S	S	S	–	Multiple	128k	32k	2k
RC2324AC2W(/U)	No fax	S	S	S	S	–	Multiple	128k	32k	2k
RC14V24ACW/64U	V.17	–	–	S	–	S	Single	64k	32k	256
RC96V24ACW/64U	V.29	–	–	S	–	S	Single	64k	32k	256
RC1424ACW/64(/U)	V.17	–	–	S	–	–	Single	64k	32k	256
RC9624ACW/64(/U)	V.29	–	–	S	–	–	Single	64k	32k	256
RC2324ACW/64(/U)	No fax	–	–	S	–	–	Single	64k	32k	256

Notes:

1. Model options:
   - (E) Optional industrial temperature range.
   - (U) Optional C39 MCU.
   - U Offered only with C39 MCU.
2. Supported Functions (S = Supported; – = Not supported):
   - Fax Fax class 1 and class 2 command functions.
   - MNP 10 Data throughput enhancement functions.
   - W-Class World class functions supporting multiple country requirements.
   - AutoSync Hayes AutoSync available in 128k-byte ROM models.
   - V.42 bis V.42 bis and MNP 5 functions.
   - Voice Voice command functions.

TECHNICAL SPECIFICATIONS

GENERAL DESCRIPTION

Modem Data Pump

The modem data pump (MDP) is a Rockwell RC14V24DP or RC96V24DP data/fax/voice modem data pump. The only external component difference between the two MDPs is the crystal frequency: 19.000265 MHz for the RC14V24DP; 24.00014 MHz for the RC96V24DP. The MDP is provided in a 68-pin PLCC or a 100-pin PQFP.

As a data modem, both MDPs can operate in 2-wire, full-duplex, synchronous/asynchronous modes at line rates up to 2400 bps.

As a fax modem, the MDP fully supports Group 3 facsimile send and receive speeds of 14400 (RC14V24DP only), 9600, 7200, 4800, and 2400 bps.

Microcontroller (MCU)

The microcontroller (MCU) performs the command processing and host interface functions. The MCU is a Rockwell C29 or C39 microcomputer packaged in a 84-pin PLCC or a 80-pin PQFP. The MCU connects to the host via a V.24 (EIA-232-D) serial interface or a parallel microcomputer bus. The MCU connects to the modem data pump via dedicated lines and an external bus. The external bus also connects to the OEM-supplied 32k/64k/128k-byte ROM and 32k/0k-byte RAM. The C29 provides a 16450-compatible parallel interface. The C39 provides a 16450/16550A-compatible parallel interface and a Stop mode. The only external component difference between the two is the crystal frequency: 8.064 MHz for the C29; 4.032 MHz for the C39.

MCU Firmware

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

SUPPORTED INTERFACES

The major hardware signal interfaces of the modem device set are illustrated in Figure 1.

Parallel Interface

A 16450 UART-compatible (C29 MCU) or 16450/16550A UART-compatible (C39 MCU) parallel interface and a supporting stop mode control signal are provided.

Host Bus Interface. Eight data lines, three address lines, and five (C29) or nine (C39) control lines are supported.

Stop Mode Control (C39). The $\overline{\text{STPMODE}}$ input is supported which controls modem entry into Stop Mode.

Serial/Switch/Indicator Interface

A DTE serial interface, direct connect and bit mapped switch inputs, and indicator/control outputs are supported.

Serial Interface. A 16-line V.24/EIA-232-D logic-compatible serial interface to the DTE is supported. A clock stop signal is also supplied to turn off transmitter and receiver clocks in asynchronous modes.

Switch Interface. A direct connect strap input can be sampled. Thirteen switch inputs, bit-mapped through an external three-state buffer, can be sampled in the world-class (W-class) configuration.

Indicator Interface. Four direct connect indicator outputs are supported. Six indicator outputs, bit-mapped through an external latch, are supported in W-class configurations.

Stop Mode Control (C39). The $\overline{\text{STPMODE}}$ input is supported which controls modem entry into Stop Mode.

NVRAM Interface

A serial interface to the optional OEM-supplied 128/256/2048-byte non-volatile RAM (NVRAM) is provided. Data stored in NVRAM can take precedence over the factory default settings. For US and single country models, a 256-byte NVRAM can store up to two user-selectable configurations and can store up to four 45-digit dial strings. For W-class models, the 2048-byte NVRAM can store up to 20 dial strings and up to 20 callback passwords/numbers.

Speaker Interface

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

MCU External Bus Interface

An external bus interface is provided to OEM-supplied 128k/64k/32k-byte ROM and 32k/0k-byte RAM. The non-multiplexed bus supports eight bidirectional data lines and 17 address lines. Dedicated ROM, RAM, MDP, and indicator/control select outputs are also provided for selecting/enabling external devices.

Line Interface

MDP. The MDP connects to the line interface circuitry via a receive analog input, two transmit analog outputs, two relay driver outputs, and a ring signal input. The relay outputs may be used to drive Caller ID and voice relays.

MCU. The MCU provides four relay control outputs to the line interface. These outputs may be used to control relays such as off-hook, pulse, mute, A/A1, earth, and talk/data. The MCU accepts ring signal and line current sense from the line interface.

COMMANDS

The modem supports data modem, fax class 1 and 2, MNP 10, voice, and W-class commands and S Registers (See Tables 2 and 3, respectively) depending on the modem model.

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

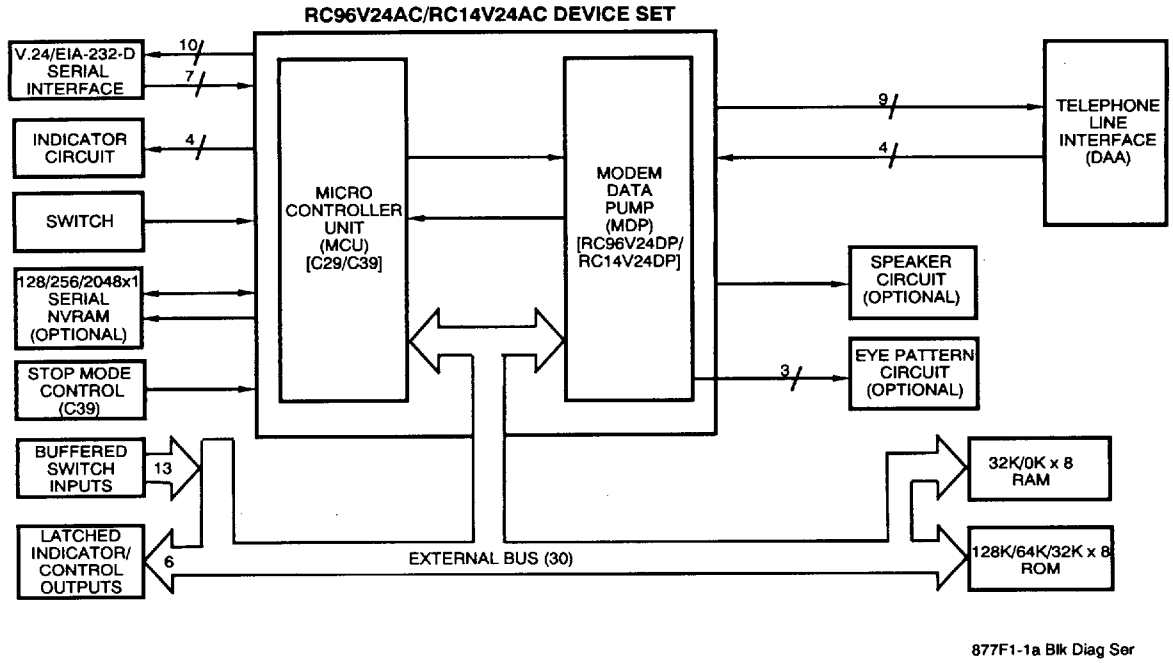
Fax Modem Operation. Models supporting facsimile functions operate in response to fax class 1 commands when +FCLASS=1 and fax class 2 commands when +FCLASS=2.

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

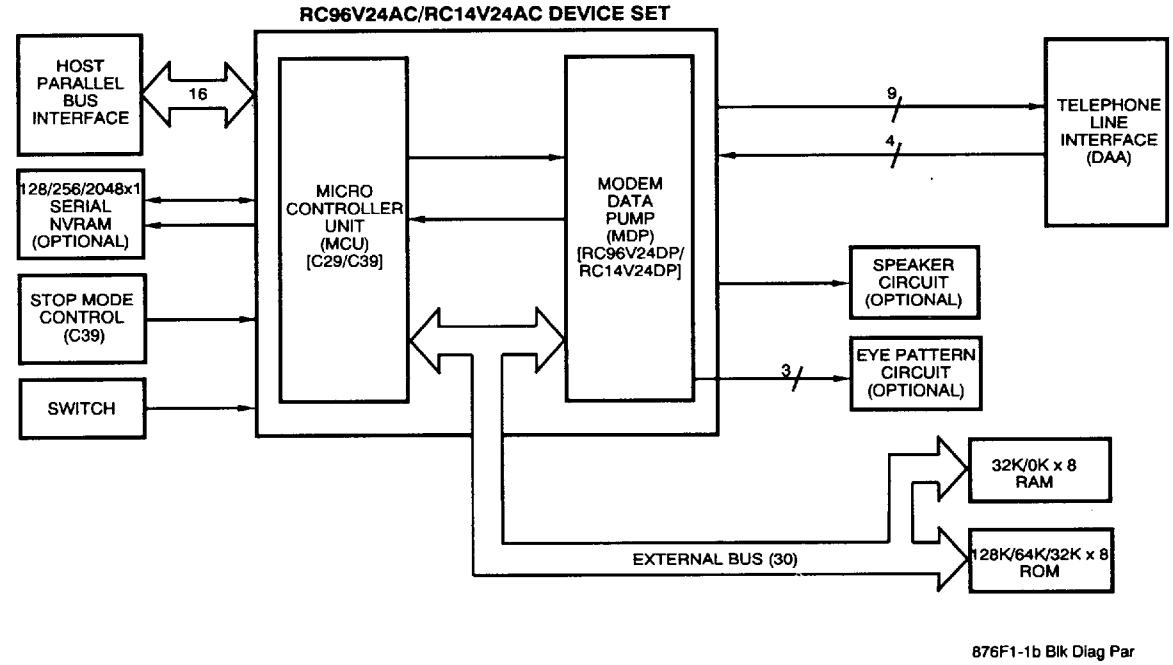
MNP 10 Operation. Models supporting MNP 10 functions operate in response to MNP 10 commands.

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

Expanded Function Operation. Expanded function (Secure Access; Remote Configuration and Access) operation is available in W-class models.



a. Serial Interface Selected



a. Parallel Interface Selected

Figure 1. Modem Device Set General Interface

Table 2. AT Commands

Command	Function
	Basic AT Commands
A/	Re-execute command
AT=x	Write to selected S Register
AT?	Read selected S Register
A	Answer a call
Bn	Set CCITT or Bell Mode
Cn	Carrier control
Dn	Dial (originate a call)
E	Command echo
Fn	Select line modulation
Hn	Disconnect (hang-up)
In	Identification
Ln	Speaker volume
Mn	Speaker control
Nn	Automode enable
On	Return to on-line data mode
P	Set pulse dial default
Qn	Quiet results codes control
Sn	Read/write S Register
T	Set tone dial default
Vn	Result code form
Wn	Error correction message control
Xn	Extended result codes
Yn	Long space disconnect
Zn	Soft reset and restore profile
&Cn	RLSD (DCD) option
&Dn	DTR option
&F	Restore factory configuration (profile)
&Gn	Select guard tone
&Jn	Telephone jack control
&Kn	Flow control
&Ln	Leased line operation
&Mn	Asynchronous/synchronous mode selection
&Pn	Select pulse dial make/break ratio
&Qn	Asynchronous/synchronous mode selection
&Rn	RTS/CTS option
&Sn	DSR override
&Tn	Test and diagnostic
&V	Display current configuration and stored profiles
&Wn	Store current configuration
&Xn	Select synchronous clock source
&Yn	Designate a default reset profile
&Zn=x	Store phone number
%En	Enable/disable line quality monitor and auto-retrain
%L	Report line signal level
%Q	Report line signal quality
%TTn	PTT testing utilities
\Gn	Modem-to-modem flow control (XON/XOFF)
\Jn	Enable DTE auto rate adjustment
\Kn	Break control
\Nn	Operating mode
#CID	Enable Caller ID detection and select reporting format

Table 2. AT Commands (Cont'd)

Command	Function
	ECC AT Commands
%C	Select data compression
\An	Maximum MNP block size
\Bn	Transmit BREAK to remote
\Ln	MNP block transfer control
	MNP 10 AT Commands
)Mn	Enable cellular power level adjustment
* Hn	Set link negotiation speed
-Kn	MNP extended services
-Qn	Enable fallback to V.22 bis/V.22
@Mn	Select initial transmit level
	Fax Class 1 AT+F Commands
+FCLASS=n	Service class
+FTS=n	Stop transmission and wait
+FRS=n	Receive silence
+FTM=n	Transmit data
+FRM=n	Receive data
+FTH=n	Transmit data with HDLC framing
+FRH=n	Receive data with HDLC framing
	Fax Class 2 AT+F Commands
+FCLASS=n	Service class
	Class 2 Action Commands
+FDT	Data transmission
+FET=N	Transmit page punctuation
+FDR	Begin or continue Phase C receive data
+FK	Terminate session
	Class 2 DCE Responses
+FCON	Facsimile connection response
+FDCS:	Report current session
+FDIS:	Report remote identification
+FCFR	Indicate confirmation to receive
+FTSI:	Report the transmit station ID
+FCSI:	Report the called station ID
+FPTS:	Page transfer status
+FET:	Post page message response
+FHNG:	Call termination with status
	Class 2 Session Parameters
+FMFR?	Identify manufacturer
+FMDL?	Identify model
+FREV?	Identify revision
+FDCC	DCE capabilities parameters
+FDIS	Current sessions parameters
+FDCS	Current session results
+FLID	Local ID string
+FPTS	Page transfer status
+FCR	Capability to receive
+FAA	Adaptive answer
+FBUF?	Buffer size (read only)
+FPHCTO	Phase C time out
+FAXERR?	Fax error value
+FBOR	Phase C data bit order

Table 2. AT Commands (Cont'd)

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

Table 3. S Registers

Register	Function
S0	Rings to auto-answer*
S1	Ring counter
S2	Escape character*
S3	Carriage return character
S4	Line feed character
S5	Backspace character
S6	Maximum time to wait for dial tone*
S7	Wait for carrier*
S8	Pause time for dial delay modifier*
S9	Carrier detect response time*
S10	Carrier loss disconnect time*
S11	Reserved*
S12	Escape code guard time*
S13	Reserved
S14	General bit mapped options*
S15	Reserved
S16	Test mode bit mapped options (&T)*
S17	Reserved
S18	Test timer*
S19-S20	Reserved
S21	V24/general bit mapped options*
S22	Speaker/results bit mapped options*
S23	General bit mapped options*
S24	Sleep inactivity timer
S25	Delay to DTR (CT108) off*
S26	RTS-to-CTS (CT105-to-CT106) delay*
S27	General bit mapped options*
S28	General bit-mapped options
S29	Flash modifier time
S30	Inactivity timer*
S31	General bit-mapped options
S32	XON character
S33	XOFF character
S34-S35	Reserved
S37	Line connection speed*
S38	Delay before forced hangup*
S39	Flow control*
S40	General bit-mapped options
S41	General bit-mapped options
S42-S45	Reserved
S91	PSTN transmit level
S95	Result code messages control*
S99	Leased line transmit level
	ECC S Registers
S36	LAPM failure control*
S46	Data compression control*
S48	V.42 negotiation control*
S82	Break handling control
S86	Call failure reason code
	W-Class S Registers
S80	Soft-switch functions

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

DATA MODEM OPERATION

Automatic Speed/Format Sensing

The modem can automatically determine the speed and format of the data sent from the DTE. The modem can sense speeds of 300, 600, 1200, 2400, 4800, 9600, and 19200 bps and the following data formats:

Parity	Data Length (No. of Bits)	No. of Stop Bits	Character Length (No. of Bits)
None	7	2	10
Odd	7	1	10
Even	7	1	10
None	8	1	10
Odd	8	1	11 *
Even	8	1	11 *

* 11-bit characters are sensed, but the parity bits are stripped off during data transmission in Normal and Error Correction modes. Direct mode does not strip off the parity bits.

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

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

ESTABLISHING DATA MODEM CONNECTIONS

Phone Number Directory

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

Dialing

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

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

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

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

Modem Handshaking Protocol

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

Call Progress Tone Detection

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

Answer Tone Detection

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

Ring Detection

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

Billing Protection

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

Connection Speeds

The modem functions as a data modem when the +FCLASS=0 command is active. The possible data connection modes/speeds are listed in Table 4. Two methods of establishing a connection are supported: use of the F command and use of N command, speed sense, and S37 register combination.

Automode Detect

Automode detection can be enabled by the N1 or F0 commands to allow the modem to connect to a remote modem at the highest compatible mode and rate supported by the remote modem

DATA MODE

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

Speed Buffering (Normal Mode)

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

Flow Control

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

Modem-to-Modem Flow Control. When enabled by the \G1 command, the modem supports XON/XOFF flow control with the remote modem to ensure data integrity. Modem-to-modem flow control is not used in error correc-

Table 4. Connection Speed Options

Configuration	Rate
V.22 bis	2400 or 1200 bps
V.22	1200 bps
V.23	1200Tx/75Rx or 75Tx/1200Rx
V.21	0-300 bps
Bell 212A	1200 bps
Bell 103	0-300 bps

tion mode. In this case, flow control is accomplished within the error-correction protocol.

Escape Sequence Detection

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

BREAK Detection

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

Telephone Line Monitoring

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

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

Send SPACE on Disconnect

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

Retrain

The modem may lose synchronization with the received line signal under poor line conditions. If this occurs, retraining may be initiated to attempt recovery depending on the type of connection.

Error-Correction Mode (LAPM/MNP). The modem initiates a retrain if any individual frame is retransmitted 5 or 9 times. The modem initiates a retrain before attempting the sixth or tenth re-transmission, respectively.

Non-Error-Correction Mode. The modem initiates a retrain if line quality becomes unacceptable if enabled by the %E command. The modem continues to retrain until an acceptable connection is achieved or until 30 seconds elapse which will result in telephone line disconnect.

Synchronous Data Mode (Serial Interface Only)

The modem can establish a synchronous connection in accordance with the &Mn, &Qn, or V.25 bis commands. Upon completing the physical handshake, the modem enters synchronous data mode. The inactivity timer is not used during synchronous data mode.

Direct Mode (Serial Interface Only)

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

Programmable Inactivity Timer

The modem will disconnect from the line if data is not sent or received for a specified length of time. In normal or error-correction mode, this inactivity timer is reset when data is received from either the DTE or from the line. This timer can be set to a value between 0 and 42 minutes with the \Tn command. The timer may also be programmed by S30 = n, where n = the number of tens of seconds.

DTE Signal Monitoring

$\overline{\text{DTR}}$. When $\overline{\text{DTR}}$ is asserted, the modem responds in accordance with the &Dn and &Qn commands.

$\overline{\text{RTS}}$. $\overline{\text{RTS}}$ is used for flow control if enabled by the &K command in normal or error-correction mode, or to affect the $\overline{\text{CTS}}$ output if enabled by the &R command in synchronous mode.

$\overline{\text{RDL}}$. When $\overline{\text{RDL}}$ is asserted, the modem requests a remote digital loop if connected in non-error-correction mode (serial interface only).

$\overline{\text{AL}}$. When $\overline{\text{AL}}$ is asserted, the modem disconnects and enters analog loop (serial interface only).

ERROR CORRECTION AND DATA COMPRESSION

V.42 Error Correction

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

MNP 2-4 Error Correction

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

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

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

V.42 bis Data Compression

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

The V.42 bis data compression employs a "string learning" algorithm in which a string of characters from the DTE is encoded as a fixed length codeword. Two 2k-byte dictionaries are used to store the strings. These dictionaries are dynamically updated during normal operation.

MNP 5 Data Compression

MNP 5 data compression mode, selected by the %Cn command, operates during an MNP connection.

In MNP 5, the modem increases its throughput by compressing data into tokens before transmitting it to the

remote modem, and by decompressing encoded received data before sending it to the DTE.

MNP 10 DATA THROUGHPUT ENHANCEMENT

MNP10 protocol, cellular functionality, and MNP Extended Services enhance performance under adverse channel conditions such as those found in rural, long distance, or cellular environments. An MNP 10 connection is established when an MNP 2-4 connection is negotiated with a remote modem supporting MNP 10. MNP 10 functions include:

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

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

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

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

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

MNP Extended Services. The modem can quickly switch to MNP 10 operation when the remote modem supports MNP 10 and both modems are configured to operate in V.42.

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

FAX CLASS 1 AND CLASS 2 OPERATION

The modem operates as a facsimile (fax) DCE whenever the +FCLASS=1 or +FCLASS=2 command is active. In the fax mode, the on-line behavior of the modem is different from the data (non-fax) mode. After dialing, modem operation is controlled by the fax commands. Some AT commands are still valid but may operate differently from data modem mode.

Calling Tone

Calling tone is generated in accordance with T.30.

VOICE MODE

Voice Mode includes three submodes: Online Voice Command Mode, Voice Receive Mode, and Voice Transmit Mode. (See Table 2.)

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

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

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

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

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

WORLD CLASS COUNTRY SUPPORT

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

V.25 bis Commands

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

Phone Number Directory

The modem can contain 20 telephone number entries.

Dialing

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

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

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

Ring Detection. The frequency range is programmable by ConfigurACE.

Adaptive Dialing. Adaptive dialing may be disabled by ConfigurACE.

Blind Dialing. Blind dialing may be disabled by ConfigurACE.

Carrier Transmit Level

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

Calling Tone

Calling tone is generated in accordance with V.25. Calling tone may be toggled (enabled/disabled) by inclusion of a "^" character in a dial string. It may also be disabled by programming a country specific parameter using ConfigurACE.

Call Progress Tone Detection

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

Answer Tone Detection

The answer tone detection period is programmable by ConfigurACE.

Blacklist Parameters

The modem can operate in accordance with requirements of individual countries to prevent misuse of the network by limiting repeated calls to the same number when previous call attempts have failed. Call failure can be detected for reasons such as no dial tone, number busy, no answer, no ringback detected, voice (rather than modem) detected, and key abort (dial attempt aborted by user). Actions resulting from such failures can include specification of minimum inter-call delay, extended delay between calls, and maximum numbers of retries before the number is permanently forbidden ("blacklisted"). Up to 40 such numbers may be tabulated. The blacklist parameters are established by ConfigurACE.

Relay Control

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

EXPANDED FUNCTION SUPPORT

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

- Secure access
- Remote configuration
- Remote access

Secure Access

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

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

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

Remote Configuration Mode (RCM)

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

Remote Access Mode (RACM)

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

CONFIGURACE UTILITY PROGRAM

The PC-based ConfigurACE utility program allows the OEM to customize the MCU firmware to suit specific application and country requirements. ConfigurACE allows programming of functions such as:

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

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

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

DIAGNOSTICS

Commanded Tests

Diagnostics are performed in response to &T commands, serial interface control signals, or switch inputs per V.54.

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

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

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

Remote Digital Loopback with Self Test. An internally generated pattern is sent from the local modem to the

remote modem which loops the data back to the local modem.

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

Power On Reset Tests

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

LOW POWER MODES

SLEEP MODE

Entry. The modem will enter the low power sleep mode when no line connection exists and no host activity occurs for the period of time specified in the S24 register. All MCU circuits are turned off except the internal MCU clock circuitry in order to consume lower power but be able to immediately wake up and resume normal operation.

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

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

STOP MODE (C39 ONLY)

Entry. The modem will enter the low power stop mode when the $\overline{\text{STPMODE}}$ input is asserted. All MCU circuits are turned off including the internal MCU clock circuitry in order to consume lower power than sleep mode. The modem will enter stop mode immediately after terminating a line connection, terminating any test in process, and allowing any data in the receive buffer to clear.

$\overline{\text{STPMODE}}$ must be returned high before the modem can wake-up.

Wake-up - Parallel Interface Configuration. Wakeup occurs when the host writes to the modem or ring is detected on the telephone line. Since the modem requires more time to attain normal operation when waking up from stop mode than sleep mode, the host must send any character to the modem before issuing the first AT command.

Wake-up - Serial Interface Configuration. Wake-up occurs when the DTE sends a character to the modem or when a ring is detected on the telephone line. Since the modem requires more time to attain normal operation when waking up from stop mode than sleep mode, the host must send any character to the modem before issuing the first AT command.

ADDITIONAL INFORMATION

Additional information is described in the RC96V24AC and RC14V24AC Modem Designer's Guide (Order No. 877) and the AT Command Reference Manual (Order No. 883).

HARDWARE INTERFACE

HARDWARE INTERFACE SIGNALS

The modem hardware interface signals for serial and parallel interface configurations are shown in Figures 2 and 3, respectively.

The MCU pin assignments for serial interface selected are shown in Figure 4 and are listed in Table 5.

The MCU pin assignments for parallel interface selected are shown in Figure 5 and are listed in Table 6.

The MDP pin assignments are shown in Figure 6 and are listed in Table 7.

The MCU hardware interface signals are defined in Table 8.

The MDP hardware interface signals are defined in Table 9.

The digital electrical characteristics for the hardware interface signals are listed in Table 10.

The analog electrical characteristics for the hardware interface signals are listed in Table 11.

The current and power requirements are listed in Table 12.

The absolute maximum ratings are listed in Table 13.

Table 14 shows the parallel interface registers and the corresponding bit assignments.

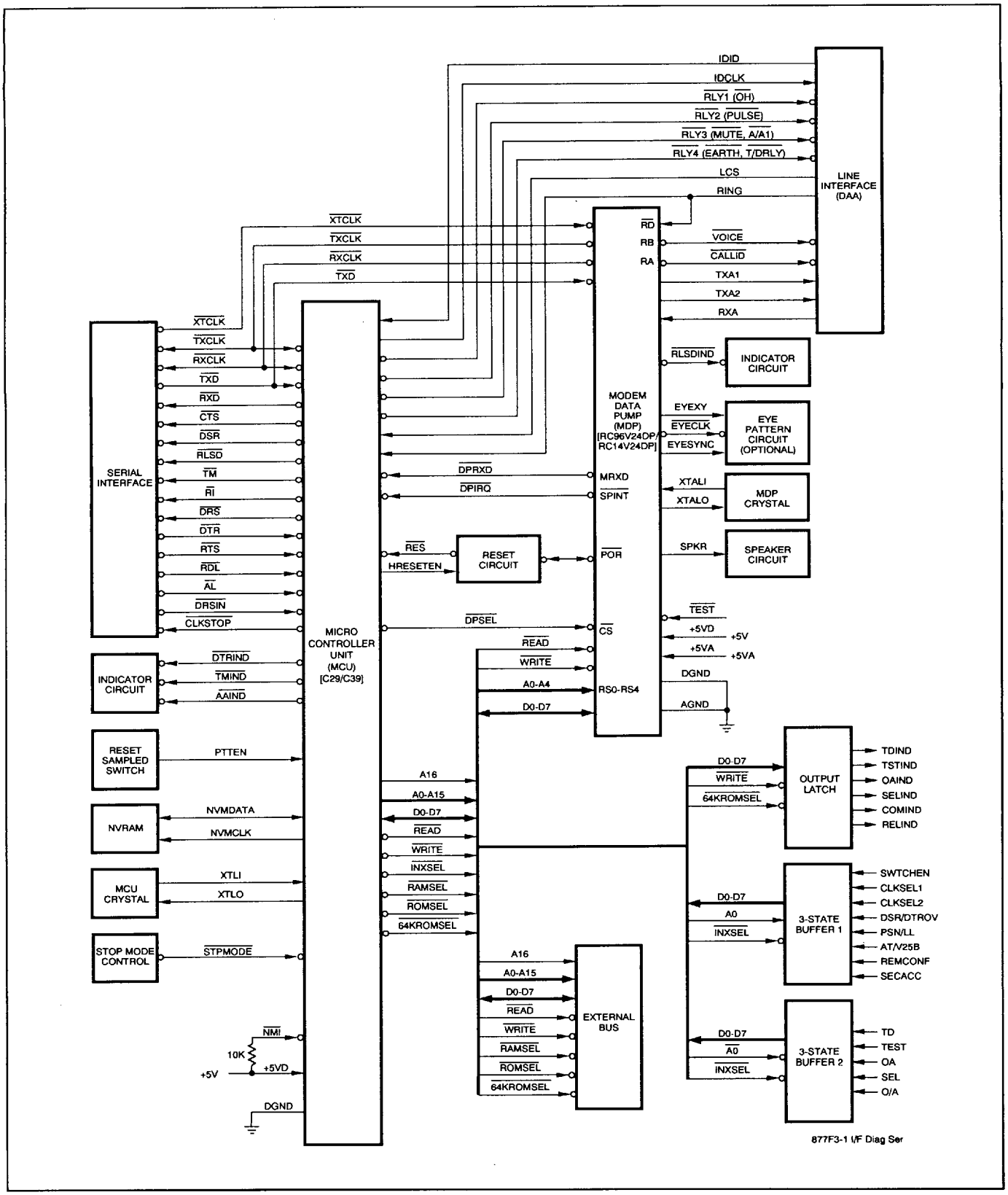


Figure 2. Hardware Interface Signals-Serial Interface

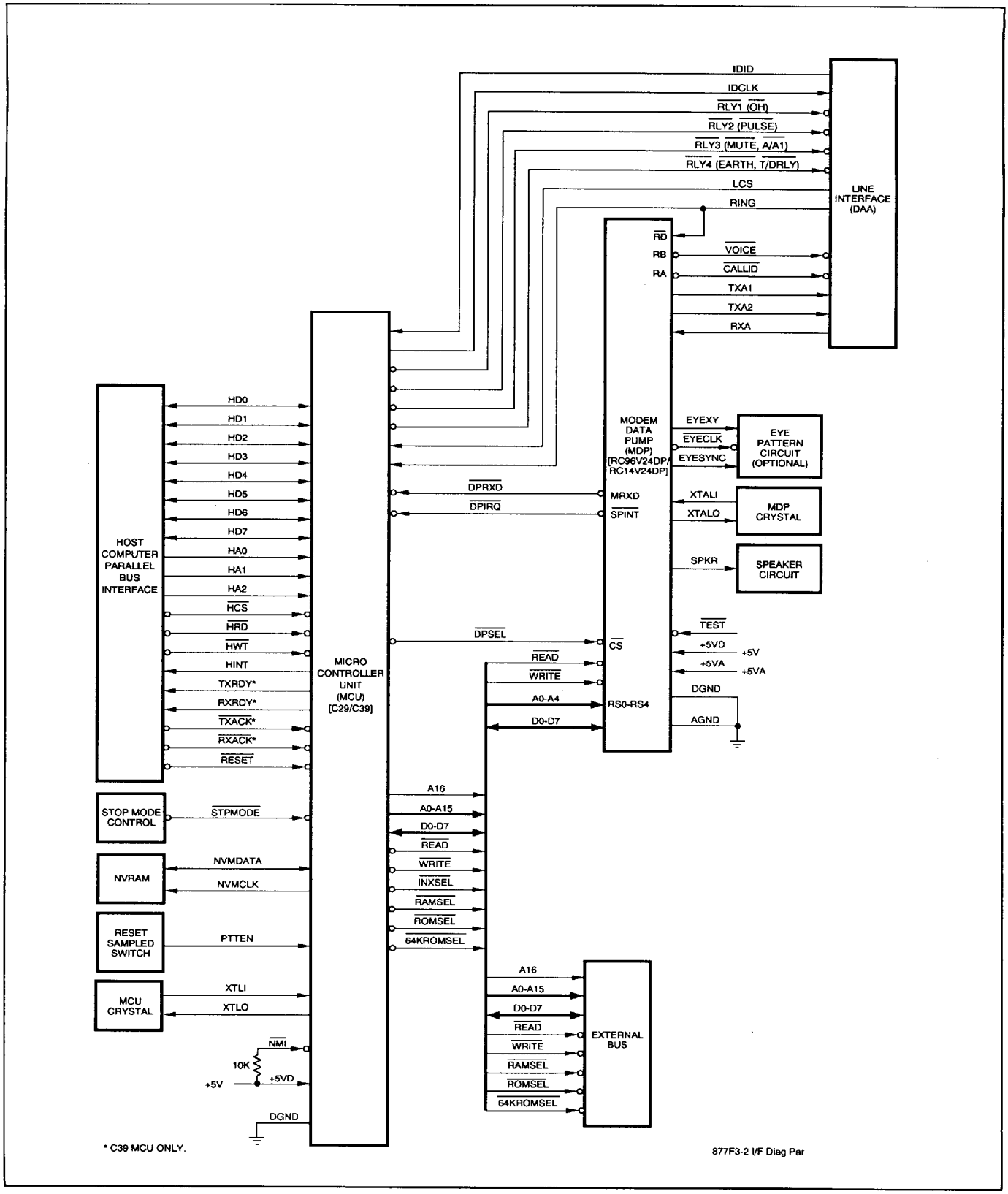


Figure 3. Hardware Interface Signals-Parallel Interface

Table 5a. MCU Signals - Serial I/F - 84-Pin PLCC

Pin	MCU Signal	I/O Type	Modem Signal
1	PE0	OA	RLY1 (OH)
2	PE1	OA	RLY2 (PULSE)
3	GND	GND	GND
4	PB0	OA	A16
5	PB1	MI	DPSEL
6	PB2	OA	ROMSEL
7	PB3	OA	RAMSEL
8	PB4	OA	INXSEL
9	PB5	OA	64KROMSEL
10	PB6	OA	AAIND
11	PB7	OA	TMIND
12	RES	IC	RES
13	NMI		+5VDC (Note 4)
14	WT	OA	WRITE
15	RD	OA	READ
16	PE2	OA	RLY3 (MUTE, A/A1)
17	PE3	IA	RLY4 (EARTH, T/DRLY)
18	SYNC/NC		NC (Note 5)
19	+5VD	PWR	+5VDC
20	XTLI	IE	XTLI
21	XTLO	OE	XTLO
22	GND	GND	GND
23	GND	GND	GND
24	GND	GND	GND
25	PC0	OA	DSR
26	PC1	OA	CTS
27	PC2	OA	RLSD
28	PC3	OA	DRS
29	PC4	IA	DRSIN
30	PC5	OA	RI
31	PC6	OA	TM
32	PC7	IA	RDL
33	NC		NC
34	PD0	OA	DTRIND
35	PD1	IA	HRESETEN
36	PD2	IA	NC
37	PD3	IA	STPMODE (C39 only) (Note 6)
38	PD4	IA	DTR
39	PD5	IA	AL
40	PD6	IA	RTS
41	PD7	MI	DPIRQ
42	GND	GND	GND
43	PE4	IA	LCS
44	PE5	OA [IA]	CLKSTOP [PTTEN]
45	PA0	IA	RING
46	PA1	IA/OA	NVMDATA (Note 4)
47	PA2	IA	TXD
48	PA3	IA	TXCLK
49	PA4	IA	RXCLK
50	PA5	MI	DPRXD
51	PA6	OA	RXD
52	PA7	OA	NVMCLK
53	TST		Connect to GND
54	D0	IA/OA	D0
55	D1	IA/OA	D1
56	D2	IA/OA	D2
57	D3	IA/OA	D3
58	D4	IA/OA	D4
59	D5	IA/OA	D5
60	D6	IA/OA	D6

Table 5a. MCU Signals - Serial I/F - 84-Pin PLCC

Pin	MCU Signal	I/O Type	Modem Signal
61	D7	IA/OA	D7
62	PE6	OA	IDCLK
63	PE7	IA	IDID
64	+5VD	PWR	+5VDC
65	GND	GND	GND
66	GND	GND	GND
67	GND	GND	GND
68	A0	OA	A0
69	A1	OA	A1
70	A2	OA	A2
71	A3	OA	A3
72	A4	OA	A4
73	A5	OA	A5
74	A6	OA	A6
75	NC		NC
76	A7	OA	A7
77	A8	OA	A8
78	A9	OA	A9
79	A10	OA	A10
80	A11	OA	A11
81	A12	OA	A12
82	A13	OA	A13
83	A14	OA	A14
84	A15	OA	A15

Notes:

1. MI = Modem interconnect.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to +5 VDC through 10 KΩ.
5. SYNC on C29, NC on C39.
6. NC on C29.

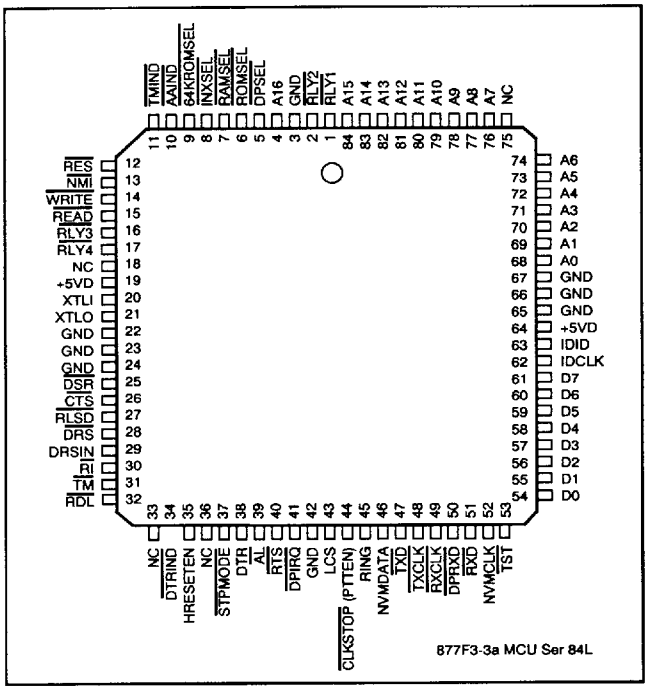


Figure 4a. MCU Signals - Serial I/F - 84-Pin PLCC

Table 5b. MCU Signals - Serial I/F - 80-Pin PQFP

Pin	MCU Signal	I/O Type	Modem Signal
1	RES	IC	RES
2	NMI		+5VD (Note 6)
3	WT	OA	WRITE
4	RD	OA	READ
5	PE2	OA	RLY3 (MUTE, A/A1)
6	PE3	OA	RLY4 (EARTH, T/DRLY)
7	SYNC/NC		NC (Note 7)
8	VCC	PWR	+5VD
9	XTLI	IE	XTLI
10	XTLO	OE	XTLO
11	GND	GND	GND
12	GND	GND	GND
13	PC0	OA	DSR
14	PC1	OA	CTS
15	PC2	OA	RLSD
16	PC3	OA	DRS
17	PC4	OA	DRSIN
18	PC5	OA	RI
19	PC6	OA	TM
20	PC7	IA	RDL
21	PD0	OA	DTRIND
22	PD1	OA	HRESETEN
23	PD2	IA	NC
24	PD3	IA	STPMODE (C39 only) (Note 8)
25	PD4	IA	DTR
26	PD5	IA	AL
27	PD6	IA	RTS
28	PD7	OA	DPIRQ (Note 5)
29	GND	GND	GND
30	PE4	IA	LCS
31	PE5	OA [IA]	CLKSTOP [PTTEN]
32	PA0	IA	RING
33	PA1	OA	NVMDATA (Note 4)
34	PA2	IA	TXD
35	PA3	IA	TXCLK
36	PA4	IA	RXCLK
37	PA5	MI	DPRXD
38	PA6	OA	RXD
39	PA7	OA	NVMCLK
40	TST		TST (Note 4)
41	D0	IA/OA	D0
42	D1	IA/OA	D1
43	D2	IA/OA	D2
44	D3	IA/OA	D3
45	D4	IA/OA	D4
46	D5	IA/OA	D5
47	D6	IA/OA	D6
48	D7	IA/OA	D7
49	PE6	OA	IDCLK
50	PE7	IA	IDID
51	+5VD	PWR	+5VD
52	GND	GND	GND
53	GND	GND	GND
54	A0	OA	A0
55	A1	OA	A1
56	A2	OA	A2
57	A3	OA	A3
58	A4	OA	A4
59	A5	OA	A5
60	A6	OA	A6

Table 5b. MCU Signals - Serial I/F - 80-Pin PQFP (Cont'd)

Pin	MCU Signal	I/O Type	Modem Signal
61	A7	OA	A7
62	A8	OA	A8
63	A9	OA	A9
64	A10	OA	A10
65	A11	OA	A11
66	A12	OA	A12
67	A13	OA	A13
68	A14	OA	A14
69	A15	OA	A15
70	PE0	OA	RLY1 (OH)
71	PE1	OA	RLY2 (PULSE)
72	GND	GND	GND
73	PB0	OA	A16
74	PB1	MI	DPSEL
75	PB2	OA	ROMSEL
76	PB3	OA	RAMSEL
77	PB4	OA	INXSEL
78	PB5	OA	64KROMSEL
79	PB6	OA	AAIND
80	PB7	OA	TMIND

Notes:

1. MI = Modem interconnect.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to GND.
5. Connect to +5 VDC through 10 KΩ.
6. Connect to +5 VDC through 4.7 KΩ.
7. SYNC on C29, NC on C39.
8. NC on C29.

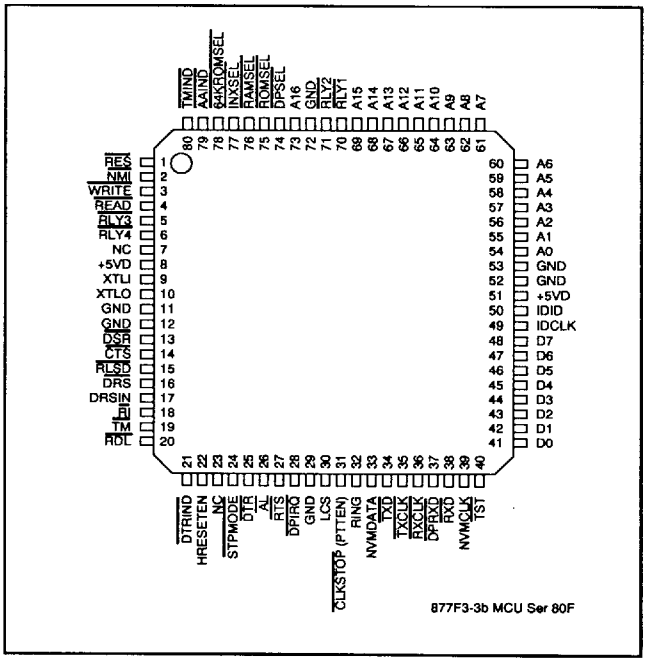


Figure 4b. MCU Signals - Serial I/F - 80-Pin PQFP

Table 6a. MCU Signals - Parallel I/F - 84-Pin PLCC

Pin	MCU Signal	I/O Type	Modem Signal
1	PE0	OA	RLY1 (OH)
2	PE1	OA	RLY2 (PULSE)
3	GND	GND	GND
4	PB0	OA	A16
5	PB1	MI	DPSEL
6	PB2	OA	ROMSEL
7	PB3	OA	RAMSEL
8	PB4		NC
9	PB5		NC
10	PB6		NC
11	PB7	OA	HINT
12	RES	IC	RES
13	NMI		+5VDC (Note 4)
14	WT	OA	WRITE
15	RD	OA	READ
16	PE2	OA	RLY3 (MUTE, A/A1)
17	PE3	OA	RLY4 (EARTH, T/DRLY)
18	SYNC/NC		NC (Note 5)
19	+5VD	PWR	+5VDC
20	XTLI	IE	XTLI
21	XTLO	OE	XTLO
22	GND	GND	GND
23	GND	GND	GND
24	GND	GND	GND
25	PC0	IA/OA	HD0
26	PC1	IA/OA	HD1
27	PC2	IA/OA	HD2
28	PC3	IA/OA	HD3
29	PC4	IA/OA	HD4
30	PC5	IA/OA	HD5
31	PC6	IA/OA	HD6
32	PC7	IA/OA	HD7
33	NC		NC
34	PD0	IA	HA0
35	PD1	IA	HA1
36	PD2	IA	HA2
37	PD3	IA	STPMODE
38	PD4	IA	HCS
39	PD5	IA	HWT
40	PD6	IA	HRD
41	PD7	MI	DPIRQ
42	GND	GND	GND
43	PE4	IA	LCS
44	PE5	IA	PTTEN
45	PA0	IA	RING
46	PA1	IA/OA	NVMDATA (Note 4)
47	PA2		NC
48	PA3	IA	TXACK (C39 only) (Note 6)
49	PA4	IA	RXACK (C39 only) (Note 6)
50	PA5	OA	TXRDY (C39 only) (Note 6)
51	PA6	OA	RXRDY (C39 only) (Note 6)
52	PA7	OA	NVMCLK
53	TST		Connect to GND
54	D0	IA/OA	D0
55	D1	IA/OA	D1
56	D2	IA/OA	D2
57	D3	IA/OA	D3
58	D4	IA/OA	D4
59	D5	IA/OA	D5
60	D6	IA/OA	D6

Table 6a. MCU Signals-Parallel I/F-84-Pin PLCC (Cont'd)

Pin	MCU Signal	I/O Type	Modem Signal
61	D7	IA/OA	D7
62	PE6	OA	IDCLK
63	PE7	IA	IDID
64	+5VD	PWR	+5VDC
65	GND	GND	GND
66	GND	GND	GND
67	GND	GND	GND
68	A0	OA	A0
69	A1	OA	A1
70	A2	OA	A2
71	A3	OA	A3
72	A4	OA	A4
73	A5	OA	A5
74	A6	OA	A6
75	NC		NC
76	A7	OA	A7
77	A8	OA	A8
78	A9	OA	A9
79	A10	OA	A10
80	A11	OA	A11
81	A12	OA	A12
82	A13	OA	A13
83	A14	OA	A14
84	A15	OA	A15

Notes:
1. MI = Modem interconnect.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to +5 VDC through 10 KΩ.
5. SYNC on C29, NC on C39.
6. NC on C29.

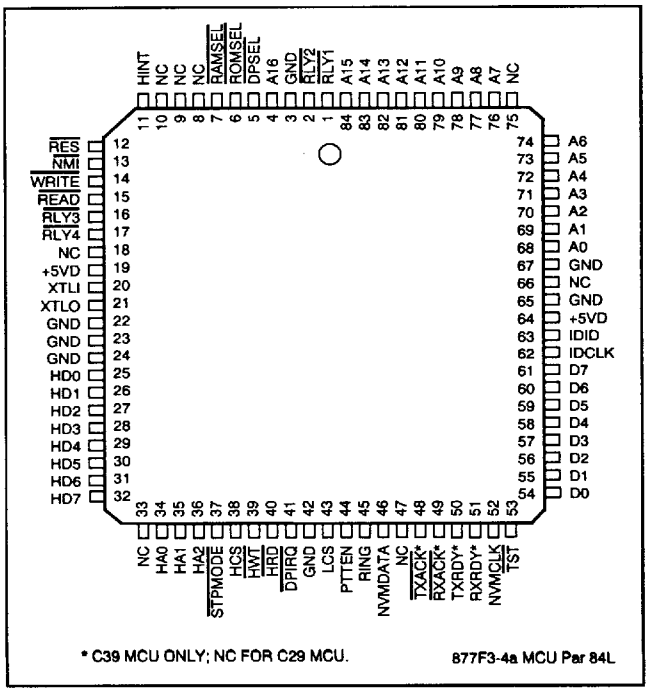


Figure 5a. MCU Signals - Parallel I/F - 84-Pin PLCC

Table 6b. MCU Signals - Parallel I/F - 80-Pin PQFP

Pin	MCU Signal	I/O Type	Modem Signal
1	RES	IC	RES
2	NMI		+5VD (Note 6)
3	WT	OA	WRITE
4	RD	OA	READ
5	PE2	OA	RLY3 (MUTE, A/A1)
6	PE3	OA	RLY4 (EARTH, T/DRLY)
7	SYNC/NC		NC (Note 7)
8	VCC	PWR	+5VD
9	XTLI	IE	XTLI
10	XTLO	OE	XTLO
11	GND	GND	GND
12	GND	GND	GND
13	PC0	IA/OA	HD0
14	PC1	IA/OA	HD1
15	PC2	IA/OA	HD2
16	PC3	IA/OA	HD3
17	PC4	IA/OA	HD4
18	PC5	IA/OA	HD5
19	PC6	IA/OA	HD6
20	PC7	IA/OA	HD7
21	PD0	IA	HA0
22	PD1	IA	HA1
23	PD2	IA	HA2
24	PD3	IA	STPMODE
25	PD4	IA	HCS
26	PD5	IA	HWT
27	PD6	IA	HRD
28	PD7	OA	DPIRQ (Note 5)
29	GND	GND	GND
30	PE4	IA	LCS
31	PE5	IA	PTTEN
32	PA0	IA	RING
33	PA1	OA	NVMDATA (Note 4)
34	PA2		NC
35	PA3	IA	TXACK (C39 only) (Note 8)
36	PA4	IA	RXACK (C39 only) (Note 8)
37	PA5	OA	TXRDY (C39 only) (Note 8)
38	PA6	OA	RXRDY (C39 only) (Note 8)
39	PA7	OA	NVMCLK
40	TST		TST (Note 4)
41	D0	IA/OA	D0
42	D1	IA/OA	D1
43	D2	IA/OA	D2
44	D3	IA/OA	D3
45	D4	IA/OA	D4
46	D5	IA/OA	D5
47	D6	IA/OA	D6
48	D7	IA/OA	D7
49	PE6	OA	IDCLK
50	PE7	IA	IDID
51	VCC	PWR	+5VD
52	GND	GND	GND
53	GND	GND	GND
54	A0	OA	A0
55	A1	OA	A1
56	A2	OA	A2
57	A3	OA	A3
58	A4	OA	A4
59	A5	OA	A5
60	A6	OA	A6

Table 6b. MCU Signals-Parallel I/F-80-Pin PQFP (Cont'd)

Pin	MCU Signal	I/O Type	Modem Signal
61	A7	OA	A7
62	A8	OA	A8
63	A9	OA	A9
64	A10	OA	A10
65	A11	OA	A11
66	A12	OA	A12
67	A13	OA	A13
68	A14	OA	A14
69	A15	OA	A15
70	PE0	OA	RLY1 (OH)
71	PE1	OA	RLY2 (PULSE)
72	GND	GND	GND
73	PB0	OA	A16
74	PB1	MI	DPSEL
75	PB2	OA	ROMSEL
76	PB3	OA	RAMSEL
77	PB4		NC
78	PB5	OA	64KROMSEL
79	PB6		NC
80	PB7	OA	HINT

Notes:

1. MI = Modem interconnect.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to GND.
5. Connect to +5 VDC through 10 KΩ.
6. Connect to +5 VDC through 4.7 KΩ.
7. SYNC on C29, NC on C39.\
8. NC on C29.

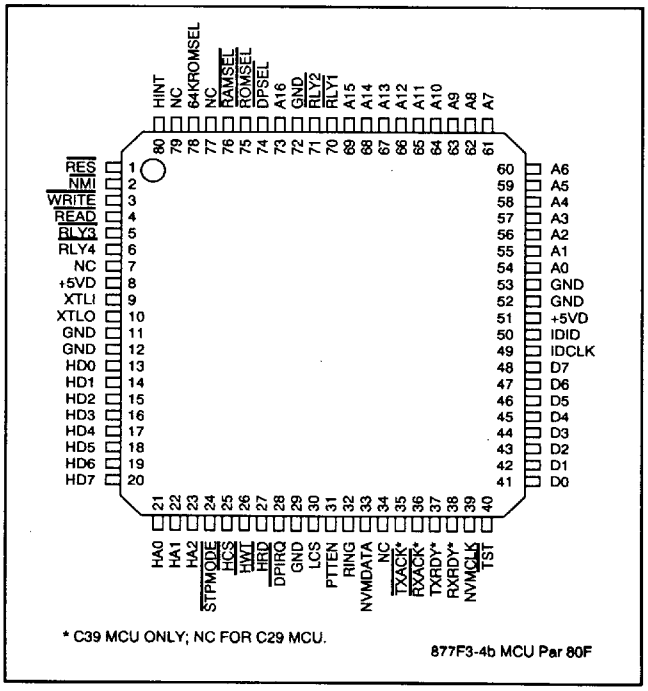


Figure 5b. MCU Signals - Parallel I/F - 80-Pin PQFP

Table 7a. MDP Signals - 68-Pin PLCC

Pin	MDP Signal	I/O Type	Modem Signal
1	RS2	IA	A2
2	RS1	IA	A1
3	RS0	IA	A0
4	TEST		TEST
5	SLEEP	OA	SLPIN
6	RING	IA	RING
7	EYEY	OB	EYEY
8	EYEX	OB	EYEX
9	EYESYNC	OB	EYESYNC
10	RESET	ID	RESET
11	XTALI	IE	XTALI
12	XTALO	OB	XTALO
13	+5VD	PWR	+5VD
14	GP18	OA	NC
15	RLSD	OA	RLSDIND
16	XTCLK	IA	XTCLK
17	DGND	GND	DGND
18	TXD	IA	TXD
19	TDCLK	OA	TXCLK
20	TRSTO	MI	TRSTO
21	TSTBO	MI	TSTBO
22	TDACO	MI	TDACO
23	RADCI	MI	RADCI
24	RAGCO	MI	RAGCO
25	MODEO	MI	MODEO
26	RSTBO	MI	RSTBO
27	RRSTO	MI	EYECLK
28	RDCLK	OA	RXCLK
29	RXD	OA	DPRXD
30	TXA2	O(DD)	TXA2
31	TXA1	O(DD)	TXA1
32	RXA	I(DA)	RXA
33	RFILO	MI	RFILO
34	AGCIN	MI	AGCIN
35	VC	OA	VC
36	NC		NC
37	NC		NC
38	NC		NC
39	RBDVR		VOICE
40	AGND	GND	AGND
41	RADVR	OD	CALLID
42	SLEEPI	IA	STPMODE
43	RAGCI	MI	RAGCI
44	NC		NC
45	RSTBI	MI	RSTBI
46	RRSTI	MI	EYECLK
47	RADCO	MI	RADCO
48	TDACI	MI	TDACI
49	TRSTI	MI	TRSTI
50	TSTBI	MI	TSTBI
51	MODEI	MI	MODEI
52	+5VA	PWR	+5VA
53	SPKR	O(OF)	SPKR
54	DGND	GND	DGND
55	D7	IA/OB	D7
56	D6	IA/OB	D6
57	D5	IA/OR	D5
58	D4	IA/OB	D4
59	D3	IA/OB	D3
60	D2	IA/OB	D2

Table 7a. MDP Signals - 68-Pin PLCC (Cont'd)

Pin	MDP Signal	I/O Type	Modem Signal
61	D1	IA/OB	D1
62	D0	IA/OB	D0
63	IRQ	OC	DPIRQ
64	WRITE	IA	WRITE
65	CS	IA	DPSEL
66	READ	IA	READ
67	RS4	IA	A4
68	RS3	IA	A3

Notes:
1. MI = Modem Interconnection.
2. NC = No external connection.

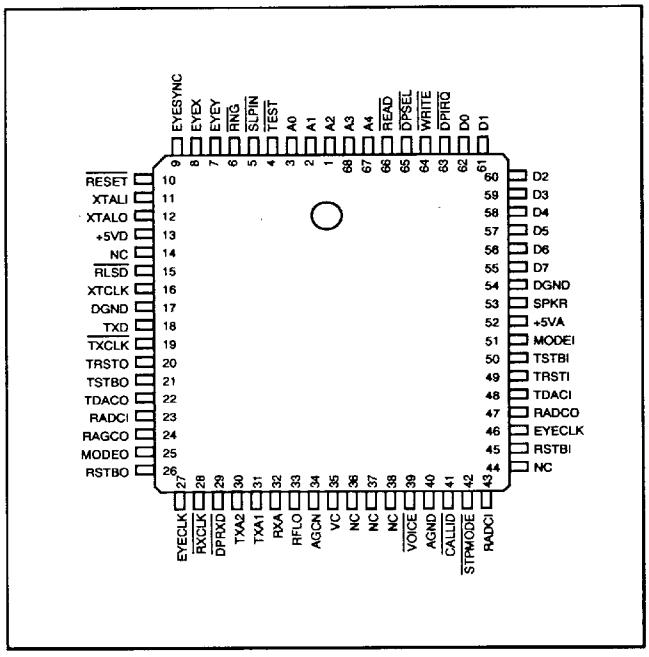


Figure 6a. MDP Signals - 68-Pin PLCC

Table 7b. MDP Signals - 100-Pin PQFP

Pin	Signal Name	I/O Type	Modem Signal
1	NC		NC
2	NC		NC
3	NC		NC
4	NC		NC
5	NC		NC
6	DGND	GND	DGND
7	DGND	GND	DGND
8	D7	IA/OB	D7
9	D6	IA/OB	D6
10	D5	IA/OR	D5
11	D4	IA/OB	D4
12	D3	IA/OB	D3
13	D2	IA/OB	D2
14	D1	IA/OB	D1
15	D0	IA/OB	D0
16	DGND	GND	DGND
17	MODEI	MI	MODEI
18	+5VA	PWR	+5VA
19	SPKR	O(OF)	SPKR
20	NC		NC
21	AGND	GND	AGND
22	TXA2	O(DD)	TXA2
23	TXA1	O(DD)	TXA1
24	NC		NC
25	RXA	I(DA)	RXA
26	NC		NC
27	RFILO	MI	RFILO
28	AGCIN	MI	AGCIN
29	VC	OA	VC
30	AGND	GND	AGND
31	NC		NC
32	NC		NC
33	NC		NC
34	NC		NC
35	NC		NC
36	$\overline{\text{RBDVR}}$		$\overline{\text{VOICE}}$
37	AGND	GND	AGND
38	$\overline{\text{RADVR}}$	OD	$\overline{\text{CALLID}}$
39	NC		NC
40	NC		NC
41	$\overline{\text{SLEEP}}$	IA	$\overline{\text{STOPMODE}}$
42	RAGCI	MI	RAGCI
43	AGND	GND	AGND
44	RSTBI	MI	RSTBI
45	RRSTI	MI	EYECLK
46	RADCO	MI	RADCO
47	TDACI	MI	TDACI
48	TRSTI	MI	TRSTI
49	TSTBI	MI	TSTBI
50	$\overline{\text{IRQ}}$	OC	$\overline{\text{DPIRQ}}$
51	NC		NC
52	$\overline{\text{WRITE}}$	IA	$\overline{\text{WRITE}}$
53	$\overline{\text{CS}}$	IA	$\overline{\text{DPSEL}}$
54	$\overline{\text{READ}}$	IA	$\overline{\text{READ}}$
55	RS4	IA	A4
56	RS3	IA	A3
57	RS2	IA	A2
58	RS1	IA	A1
59	RS0	IA	A0
60	$\overline{\text{TEST}}$		$\overline{\text{TEST}}$

Table 7b. MDP Signals - 100-Pin PQFP (Cont'd)

Pin	Signal Name	I/O Type	Modem Signal
61	$\overline{\text{SLEEP}}$	OA	$\overline{\text{SLPIN}}$
62	$\overline{\text{RING}}$	IA	$\overline{\text{RING}}$
63	EYEY	OB	EYEY
64	EYEX	OB	EYEX
65	EYESYNC	OB	EYESYNC
66	DGND	GND	DGND
67	NC		NC
68	$\overline{\text{RESET}}$	ID	$\overline{\text{RESET}}$
69	XTALI	IE	XTALI
70	XTALO	OB	XTALO
71	+5VD	PWR	+5VD
72	+5VD	PWR	+5VD
73	+5VD	PWR	+5VD
74	GP18	OA	NC
75	$\overline{\text{RLSD}}$	OA	$\overline{\text{RLSDIND}}$
76	XTCLK	IA	$\overline{\text{XTCLK}}$
77	DGND	GND	DGND
78	DGND	GND	DGND
79	TXD	IA	$\overline{\text{TXD}}$
80	DGND	GND	DGND
81	DGND	GND	DGND
82	NC		NC
83	TDCLK	OA	$\overline{\text{TXCLK}}$
84	TRSTO	MI	TRSTO
85	TSTBO	MI	TSTBO
86	TDACO	MI	TDACO
87	RADCI	MI	RADCI
88	RAGCO	MI	RAGCO
89	DGND	GND	DGND
90	MODEO	MI	MODEO
91	RSTBO	MI	RSTBO
92	RRSTO	MI	EYECLK
93	$\overline{\text{RDCLK}}$	OA	$\overline{\text{RXCLK}}$
94	RXD	OA	$\overline{\text{DPRXD}}$
95	NC		NC
96	NC		NC
97	DGND	GND	DGND
98	NC		NC
99	NC		NC
100	NC		NC

Notes:
1. MI = Modem Interconnection.
2. NC = No external connection.

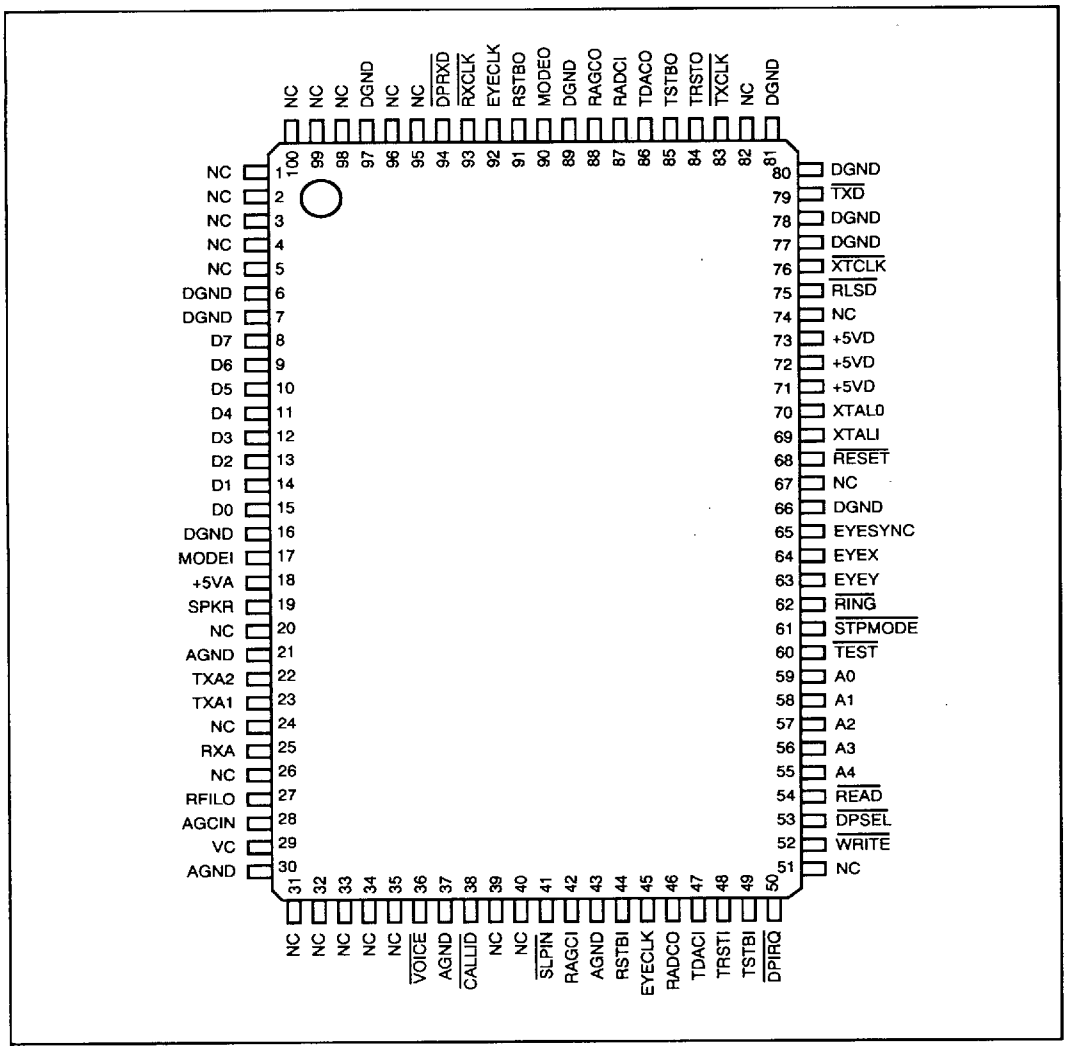


Figure 6b. MDP Signals - 100-Pin PQFP

Table 8. MCU Signal Definitions

Label	I/O Type	Signal Name/Description
		MCU SYSTEM
XTLI, XTLO	IE, OE	**MCU Crystal/Clock In and Crystal Out.** Connects to an external crystal circuit consisting of a 8.064 MHz (C29) or 4.032 MHz (C39) crystal and a capacitance network.
$\overline{\text{RES}}$	IC	**MCU Reset.** The active low $\overline{\text{RES}}$ input resets the MCU logic and returns the AT command set to the original factory default values and to "stored values" in NVRAM. For serial Interface, the $\overline{\text{RES}}$ input is typically connected to MDP $\overline{\text{POR}}$, a reset switch, and/or the DTR input as enabled by the HRESETEN output. For parallel Interface, the $\overline{\text{RES}}$ input is typically connected to the host bus RESET line through an inverter.
$\overline{\text{DPIRQ}}$	IA	**MDP Interrupt Request.** Connects to the MDP IRQ output.
$\overline{\text{DPRXD}}$	IA	**MDP Received Data.** Connects to the MDP MRXD output.
+5VD	PWR	**+ 5V Digital Supply.** +5V ± 5%.
GND	GND	**Digital Ground.** Connect to ground.
		LINE INTERFACE
$\overline{\text{RLY1}}$	OA	**Relay 1 Control** ($\overline{\text{OH}}$). The active low $\overline{\text{RLY1}}$ output can be used to control the normally open off-hook relay.
$\overline{\text{RLY2}}$	OA	**Relay 2 Control** ($\overline{\text{PULSE}}$). The active low $\overline{\text{RLY2}}$ output can be used to control the normally open pulse dial relay.
$\overline{\text{RLY3}}$	OA	**Relay 3 Control** ($\overline{\text{MUTE}}$, $\overline{\text{A/A1}}$). The active low $\overline{\text{RLY3}}$ output can be used to control the normally open mute relay or the normally open key telephone hold indicator (A/A1) relay.
$\overline{\text{RLY4}}$	OA	**Relay 4 Control** ($\overline{\text{EARTH}}$, $\overline{\text{T/DRLY}}$). The active low $\overline{\text{RLY4}}$ output can be used to control the normally open earthing relay or the normally closed talk/data relay.
LCS	IA	**Line Current Sense.** LCS is an active high input that indicates handset off-hook status.
RING	IA	**Ring Frequency.** The RING input from an external ring detect circuit is monitored to determine when to wake up from sleep or stop (C39) mode.
IDCLK	OA	**Country Identifier Clock.** IDCLK is an output clock to the country identifier shift register.
IDID	IA	**Country Identifier Code.** IDID is an input serial stream from the country identifier shift register.
		NVRAM INTERFACE
NVMCLK	OA	**NVRAM Clock.** NVMCLK output high enables the NVRAM.
NVMDATA	IA/OA	**NVRAM Data.** The NVMDATA pin supplies a serial data interface to the NVRAM.
		EXTERNAL MEMORY BUS INTERFACE
A0-A15	OA	**Address Lines 0-15.** A0-A15 are the external memory bus address lines.
A16	OA	**Address Line 16.** A16 is a bank select line.
D0-D7	IA/OA	**Data Line 0-7.** D0-D7 are the external memory bus data lines.
$\overline{\text{READ}}$	OA	**Read Enable.** $\overline{\text{READ}}$ output low enables data transfer from the selected device to the D0-D7 lines.
$\overline{\text{WRITE}}$	OA	**Write Enable.** $\overline{\text{WRITE}}$ output low enables data transfer from the D0-D7 lines to the selected device.
$\overline{\text{DPSEL}}$	OA	**Modem Data Pump Select.** $\overline{\text{DPSEL}}$ output low selects the MDP.
$\overline{\text{RAMSEL}}$	OA	**RAM Select.** $\overline{\text{RAMSEL}}$ output low selects the external RAM.
$\overline{\text{ROMSEL}}$	OA	**ROM Select.** $\overline{\text{ROMSEL}}$ output low selects an external 32k/64k/128k-byte ROM.
$\overline{\text{64KROMSEL}}$	OA	**64K ROM Select.** $\overline{\text{64KROMSEL}}$ low and $\overline{\text{WRITE}}$ low select the external indicator output latch.
$\overline{\text{INXSEL}}$	OA	**Input Buffer Select.** $\overline{\text{INXSEL}}$ output low and A0 high select external input buffer 1. $\overline{\text{INXSEL}}$ output low and A0 low select external input buffer 2. (Serial interface selected only.)

Table 8. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		V.24 (EIA-232-D) SERIAL INTERFACE (SERIAL INTERFACE SELECTED)
		The serial interface signals correspond functionally to V.24/EIA-232-D signals. The signals levels are TTL compatible and are inverted from V.24/EIA-232-D levels.
$\overline{TXD}$	IA	**Transmitted Data (EIA BA/CCITT CT103).** The DTE uses the $\overline{TXD}$ line to send data to the modem for transmission over the telephone line or to transmit commands to the modem.
$\overline{RXD}$	OA	**Received Data (EIA BB/CCITT CT 104).** The modem uses the $\overline{RXD}$ line to send data received from the telephone line to the DTE and to send modem responses to the DTE. During command mode, $\overline{RXD}$ data represents the modem responses to the DTE.
$\overline{CTS}$	OA	**Clear To Send (EIA CB/CCITT CT106).** $\overline{CTS}$ is controlled by the modem to indicate whether or not the modem is ready to transmit data. $\overline{CTS}$ ON, together with the $\overline{RTS}$ ON, $\overline{DSR}$ ON, and $\overline{DTR}$ ON (where implemented), indicates to the DTE that signals presented on $\overline{TXD}$ will be transmitted to the telephone line. $\overline{CTS}$ OFF indicates to the DTE that it should not transfer data across the interface on $\overline{TXD}$. $\overline{CTS}$ ON is a response to $\overline{DTR}$ ON and $\overline{RTS}$, delayed as may be appropriate for the modem to establish a telephone connection. $\overline{CTS}$ output is controlled by the AT&Rn command.
$\overline{DSR}$	OA	**Data Set Ready (EIA CC/CCITT CT107).** $\overline{DSR}$ indicates modem status to the DTE. $\overline{DSR}$ OFF (high) indicates that the DTE is to disregard all signals appearing on the interchange circuits except Ring Indicator ($\overline{RI}$). $\overline{DSR}$ output is controlled by the AT&Sn command.
$\overline{RLSD}$	OA	**Received Line Signal Detector (EIA CF/CCITT CT109).** When AT&C0 command is not in effect, $\overline{RLSD}$ output is ON when a carrier is detected on the telephone line or OFF when carrier is not detected.
$\overline{TM}$	OA	**Test Mode Indicate (EIA TM/CCITT CT142).** The $\overline{TM}$ output indicates the modem is in test mode (low) or in any other mode (high).
$\overline{RI}$	OA	**Ring Indicator (EIA CE/CCITT CT125).** $\overline{RI}$ output ON (low) indicates the presence of an ON segment of a ring signal on the telephone line.
$\overline{DRS}$	OA	**Data Signalling Rate Indicator (EIA CI/CCITT CT112).** $\overline{DRS}$ is ON (low) when the modem desires or is engaged in the high speed (2400 bps) mode. $\overline{DRS}$ is OFF (high) otherwise.
$\overline{DTR}$	IA	**Data Terminal Ready (EIA CD/CCITT CT108).** The $\overline{DTR}$ input is turned ON (low) by the DTE when the DTE is ready to transmit or receive data. $\overline{DTR}$ ON prepares the modem to be connected to the telephone line, and maintains the connection established by the DTE (manual answering) or internally (automatic answering). $\overline{DTR}$ OFF places the modem in the disconnect state under control of the &Dn and &Qn commands.
$\overline{RTS}$	IA	**Request To Send (EIA CA/CCITT CT105).** $\overline{RTS}$ is used to condition the local modem for data transmission and, during half-duplex operation, to control the direction of data transmission.
$\overline{RDL}$	IA	**Remote Digital Loop Select (EIA RL/CCITT CT140).** $\overline{RDL}$ input low activates remote digital loop request. The loop is executed at the speed for which the modem is currently configured (2400 or 1200 bps).
$\overline{AL}$	IA	**Analog Loop (EIA LL/CCITT CT141).** The $\overline{AL}$ input low causes the modem to assume the analog loop test mode.
$\overline{DRSIN}$	IA	**Data Signalling Rate Select (EIA CI/CCITT CT111).** This signal, relevant only in Central Europe, applies only to V.22 bis and V.22 modes. $\overline{DRSIN}$ ON (low) will result in a 2400 bps connection. $\overline{DRSIN}$ OFF (high) will force a 1200 bps connection, or will result in a fallback from 2400 bps to 1200 bps if already on-line.

Table 1. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		LED INDICATOR CIRCUIT INTERFACE (SERIAL INTERFACE SELECTED)
$\overline{\text{AAIND}}$	OA	**Auto Answer Indicator**. $\overline{\text{AAIND}}$ output ON (low) corresponds to the indicator on. $\overline{\text{AAIND}}$ output is active when modem will answer the ring automatically (ATS0 command ≠ 0).
$\overline{\text{TMIND}}$	OA	**Test Mode Indicator.** $\overline{\text{TMIND}}$ output ON (low) corresponds to the indicator on. $\overline{\text{TMIND}}$ output pulses (LED flashes) when modem is in test mode and if an error is detected.
$\overline{\text{DTRIND}}$	OA	**DTR Indicator.** $\overline{\text{DTRIND}}$ output ON (low) corresponds to the indicator on. The $\overline{\text{DTRIND}}$ state reflects the $\overline{\text{DTR}}$ output state except when the &D0 command is active, in which case $\overline{\text{DTRIND}}$ is low.
		AUXILIARY CIRCUITS (SERIAL INTERFACE SELECTED)
HRESETEN	OA	**Host Reset Enable.** The HRESETEN output can be as an MCU reset enable (high) or disable (low) control signal. For example, HRESETEN can be NANDed with the $\overline{\text{DTR}}$ input to drive the $\overline{\text{RES}}$ input in order to allow the modem to reset the modem by asserting $\overline{\text{DTR}}$.
$\overline{\text{CLKSTOP}}$	IA	**Clock Stop.** Active low output that forces the $\overline{\text{RXCLK}}$ and $\overline{\text{TXCLK}}$ outputs high when NANDed through a transceiver.
		RESET SAMPLED DIRECT SWITCH INPUT TO MCU This switch input can be read upon power up or after a warm reset.
PTTEN	IA	**PTT Test Enable.** The PTTEN input enables (high) or disables (low) the use of the PTT test commands. PTTEN is checked only for countries which do not permit the use of the %TT command at the approval site (e.g., Germany).
		EXTERNAL BUFFER 1 INPUTS TO MCU (SERIAL INTERFACE SELECTED) Switch inputs are available via external buffer 1 as enabled by ConfigurACE. These inputs are sampled onto the data bus, typically via a 74HCT541 three-state buffer, when the $\overline{\text{INXSEL}}$ is active and A0 is active. The data bus bit number for each signal is defined below.
SWTCHEN	Bus	**Switch Enable**. The SWTCHEN input (bit 0) enables (high) or disables (low) use of external switch inputs to invoke AT commands and S Register functions rather than default values from ROM.
CLKSEL1/2	Bus	**Clock Select 1 and 2**. The CLKSEL1 and CLKSEL2 inputs (bits 1 and 2, respectively) select async/sync operation and the clock source for synchronous operation. The selectable options are: **Mode/Clock Source** — **CLKSEL1** — **CLKSEL2** Asynchronous — L — L Synchronous with Internal clock — L — H Synchronous with External clock — H — L Synchronous with Slave clock — H — H
DSRDTROV	Bus	**DSR/DTR Override**. The DSRDTROV input (bit 3) enables (high) or disables (low) override of DSR and DTR from the EIA (V.24) interface.
PSN/LL	Bus	**PSTN/Leased Line Operation Select.** The PSN/LL input (bit 4) selects leased line (high) or PSTN (low) output levels and handshake operation. This may be overridden by the end user.
AT/V25B	Bus	**AT/V.25 bis Commands Select.** The AT/V25B input (bit 5) selects V.25 bis (high) or AT command (low) operation.
REMCONF	Bus	**Remote Configuration Enable.** The REMCONF input (bit 6) enables (high) or disables (low) remote configuration.
SECACC	Bus	**Callback Security.** The SECACC input (bit 7) enforces (high) or disables (low) callback security.

Table 8. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		EXTERNAL BUFFER 2 INPUTS TO MCU (SERIAL INTERFACE SELECTED) Four momentary switch (TD, TEST, OA, and SEL) and one discrete switch (O/A) inputs are available via external buffer 2 as enabled by ConfigurACE. These inputs are sampled onto the data bus, typically via a 74HCT541 three-state buffer, when INXSEL is active and A0 is inactive. The momentary switch inputs are asserted upon the ON-to-OFF transition. The data bus bit number for each signal is defined below.
TD	Bus	**Data/Talk.** TD input (bit 0) operation depends upon the SELIND, TDIND, and TSTIND outputs. a. If SELIND is ON, the TD input ON-to-OFF transition steps the selected directory to the next entry (see SELIND output). b. If SELIND is OFF and TDIND is ON, the TD input ON-to-OFF transition will cause the modem to disconnect from the line. c. If SELIND is OFF and TDIND is OFF, the telephone set may be used for voice communication. If a directory entry has been selected, TD ON-to-OFF transition will cause the modem to dial the telephone number from the selected directory entry. If no directory entry has been selected, the modem will go off-hook and attempt a handshake depending upon the OAIND output state.
TEST	Bus	**Test.** TEST input (bit 1) operation depends upon the SELIND, TDIND, and TSTIND outputs. a. If SELIND is ON, the TEST input is not operative. b. If SELIND is OFF and TSTIND is ON, the modem is in a test mode. The TEST ON-to-OFF transition will cause the modem to exit the test mode and to turn TSTIND OFF. c. If SELIND is OFF, TSTIND is OFF, and TDIND is OFF, the TEST ON-to-OFF transition will cause the modem to enter local analog loopback (V.54 loop 3) and to turn the TSTIND ON. d. If SELIND is OFF, TSTIND is OFF, and TDIND is ON, the TEST ON-to-OFF transition will cause the modem to establish remote digital loopback (V.54 loop 2) in the remote modem and turn TSTIND ON. If the remote end does not accept the RDL then TSTIND will not be turned ON and the modem will remain in data mode.
OA	Bus	**Answer/Originate.** If SELIND is OFF, the OA input (bit 2) ON-to-OFF transition will toggle the OAIND output to answer (ON) or originate (OFF). If SELIND is ON, the OA input is not operative.
SEL	Bus	**Select.** The SEL ON-to-OFF transition will toggle the SELIND output to ON or OFF.
O/A	Bus	**Originate/Answer.** The O/A input selects answer (ON) or originate (OFF) mode.
		EXTERNAL LATCHED OUTPUTS FROM MCU (SERIAL INTERFACE SELECTED) Outputs are available via an external output latch as enabled by ConfigurACE. These outputs are extracted from the data bus, typically by a 74HCT377 data latch, when the ROMSEL and WRITE outputs are active. The data bus bit number for each signal is defined below.
SELIND	Bus	**Select Indicate**. SELIND output (bit 3) toggles in response to the SEL input ON-to-OFF transition to reflect the directory entry (SELIND ON) or normal (SELIND OFF) operation. If SELIND is ON, the TD input ON-to-OFF transition steps the selected directory to the next entry. The selected entry is indicated by the TDIND, OAIND, and TSTIND outputs as follows: **TDIND / OAIND / TSTIND / Selection** 0 / 0 / 0 / No selection 0 / 0 / 1 / Entry 1 0 / 1 / 0 / Entry 2 . . . 1 / 1 / 1 / Entry 7
TDIND	Bus	**Talk/Data Indicate**. When SELIND is OFF, the TDIND output (bit 0) reflects the state of the off-hook relay. When SELIND is ON, the TDIND output reflects the state of bit 2 of the directory entry selection (see SELIND output).

Table 8. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
TSTIND	Bus	**Test Indicate.** When SELIND is OFF, the TSTIND output (bit 1) is ON during modem test (see TEST input). When SELIND is ON, the TSTIND output reflects the state of bit 0 of the directory entry selection (see SELIND output).
OAIND	Bus	**Originate/Answer Indicate.** When SELIND is OFF, OAIND output (bit 2) reflect the originate (OFF) or answer (ON) state when connected or toggles to originate (OFF) or answer (ON) in response to the OA input ON-to-OFF transition. When SELIND is ON, the OAIND output reflects the state of bit 1 of the directory entry selection (see SELIND output).
COMIND	Bus	**Compressed Indicate.** COMIND output (bit 4) indicates data compression (MNP 5, V.42 bis) is in effect (high) or is not in effect (low).
RELIND	Bus	**Reliable Connection Indicate.** RELIND output (bit 5) indicates that a reliable connection (MNP, LAPM) is in effect (high) or a non-error-connected connection exists or the modem is off-line (low).
		PARALLEL HOST INTERFACE (PARALLEL INTERFACE SELECTED) The parallel interface emulates a 16450 (C29 MCU) or 16450/16550A (C39 MCU) UART interface. The parallel interface is compatible with communications software designed to operate with a 16450/16550A interface.
HA0-HA2	IA	**Host Bus Address Lines 0-2.** During a host read or write operation, HA0-HA2 select an internal MCU 16450/16550A-compatible register.
HD0-HD7	IA/OA	**Host Bus Data Lines 0-7.** HD0-HD7 are comprised of eight three-state input/output lines providing bidirectional communication between the host and the MCU. Data, control words, and status information are transferred through HD0-HD7.
$\overline{\text{HCS}}$	IA	**Host Bus Chip Select.** $\overline{\text{HCS}}$ input low selects the host bus.
$\overline{\text{HRD}}$	IA	**Host Bus Read.** $\overline{\text{HRD}}$ is an active low, read control input. When $\overline{\text{HCS}}$ is low, $\overline{\text{HRD}}$ low allows the host to read status information or data from a selected MCU register.
$\overline{\text{HWT}}$	IA	**Host Bus Write.** $\overline{\text{HWT}}$ is an active low, write control input. When $\overline{\text{HCS}}$ is low, $\overline{\text{HWT}}$ low allows the host to write data or control words into a selected MCU register.
HINT	OA	**Host Bus Interrupt.** HINT output is set high when the receiver error flag, received data available, transmitter holding register empty, or modem status interrupt has an active high condition. HINT is reset low upon the appropriate interrupt service or master reset operation.
$\overline{\text{TXACK}}$	IA	**Host Transmit Acknowledge.** $\overline{\text{TXACK}}$ is an active low transmit acknowledge input acknowledging that the DMA controller received the Transmit Ready (TXRDY) data transfer request output. (C39 MCU only.)
$\overline{\text{RXACK}}$	IA	**Host Receive Acknowledge.** $\overline{\text{RXACK}}$ is an active low receive acknowledge input acknowledging that the DMA controller received the Receiver Ready (RXRDY) data transfer request output. (C39 MCU only.)
TXRDY	OA	**Transmitter Ready.** TXRDY is an active high transmit ready output in the FIFO mode (FCR0 = 1). When asserted, TXRDY indicates that the TX FIFO is not full, i.e., the TX FIFO can accept data to be transmitted. (C39 MCU only.)
RXRDY	OA	**Receiver Ready.** RXRDY is an active high receiver ready output in the FIFO mode (FCR0 = 1). When asserted, RXRDY indicates that the RX FIFO is not empty, i.e., the RX FIFO has received data ready for transfer. (C39 MCU only.)
		STOP MODE CONTROL
$\overline{\text{STPMODE}}$	IA	**Stop Mode.** $\overline{\text{STPMODE}}$ low causes the modem to enter the stop mode immediately after terminating a line connection if connected, terminating any test in process, and allowing any data in the receive buffer to clear. $\overline{\text{STPMODE}}$ must be high before the modem can attain normal operation after power turn-on, reset, or wake-up from sleep or stop mode.

Table 9. MDP Signal Definitions

Label	I/O Type	Signal Name/Description
		OVERHEAD SIGNALS
XTALI, XTALO	IE, OE	**MDP Crystal/Clock In and Crystal Out.** Connect the MDP XTALI and XTALO pins to a external crystal circuit consisting of a 24.00014 MHz (RC96V24DP) or 19.000265 MHz (RC14V24DP) crystal and two capacitors. Alternatively, connect XTALI to a buffered clock or a sine wave oscillator and leave XTALO open.
$\overline{\text{RESET}}$	ID	**Reset.** Connect to MCU $\overline{\text{RES}}$.
+5VD (P5VD)	PWR	**+ 5V Digital Supply.** Connect +5V ± 5%.
+5VA (P5VA)	PWR	**+ 5V Analog Supply.** Connect to +5VA.
DGND	GND	**Digital Ground.** Connect to ground.
AGND	GND	**Analog Ground.** Connect to ground.
VC	OA	**Centerpoint Voltage.** Connect VC to ground through 0.1 µF.
		MCU INTERFACE
D0–D7	IA/OB	**Data Lines.** Connect to the MCU D0-D7, respectively.
RS0–RS4	IA	**Register Select Lines.** Connect to the MCU A0–A4, respectively.
$\overline{\text{CS}}$	IA	**Chip Select.** Connect to MCU $\overline{\text{DPSEL}}$ output.
$\overline{\text{READ}}$	IA	**Read Enable.** Connect to MCU $\overline{\text{READ}}$.
$\overline{\text{WRITE}}$	IA	**Write Enable.** Connect to MCU $\overline{\text{WRITE}}$.
$\overline{\text{IRQ}}$	OC	**Interrupt Request.** Connect to MCU $\overline{\text{DPIRQ}}$.
		SERIAL INTERFACE (SERIAL INTERFACE SELECTED)
$\overline{\text{TXD}}$	IA	**Transmitted Data.** The MDP obtains serial data to be transmitted from the DTE on the TXD input.
$\overline{\text{RXD}}$	OA	**Received Data.** The MDP presents received serial data to the DTE on the RXD output.
$\overline{\text{TDCLK}}$	OA	**Transmit Data Clock.** The modem outputs a synchronous Transmit Data Clock (TDCLK) for USRT timing. The TDCLK frequency is the data rate (±0.01%) with a duty cycle of 50 ±1%.
$\overline{\text{XTCLK}}$	IA	**External Transmit Clock.** In synchronous communication, an external transmit data clock can be connected to the MDP $\overline{\text{XTCLK}}$ input. The clock supplied at $\overline{\text{XTCLK}}$ must exhibit the same characteristics as $\overline{\text{TDCLK}}$.
$\overline{\text{RDCLK}}$	OA	**Receive Data Clock.** The modem outputs a synchronous Receive Data Clock (RDCLK) for USRT timing.
		SERIAL INTERFACE (PARALLEL INTERFACE SELECTED)
TXD	IA	**Transmitted Data.** Not used, leave open.
RXD	OA	**Received Data.** Not used, leave open.
$\overline{\text{TDCLK}}$	OB	**Transmit Data Clock.** Not used, leave open.
$\overline{\text{XTCLK}}$	IA	**External Transmit Clock.** Not used, leave open.
$\overline{\text{RDCLK}}$	OB	**Receive Data Clock.** Not used, leave open.

Table 9. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		LINE INTERFACE (DAA)
TXA1, TXA2	O(DD)	**Transmit Analog Output.** The TXA1 and TXA2 outputs are differential outputs to the line interface or to an optional external hybrid circuit.
RXA	I(DA)	**Receive Analog Input.** RXA is a single-ended receive data input from the telephone line interface or an optional external hybrid circuit.
RING	IA	**Ring Frequency.** A low-going edge on the RING input to the MDP initiates an internal ring frequency measurement. The MDP RING input is typically connected to the output of an 4N35 optoisolator. The optoisolator output should not respond to a voltage less than 40 Vrms appearing across TIP and RING with respect to ground.
$\overline{\text{CALLID}}$	OD	**Caller ID Relay Control (MDP $\overline{\text{OHRC}}$).** Typically, the MDP $\overline{\text{CALLID}}$ output is connected to the normally open Caller ID relay. When the modem detects a ring signal and a Calling Number Delivery (CND) message has been enabled, the $\overline{\text{CALLID}}$ output is asserted to close the CALLID relay in order to AC couple the CND information to the modem RIN input (without allowing loop current flow which would indicate an off-hook condition). For local handset operation in voice mode, the the $\overline{\text{CALLID}}$ output is asserted to close the CALLID relay in order to AC couple and route the voice signal to the modem RIN input.
$\overline{\text{VOICE}}$	OD	**Voice Relay Control (MDP $\overline{\text{TALK}}$).** Typically, the MDP $\overline{\text{VOICE}}$ output is connected to the normally open Voice relay (DPDT). In voice mode, $\overline{\text{VOICE}}$ active closes the relay to switch the handset from the telephone line to a current source to power the handset so it can be used as a microphone and speaker interface to the modem. The MDP $\overline{\text{CALLID}}$ and $\overline{\text{VOICE}}$ outputs can each directly drive a +5V reed relay coil with a minimum resistance of 360 ohms and having a must-operate voltage of no greater than 4.0 Vdc. A clamp diode, such as a 1N4148, should be installed across the relay coil. An external transistor, such as an MPSA20, can be used to drive heavier loads (e.g., electro-mechanical relays).
		SPEAKER INTERFACE
SPKR	O(DF)	**Speaker Analog Output.** The SPKR output reflects the received analog input signal. The SPKR is controlled by the ATMn command. The SPKR output can drive an impedance as low as 300 ohms. In a typical application, the SPKR output is an input to an external LM386 audio power amplifier.
		DIAGNOSTIC SIGNALS Four signals provide the timing and data necessary to create an oscilloscope quadrature eye pattern (received baseband constellation). By observing this constellation, common line disturbances can usually be identified.
EYEX, EYEY	OB	**Eye Pattern Data X and Eye Pattern Data Y.** The EYEX and EYEY outputs are two 8-bit serial bit streams containing data for display on the oscilloscope X axis and Y axis, respectively.
$\overline{\text{EYECLK}}$	OA	**Eye Pattern Clock.** EYECLK is a clock for use by the serial-to-parallel converters. The $\overline{\text{EYECLK}}$ output is a 7200-9600 Hz clock.
EYESYNC	OB	**Eye Pattern Sync.** EYESYNC is a strobe for word synchronization.

Table 10. Digital Interface Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions[1]
Input High Voltage	V_{IH}				Vdc	
Type IA		2.0	–	V_{CC}		
Type IC		0.7 V_{CC}	–	V_{CC} + 0.3		
Type ID		0.8 V_{CC}	–	V_{CC} + 0.3		
Type IE		–	4.0	–		Note 2.
Input Low Voltage	V_{IL}				Vdc	
Type IA,IC, and ID		–0.3		0.8		
Type IE		–	1.0	–		Note 2.
Input Leakage Current	I_{IN}				µAdc	V_{IN} = 0 to V_{CC}
$\overline{RES}$ and PD0-PD7		–	–	±2.5		
XTLI		–	–	±10		
NMI and $\overline{TST}$		–	–	±100		
Output High Voltage	V_{OH}				Vdc	
Type OA and OB		2.4	–	–		I_{LOAD} = – 100 µA
Type OD		–	–	V_{CC}		I_{LOAD} = 0 mA
Type OE						Note 3.
Output Low Voltage	V_{OL}				Vdc	
Type OA		–	–	0.4		I_{LOAD} = 1.6 mA
Type OB		–	–	0.4		I_{LOAD} = 0.8 mA
Type OD		–	0.75	–		I_{LOAD} = 15 mA
Three-State (Off) Current	I_{TSI}			±10	µAdc	V_{IN} = 0 V to V_{CC}

Notes:
1. Test Conditions: V_{CC} = 5V ± 5%, T_A = 0°C to 70°C (Commercial) or -40°C to 85°C (Extended), (unless otherwise stated).
   Output loads: Data bus (D0-D7), address bus (A0-A15), chip selects, $\overline{READ}$, and $\overline{WRITE}$ = 70 pF + one TTL.
   Other = 50 pF + one TTL.
2. Type IE inputs are centered approximately 2.5 V and swing 1.5 V_{PEAK} in each direction.
3. Type OE outputs provide oscillator feedback when operating with an external crystal.

Table 11. Analog Interface Characteristics

Name	Type	Characteristic	Value
RXA	I (DA)	Input Impedance	> 50K Ω
		Voltage Range	2.5 ±1.6 V
TXA1, TXA2	O (DD)	Minimum Load	300 Ω
		Maximum Capacitive Load	0.01 µF
		Output Impedance	10 Ω
		Output Voltage	2.5 ± 1.6 V
		D.C. Offset	< 200 mV
SPKR	O (DF)	Minimum Load	300 Ω
		Maximum Capacitive Load	0.01 µF
		Output Impedance	10 Ω
		Output Voltage	2.5 ± 1.6 V
		D.C. Offset	< 20 mV

Table 12. Current and Power Requirements

Mode	Current (I_D)			Power (P_D)			Notes
	Typical Current @ 25°C	Maximum Current @ 0°C	Maximum Current @ -40°C[1]	Typical Power @ 25°C	Maximum Power @ 0°C	Maximum Power @ -40°C[1]	
MCU (C29)							f_{IN} = 8.064 MHz (internal divide by 2)
Normal mode	12 mA	13.6 mA	14.0 mA	60 mW	72 mW	74 mW	
Sleep mode	1.4 mA	1.9 mA	2.0 mA	7.0 mW	10.0 mW	11.0 mW	
MCU (C39)							f_{IN} = 4.032 MHz (internal divide by 1)
Normal mode	12 mA	13.6 mA	14.0 mA	60 mW	72 mW	74 mW	
Sleep mode	0.9 mA	1.1 mA	1.2 mA	4.5 mW	5.8 mW	6.3 mW	
Stop mode	0.15 mA	0.2 mA	0.2 mA	0.8 mW	1.1 mW	1.1 mW	
MDP (RC96V24DP)							f_{IN} = 24.00014 MHz
Normal mode	38 mA	46 mA	60 mA	190 mW	240 mW	315 mW	
Sleep mode	2.0 mA	2.4 mA	3.1 mA	10.0 mW	12.5 mW	16.3 mW	
MDP (RC14V24DP)							f_{IN} = 19.000265 MHz
Normal mode	51 mA	61 mA	80 mA	255 mW	320 mW	420 mW	
Sleep mode	1.0 mA	1.2 mA	1.6 mA	5.0 mW	6.3 mW	8.4 mW	
RC96V24AC (C29)							
Normal mode	50 mA	59.6 mA	74.0 mA	250 mW	312 mW	389 mW	
Sleep mode	3.4 mA	4.3 mA	5.1 mA	17.0 mW	22.5 mW	27.3 mW	
RC96V24AC (C39)							
Normal mode	50 mA	59.6 mA	74.0 mA	250 mW	312 mW	389 mW	
Sleep mode	2.9 mA	3.5 mA	4.3 mA	14.5 mW	18.3 mW	22.6 mW	
Stop mode	2.15 mA	2.6 mA	3.3mA	10.8 mW	13.6 mW	17.4 mW	
RC14V24AC (C29)							
Normal mode	63 mA	74.6 mA	94 mA	315 mW	392 mW	494 mW	
Sleep mode	2.4 mA	3.1 mA	3.6 mA	12.0 mW	16.3 mW	19.4 mW	
RC14V24AC (C39)							
Normal mode	63 mA	74.6 mA	94 mA	315 mW	392 mW	494 mW	
Sleep mode	1.9 mA	2.3 mA	2.8 mA	9.5 mW	12.1 mW	14.7 mW	
Stop mode	1.15 mA	1.40 mA	1.8 mA	5.8 mW	7.4 mW	9.5 mW	

Notes:
1. Maximum power @ -40°C specified only for extended temperature range parts.
2. Test conditions: VDD = 5.0 VDC for typical values; VDD = 5.25 VDC for maximum values.

Table 13. Absolute Maximum Ratings

Parameter	Symbol	Limits	Units
Supply Voltage	V_{DD}	-0.5 to +7.0	V
Input Voltage	V_{IN}	-0.5 to +5VD +0.5	V
Analog Inputs	V_{IN}	-0.3 to +5VA + 0.3	V
Voltage Applied to Outputs in High Z State	V_{HZ}	-0.5 to +5VD + 0.5	V
DC Input Clamp Current	I_{IK}	±20	mA
DC Output Clamp Current	I_{OK}	±20	mA
Static Discharge Voltage (@ 25°C)	V_{ESD}	±3000	V
Latch-Up Current (@ 25°C)	I_{TRIG}	±200	mA
Operating Temperature Range	T_A		
Commercial		-0 to +70	°C
Extended		-40 to +85	°C
Storage Temperature Range	T_{STG}	-55 to +125	°C

Table 14. Parallel Interface Registers

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

* C39 MCU only.