Rockwell

RC144ACG 3.3V, Low Power, Integrated High Speed Data/Fax/Voice Modem Device Set with Cellular Direct Connect Support

INTRODUCTION

The Rockwell RC144ACG integrated data/fax/voice modem device set family supports high speed data and high speed fax modem operation in the US or world-wide over a dial-up telephone line and, for US versions, a cellular phone. (Table 1 lists the models).

Small size (two PQFP or two TQFP packages), flexible power supply (supply adaptive to 3.3V or 5V), and very low power consumption make this device set ideal for laptop, notebook, and palmtop applications.

As a data modem, the modem operates at line speeds to 14400 bps. Error correction (V.42/MNP 2–4) and data compression (V.42 bis/MNP5) maximize data transfer integrity and boost average data throughput up to 57.6 kbps. Non-error-correcting mode is also supported.

As a fax modem, the modem supports Group 3 send and receive rates up to 14400 bps and supports T.30 protocol.

In voice mode, enhanced Adaptive Differential Pulse Coded Modulation coding and decoding supports efficient digital storage of voice using 2-bit or 4-bit compression and decompression at 7200 bps. Coder silence deletion and decoder silence interpolation is available to significantly increase compression rates.

Voice models operating with the parallel host bus also support business audio and the Integrated Communications System (ICS) program. The modem supports data throughput in excess of 176 kbps utilizing the Rockwell High Speed Interface (RHSI), a data rate required by 16-bit audio record/playback at 11.025 kHz. RHSI allows slower PCs such as 16 MHz 386-based computers to sustain data rates of 115.2 kbps and higher. Record and playback of monophonic (mono) audio data in 8-bit unsigned linear pulse code modulation (PCM) or 16-bit signed linear PCM format at 11.025 kHz or 7200 Hz sampling rate is supported. These features can be used in applications such as digital answering machine, voice annotation, audio file play and record, and text-to speech.

Cellular direct connect operation is supported by licensed firmware unique to a specific cellular phone type.

"AT" commands provide data, fax class 1 and class 2, MNP 10, voice/audio, cellular, and W-class functions while using minimal external ROM, RAM, and optional NVRAM.

Use of AccelerATor kits for PC half cards and PCMCIA PC cards minimize application design time and costs. The kits also include design layout files on floppy disk, sample modem devices, crystals, and full documentation.

PC-based "ConfigurACE™" software allows MCU firmware to customized to application and country requirements.

FEATURES

- Data modem throughput up to 57.6 kbps (beyond 57.6 kbps when RHSI is active)
  - V.32 bis, V.32, 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
- MNP 10 data throughput enhancement
- Fax modem send and receive rates up to 14400 bps
  - V.17, V.29, V.27 ter, and V.21 channel 2
- Cellular direct connect
- Voice mode (option)
  - Enhanced ADPCM compression/decompression
  - Tone detection/generation and call discrimination
  - Concurrent DTMF detection
  - Timing marks
- Business audio mode (with parallel bus interface)
  - Record or playback mono data using 8-bit or 16-bit audio data encoding at 11.025 kHz or 7200 Hz
  - Concurrent DTMF/tone detection detection
- World-class operation (option)
  - Call progress and blacklisting parameters
  - Multiple country support
- Hayes AutoSync (option)
- Communication software compatible command sets
  - AT, fax class 1 and 2, and voice commands
- NVRAM directory and stored profiles
- Built-in DTE interfaces
  - DTE speed to 57.6 kbps
  - Parallel 16450 or 16550A UART interface
  - Serial CCITT V.24 (EIA/TIA-232-E)
- Rockwell High Speed Interface (RHSI)
- Automatic format/speed sensing to 57.6 kbps
- Flow control and speed buffering
- Serial sync/async data; parallel async data
- Auto dial and auto answer
- Tone, pulse, and adaptive dialing
- Calling Number Delivery (Caller ID) detect
- Extended operating temperature models available
- Flexible packaging options
  - MCU: One 80-pin PQFP or one 100-pin TQFP
  - MDP: One 100-pin PQFP or one 128-pin TQFP
- +5V operation; typical power consumption:

Mode	+3.3V	+5V
Operating:	250 mW	345 mW
Sleep mode:	14.6 mW	17.9 mW
Sleep mode	8.5 mW	10.8 mW

Data Sheet
(Preliminary)

Order No. MD105
Rev. 1, October 11, 1994
(Supersedes earlier issues)

Table 1. Modem Models and Functions

Model	Supported Functions			Country
	Data/Fax	W-Class	Voice	
RC144ACG/U	V.32 bis/V.17	–	–	US/Canada
RC144ACGWD/U	V.32 bis/No fax	S	–	Multiple
RC144ACGW/U	V.32 bis/V.17	S	–	Multiple
RCV144ACG-BA	V.32 bis/V.17	–	S	US/Canada
RCV144ACGW(E)-BA	V.32 bis/V.17	S	S	Multiple
RC96ACG/U	V.32/V.29	–	–	US/Canada
RC96ACGWD/U	V.32/No fax	S	–	Multiple
RC96ACGW/U	V.32/V.29	S	–	Multiple
RCV96ACG-BA	V.32/V.29	–	S	US/Canada
RCV96ACGW-BA	V.32/V.29	S	S	Multiple

Notes:

1. Model options:
   - BA – Business audio.
   - D – Data only (no fax).
   - V – Voice functions.
   - W – World class support.
   - (E) – Optional industrial temperature range.
   - U – Available only with 16550A interface.
2. Supported functions (S = Supported; – = Not supported):
   - Fax – Fax class 1 and class 2 command functions.
   - W-Class – World class functions supporting multiple country requirements.
   - Voice – Voice and business audio command functions.

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TECHNICAL SPECIFICATIONS

GENERAL DESCRIPTION

The modem device set provides the processing core of the modem. The OEM adds a crystal, discrete components, and a digital access arrangement (DAA) and/or cellular interface circuit to complete the modem system.

Modem Data Pump (MDP)

The MDP is a Rockwell RC96DPG or RC144DPG data/fax/voice modem data pump packaged in a 100-pin PQFP or a 128-pin TQFP. The crystal frequency is 35.2512 MHz.

As a data modem, the MDP can operate in 2-wire, full-duplex, synchronous/asynchronous modes at line rates up to 14400 bps (RC144DPG) or 9600 bps (RC96DPG).

As a fax modem, the MDP fully supports Group 3 facsimile send and receive speeds of 14400 (RC144DPG), 12000 (RC144DPG), 9600, 7200, 4800, or 2400 bps.

ADPCM voice processing in the MDP is supported in ACG models supporting voice commands.

Microcontroller (MCU)

The MCU is a Rockwell L39 or P39 microcomputer packaged in an 80-pin PQFP or a 100-pin TQFP.

The MCU is a Rockwell L39 or P39 microcomputer. The MCU performs the command processing and host interface functions. The crystal frequency is 9.8304 MHz.

The L39 MCUs are packaged in an 80-pin PQFP or 100-pin TQFP

The L39 MCU connects to the host via a V.24 (EIA/TIA-232-E) serial interface or a parallel microcomputer bus depending on installed MCU firmware. In parallel interface operation, the MCU can connect to a PCMCIA connector using a Rockwell PCMCIA Interface Control Adapter (PICA) device (see data sheet Order No. MD99) and a PCMCIA Card Information Structure (CIS) memory device.

The P39 MCU performs all the functions as the L39 MCU and, in addition, incorporates a built-in PCMCIA interface and CIS memory allowing the P39 MCU to directly connect to the PCMCIA connector without requiring these two external parts. The P39 MCU is packaged in an 128-pin PQFP. The P39 MCU interface is described in Application Note 1057, "P39 MCU (8-Bit Microcontroller with PCMCIA Interface) Application to Rockwell 14400 bps and 28800 bps Low Power Modems".

The MCU connects to the MDP via dedicated lines and the external bus. The MCU external bus also connects to OEM-supplied ROM and RAM and, high performance configuration, to the CEP. The ROM size is 128k bytes. The RAM size is 32k bytes for the low cost configuration or 8k bytes for the high performance configuration.

For all models, 256 bytes NVRAM can optionally be connected to the MCU over a dedicated serial interface.

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/audio, HSI, and DTE/host interface functions. Configurations of the MCU firmware are provided to support parallel host bus interface operation or serial DTE interface operation. The MCU firmware is provided 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 Host Bus Interface

A 16450-compatible or 16450/16550A UART-compatible parallel interface is provided depending upon modem model. Eight data lines, three address lines, four DMA request/acknowledge lines, four control/status lines, and a reset line are supported.

DTE Serial Interface and Indicator Outputs

A DTE serial interface and indicator/control outputs are supported.

V.24/EIA/TIA-232-E DTE Serial Interface. A V.24/EIA/TIA-232-E logic-compatible DTE serial interface is supported. A clock stop signal is provided which can be used to turn off transmitter and receiver clocks to the DTE in asynchronous modes.

Indicator Outputs. Four indicator outputs are supported.

NVRAM Interface

A serial interface to an optional OEM-supplied non-volatile RAM (NVRAM) is provided. Data stored in NVRAM can take precedence over the factory default settings. A 256-byte NVRAM can store up to two user-selectable configurations and can store up to four 35-digit dial strings.

Speaker Interface

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

External Bus Interface

The MCU external bus connects to the MDP and to OEM-supplied ROM, and RAM. This non-multiplexed bus supports eight bidirectional data lines and 17 address output lines. Read enable, write enable and chip select outputs (MDP select, ROM select, and RAM select) are also supported.

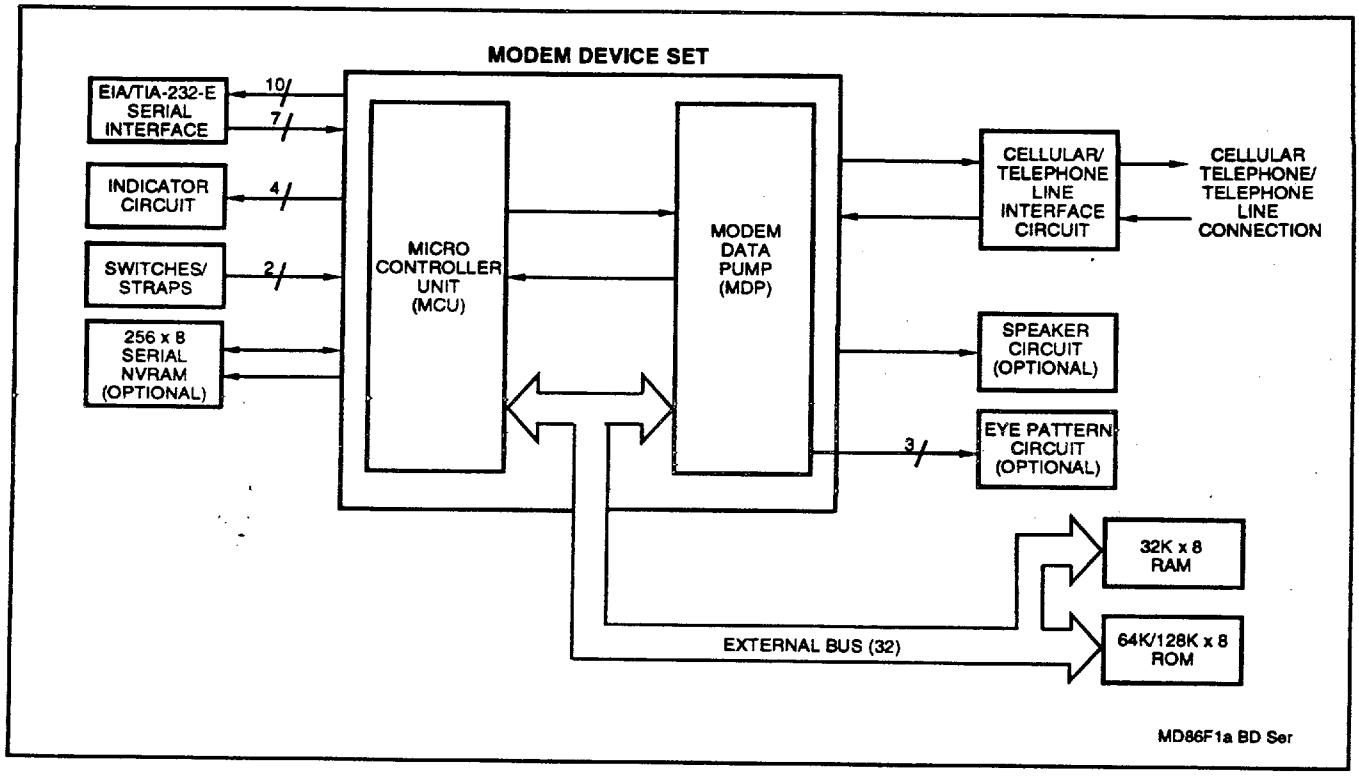

Figure 1a. Block Diagram - Serial Interface

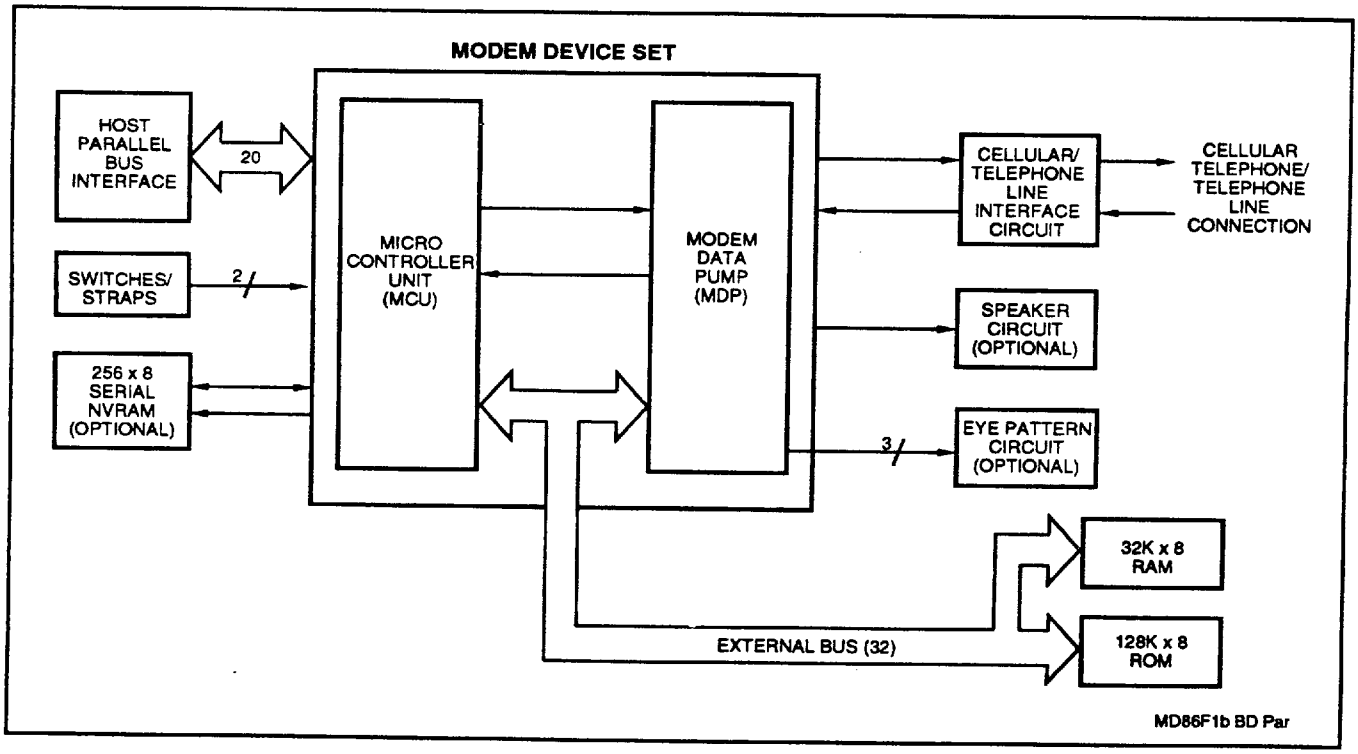

Figure 1b. Block Diagram - Parallel Interface

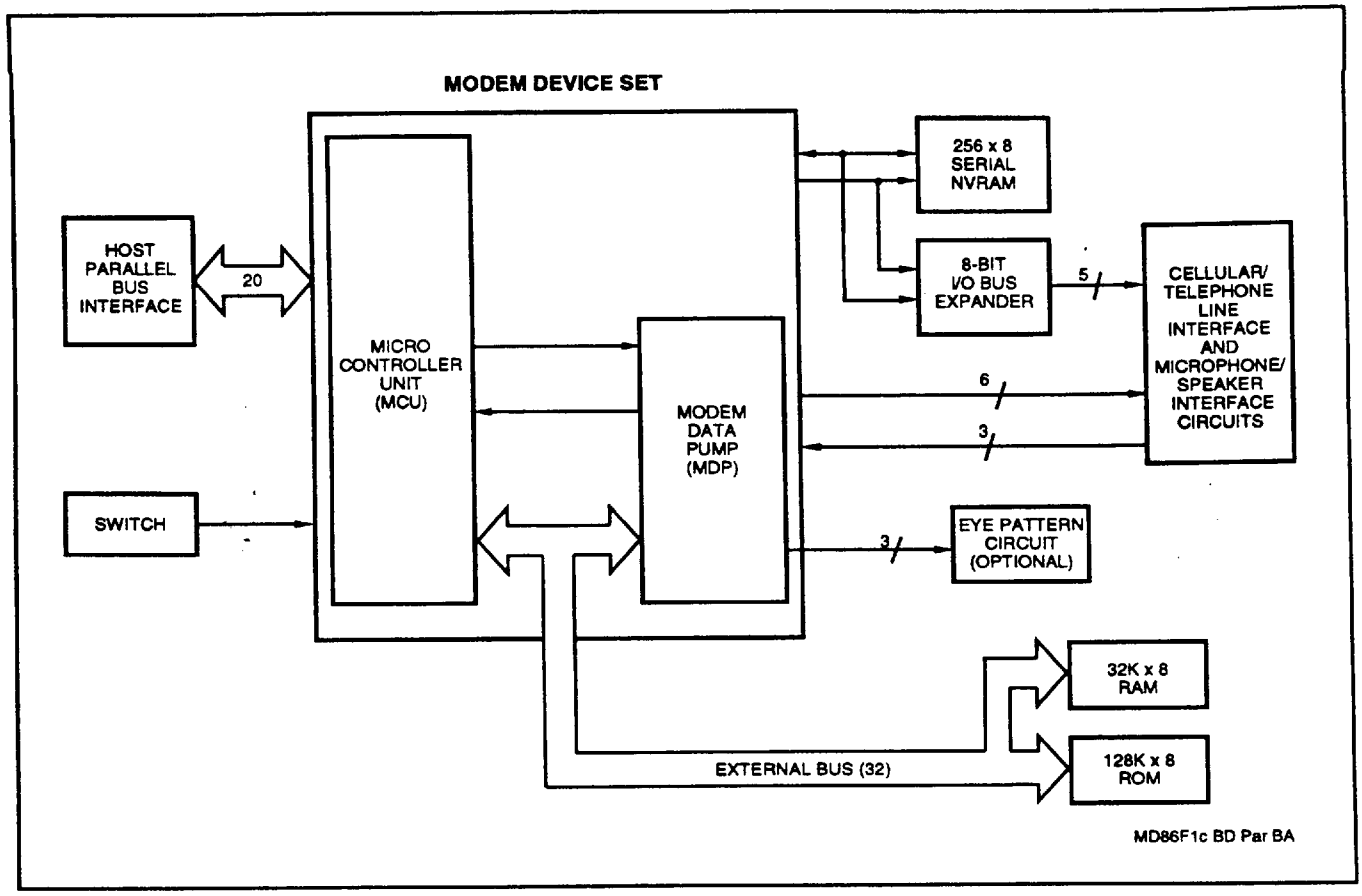

Figure 1c. Block Diagram - Parallel Interface with Business Audio

Telephone Line Interface

MCU. Wireline operation is selected when a DAA interface is indicated on the DAA/CELL input or when a cellular interface is indicated on the DAA/CELL input but no cellular firmware driver is loaded. Four relay control outputs to the line interface are supported. 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.

MDP. A receive analog input, two transmit analog outputs, two relay driver outputs, and a ring signal input are supported. The relay outputs may be used to drive Caller ID and voice relays.

Business Audio Interface

The MCU outputs two encoded analog switch control signals to select RIN and TXA1/TXA2 routing. In addition, three outputs are provided to select volume control, control volume up/down direction, and volume increment.

Cellular Phone Interface

MCU. Cellular operation is selected when a cellular interface is indicated on the DAA/CELL input and a cellular firmware driver is loaded. Signals supported are two encoded control outputs (CTRL0 and CTRL1), a bidirectional serial data line (CELDATA), a data clock input (CELCLK), a cellular busy output (CELBSY), and a cellular busy input (~CELBSY). Host DMA is not available in parallel interface operation when cellular is selected.

MDP. A receive analog input, two transmit analog outputs, two relay driver outputs, and a ring signal input are supported.

Eye Pattern Generator Interface

Eye pattern data, clock, and sync interface signals are provided to allow an external eye pattern generator circuit to be easily added in order to observe data modem performance relative to line impairments.

Microsoft Windows Interface. Microsoft Windows is supported in the host using the proprietary RHSI. The use of RHSI overcomes the limitation of predefined UART speeds. Support for RHSI is in the form of modem microcomputer firmware and Windows driver RHSICOMM.DRV. The Rockwell RHSICOMM.DRV driver is downward compatible with the standard Microsoft Windows communications driver COMM.DRV.

COMMANDS

The modem supports data modem, fax class 1 and 2, and MNP 10 commands, and S Registers (see Tables 2 and 3, respectively) in accordance with modem model options.

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

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

AutoSync Operation. AutoSync operates in response to the &Q4 command.

Fax Modem Operation. Facsimile functions operate in response to fax class 1 commands when +FCLASS=1 or #CLS=1 or to fax class 2 commands when +FCLASS=2 or #CLS=2.

Voice Operation. Voice mode functions operate in response to voice/audio commands when #CLS=8 and #VBS=2 or #VBS=4 is selected.

Audio Operation. Audio mode functions operate in response to voice/audio commands when #CLS=8 and #VBS=8 or #VBS=16 is selected. Sampling rate is determined by #VSR=11025 or #VSR=7200.

Cellular Operation. Cellular functions operate when a cellular phone driver is loaded and a cellular phone interface is detected.

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

DTE SERIAL INTERFACE 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, 7200, 9600, 12000, 14400, 16800, 19200, 21600, 24000, 26400, 28800, 38400, and 57600 bps and the following data formats:

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

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

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

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

HOST PARALLEL BUS INTERFACE OPERATION

The modem can operate at rates up to 57600 bps by programming the Divisor Latch in the parallel interface registers.

ESTABLISHING DATA MODEM CONNECTIONS

Telephone Number Directory

The modem supports four telephone number entries in a directory that can be saved in a serial NVRAM. Each telephone number can be up to 35 characters in length. A telephone number can be saved using the &Zn=x command, and a saved telephone number can be dialed using the DS=n command.

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/TIA-496-A.

Adaptive Dialing. If DTMF dialing is selected (T command) and the telephone network does not recognize DTMF tones, the modem switches to pulse dialing. If pulse dialing is selected (P command), pulse dialing is used.

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 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 of data are prevented for 2 seconds (data modem) or 4 seconds (fax adaptive answer) to allow transmission of the billing signal.

Connection Speeds

The possible data connection modes/speeds are 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

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

Table 2. AT Commands

Command	Function
	Basic AT Commands
A/	Re-execute command
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=x	Write to S Register
Sn?	Read 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 or fallback/fall forward
%L	Report line signal level
%Q	Report line signal quality
%TTn	PTT testing utilities
\Gn	Modem-to-modem flow control (XON/XOFF)
\Kn	Break control
\Nn	Operating mode
#CID	Caller ID detection and reporting
**	Download to flash memory
	Cellular Commands
^C2	Download Cellular Phone Driver
^I	Identify Cellular Phone Driver
^T6	Indicate Status Of Cellular Phone

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
	MNP 10 AT Commands
)Mn	Enable/disable 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
:E	Compromise equalizer enable
	Fax Class 1 AT+F Commands
+FCLASS=n	Service class
+FAE	Data/fax auto answer
+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
+FCIG	Set the polled station identification
+FDT	Data transmission
+FET=N	Transmit page punctuation
+FDR	Begin or continue Phase C receive data
+FK	Terminate session
+FLPL	Document for polling
+FSPL	Enable polling
	Class 2 DCE Responses
+FCIG:	Report the polled station identification
+FCON	Facsimile connection response
+FDCS:	Report current session
+FDIS:	Report remote capabilities
+FDTC:	Report the polled station capabilities
+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
+FPOLL	Indicates polling request
	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
*B	Display blacklisted numbers
*D	Display delayed numbers
*NCnn	Country select

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	DTMF Tone Duration
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 attenuation level
S92	Fax transmit attenuation level
S95	Result code messages control
	ECC S Registers
S36	LAPM failure control
S46	Data compression control
S48	V.42 negotiation control
S82	Break handling control
	Cellular Registers
S201	Cellular transmit level

Table 4. Connection Speed Options

Configuration	Rate (bps)
V.32 bis	14400 (RC144ACG), 12000 (RC144ACG), 9600, 7200, or 4800
V.32	9600 or 4800
V.22 bis	2400 or 1200
V.22	1200
V.23	1200Tx/75Rx or 75TX/1200Rx
V.21	0-300
Bell 212A	1200
Bell 103	0-300

DATA MODE

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

Speed Buffering (Normal Mode)

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

Flow Control

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

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

Escape Sequence Detection

The "+++" escape sequence with guard time can be used to return control to the command mode from the data mode. Escape sequence detection is disabled by an 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

GSTN Cleardown (V.32 bis, V.32). Upon receiving GSTN Cleardown from the remote modem in a non-error correcting mode, the modem cleanly terminates the call.

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

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

Fall Forward/Fallback (V.32 bis/V.32)

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

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

Retrain

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

The modem initiates a retrain if line quality becomes unacceptable if enabled by the %E command. The modem continues to retrain until an acceptable connection is achieved, or until 30 seconds elapse resulting in line disconnect.

Programmable Inactivity Timer

The modem disconnects from the line if data is not sent or received for a specified length of time. In normal or error-correction mode, this inactivity timer is reset when data is received from either the DTE or from the line. This timer can be set to a value between 0 and 2550 seconds by using register S30. A value of 0 disables the inactivity timer.

Synchronous Data Mode (Serial Interface Only)

The modem can establish a synchronous connection in accordance with the &Mn or &Qn 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.

DTE Signal Monitoring (Serial Interface Only)

~DTR. When ~DTR is asserted, the modem responds in accordance with the &Dn and &Qn commands.

~RTS. ~RTS is used for flow control if enabled by the &K command in normal or error-correction mode or to affect the ~CTS output if enabled by the &R command in synchronous mode.

~RDL. When ~RDL is asserted, the modem requests a remote digital loop if connected in non-error-correction mode.

~AL. When ~AL is asserted, the modem disconnects and enters analog loop.

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

V.42 bis Data Compression

V.42 bis data compression mode, enabled by the %Cn command or S46 register, operates when a LAPM or MNP 10 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, enabled by the %Cn command, operates during an MNP connection.

In MNP 5, the modem increases its throughput by compressing data into tokens before transmitting it to the remote modem, and by decompressing encoded received data before sending it to the DTE.

MNP 10 DATA THROUGHPUT ENHANCEMENT

MNP 10 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. A 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 for 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. When enabled by the)M2 command, 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. V.42 bis/MNP 10 can operate with V.42 bis or MNP 5 data compression.

AUTOSYNC

Hayes AutoSync mode, when used with communications software incorporating the Hayes Synchronous Interface (HSI), provides synchronous communication capabilities from an asynchronous data terminal. In AutoSync, the modem places the call asynchronously then automatically switches to synchronous operation once the telephone connection has been established. AutoSync allows communication from an asynchronous DTE (typically a personal computer) to synchronous DTE (typically a mainframe computer or minicomputer).

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 fax commands. Some AT commands are still valid but may operate differently than in data modem mode.

Calling tone is generated in accordance with T.30.

VOICE/AUDIO MODE

Voice and audio functions are supported by the Voice Mode. Voice Mode includes three submodes: Online Voice Command Mode, Voice Receive Mode, and Voice Transmit Mode (Table 2).

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

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

Received analog voice samples are converted to digital form and compressed for reading by the host. AT commands control the codec bits-per-sample rate and, optionally, select silence deletion including silence detection period adjustment.

Received analog mono audio samples are converted to digital form and formatted into 8-bit unsigned linear PCM or 16-bit signed linear PCM format for reading by the host. AT commands control the bit length and sampling rate. Concurrent DTMF/tone detection is available at the 7200 Hz sample rate.

Voice Transmit Mode. This mode is entered when the #VTX command is active in order to playback voice or audio data to the TXA1/TXA2 output pins, typically to a speaker/handset or to the telephone line.

Digitized voice data is decompressed and converted to analog form at the original compression quantization sample-per-bits rate then output to the TXA1/TXA2 pins. Optional silence interpolation is enabled if silence deletion was selected for voice compression.

Digitized audio data is converted to analog form then output to the TXA1/TXA2 pins.

CALLER ID

Caller ID can be enabled/disabled using the #CID command. When enabled, caller ID information (date, time, caller code, and name) can be passed to the DTE in formatted or unformatted form. Inquiry support allows the current caller ID mode and mode capabilities of the modem to be retrieved from the modem.

CELLULAR DIRECT CONNECT

In US models, the modem provides defined hardware and firmware interfaces for connection to a cellular telephone. The modem controls downloading and execution of a cellular phone driver firmware into MCU RAM to support direct connection to a cellular phone. Different drivers are required to support different cellular phones or phone models as required by the phone manufacturer.

Cellular Interface Signals

The following MCU ports are assigned to cellular phone interface signals:

MCU Port	Cellular Use		Non-Cellular Use	
	Signal	I/O	DTE Serial Interface	Host Parallel Interface
PE0	CTRL0	O	~OH	~OH
PE1	CTRL1	O	~PULSE	~PULSE
PE2	CELBSY	O	~MUTE, ~A/A1	~MUTE, ~A/A1
PE5	CELDATA	I/O	~CLKSTOP, PTTEN*	PTTEN*
PE7	DAA/CELL	I	IDID*	IDID*
PA3	~CELBSY	I	~TXCLK	~TXACK
PA4	CELCLK	I	~RXCLK	~RXACK

* Used during reset initialization only in W-class models.

Support for these signals is supplied by the cellular driver. When the cellular driver is loaded and a cellular phone interface is indicated on the DAA/CELL input line, the cellular signals are used instead of the wireline signals assigned to the same lines. When the cellular driver is not loaded or when a cellular phone interface is not indicated on the DAA/CELL line when a cellular driver is loaded, the wireline signals are supported.

The cellular and wireline signals are supported in an AccelerATor Kit design and are routed to a standard 15-pin connector which connects to a cable from the cellular phone.

Cellular AT Commands

The modem supports three cellular AT commands that can be used to load the cellular driver and to provide cellular phone identification and status.

^C2 - Download Cellular Phone Driver. The ^C2 command initiates download of the cellular phone driver into MCU RAM.

^I - Identify Cellular Phone Driver. The ^I command. reports the identification of the loaded cellular phone driver.

^T6 - Indicates Status Of Cellular Phone. The ^T6 command reports the status of the cellular phone connection to the modem. The following bit mapped status is reported:

- Bit 0=1: Cellular phone is receiving an incoming call
- Bit 1=1: Cellular phone is in use
- Bit 2=1: Cellular phone is locked (cannot be used)
- Bit 3=1: There is no service for cellular phone (does not indicate signal strength)
- Bit 4=1: Cellular phone is powered on
- Bit 5=1: Cellular driver is initialized
- Bit 6 Reserved
- Bit 7=1 Cellular cable detected (DAA/CELL = low)

The information obtained by issuing the ^T6 can be used to determine if the loading of the cellular phone driver is necessary by the host software. Download of the cellular phone driver is not required if a cellular interface cable is not connected to the modem (DAA/CELL = high). A download is necessary when a cellular cable is detected (DAA/CELL = low), which implies a cellular phone is also connected, before operation of the phone. Once a driver is downloaded, the modem can operate in wireline mode or cellular mode based on the connection of a cellular cable.

Operation

Once the cellular driver is loaded and the modem is connected to the cellular phone and the phone is powered on, dial/answer functions will be routed through the phone instead of the wireline DAA. No special commands are needed to place or answer cellular calls and the same AT commands and software packages that are used for wireline communication sessions can be used. If a V.42 bis connection is established in wireline mode, the cellular phone driver is removed from MCU RAM so that the V.42 bis dictionaries can be increased to their full size.

Result Messages

While the modem is being used with a cellular phone, result messages are changed from wireline operation status to reflect cellular operation status as follows:

NO DIALTONE - Indicates that cellular service is not currently available or the cellular phone is powered off.

RING - Indicates that the cellular phone is receiving an incoming call.

WORLD CLASS COUNTRY SUPPORT

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

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.

Blind Dialing. Blind dialing may be disabled by ConfigurACE.

Carrier Transmit Level

The carrier transmit level can be programmed through S91 for data and S92 for fax. The maximum, minimum, and default values can be defined by ConfigurACE to match specific country and DAA requirements.

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.

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 by 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 MDP, RAM, ROM, and NVRAM.

LOW POWER SLEEP AND STOP MODES

Sleep Mode Entry. The modem enters 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 reduced power while being able to immediately wake up and resume normal operation.

Stop Mode Entry. The modem enters the low power stop mode when the ~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, terminating a line connection, terminating any test in process, and allowing any data in the Receive Buffer Register to clear.

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

Wake-up. Wakeup occurs when a ring is detected on the telephone line, the host writes to the modem (parallel interface version), or the DTE sends a character to the modem (serial interface version). 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.

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
- Limitation 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.

ADDITIONAL INFORMATION

Additional information is described in the RC144ACG Designer's Guide (Order No. 1008) and in the AT Command Reference Manual (Order No. 883).

HARDWARE INTERFACES

The modem hardware interface signals for serial interface configuration is shown in Figure 2.

The modem hardware interface signals for parallel interface configuration is shown in Figure 3. Figure 3a shows the general parallel interface for cellular and W-class applications. Figure 3b shows the general interface for business audio application.

The MCU pin assignments for the 80-pin PQFP are shown in Figure 4 and are listed in Table 5.

The MCU pin assignments for the 100-pin TQFP are shown in Figure 5 and are listed in Table 6.

The MDP pin assignments for the 100-pin PQFP are shown in Figure 6 and are listed in Table 7.

The MDP pin assignments for the 128-pin TQFP are shown in Figure 7 and are listed in Table 8.

The MCU hardware interface signals are defined in Table 9.

The MDP hardware interface signals are defined in Table 10.

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

The analog electrical characteristics for the hardware interface signals are listed in Table 12.

The current and power requirements are listed in Table 13.

The absolute maximum ratings are listed in Table 14.

Table 15 shows the parallel interface registers and the corresponding bit assignments.

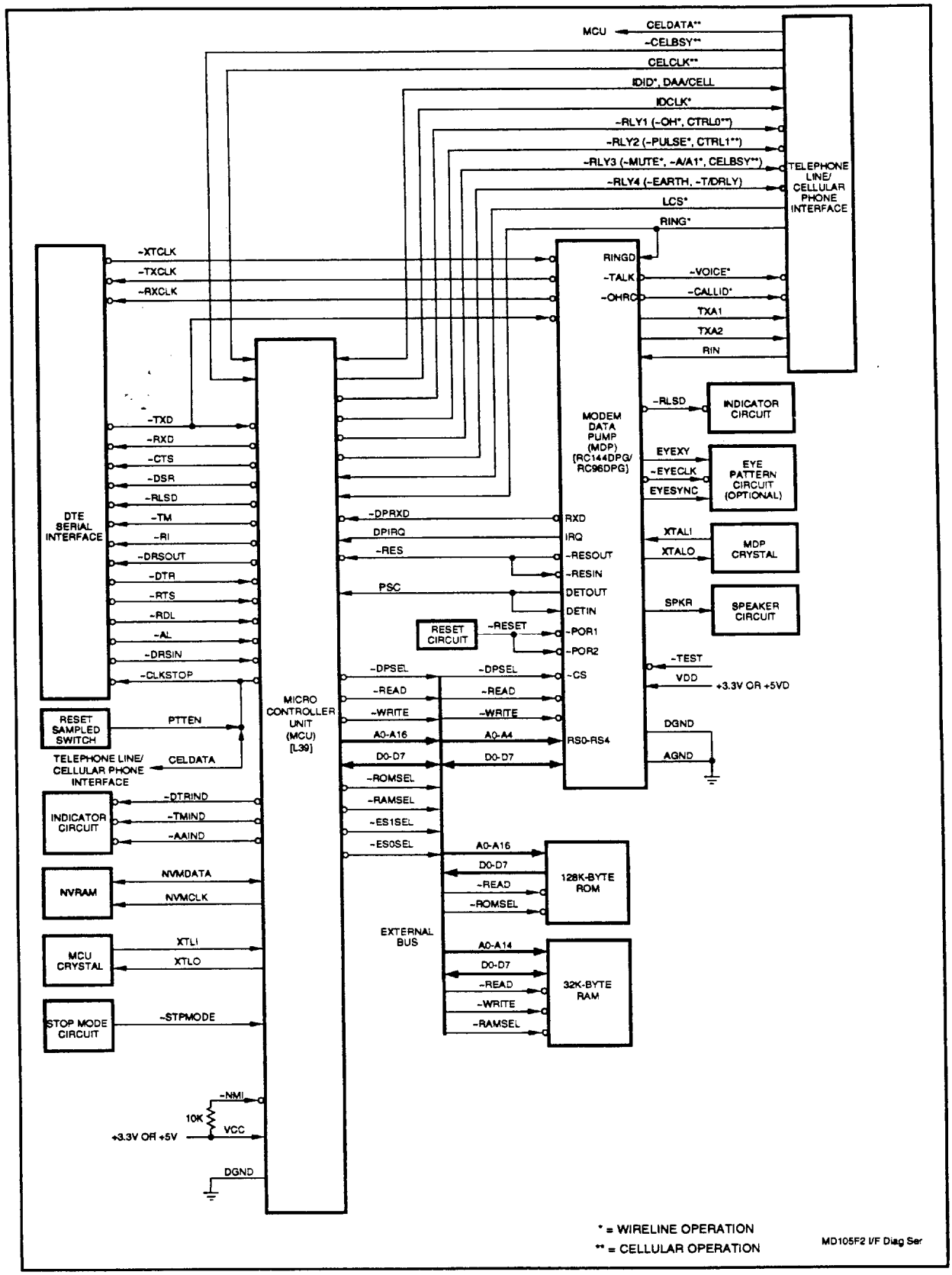

Figure 2. Hardware Interface Signals - Serial Interface

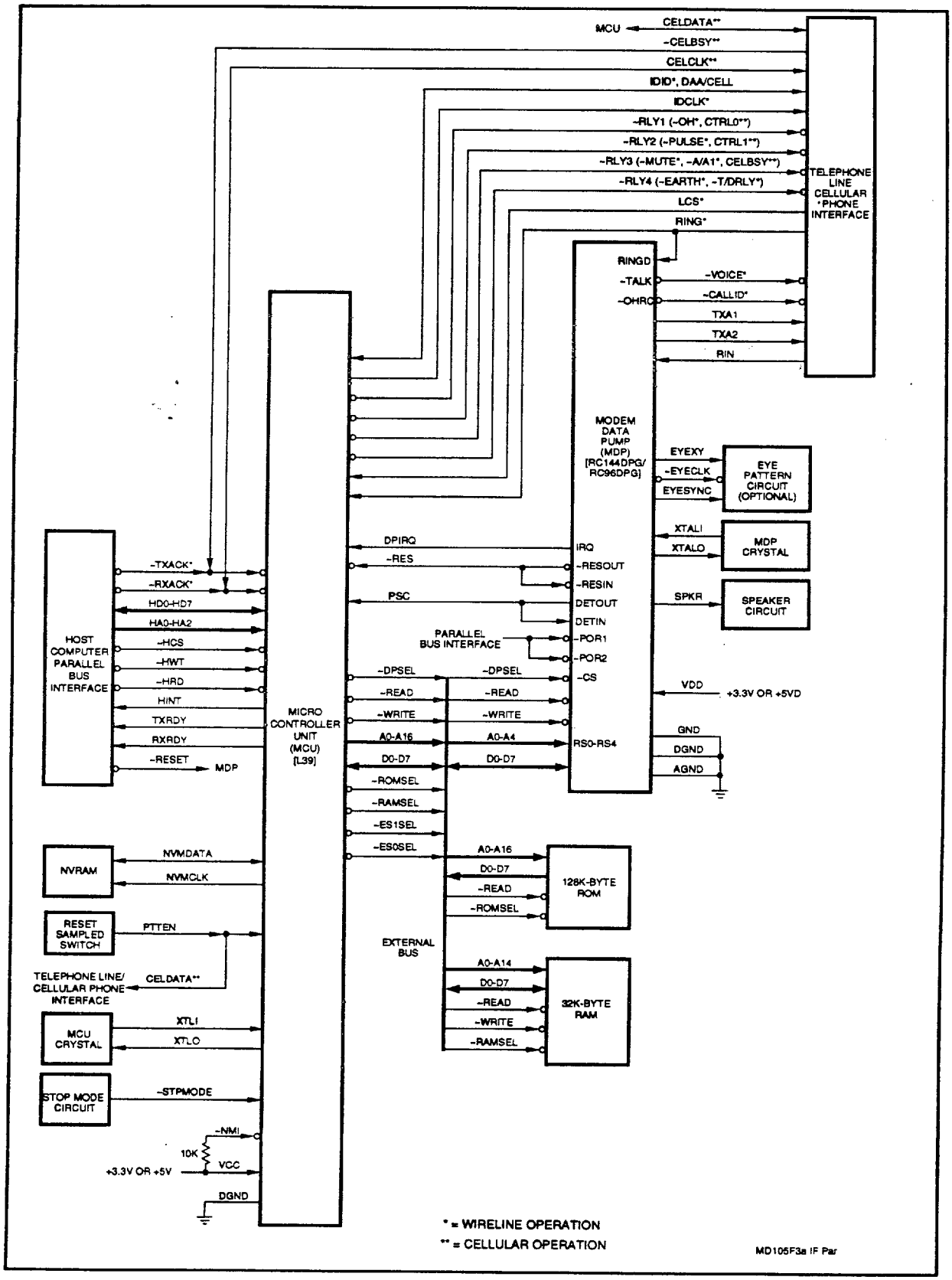

Figure 3a. Hardware Interface Signals - Parallel Interface

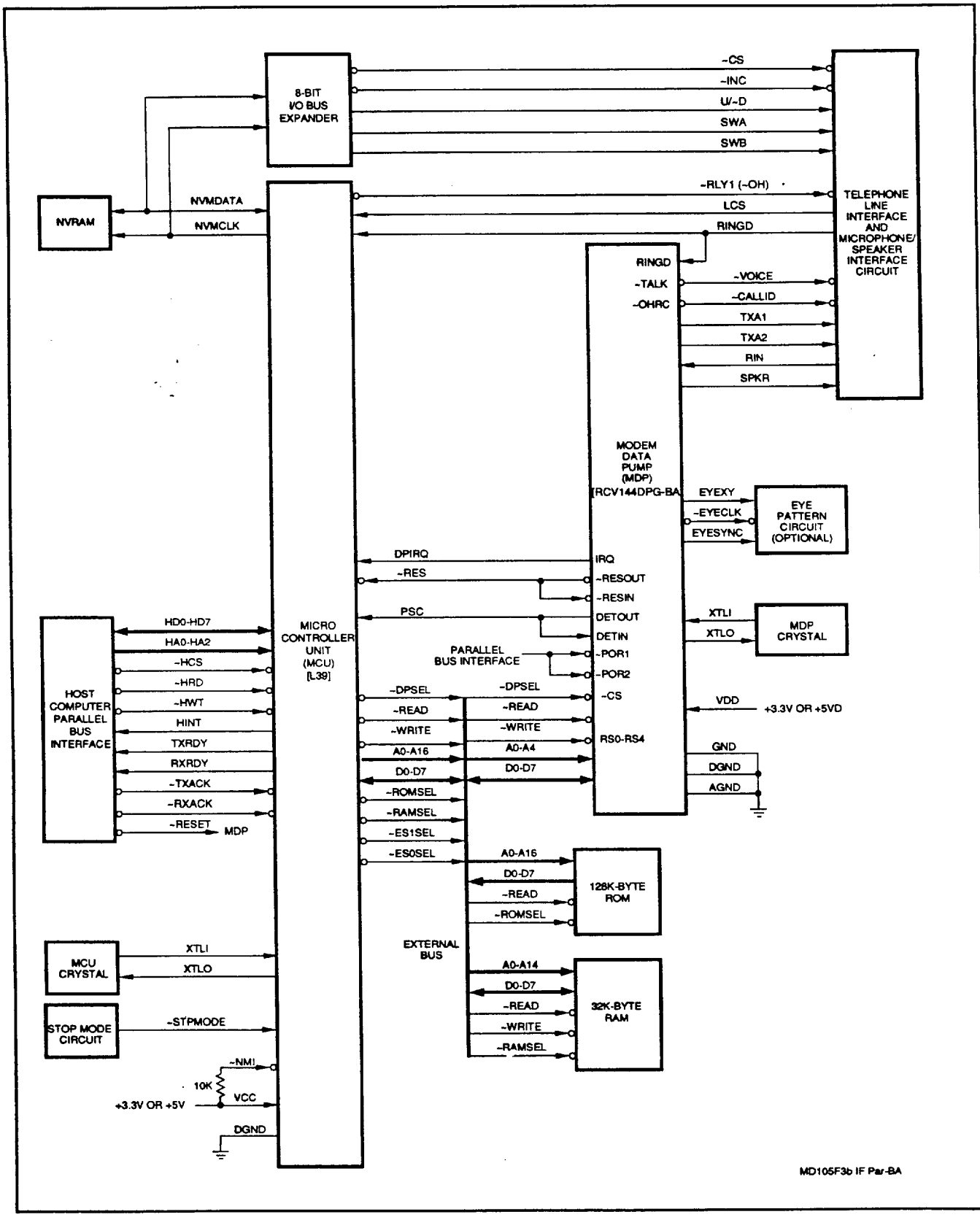

Figure 3b. Hardware Interface Signals - Parallel Interface with Business Audio

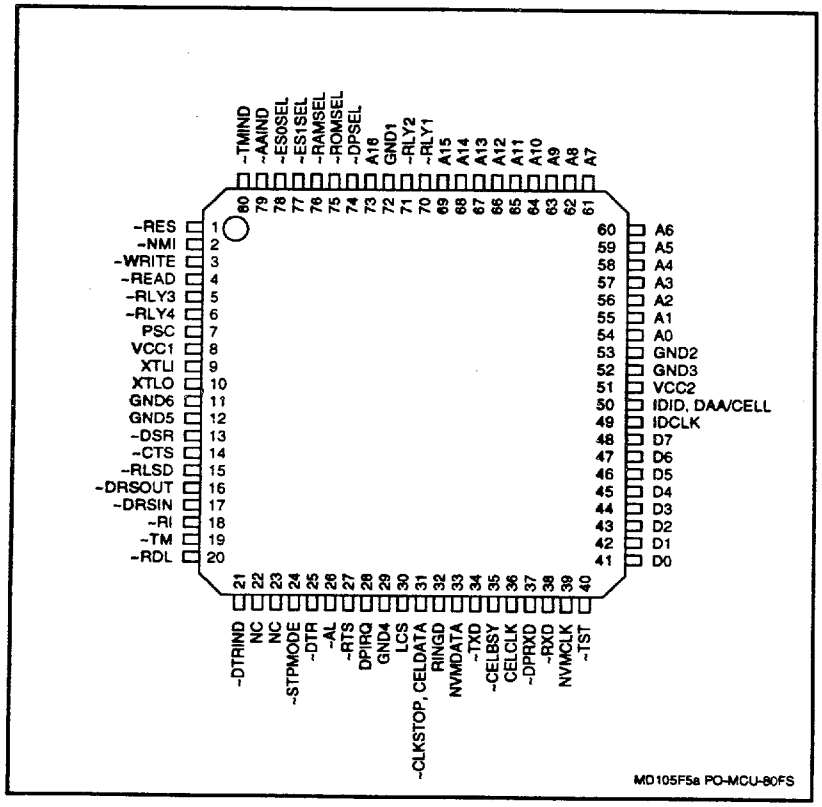

Figure 4a. MCU Pin Signals- 80-Pin PQFP - Serial Interface

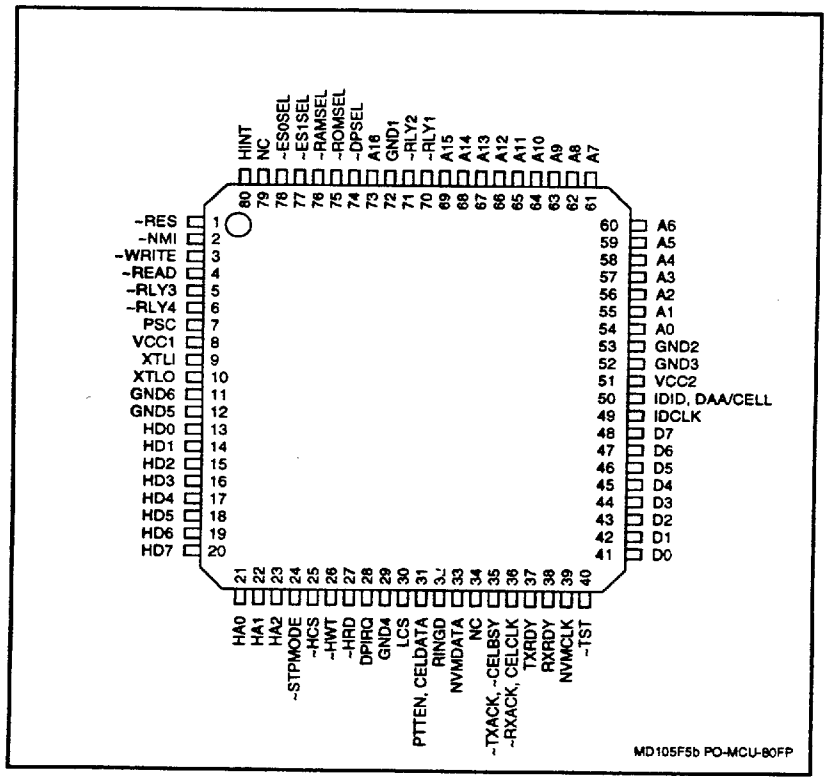

Figure 4b. MCU Pin Signals- 80-Pin PQFP - Parallel Interface

Table 5a. MCU Pin Signals - 80-Pin PQFP - Serial Interface

Pin	Signal Label	I/O Type	Interface	Pin	Signal Label	I/O Type	Interface
1	~RES	IC	MDP: ~RESOUT	41	D0	IA/OA	EB: D0
2	~NMI	MI	Note 4	42	D1	IA/OA	EB: D1
3	~WRITE	OA	EB: ~WRITE	43	D2	IA/OA	EB: D2
4	~READ	OA	EB: ~READ	44	D3	IA/OA	EB: D3
5	(PE2) ~RLY3	OA	WL: DAA: A/A1, ~MUTE, Cellular: CELBSY	45	D4	IA/OA	EB: D4
6	(PE3) ~RLY4	OA	WL: DAA: ~T/DRLY, ~EARTH	46	D5	IA/OA	EB: D5
7	PSC	IA	MDP: DETOUT	47	D6	IA/OA	EB: D6
8	VCC1	PWR	VCC	48	D7	IA/OA	EB: D7
9	XTLI	IE	XTLI	49	(PE6) IDCLK	OA	WL: DAA: IDCLK
10	XTLO	OE	XTLO	50	(PE7) IDID Cellular: DAA/CELL	IA	WL: DAA: IDID Cellular: DAA/CELL
11	GND6	GND	GND	51	VCC2	PWR	VCC
12	GND5	GND	GND	52	GND3	GND	GND
13	(PC0) ~DSR	OA	DTE: ~DSR	53	GND2	GND	GND
14	(PC1) ~CTS	OA	DTE: ~CTS	54	A0	OA	EB: A0
15	(PC2) ~RLSD	OA	DTE: ~RLSD	55	A1	OA	EB: A1
16	(PC3) ~DRSOUT	OA	DTE: ~DRSOUT	56	A2	OA	EB: A2
17	(PC4) ~DRSIN	OA	DTE: ~DRSIN	57	A3	OA	EB: A3
18	(PC5) ~RI	OA	DTE: ~RI	58	A4	OA	EB: A4
19	(PC6) ~TM	OA	DTE: ~TM	59	A5	OA	EB: A5
20	(PC7) ~RDL	IA	DTE: ~RDL	60	A6	OA	EB: A6
21	(PD0) ~DTRIND	OA	Indicator Circuit	61	A7	OA	EB: A7
22	(PD1) NC		NC	62	A8	OA	EB: A8
23	(PD2) NC		NC	63	A9	OA	EB: A9
24	(PD3) ~STPMODE	IA	Stop Mode Circuit	64	A10	OA	EB: A10
25	(PD4) ~DTR	IA	DTE: ~DTR	65	A11	OA	EB: A11
26	(PD5) ~AL	IA	DTE: ~AL	66	A12	OA	EB: A12
27	(PD6) ~RTS	IA	DTE: ~RTS	67	A13	OA	EB: A13
28	(PD7) DPIRQ	IA	MDP: IRQ	68	A14	OA	EB: A14
29	GND4	GND	GND	69	A15	OA	EB: A15
30	(PE4) WL: LCS	IA	WL: DAA: LCS	70	(PE0) ~RLY1	OA	WL: DAA: ~OH Cellular: CTRL0
31	(PE5) PTTEN WL: ~CLKSTOP Cellular: CELDATA	IA OA IA/OA	PTTEN WL: ~CLKSTOP Cellular: CELDATA	71	(PE1) ~RLY2	OA	WL: DAA: ~PULSE Cellular: CTRL1
32	(PA0) RINGD	IA	DAA: RINGD	72	GND1	GND	GND
33	(PA1) NVMDATA	IA/OA	NVRAM: SDA (Note 4)	73	(PB0) A16	OA	EB: A16
34	(PA2) ~TXD	IA	DTE: ~TXD	74	(PB1) ~DPSEL	OA	EB: MDP: ~CS
35	(PA3) Cellular: ~CELBSY	IA	Cellular: ~CELBSY	75	(PB2) ~ROMSEL	OA	EB: ROM: ~CE
36	(PA4) Cellular: CELCLK	IA	Cellular: CELCLK	76	(PB3) ~RAMSEL	OA	EB: RAM: ~CS
37	(PA5) ~DPRXD	MI	MDP: RXD	77	(PB4) ~ES1SEL	OA	Not used
38	(PA6) ~RXD	OA	DTE: ~RXD	78	(PB5) ~ES0SEL	OA	Not Used
39	(PA7) NVMCLK	OA	NVRAM: SCL	79	(PB6) ~AAIND	OA	Indicator Circuit
40	~TST	MI	NC (Note 5)	80	(PB7) ~TMIND	OA	Indicator Circuit

Notes:

1. I/O types:
   MI = Modem interconnect.
   IA, IB, IC, IE = Digital input.
   OA, OB, OE = Digital output.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to VCC through 10 K ohms.
5. Leave open to allow internal MCU ROM use; connect to GND through 10K ohms to force external ROM use only.
6. Connect to GND through 10K ohms.
7. Connect to GND through 100K ohms.

Table 5b. MCU Pin Signals- 80-Pin PQFP - Parallel Interface

Pin	Signal Label	Type	Interface	Pin	Signal Label	Type	Interface
1	~RES	IC	MDP: ~RESOUT	41	D0	IA/OA	EB: D0
2	~NMI	MI	Note 4	42	D1	IA/OA	EB: D1
3	~WRITE	OA	EB: ~WRITE	43	D2	IA/OA	EB: D2
4	~READ	OA	EB: ~READ	44	D3	IA/OA	EB: D3
5	(PE2) ~RLY3	OA	WL: DAA: A/A1, ~MUTE Cellular: CELBSY	45	D4	IA/OA	EB: D4
6	(PE3) ~RLY4	OA	WL: DAA: ~T/DRLY, ~EARTH	46	D5	IA/OA	EB: D5
7	PSC	IA	MDP: DETOUT	47	D6	IA/OA	EB: D6
8	VCC1	PWR	VCC	48	D7	IA/OA	EB: D7
9	XTLI	IE	XTLI	49	(PE6) IDCLK	OA	WL: DAA: IDCLK
10	XTLO	OE	XTLO	50	(PE7) IDID Cellular: DAA/CELL	IA	WL: DAA: IDID Cellular: DAA/CELL
11	GND6	GND	GND	51	VCC2	PWR	VCC
12	GND5	GND	GND	52	GND3	GND	GND
13	(PC0) HD0	IA/OA	HB: HD0	53	GND2	GND	GND
14	(PC1) HD1	IA/OA	HB: HD1	54	A0	OA	EB: A0
15	(PC2) HD2	IA/OA	HB: HD2	55	A1	OA	EB: A1
16	(PC3) HD3	IA/OA	HB: HD3	56	A2	OA	EB: A2
17	(PC4) HD4	IA/OA	HB: HD4	57	A3	OA	EB: A3
18	(PC5) HD5	IA/OA	HB: HD5	58	A4	OA	EB: A4
19	(PC6) HD6	IA/OA	HB: HD6	59	A5	OA	EB: A5
20	(PC7) HD7	IA/OA	HB: HD7	60	A6	OA	EB: A6
21	(PD0) HA0	IA	HB: HA0	61	A7	OA	EB: A7
22	(PD1) HA1	IA	HB: HA1	62	A8	OA	EB: A8
23	(PD2) HA2	IA	HB: HA2	63	A9	OA	EB: A9
24	(PD3) ~STPMODE	IA	Stop Mode Circuit	64	A10	OA	EB: A10
25	(PD4) ~HCS	IA	HB: ~CS	65	A11	OA	EB: A11
26	(PD5) ~HWT	IA	HB: ~WT	66	A12	OA	EB: A12
27	(PD6) ~HRD	IA	HB: ~RD	67	A13	OA	EB: A13
28	(PD7) DPIRQ	IA	MDP: IRQ	68	A14	OA	EB: A14
29	GND4	GND	GND	69	A15	OA	EB: A15
30	(PE4) WL: LCS	IA	WL: DAA: LCS	70	(PE0) ~RLY1	OA	WL: DAA: ~OH Cellular: CTRL0
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32	(PA0) RINGD	IA	DAA: RINGD	72	GND1	GND	GND
33	(PA1) NVMDATA	IA/OA	NVRAM: SDA (Note 4)	73	(PB0) A16	OA	EB: A16
34	(PA2) NC		NC	74	(PB1) ~DPSEL	OA	EB: MDP: ~CS
35	(PA3) WL: ~TXACK Cellular: ~CELBSY	IA	WL: HB: ~TXACK Cellular: ~CELBSY	75	(PB2) ~ROMSEL	OA	EB: ROM:: ~CE
36	(PA4) WL: ~RXACK Cellular: CELCLK	IA	WL: HB: ~RXACK Cellular: CELCLK	76	(PB3) ~RAMSEL	OA	EB: RAM: ~CS
37	(PA5) TXRDY	OA	HB: TXRDY	77	(PB4) ~ES1SEL	OA	Not used
38	(PA6) RXRDY	OA	HB: RXRDY	78	(PB5) ~ES0SEL	OA	Not used
39	(PA7) NVMCLK	OA	NVRAM: SCL	79	(PB6) HDIS	OA	NC
40	~TST	MI	NC (Note 5)	80	(PB7) HINT	OA	HB: HINT

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB, IE = Digital input.
   - OA, OB, OE = Digital output.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to VCC through 10 K ohms.
5. Leave open to allow internal MCU ROM use; connect to GND through 10K ohms to force external ROM use only.
6. Connect to HB: RESET through inverter.

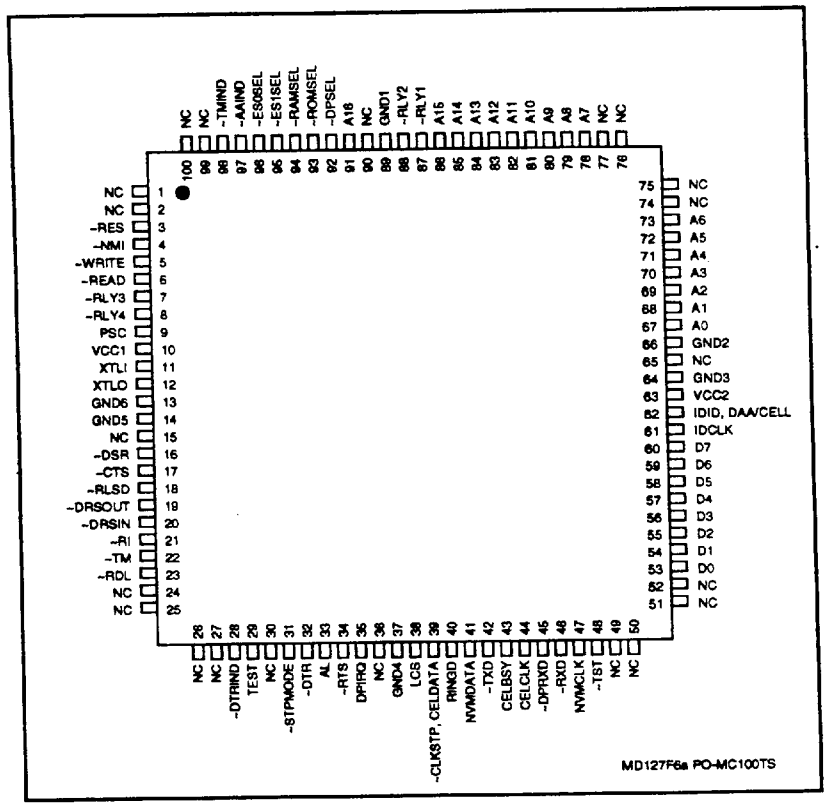


Figure 5a. MCU Pin Signals- 100-Pin TQFP - Serial Interface

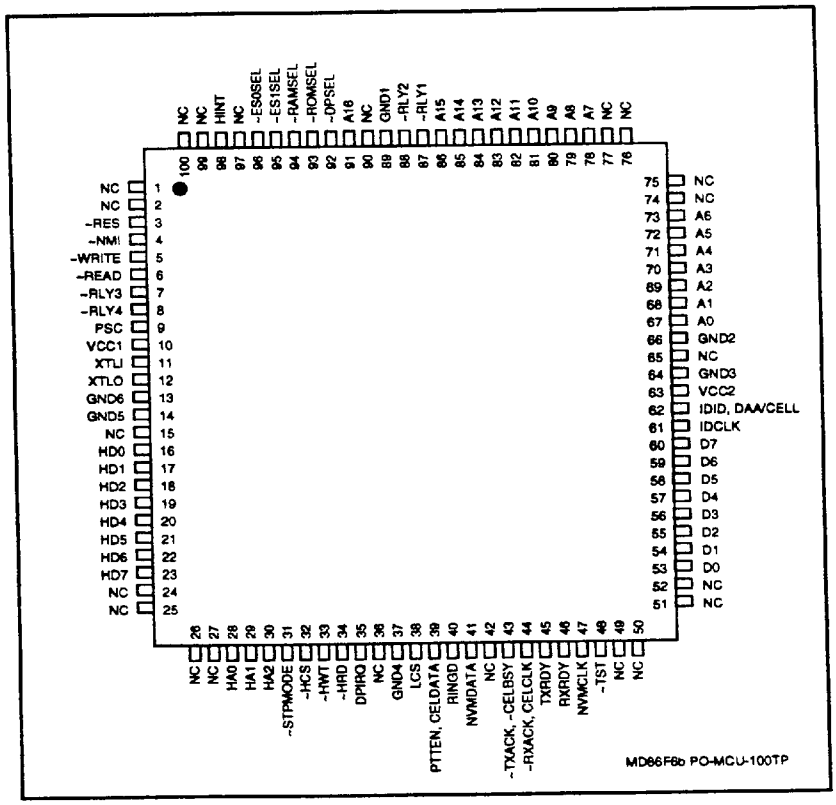


Figure 5b. MCU Pin Signals- 100-Pin TQFP - Parallel Interface

Table 6a. MCU Pin Signals- 100-Pin TQFP - Serial Interface

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
1	NC		NC	51	NC		NC
2	NC		NC	52	NC		NC
3	~RES	IC	MDP: ~RESOUT	53	D0	IA/OA	EB: D0
4	~NMI	MI	Note 4	54	D1	IA/OA	EB: D1
5	~WRITE	OA	EB: ~WRITE	55	D2	IA/OA	EB: D2
6	~READ	OA	EB: ~READ	56	D3	IA/OA	EB: D3
7	(PE2) ~RLY3	OA	WL: DAA: A/A1, ~MUTE, Cellular: CELBSY	57	D4	IA/OA	EB: D4
8	(PE3) ~RLY4	OA	WL: DAA: ~T/DRLY, ~EARTH	58	D5	IA/OA	EB: D5
9	PSC	IA	MDP: DETOUT	59	D6	IA/OA	EB: D6
10	VCC1	PWR	VCC	60	D7	IA/OA	EB: D7
11	XTLI	IE	XTLI	61	(PE6) IDCLK	OA	WL: DAA: IDCLK
12	XTLO	OE	XTLO	62	(PE7) IDID Cellular: DAA/CELL	IA	WL: DAA: IDID Cellular: DAA/CELL
13	GND6	GND	GND	63	VCC2	PWR	VCC
14	GND5	GND	GND	64	GND3	GND	GND
15	NC		NC	65	NC		NC
16	(PC0) ~DSR	OA	DTE: ~DSR	66	GND2	GND	GND
17	(PC1) ~CTS	OA	DTE: ~CTS	67	A0	OA	EB: A0
18	(PC2) ~RLSD	OA	DTE: ~RLSD	68	A1	OA	EB: A1
19	(PC3) ~DRSOUT	OA	DTE: ~DRSOUT	69	A2	OA	EB: A2
20	(PC4) ~DRSIN	OA	DTE: ~DRSIN	70	A3	OA	EB: A3
21	(PC5) ~RI	OA	DTE: ~RI	71	A4	OA	EB: A4
22	(PC6) ~TM	OA	DTE: ~TM	72	A5	OA	EB: A5
23	(PC7) ~RDL	IA	DTE: ~RDL	73	A6	OA	EB: A6
24	NC		NC	74	NC		NC
25	NC		NC	75	NC		NC
26	NC		NC	76	NC		NC
27	NC		NC	77	NC		NC
28	(PD0) ~DTRIND	OA	Indicator Circuit	78	A7	OA	EB: A7
29	(PD1) NC		NC	79	A8	OA	EB: A8
30	(PD2) NC		NC	80	A9	OA	EB: A9
31	(PD3) ~STPMODE	IA	Stop Mode Circuit	81	A10	OA	EB: A10
32	(PD4) ~DTR	IA	DTE: ~DTR	82	A11	OA	EB: A11
33	(PD5) ~AL	IA	DTE: ~AL	83	A12	OA	EB: A12
34	(PD6) ~RTS	IA	DTE: ~RTS	84	A13	OA	EB: A13
35	(PD7) DPIRQ	IA	MDP: IRQ	85	A14	OA	EB: A14
36	NC		NC	86	A15	OA	EB: A15
37	GND4	GND	GND	87	(PE0) ~RLY1	OA	WL: DAA: ~OH Cellular: CTRL0
38	(PE4) WL: LCS	IA	WL: DAA: LCS	88	(PE1) ~RLY2	OA	WL: DAA: ~PULSE Cellular: CTRL1
39	(PE5) PTTEN WL: ~CLKSTOP Cellular: CELDATA	IA OA IA/OA	PTTEN WL: ~CLKSTOP Cellular: CELDATA	89	GND1	GND	GND
40	(PA0) RINGD	IA	DAA: RINGD	90	NC		NC
41	(PA1) NVMDATA	IA/OA	NVRAM: SDA (Note 4)	91	(PB0) A16	OA	EB: A16
42	(PA2) ~TXD	IA	DTE: ~TXD	92	(PB1) ~DPSEL	OA	EB: MDP: ~CS
43	(PA3) Cellular: ~CELBSY	IA	Cellular: ~CELBSY	93	(PB2) ~ROMSEL	OA	EB: ROM: ~CE
44	(PA4) Cellular: CELCLK	IA	Cellular: CELCLK	94	(PB3) ~RAMSEL	OA	EB: RAM: ~CS
45	(PA5) ~DPRXD	MI	MDP: RXD	95	(PB4) ~ES1SEL	OA	Not used
46	(PA6) ~RXD	OA	DTE: ~RXD	96	(PB5) ~ES0SEL	OA	Not used
47	(PA7) NVMCLK	OA	NVRAM: SCL	97	(PB6) ~AAIND	OA	Indicator Circuit
48	~TST	MI	NC (Note 5)	98	(PB7) ~TMIND	OA	Indicator Circuit
49	NC		NC	99	NC		NC
50	NC		NC	100	NC		NC

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB, IC, IE = Digital input.
   - OA, OB, OE = Digital output.
2. NC = No external connection.
3. NU = Not used; connect as noted.
4. Connect to VCC through 10 K ohms.
5. Leave open to allow internal MCU ROM use; connect to GND through 10K ohms to force external ROM use only.
6. Connect to GND through 10K ohms.
7. Connect to GND through 100K ohms.

Table 6b. MCU Pin Signals- 100-Pin TQFP - Parallel Interface

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
1	NC		NC	51	NC		NC
2	NC		NC	52	NC		NC
3	~RES	IC	MDP: ~RESOUT	53	D0	IA/OA	EB: D0
4	~NMI	MI	Note 4	54	D1	IA/OA	EB: D1
5	~WRITE	OA	EB: ~WRITE	55	D2	IA/OA	EB: D2
6	~READ	OA	EB: ~READ	56	D3	IA/OA	EB: D3
7	(PE2) ~RLY3	OA	WL: DAA: A/A1, ~MUTE, Cellular: CELBSY	57	D4	IA/OA	EB: D4
8	(PE3) ~RLY4	OA	WL: DAA: ~T/DRLY, ~EARTH	58	D5	IA/OA	EB: D5
9	PSC	IA	MDP: DETOUT	59	D6	IA/OA	EB: D6
10	VCC1	PWR	VCC	60	D7	IA/OA	EB: D7
11	XTLI	IE	XTLI	61	(PE6) IDCLK	OA	WL: DAA: IDCLK
12	XTLO	OE	XTLO	62	(PE7) IDID Cellular: DAA/CELL	IA	WL: DAA: IDID Cellular: DAA/CELL
13	GND6	GND	GND	63	VCC2	PWR	VCC
14	GND5	GND	GND	64	GND3	GND	GND
15	NC		NC	65	NC		NC
16	(PC0) HD0	IA/OA	HB: HD0	66	GND2	GND	GND
17	(PC1) HD1	IA/OA	HB: HD1	67	A0	OA	EB: A0
18	(PC2) HD2	IA/OA	HB: HD2	68	A1	OA	EB: A1
19	(PC3) HD3	IA/OA	HB: HD3	69	A2	OA	EB: A2
20	(PC4) HD4	IA/OA	HB: HD4	70	A3	OA	EB: A3
21	(PC5) HD5	IA/OA	HB: HD5	71	A4	OA	EB: A4
22	(PC6) HD6	IA/OA	HB: HD6	72	A5	OA	EB: A5
23	(PC7) HD7	IA/OA	HB: HD7	73	A6	OA	EB: A6
24	NC		NC	74	NC		NC
25	NC		NC	75	NC		NC
26	NC		NC	76	NC		NC
27	NC		NC	77	NC		NC
28	(PD0) HA0	IA	HB: HA0	78	A7	OA	EB: A7
29	(PD1) HA1	IA	HB: HA1	79	A8	OA	EB: A8
30	(PD2) HA2	IA	HB: HA2	80	A9	OA	EB: A9
31	(PD3) ~STPMODE	IA	Stop Mode Circuit	81	A10	OA	EB: A10
32	(PD4) ~HCS	IA	HB: ~CS	82	A11	OA	EB: A11
33	(PD5) ~HWT	IA	HB: ~WT	83	A12	OA	EB: A12
34	(PD6) ~HRD	IA	HB: ~RD	84	A13	OA	EB: A13
35	(PD7) DPIRQ	IA	MDP: IRQ	85	A14	OA	EB: A14
36	NC		NC	86	A15	OA	EB: A15
37	GND4	GND	GND	87	(PE0) ~RLY1	OA	WL: DAA: ~OH Cellular: CTRL0
38	(PE4) WL: LCS	IA	WL: DAA: LCS	88	(PE1) ~RLY2	OA	WL: DAA: ~PULSE Cellular: CTRL1
39	(PE5) PTTEN WL: ~CLKSTOP Cellular: CELDATA	IA OA IA/OA	PTTEN WL: ~CLKSTOP Cellular: CELDATA	89	GND1	GND	GND
40	(PA0) RINGD	IA	DAA: RINGD	90	NC		NC
41	(PA1) NVMDATA	IA/OA	NVRAM: SDA (Note 4)	91	(PB0) A16	OA	EB: A16
42	(PA2) NC		NC	92	(PB1) ~DPSEL	OA	EB: MDP: ~CS
43	(PA3) WL: ~TXACK Cellular: ~CELBSY	IA	WL: HB: ~TXACK Cellular: ~CELBSY	93	(PB2) ~ROMSEL	OA	EB: ROM: ~CE
44	(PA4) WL: ~RXACK Cellular: CELCLK	IA	WL: HB: ~RXACK Cellular: CELCLK	94	(PB3) ~RAMSEL	OA	EB: RAM: ~CS
45	(PA5) TXRDY	OA	HB: TXRDY	95	(PB4) ~ES1SEL	OA	Not used
46	(PA6) RXRDY	OA	HB: RXRDY	96	(PB5) ~ES0SEL	OA	Not used
47	(PA7) NVMCLK	OA	NVRAM: SCL	97	(PB6) HDIS	OA	NC
48	~TST	MI	NC (Note 5)	98	(PB7) HINT	OA	HB: HINT
49	NC		NC	99	NC		NC
50	NC		NC	100	NC		NC

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB, IE = Digital input.
   - OA, OB, OE = Digital output.
2. NC = No external connection allowed.
3. NU = Not used; connect as noted.
4. Connect to VCC through 10 K ohms.
5. Leave open to allow internal MCU ROM use; connect to GND through 10K ohms to force external ROM use only.
6. Connect to HB: RESET through inverter.

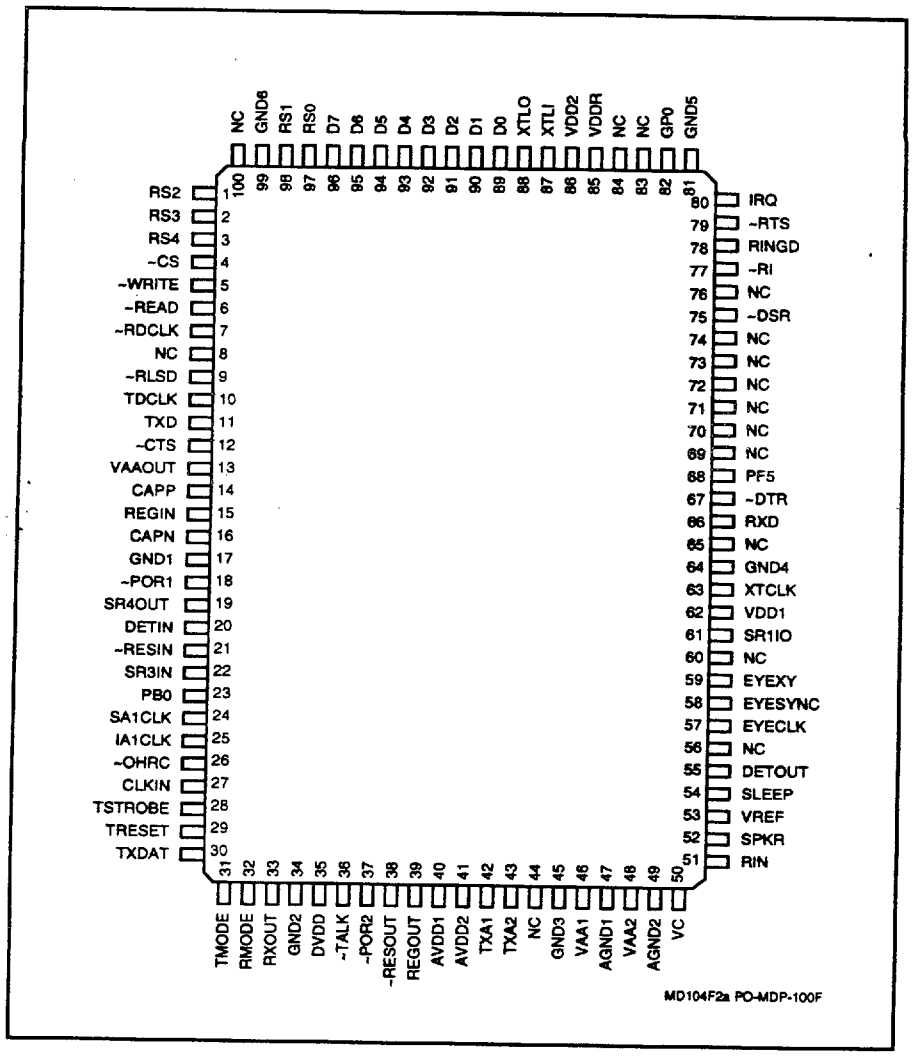


Figure 6. MDP Pin Signals - 100-Pin PQFP

Table 7. MDP Pin Signals - 100-Pin PQFP

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
1	RS2	IA	MCU: A2	51	RIN	I(DA)	DAA: RIN
2	RS3	IA	MCU: A3	52	SPKR	O(DF)	Speaker Circuit
3	RS4	IA	MCU: A4	53	VREF	MI	VC through capacitors
4	~CS	IA	MCU: ~DPSEL	54	SLEEP	MI	PF5 (68)
5	~WRITE	IA	MCU: ~WRITE	55	DETOUT	MI	DETIN (20); Controller
6	~READ	IA	MCU: ~READ	56	NC		NC
7	~RDCLK	OA	PIF: NC SIF: DTE I/F: ~RXCLK	57	EYECLK	OA	NC
8	NC		NC	58	EYESYNC	OA	NC
9	~RLSD	OA	NC	59	EYEXY	OA	NC
10	TDCLK	OA	PIF: NC SIF: DTE I/F: ~TXCLK	60	NC		NC
11	TXD	IA	SIF: DTE & MCU TXD (Note 4)	61	SR1IO	MI	TMODE (31)
12	~CTS	OA	NC	62	VDD1	PWR	VCC
13	VAAOUT	MI	VAA1 and VAA2	63	XTCLK	IA	PIF: NC SIF: DTE I/F: ~XTCLK
14	CAPP	MI	To CAPN through 0.1 µF	64	GND4	GND	GND
15	REGIN	MI	REGOUT (39)	65	NC		NC
16	CAPN	MI	To CAPP through 0.1 µF	66	RXD	OA	MCU: ~DPRXD
17	GND1	GND	GND	67	~DTR	IA	VCC (Note 4)
18	~POR1	IA	Reset Circuit/Host Interface	68	PF5	MI	Connect to SLEEP (54)
19	SR4OUT	MI	TXDAT (30)	69	NC		NC
20	DETIN	MI	DETOUT (55)	70	NC		NC
21	~RESIN	MI	~RESOUT (38)	71	NC		NC
22	SR3IN	MI	RXOUT (33)	72	NC		NC
23	PB0	MI	CLKIN (27)	73	NC		NC
24	SA1CLK	MI	TRESET (29)	74	NC		NC
25	IA1CLK	MI	TSTROBE (28)	75	~DSR	OA	NC
26	~OHRC	OD	WL: DAA: Caller ID Relay	76	NC		NC
27	CLKIN	MI	PB0 (23)	77	~RI	OA	NC
28	TSTROBE	MI	IA1CLK (25)	78	RINGD	IA	DAA: RINGD
29	TRESET	MI	SA1CLK (24)	79	~RTS	IA	VCC (Note 4)
30	TXDAT	MI	SR4OUT (19)	80	IRQ	OA	MCU: DPIRQ
31	TMODE	MI	RMODE (32)	81	GND5	GND	GND
32	RMODE	MI	TMODE (31)	82	GP0	MI	EYESYNC
33	RXOUT	MI	SR3IN (22)	83	NC		NC
34	GND2	GND	GND	84	NC		NC
35	DVDD	PWR	VCC	85	VDDR	MI	0.1 µF to GND
36	~TALK	OD	WL: DAA: Voice Relay	86	VDD2	PWR	VCC
37	~POR2	IA	Reset Circuit/Host Interface	87	XTLI	I	Crystal/Clock Circuit
38	~RESOUT	IA	~RESIN (21); Controller	88	XTLO	O	Crystal/Clock Circuit
39	REGOUT	MI	REGIN (15)	89	D0	IA/OA	MCU: D0
40	AVDD1	PWR	VCC	90	D1	IA/OA	MCU: D1
41	AVDD2	PWR	VCC with RC filter	91	D2	IA/OA	MCU: D2
42	TXA1	O(DD)	DAA: TXA1	92	D3	IA/OA	MCU: D3
43	TXA2	O(DD)	DAA: TXA2	93	D4	IA/OA	MCU: D4
44	NC		NC	94	D5	IA/OA	MCU: D5
45	GND3	GND	GND	95	D6	IA/OA	MCU: D6
46	VAA1	PWR	VAAOUT	96	D7	IA/OA	MCU: D7
47	AGND1	GND	AGND	97	RS0	IA	MCU: A0
48	VAA2	PWR	VAAOUT	98	RS1	IA	MCU: A1
49	AGND2	GND	AGND	99	GND6	GND	GND
50	VC	MI	AGND through capacitors	100	NC		NC

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB = Digital input.
   - OA, OB = Digital output.
   - I(DA)] = Analog ihput.
   - O(DD), O(DF) = Analog output.
2. NC = No external connection allowed.
3. Interface Legend:
   - PIF = Host Parallel Interface Configuration
   - SIF = DTE Serial Interface Configuration
   - WL = Wireline.
   - DTE = Data Terminal Equipment.
4. Connect to VCC through 20K ohms.
5. To GND through 82k ohms at DAA interface.

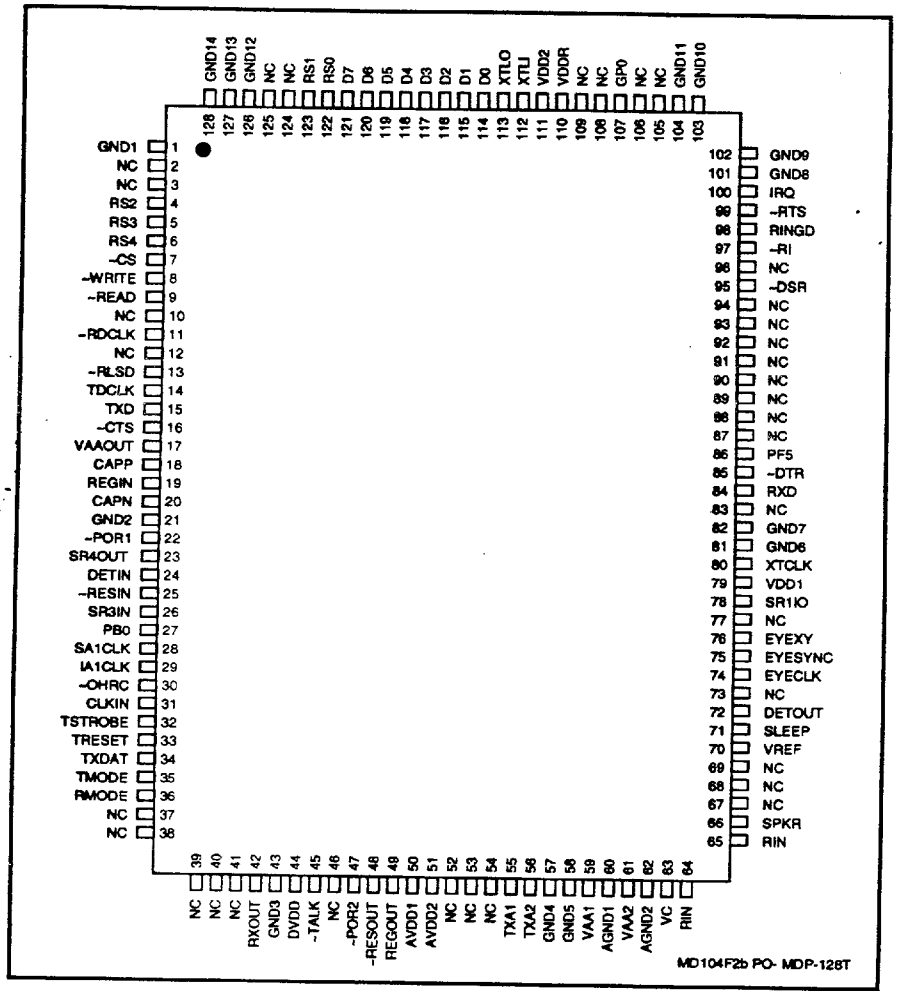


Figure 7. MDP Pin Signals - 128-Pin TQFP

Table 8. MDP Pin Signals - 128-Pin TQFP

Pin	Signal Label	I/O Type	Interface[3]	Pin	Signal Label	I/O Type	Interface
1	GND1	GND	GND	65	RIN2	I(DA)	DAA: RIN
2	NC		NC	66	SPKR	O(DF)	Speaker Circuit
3	NC		NC	67	NC		NC
4	RS2	IA	MCU: A2	68	NC		NC
5	RS3	IA	MCU: A3	69	NC		NC
6	RS4	IA	MCU: A4	70	VREF	MI	VC through capacitors
7	~CS	IA	MCU: ~DPSEL	71	SLEEP	MI	PF5 (86)
8	~WRITE	IA	MCU: ~WRITE	72	DETOUT	MI	DETIN (24); Controller
9	~READ	IA	MCU: ~READ	73	NC		NC
10	NC		NC	74	EYECLK	OA	NC
11	~RDCLK	OA	PIF: NC SIF: DTE I/F: ~RXCLK	75	EYESYNC	OA	NC
12	NC		NC	76	EYEXY	OA	NC
13	~RLSD	OA	NC	77	NC		NC
14	TDCLK	OA	PIF: NC SIF: DTE I/F: ~TXCLK	78	SR1IO	MI	TMODE (35)
15	TXD	IA	SIF: DTE & MCU TXD (Note 4)	79	VDD1	PWR	VCC
16	~CTS	OA	NC	80	XTCLK	IA	DTE Serial Interface
17	VAAOUT	MI	VAA1 and VAA2	81	GND6	GND	GND
18	CAPP	MI	To CAPN through 0.1 µF	82	GND7	GND	GND
19	REGIN	MI	REGOUT (49)	83	NC		NC
20	CAPN	MI	To CAPP through 0.1 µF	84	RXD	OA	MCU: ~DPRXD
21	GND2	GND	GND	85	~DTR	IA	VCC (Note 4)
22	~POR1	IA	Reset Circuit/Host Interface	86	PF5	MI	SLEEP (71)
23	SR4OUT	MI	TXDAT (34)	87	NC		NC
24	DETIN	MI	DETOUT (72)	88	NC		NC
25	~RESIN	MI	~RESOUT (48)	89	NC		NC
26	SR3IN	MI	RXOUT (42)	90	NC		NC
27	PB0	MI	CLKIN (31)	91	NC		NC
28	SA1CLK	MI	TRESET (33)	92	NC		NC
29	IA1CLK	MI	TSTROBE (32)	93	NC		NC
30	~OHRC	OD	WL: DAA: Caller ID Relay	94	NC		NC
31	CLKIN	MI	PB0 (27)	95	~DSR	OA	NC
32	TSTROBE	MI	IA1CLK (29)	96	NC		NC
33	TRESET	MI	SA1CLK (28)	97	~RI	OA	NC
34	TXDAT	MI	SR4OUT (23)	98	RINGD	IA	DAA: RINGD
35	TMODE	MI	RMODE (36)	99	~RTS	IA	VCC (Note 4)
36	RMODE	MI	TMODE (35)	100	IRQ	OA	MCU: DPIRQ
37	NC		NC	101	GND8	GND	GND
38	NC		NC	102	GND9	GND	GND
39	NC		NC	103	GND10	GND	GND
40	NC		NC	104	GND11	GND	GND
41	NC		NC	105	NC		NC
42	RXOUT	MI	SR3IN (26)	106	NC		NC
43	GND3	GND	GND	107	GP0	MI	EYESYNC
44	DVDD	PWR	VCC	108	NC		NC
45	~TALK	OD	WL: DAA: Voice Relay	109	NC		NC
46	NC		NC	110	VDDR	MI	0.1 µF to GND
47	~POR2	IA	Reset Circuit/Host Interface	111	VDD2	PWR	VCC
48	~RESOUT	IA	~RESIN (25); Controller	112	XTLI	I	Crystal/Clock Circuit
49	REGOUT	MI	REGIN (19)	113	XTLO	O	Crystal/Clock Circuit
50	AVDD1	PWR	VCC	114	D0	IA/OA	MCU: D0
51	AVDD2	PWR	VCC with RC filter	115	D1	IA/OA	MCU: D1
52	NC		NC	116	D2	IA/OA	MCU: D2
53	NC		NC	117	D3	IA/OA	MCU: D3
54	NC		NC	118	D4	IA/OA	MCU: D4
55	TXA1	O(DD)	DAA: TXA1	119	D5	IA/OA	MCU: D5
56	TXA2	O(DD)	DAA: TXA2	120	D6	IA/OA	MCU: D6
57	GND4	GND	GND	121	D7	IA/OA	MCU: D7
58	GND5	GND	GND	122	RS0	IA	MCU: A0
59	VAA1	PWR	VAAOUT	123	RS1	IA	MCU: A1
60	AGND1	GND	AGND	124	NC		NC

Table 8. MDP Pin Signals - 128-Pin TQFP (Cont'd)

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

Notes:

1. I/O types:
   - MI = Modem interconnect.
   - IA, IB = Digital input.
   - OA, OB = Digital output.
   - I(DA)] = Analog input.
   - O(DD), O(DF) = Analog output.
2. NC = No external connection allowed.
3. Interface Legend:
   - MDP1 or MDP2 = Modem Data Pump 1 or Modem Data Pump 2 device.
   - PIF = Host Parallel Interface Configuration
   - SIF = DTE Serial Interface Configuration
   - WL = Wireline.
   - DTE = Data Terminal Equipment.
4. Connect to VCC through 20K ohms.

Table 9. MCU Signal Definitions

Label	I/O Type	Signal Name/Description
BASIC CONFIGURATION		
SYSTEM OVERHEAD		
XTLI, XTLO	IE, OE	**MCU Crystal/Clock In and Crystal Out.** Connects to an external crystal circuit consisting of a 9.8304 MHz crystal and a capacitance network.
~RES	IC	**MCU Reset.** The active low ~RES input resets the MCU logic, and restores the saved configuration from NVRAM or returns the modem to the factory default values if NVRAM is not present. For serial interface, the ~RES input is typically connected to a reset switch circuit and MDP ~POR. For parallel interface, the ~RES input is typically connected to the host bus RESET line through an inverter and to MDP ~POR.
DPIRQ	IA	**MDP Interrupt Request.** Connects to the MDP IRQ output.
~DPRXD	MI	**MDP Received Data.** Connects to the MDP RXD output (serial interface).
VCC1-VCC2	PWR	**+ 5V Digital Supply.** +5V ± 5%.
GND1-GND6	GND	**Digital Ground.** Connect to ground.
DAA/CELLULAR SELECT		
DAA/CELL	IA	**DAA/Cellular Interface Select.** When DAA/CELL input is high, the wireline DAA interface is selected. When DAA/CELL input is low, the cellular interface is selected with the following cellular signals assigned to the corresponding ports instead of the wireline signals. MCU Port / Cellular Signal (DAA/CELL = Low) / Wireline Signal for DTE Serial Interface (DAA/CELL = High) / Wireline Signal for Host Parallel Interface (DAA/CELL = High) PE0 / CTRL0 / ~OH / ~OH PE1 / CTRL1 / ~PULSE / ~PULSE PE2 / CELBSY / ~MUTE, ~A/A1 / ~MUTE, ~A/A1 PE5 / CELDATA / ~CLKSTOP, PTTEN* / PTTEN* PE7 / DAA/CELL / IDID* / IDID* PA3 / ~CELBSY / ~TXCLK / ~TXACK PA4 / CELCLK / ~RXCLK / ~RXACK * Used during reset initialization only.
DIRECT INPUTS		
PTTEN	IA	**PTT Test Enable (W-Class Only).** 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).
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.
~READ	OA	**Read Enable.** ~READ output low enables data transfer from the selected device to the D0-D7 lines.
~WRITE	OA	**Write Enable.** ~WRITE output low enables data transfer from the D0-D7 lines to the selected device.
~DPSEL	OA	**Modem Data Pump Select.** ~DPSEL output low selects the MDP.
~RAMSEL	OA	**RAM Select.** ~RAMSEL output low selects the external RAM.
~ROMSEL	OA	**ROM Select.** ~ROMSEL output low selects an external ROM or flash ROM.
~ES1SEL	OA	**ES1 Select.** ~ES1SEL output low and A0 high select external input buffer 1. ~ES1SEL output low and a low from A0 NANDed with ~WRITE selects external input buffer 2. ~ES1SEL output low clocked by ~WRITE selects the external latch. (Serial interface only.)
~ES0SEL	OA	**ES0 Select.** ~ES0SEL output low selects an external device (not used).

Table 9. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
PARALLEL HOST INTERFACE (PARALLEL INTERFACE VERSION)		
The parallel interface emulates a 16450 or 16550A/16450 UART-compatible 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 with ~HCS low, 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 over HD0-HD7.
~HCS	IA	**Host Bus Chip Select.** ~HCS input low selects the host bus.
~HRD	IA	**Host Bus Read.** ~HRD is an active low, read control input. When ~HCS is low, ~HRD low allows the host to read status information or data from a selected MCU register.
~HWT	IA	**Host Bus Write.** ~HWT is an active low, write control input. When ~HCS is low, ~HWT low allows the host to write data or control words into a selected 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 is asserted. HINT is reset low upon the appropriate interrupt service or master reset operation.
~TXACK	IA	**Host Transmit Acknowledge.** ~TXACK is an active low transmit acknowledge input, acknowledging that the DMA controller received the Transmit Ready (TXRDY) data transfer request output.
~RXACK	IA	**Host Receive Acknowledge.** ~RXACK is an active low receive acknowledge input, acknowledging that the DMA controller received the Receiver Ready (RXRDY) data transfer request output.
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).
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).
8-BIT I/O EXPANDER TO MICROPHONE/SPEAKER INTERFACE (PARALLEL INTERFACE VERSION)		
SWA, SWB	OA	**Analog Switch Control.** Encoded outputs select the RIN and TXA1/TXA2 routing as follows: **SWA** **SWB** **Description** 0 0 Data mode (connect RIN to the line and the speaker; connect TXA1/TXA2 to the line and the speaker). 0 1 Voice mode - playback or record from the line or the telephone set (connect RIN to the line; connect TXA1/TXA2 to the line). 1 0 Voice mode - record from the microphone (connect RIN to microphone input circuit; connect TXA1/TXA2 to line). 1 1 Not used.
U/~D	OA	**Volume Up/Down Select.** Controls increase (high) or decrease (low) of volume when ~INC is pulsed and ~CS = low.
~INC	OA	**Volume Increment.** When ~INC is pulsed while ~CS is low, the volume is increased (U/~D = high) or decreased (U/~D = low).
~CS	OA	**Volume Control Chip Select.** Enables (low) or disables (high) adjustment of volume using U/~D and ~INC.
LED INDICATOR CIRCUIT INTERFACE (SERIAL INTERFACE VERSION)		
~AAIND	OA	**Auto Answer Indicator.** ~AAIND output ON (low) corresponds to the indicator on. ~AAIND output is active when the modem is configured to answer the ring automatically (ATSO command ≠ 0).
~TMIND	OA	**Test Mode Indicator.** ~TMIND output ON (low) corresponds to the indicator on. ~TMIND output pulses (LED flashes) when the modem is in test mode and if an error is detected.
~DTRIND	OA	**DTR Indicator.** ~DTRIND output ON (low) corresponds to the indicator on. The ~DTRIND state reflects the ~DTR output state except when the &D0 command is active, in which case ~DTRIND is low.

Table 9. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
V.24 (EIA-232-D) DTE SERIAL INTERFACE (SERIAL INTERFACE VERSION)		
The serial interface signals correspond functionally to V.24/EIA/TIA-232-E signals. The signal levels are TTL compatible and are inverted from V.24/EIA/TIA-232-E levels.		
~TXD	IA	**Transmitted Data (EIA BA/CCITT CT103).** The DTE uses the ~TXD line to send data to the modem for transmission over the telephone line or to transmit commands to the modem.
~RXD	OA	**Received Data (EIA BB/CCITT CT 104).** The modem uses the ~RXD line to send data received from the telephone line to the DTE and to send modem responses to the DTE. During command mode, ~RXD data represents the modem responses to the DTE.
~CTS	OA	**Clear To Send (EIA CB/CCITT CT106).** ~CTS output ON (low) indicates that the DTE is ready to accept data from the DTE. In asynchronous operation, in error correction or normal mode, ~CTS is always ON (low) unless RTS/CTS flow control is selected by the &Kn command. In synchronous operation, the modem also holds ~CTS ON during asynchronous command state. The modem turns ~CTS OFF immediately upon going off-hook and holds ~CTS OFF until both ~DSR and ~RLSD are ON and the modem is ready to transmit and receive synchronous data. The modem can also be commanded by the &Rn command to turn ~CTS ON in response to an ~RTS OFF-to-ON transition.
~DSR	OA	**Data Set Ready (EIA CC/CCITT CT107).** ~DSR indicates modem status to the DTE. ~DSR OFF (high) indicates that the DTE is to disregard all signals appearing on the interchange circuits except Ring Indicator (~RI). ~DSR output is controlled by the AT&Sn command.
~RLSD	OA	**Received Line Signal Detector (EIA CF/CCITT CT109).** When AT&C0 command is not in effect, ~RLSD output is ON when a carrier is detected on the telephone line or OFF when carrier is not detected.
~TM	OA	**Test Mode Indicate (EIA TM/CCITT CT142).** The ~TM output indicates the modem is in test mode (low) or in any other mode (high).
~RI	OA	**Ring Indicator (EIA CE/CCITT CT125).** ~RI output ON (low) indicates the presence of an ON segment of a ring signal on the telephone line.
~DRSOUT	OA	**Data Signaling Rate Indicator (EIA CI/CCITT CT112).** ~DRSOUT is ON (low) when the modem desires or is engaged in the high speed (2400 bps or higher) mode. ~DRSOUT is OFF (high) otherwise.
~DTR	IA	**Data Terminal Ready (EIA CD/CCITT CT108).** The ~DTR input is turned ON (low) by the DTE when the DTE is ready to transmit or receive data. ~DTR ON prepares the modem to be connected to the telephone line, and maintains the connection established by the DTE (manual answering) or internally (automatic answering). ~DTR OFF places the modem in the disconnect state under control of the &Dn and &Qn commands.
~RTS	IA	**Request To Send (EIA CA/CCITT CT105).** ~RTS input ON (low) indicates that the DTE is ready to accept data from the modem. In the command state, the modem ignores ~RTS. In asynchronous operation, the modem ignores ~RTS unless RTS/CTS flow control is selected by the &Kn command. In synchronous on-line operation, the modem can be commanded by the &Rn command to ignore ~RTS or to respond to ~RTS by turning on ~CTS after the delay specified by Register S26.
~RDL	IA	**Remote Digital Loop Select (EIA RL/CCITT CT140).** ~RDL input low activates remote digital loop request. The loop is executed at the speed for which the modem is currently configured.
~AL	IA	**Analog Loop (EIA LL/CCITT CT141).** ~AL input low causes the modem to operate in the analog loop test mode.
~DRSIN	IA	**Data Signaling Rate Select (EIA CI/CCITT CT111).** This signal, relevant only in Central Europe, applies only to V.22 bis and V.22 modes. ~DRSIN ON (low) will result in a 2400 bps connection. ~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 9. MCU Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
		TELEPHONE LINE INTERFACE (WIRELINE OPERATION ONLY)
~RLY1	OA	**Relay 1 Control (~OH).** When cellular interface is not selected (CELL/DAA = high), PE0 is assigned to the ~RLY1 output signal. The active low ~RLY1 output can be used to control the normally open off-hook relay. The ~PULSE function can alternatively be provided on this line in addition to the ~OH function for single ~OH/~PULSE relay application.
~RLY2	OA	**Relay 2 Control (~PULSE).** When cellular interface is not selected (CELL/DAA = high), PE1 is assigned to the ~RLY2 output signal. The active low ~RLY2 output can be used to control the normally open pulse dial relay. The ~PULSE function can alternatively be provided on the ~RLY1 line in addition to the ~OH function for single ~OH/~PULSE relay application.
~RLY3	OA	**Relay 3 Control (~A/A1, ~MUTE).** The active low ~RLY3 output can be used to control the normally open key telephone hold indicator (A/A1) relay. In W-class, ~RLY3 output can be used to control the normally open mute relay.
~RLY4	OA	**Relay 4 Control (~T/DRLY, ~EARTH).** The active low ~RLY4 output can be used to control the normally closed talk/data relay. In W-class, ~RLY4 output can be used to control the normally open earthing relay.
LCS	IA	**Loop Current Sense.** LCS is an active high input that indicates a handset off-hook status.
RINGD	IA	**Ring Frequency.** A high-going edge on the RINGD input initiates an internal ring frequency measurement. The RINGD input from an external ring detect circuit is monitored to determine when to wake up from sleep or stop mode. The RINGD input is typically connected to the output of an optoisolator or equivalent. The idle state (no ringing) output of the ring detect circuit should be low.
		CELLULAR PHONE INTERFACE (CELLULAR OPERATION ONLY)
CTRL0	OA	**Cellular Control 0.** When cellular interface is selected (CELL/DAA = low), PE0 is assigned to the CTRL0 output signal. CTRL0 is defined by the cellular firmware driver.
CTRL1	OA	**Cellular Control 1.** When cellular interface is selected (CELL/DAA = low), PE1 is assigned to the CTRL1 output signal. CTRL1 is defined by the cellular firmware driver.
CELCLK	IA	**Cellular Clock.** When cellular interface is selected (CELL/DAA = low), PA4 is assigned to the CELCLK input signal. CELCLK is defined by the cellular firmware driver.
CELDATA	IA/OA	**Cellular Data.** When cellular interface is selected (CELL/DAA = low), PE5 is assigned to the bidirectional CELDATA line. CELDATA is defined by the cellular firmware driver.
CELBSY	OA	**Cellular Busy.** When cellular interface is selected (CELL/DAA = low), PE2 is assigned to the CELBSY output signal. CELBSY is defined by the cellular firmware driver.
~CELBSY	IA	**Cellular Not Busy.** When cellular interface is selected (CELL/DAA = low), PA3 is assigned to the ~CELBSY input signal. ~CELBSY is defined by the cellular firmware driver.
		STOP MODE CIRCUIT
~STPMODE	IA	**Stop Mode.** ~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. ~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 10. MDP Signal Definitions

Label	I/O Type	Signal/Definition
COMMON SIGNALS TO PARALLEL AND SERIAL INTERFACE		
OVERHEAD SIGNALS		
XTLI, XTLO	I, O	**Crystal In and Crystal Out.** Connect to an external crystal circuit consisting of a 35.2512 MHz crystal, three capacitors, a resistor, and an inductor; or connect to a square wave generator/sine wave oscillator.
~POR1, ~POR2	IA	**Power-On Reset.** ~POR1 and ~POR2 low hold the modem in the reset state. ~POR1 and ~POR2 must be low for at least 3 µs. ~POR1 and ~POR2 going high initiates internal hardware normal operation (but not modem processing). For serial Interface, the ~POR inputs are typically connected to a reset circuit. For parallel Interface, the ~POR inputs are typically connected to the host bus RESET line through an inverter.
~RESIN	OA	**Reset Input.** Connect ~RESIN to ~RESOUT.
VC	MI	**Centerpoint Voltage.** Connect to analog ground through 10 µF (polarized, + terminal to VC) and 0.1 µF (ceramic) in parallel.
VREF	MI	**Voltage Reference.** Connect to VC through 10 µF (polarized, + terminal to VREF) and 0.1 µF (ceramic) in parallel.
VREG	MI	**Voltage Reference.** Can be left open. Connect to ground through 0.1 µF for compatibility with future products.
DETIN	MI	**Detected Level In.** Connect to DETOUT.
VDDR	MI	**Digital Supply Voltage Regulated.** Connect to GND through 0.1 µµF capacitor.
GND	GND	**Digital Ground.** Connect to ground.
AGND	GND	**Analog Ground.** Connect to ground.
VDD1, VDD2	PWR	**DSP Digital Supply Voltage.** Connect to VCC.
DVDD	PWR	**IA Digital Circuits Power.** Connect to VCC.
AVDD1	PWR	**IA Digital Supply Voltage 1.** Connect to VCC.
AVDD2	PWR	**IA Digital Supply Voltage 2.** Connect to VCC through RC filter.
VAAOUT	MI	**Analog Supply Voltage Output.** Connect to VAA1 and VAA2.
VAA1, VAA2	PWR	**Analog Supply Voltage.** Connect to VAAOUT. Connect to analog ground through 10 µF and 0.1 µF capacitors in parallel.
REGOUT	MI	**Regulator Out.** Connect to REGIN.
REGIN	MI	**Regulator In.** Connect to REGOUT.
CAPP	MI	**Capacitor Plus Connection.** Connect CAPP to the plus terminal of a 1 µF capacitor.
CAPN	MI	**Capacitor Negative Connection.** Connect CAPN to the negative terminal of a 1 µF capacitor.
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.
~CS	IA	**Chip Select.** Connect to MCU ~DPSEL output.
~READ	IA	**Read Enable.** Connect to MCU ~READ.
~WRITE	IA	**Write Enable.** Connect to MCU ~WRITE.
IRQ	OA	**Interrupt Request.** Connect to MCU ~DPIRQ.
~RESOUT	OA	**Reset Output.** ~RESOUT going high indicates internal hardware normal operation has been attained and initiates internal modem processing. The MDP is ready to use 500 ms after the low-to-high transition of ~RESOUT. Connect to he MCU ~RES pin.
DETOUT	OA	**Detected Level Out.** DETOUT indicates the supply voltage level (high = 5V; low = 3.3V). Connect to DETIN and to the MCU PSC pin.

Table 10. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
COMMON TELEPHONE LINE AND CELLULAR PHONE SIGNALS		
TXA1, TXA2	O(DF)	**Transmit Analog 1 and 2.** The TXA1 and TXA2 outputs are differential outputs 180 degrees out of phase with each other. Each output can drive a 300 Ω load.
RIN	I(DA)	**Receive Analog.** RIN is a single-ended receive data input from the telephone line interface or an optional external hybrid circuit.
TELEPHONE LINE INTERFACE ONLY SIGNALS		
RINGD	IA	**Ring Detect.** The RINGD input is monitored for pulses in the range of 15 Hz to 68 Hz. The frequency detection range may be changed by the host in DSP RAM. The circuit driving RINGD should be a 4N35 optoisolator or equivalent. The circuit driving RINGD should not respond to momentary bursts of ringing less than 125 ms in duration, or less than 40 VRMS (15 Hz to 68 Hz) across TIP and RING. Detected ring signals are reflected on the ~RI output signal as well as the RI bit.
~RLYA (~OHRC)	OD	**Relay A Control.** The MDP ~RLYA output is connected to the normally closed Caller ID relay (DPDT). When Caller ID is enabled, the modem will assert this output to open the Caller ID relay and close the off-hook relay in order to detect Caller ID information between the first and second rings. The ~RLYA output 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). ~RLYA is controlled by host setting/resetting of the RA bit.
~RLYB (~TALK)	OD	**Relay B Control.** The MDP ~RLYB output is connected to the normally open Voice relay (DPDT). In voice mode, ~VOICE active closes the relay to switch the handset from the telephone line to a current source to power the handset so it can be used as a microphone and speaker interface to the modem. The ~RLYB output 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). ~RLYB is controlled by host setting/resetting of the RB bit.
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 Three signals provide the timing and data necessary to create an oscilloscope quadrature eye pattern. The eye pattern is simply a display of the received baseband constellation. By observing this constellation, common line disturbances can usually be identified.		
EYEXY	OA	**Serial Eye Pattern X/Y Output.** EYEXY is a serial output containing two 15-bit diagnostic words (EYEX and EYEY) for display on the oscilloscope X axis (EYEX) and Y axis (EYEY). EYEX is the first word clocked out; EYEY follows. Each word has 8-bits of significance. Each 15-bit data word is shifted out most significant bit first with the seven most significant bits set to zero. EYEXY is clocked by the rising edge of /EYECLK. This serial digital data must be converted to parallel digital form by a serial-to-parallel converter, and then to analog form by two digital-to-analog (D/A) converters.
~EYECLK	OA	**Serial Eye Pattern Clock.** ~EYECLK is a 288 kHz output clock for use by the serial-to-parallel converters. The low-to-high transitions of ~RDCLK coincide with the low-to-high transitions of ~EYECLK. ~EYECLK, therefore, can be used as a receiver multiplexer clock.
EYESYNC	OA	**Serial Eye Pattern Strobe.** EYESYNC is a strobe for loading the D/A converters.

Table 10. MDP Signal Definitions (Cont'd)

Label	I/O Type	Signal Name/Description
SERIAL INTERFACE VERSION		
DTE SERIAL/CONTROL/INDICATOR SIGNALS		
TXD	IA	**Transmitted Data.** The MDP obtains serial data to be transmitted from the DTE on the TXD input.
RXD	OA	**Received Data.** The MDP presents received serial data to the DTE on the RXD output. RXD is also connected to the MCU DPRXD input.
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%.
XTCLK	IA	**External Transmit Clock.** In synchronous communication, an external transmit data clock can be connected to the MDP XTCLK input. The clock supplied at XTCLK must exhibit the same characteristics as TDCLK.
~RLSD	OA	**Received Line Signal Detector.** ~RLSD active indicates that energy above the receive level threshold is present on the receiver input, and that the energy is not a training sequence.
~RDCLK	OA	**Receive Data Clock.** The modem outputs a synchronous Receive Data Clock (~RDCLK) for USRT timing.
~RTS	IA	**Request to Send.** Not used; pull up to VCC through 10k Ω.
~DTR	IA	**Data Terminal Ready.** Not used; pull up to VCC through 10k Ω.
~CTS	OA	**Clear to Send.** Not used; leave open.
~DSR	OA	**Data Set Ready.** Not used; leave open.
PARALLEL INTERFACE VERSION		
DTE SERIAL/CONTROL/INDICATOR SIGNALS		
TXD	IA	**Transmitted Data.** Not used; pull up to VCC through 10k Ω.
RXD	OA	**Received Data.** Not used; leave open.
TDCLK	OA	**Transmit Data Clock.** Not used; leave open.
XTCLK	IA	**External Transmit Clock.** Not used; leave open.
~RDCLK	OA	**Receive Data Clock.** Not used; leave open.
~RLSD	OA	**Received Line Signal Detector.** Not used, leave open.
~RTS	IA	**Request to Send.** Not used; pull up to VCC through 10k Ω.
~DTR	IA	**Data Terminal Ready.** Not used; pull up to VCC through 10k Ω.
~CTS	OA	**Clear to Send.** Not used; leave open.
~DSR	OA	**Data Set Ready.** Not used; leave open.

Table 11. Digital Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions[1] (+3.3V Operation)	Test Conditions[1] (+5V Operation)
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.	Note 2.
Input Low Voltage	V_{IL}				VDC		
Type IA,1C, and ID		–0.3		0.8			
Type IE		–	1.0	–		Note 2.	Note 2.
Input High Current	I_{IH}			40	µA	V_{CC} = 3.6V, V_{IN} = 3.6V	V_{CC} = 5.25V, V_{IN} = 5.25V
Input Low Current	I_{IL}			400	µA	V_{CC} = 3.6V,	V_{CC} = 5.25V
Input Leakage Current	I_{IN}				µADC	V_{IN} = 0 to 3.3V, V_{CC} = 3.6V	V_{IN} = 0 to 5V, V_{CC} = 5.25V
~RES and PD0-PD7		–	–	±2.5			
XTLI		–	–	±10			
~NMI and ~TST		–	–	±100			
Output High Voltage	V_{OH}				VDC		
Type OA and OB		2.4	–	–		I_{LOAD} = – 100 µA	I_{LOAD} = – 100 µA
Type OD		–	–	V_{CC}		I_{LOAD} = 0 mA	I_{LOAD} = 0 mA
Type OE						Note 3.	Note 3.
Output Low Voltage	V_{OL}				VDC		
Type OA		–	–	0.4		I_{LOAD} = 1.6 mA	I_{LOAD} = 1.6 mA
Type OB		–	–	0.4		I_{LOAD} = 0.8 mA	I_{LOAD} = 0.8 mA
Type OD		–	–	0.75		I_{LOAD} = 15 mA	I_{LOAD} = 15 mA
Three-State (Off) Current	I_{TSI}			±10	µADC	V_{IN} = 0 V to V_{CC}	V_{IN} = 0 V to V_{CC}

Notes:

1. Test Conditions: +5V operation: VCC = 5V ± 5%; +3.3V operation: VCC = 3.3V ± 0.3V, TA = 0°C to 70°C, (unless otherwise stated).
   Output loads: Data bus (D0-D7), address bus (A0-A15), chip selects, ~READ, and ~WRITE loads = 70 pF + one TTL load.
   Other = 50 pF + one TTL load.
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 12. Analog Electrical Characteristics

Name	Type	Characteristic	Value
RIN	I (DA)	Input Impedance AC Input Voltage Range Reference Voltage	> 70K Ω 1.1 VP-P** +2.5 VDC
TXA1, TXA2	O (DD)	Minimum Load Maximum Capacitive Load Output Impedance AC Output Voltage Range Reference Voltage DC Offset Voltage	300 Ω 0 µF 10 Ω 2.2 VP-P +2.5 VDC ± 200 mV
SPKR	O (DF)	Minimum Load Maximum Capacitive Load Output Impedance AC Output Voltage Range Reference Voltage DC Offset Voltage	300 Ω 0.01 µF 10 Ω 1.1 VP-P +2.5 VDC ± 20 mV

* Reference Voltage provided internal to the modem data pump.
** Corresponds to 2.2 VP-P at Tip and Ring.

Table 13. Current and Power Requirements

Mode	Current (ID) Typical Current @ 25°C (mA)	Current (ID) Maximum Current @ 0°C (mA)	Current (ID) Maximum Current @ -40°C[1] (mA)	Power (PD) Typical Power @ 25°C (mW)	Power (PD) Maximum Power @ 0°C (mW)	Power (PD) Maximum Power @ -40°C[1] (mW)	Notes
+3.3V Operation							
MCU							f_{IN} = 9.8304 MHz
Normal mode	24.2	29.2	33.3	80	105	120	
Sleep mode	2.0	2.6	3.0	6.6	9.4	10.8	
Stop mode	0.15	0.2	0.2	0.5	0.7	0.7	
MDP							f_{IN} = 35.2512MHz
Normal mode	51.5	62.0	77.0	170	225	280	
Sleep mode	2.4	3.0	3.3	8.0	10.8	11.9	
Total							
Normal mode	75.7	91.2	110.3	250	330	400	
Sleep mode	4.4	5.6	6.3	14.6	20.2	22.7	
Stop mode	2.55	3.2	3.5	8.5	11.5	12.6	
+5V Operation							
MCU							f_{IN} = 9.8304 MHz
Normal mode	24.0	30.5	34.3	120	160	180	
Sleep mode	2.4	3.0	3.3	7.9	10.8	11.9	
Stop mode	0.15	0.2	0.2	0.8	1.1	1.1	
MDP							f_{IN} = 35.2512MHz
Normal mode	45.0	54.0	68.0	225	285	355	
Sleep mode	2.0	2.4	3.1	10	12.6	16.3	
Total							
Normal mode	69.0	84.5	102.3	345	445	535	
Sleep mode	4.4	5.4	6.4	17.9	23.3	28.2	
Stop mode	2.15	2.6	3.3	10.8	13.7	17.4	

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

Table 14. 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
Operating Temperature Range	T_A		°C
Commercial		-0 to +70	
Extended		-40 to +85	
Storage Temperature Range	T_{STG}	-55 to +125	°C
Analog Inputs	V_{IN}	-0.3 to (+5VA + 0.3)	V
Voltage Applied to Outputs in High Impedance (Off) State	V_{HZ}	-0.5 to (+5VD + 0.5)	V
DC Input Clamp Current	I_{IK}	±20	
DC Output Clamp Current	I_{OK}	±20	
Static Discharge Voltage (25°C)	V_{ESD}	±2500	V
Latch-up Current (25°C)	I_{TRIG}	±200	

Table 15. 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 FIFO Buffer Register (Write Only)							
0 (DLAB = 0)	Receiver Buffer Register (RBR)	Receiver FIFO Buffer Register (Read Only)							
1 (DLAB = 1)	Divisor Latch MSB Register (DLM)	Divisor Latch MSB							
0 (DLAB = 1)	Divisor Latch LSB Register (DLL)	Divisor Latch LSB							

SCHEMATICS

Typical interface schematics for the MCU with parallel host interface and with serial DTE interface are shown in Figures 8 and 9, respectively.

Typical interface schematics for the MDP are shown in Figures 10.

A schematic for a typical line interface circuit is shown in Figure 11.

Figure 12 is a schematic of a typical external hybrid circuit.

A schematic for a typical speaker circuit connected to the MDP SPKR output is shown in Figure 13.

Consult the AccelerATor Kits for full schematics of typical applications.

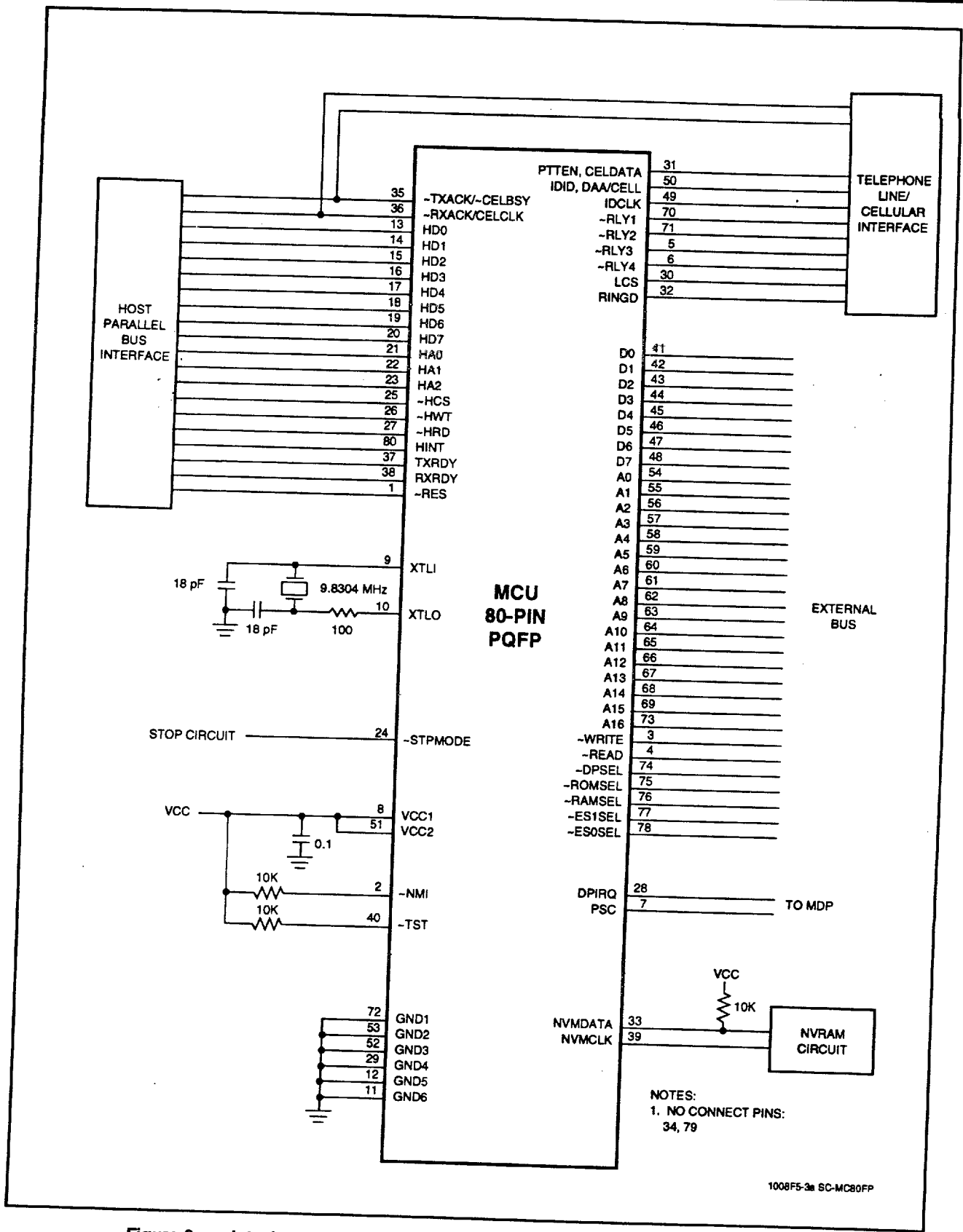


Figure 8a. Interface Schematic - MCU with Parallel Host Interface - 80-Pin PQFP

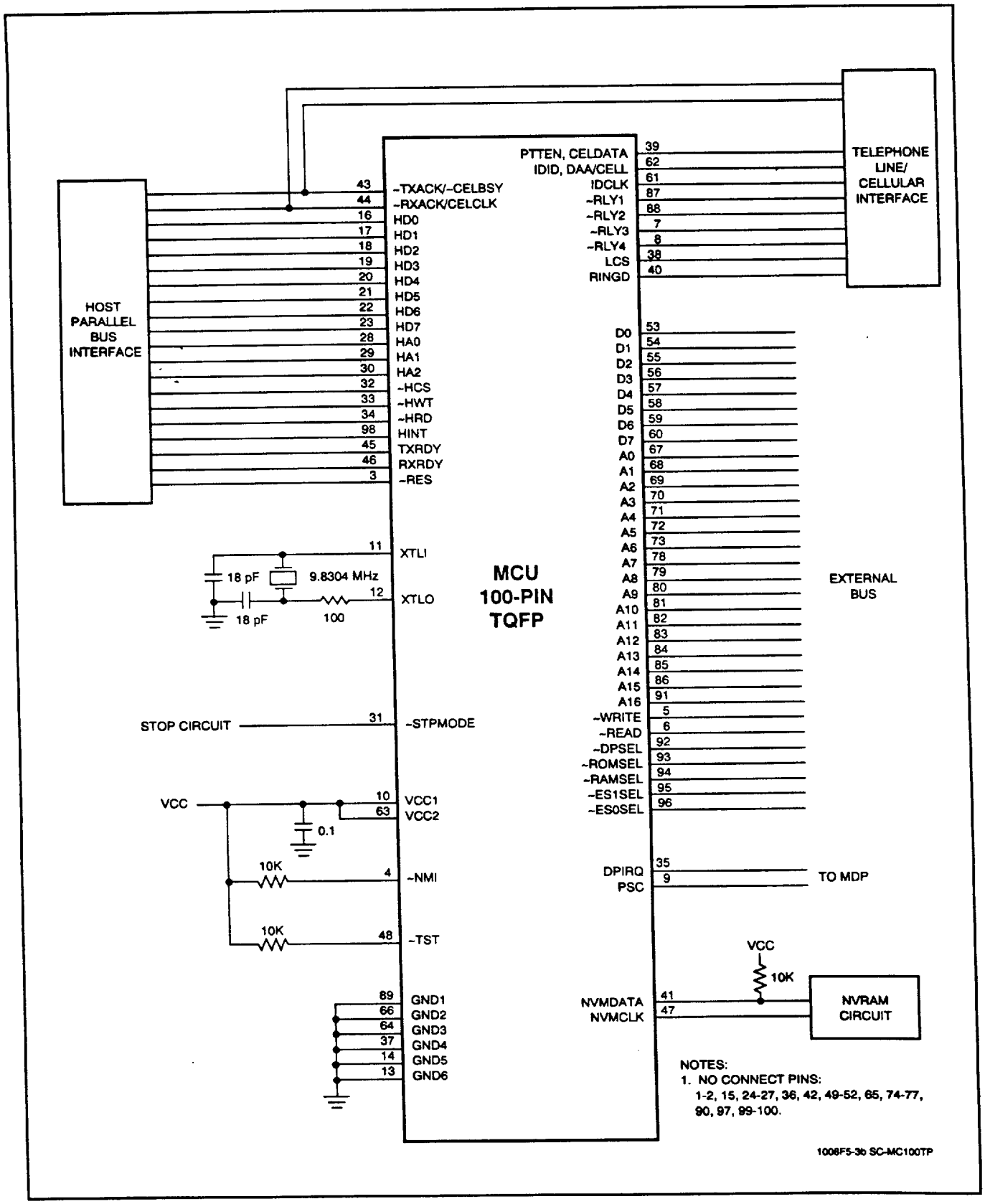


Figure 8b. Interface Schematic - MCU with Parallel Host Interface - 100-Pin TQFP

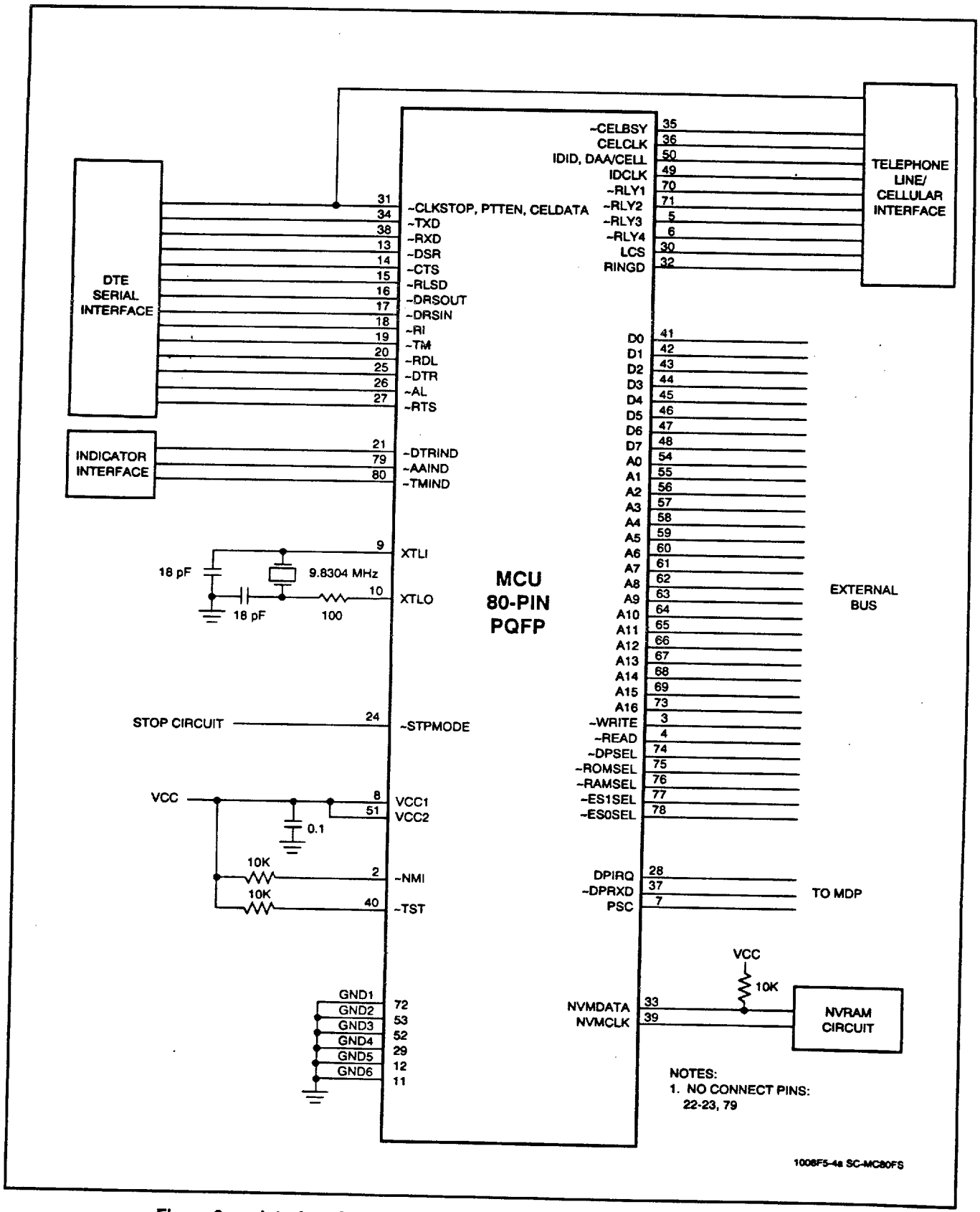


Figure 9a. Interface Schematic - MCU with Serial DTE Interface - 80-Pin PQFP

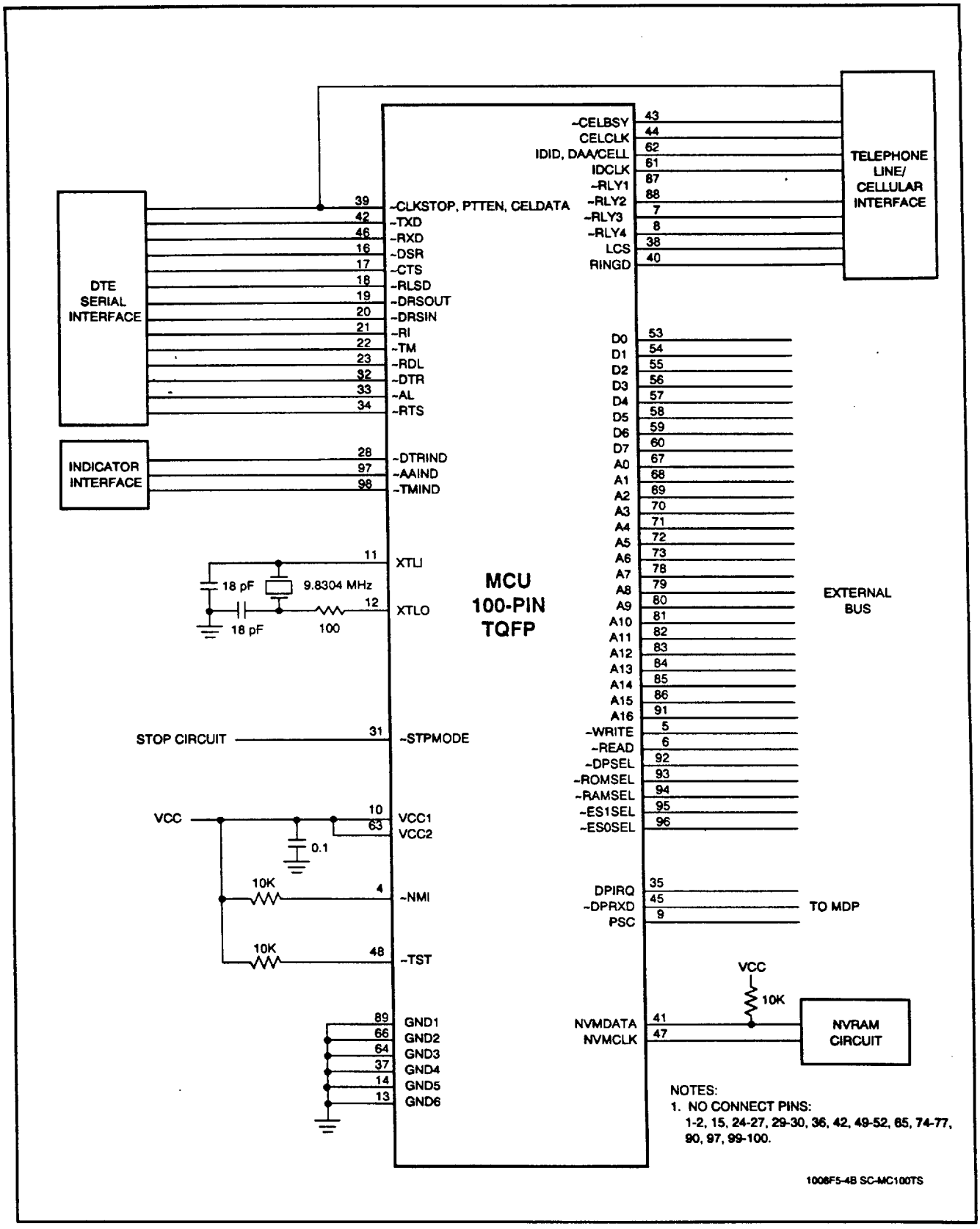
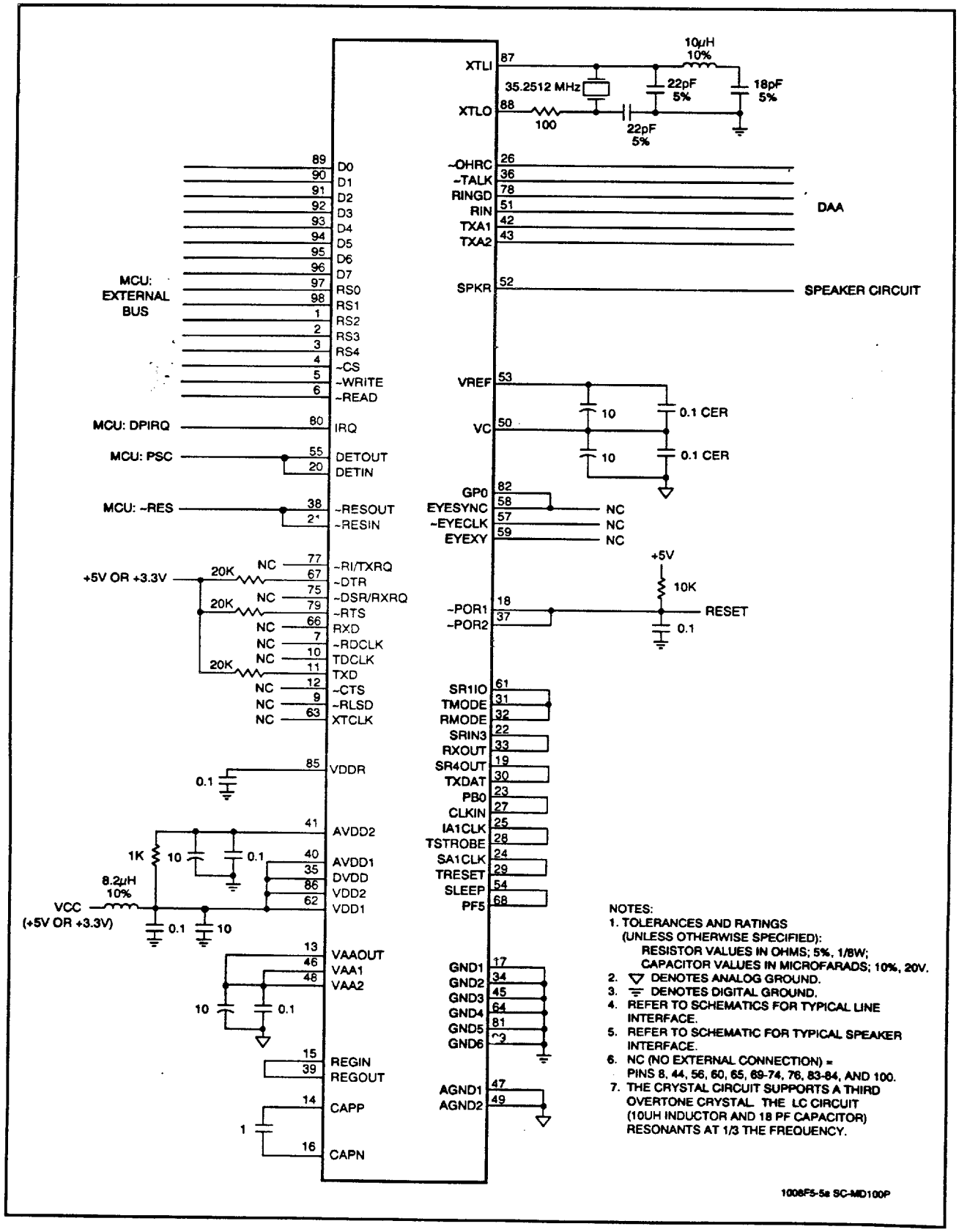


Figure 9b. Interface Schematic - MCU with Serial DTE Interface - 100-Pin TQFP



NOTES:
1. TOLERANCES AND RATINGS (UNLESS OTHERWISE SPECIFIED): RESISTOR VALUES IN OHMS; 5%, 1/8W; CAPACITOR VALUES IN MICROFARADS; 10%, 20V.
2. ▽ DENOTES ANALOG GROUND.
3. ⏚ DENOTES DIGITAL GROUND.
4. REFER TO SCHEMATICS FOR TYPICAL LINE INTERFACE.
5. REFER TO SCHEMATIC FOR TYPICAL SPEAKER INTERFACE.
6. NC (NO EXTERNAL CONNECTION) = PINS 8, 44, 56, 60, 65, 69-74, 76, 83-84, AND 100.
7. THE CRYSTAL CIRCUIT SUPPORTS A THIRD OVERTONE CRYSTAL. THE LC CIRCUIT (10UH INDUCTOR AND 18 PF CAPACITOR) RESONANTS AT 1/3 THE FREQUENCY.

1008F5-5a SC-MD100P

Figure 10a. Interface Schematic - MDP - 100-Pin PQFP

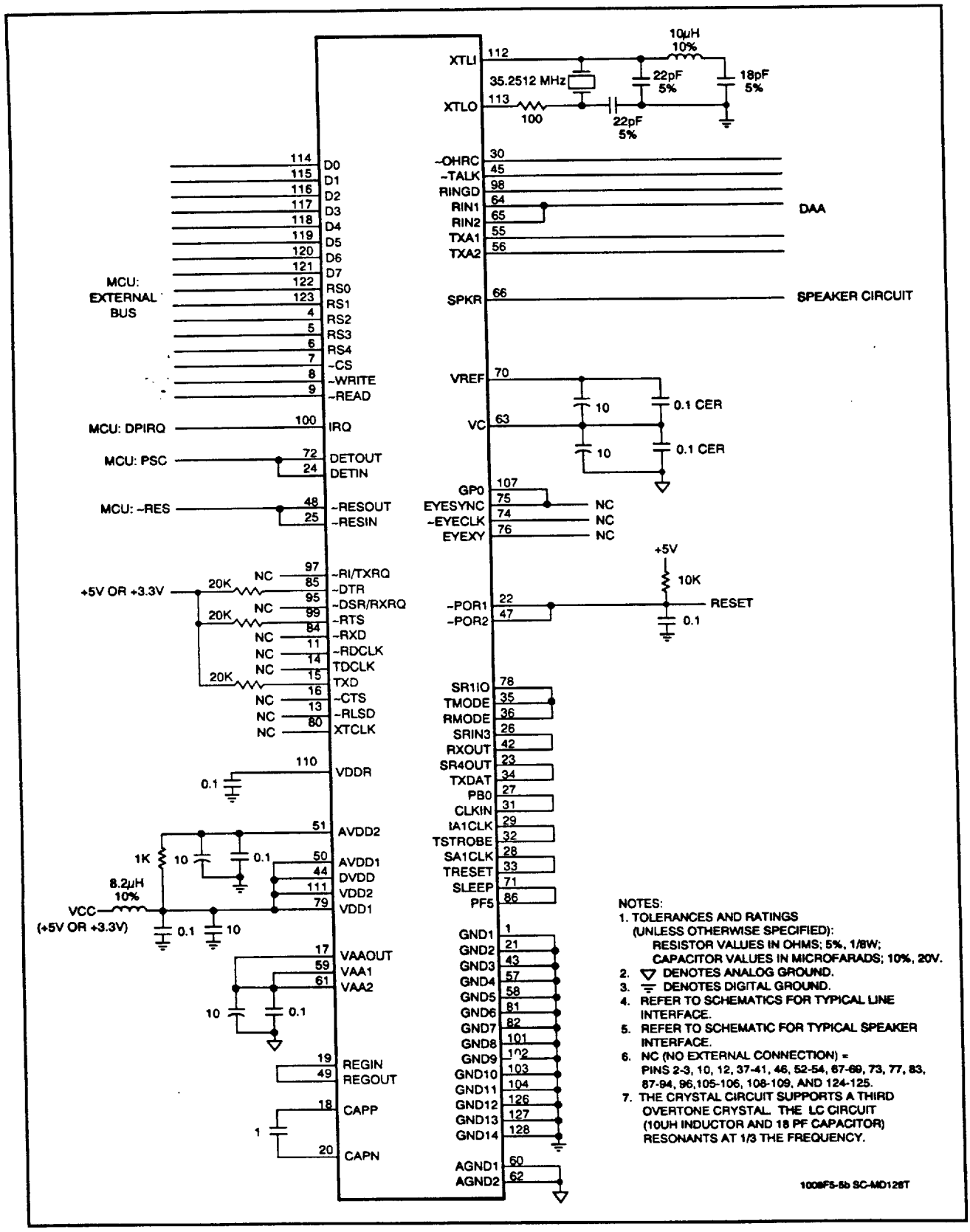


Figure 10b. Interface Schematic - MDP - 128-Pin TQFP

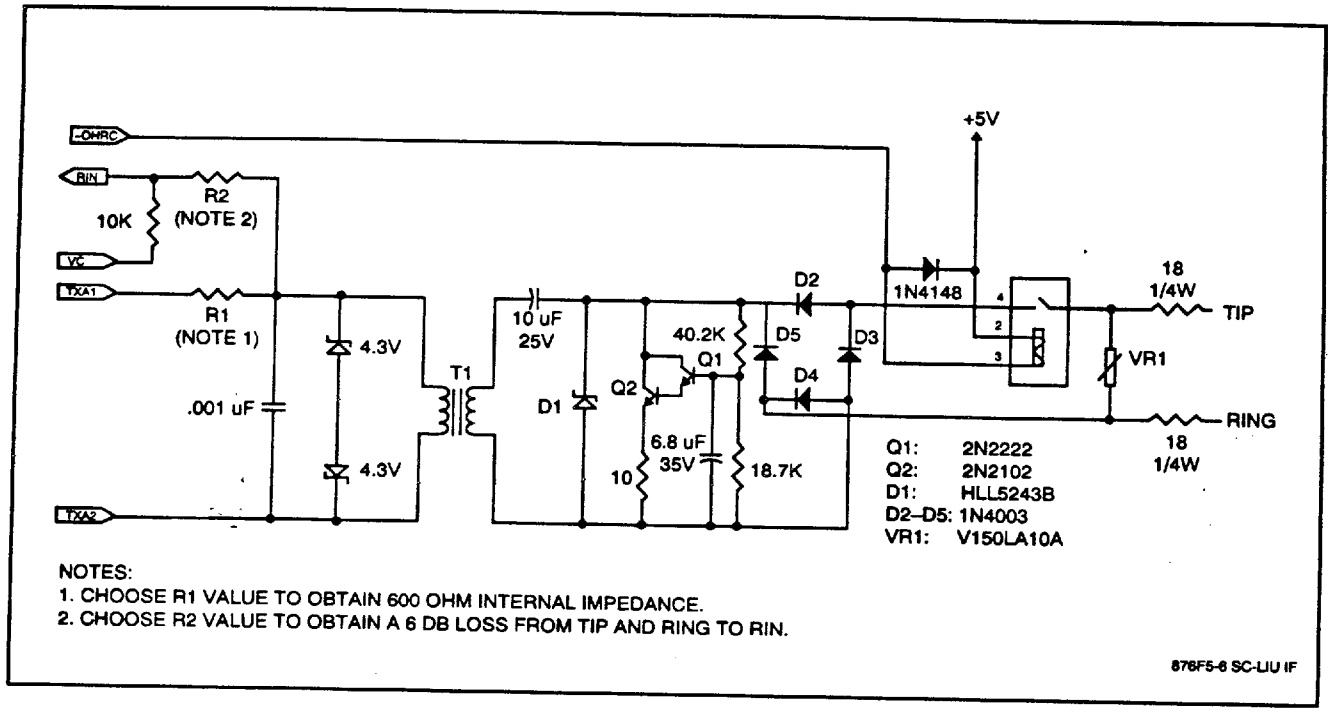


Figure 11. Typical Line Interface

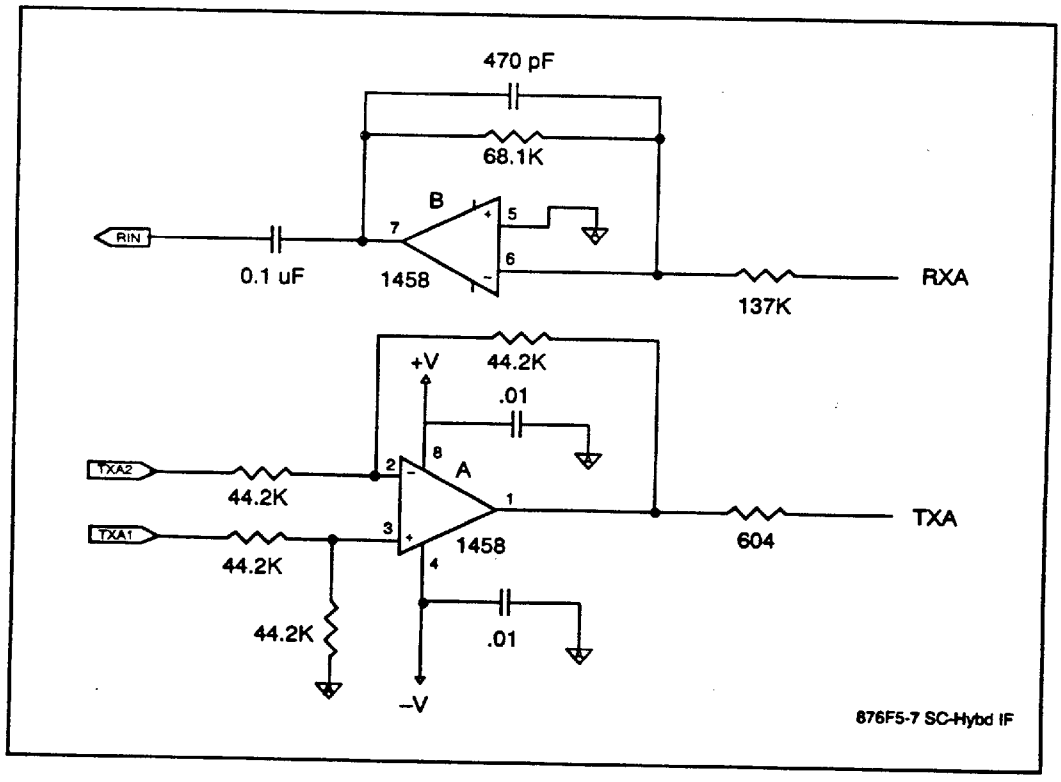


Figure 12. Typical Interface to External Hybrid

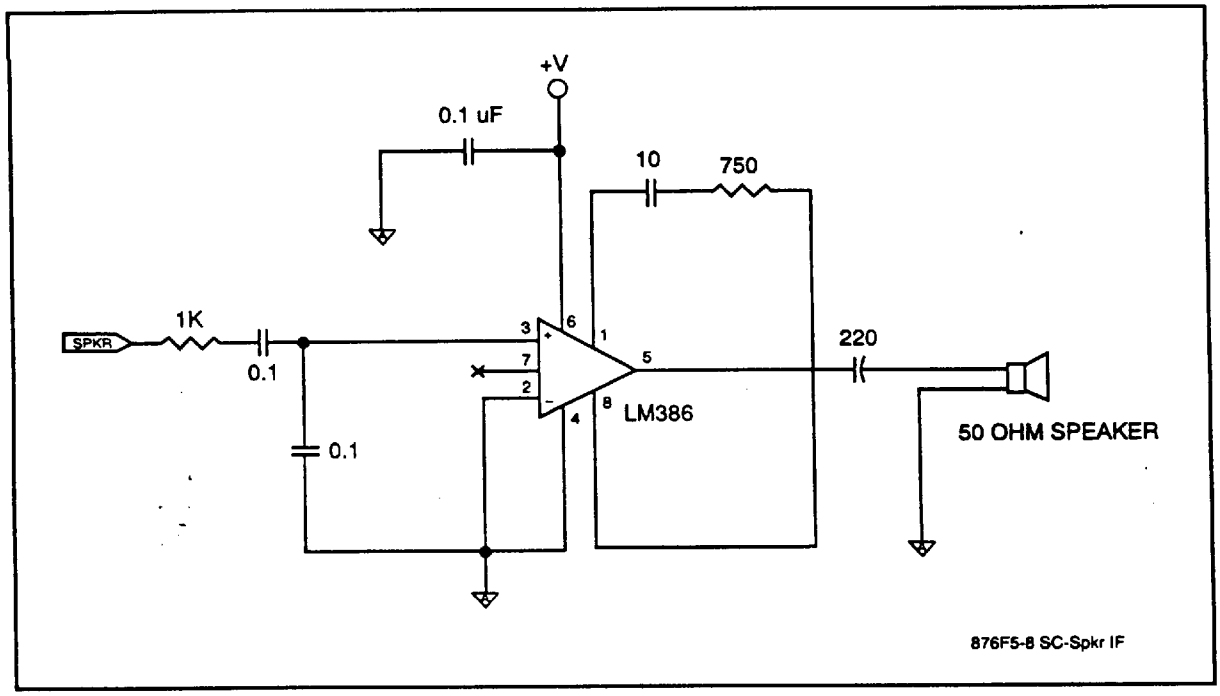
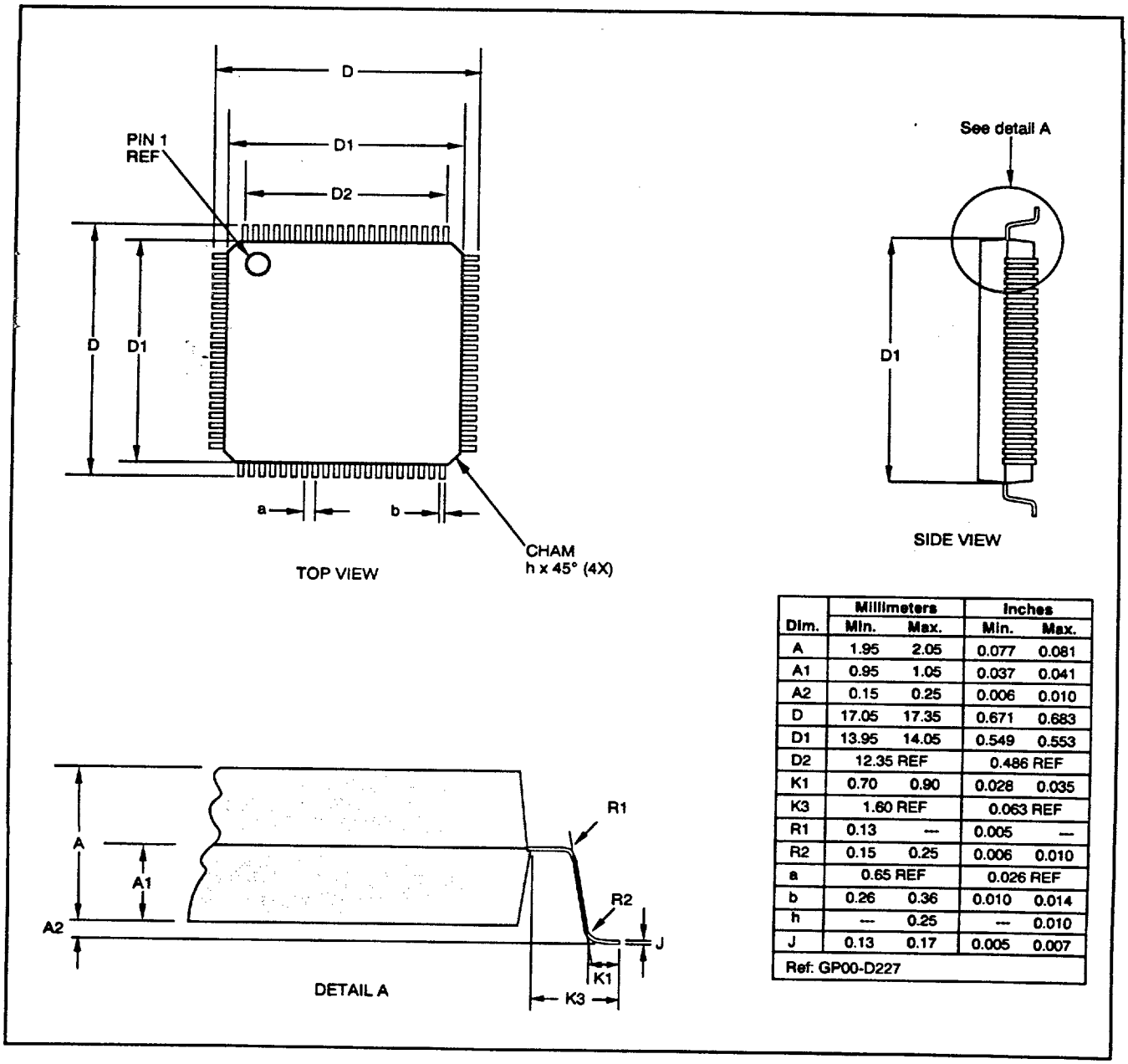


Figure 13. Typical External Speaker Circuit

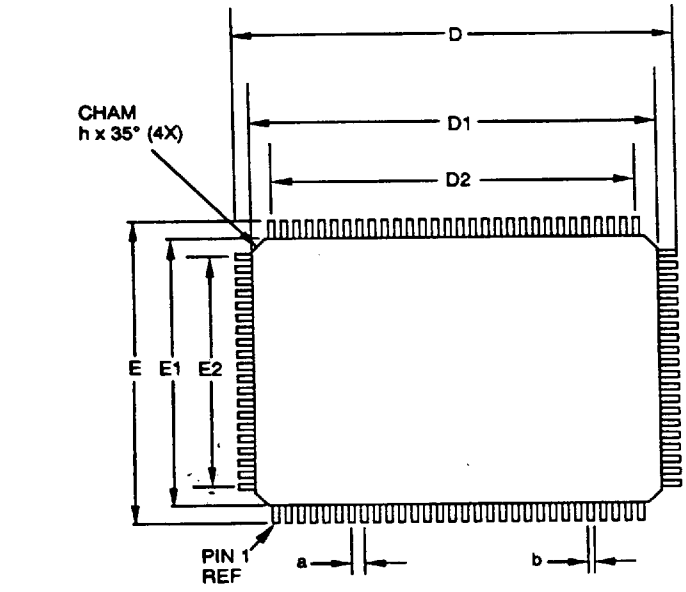
PACKAGE DIMENSIONS

The package dimensions are shown in Figure 14.

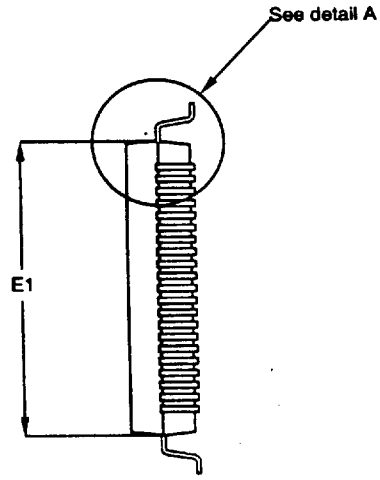


Dim.	Millimeters Min.	Millimeters Max.	Inches Min.	Inches Max.
A	1.95	2.05	0.077	0.081
A1	0.95	1.05	0.037	0.041
A2	0.15	0.25	0.006	0.010
D	17.05	17.35	0.671	0.683
D1	13.95	14.05	0.549	0.553
D2	12.35 REF		0.486 REF	
K1	0.70	0.90	0.028	0.035
K3	1.60 REF		0.063 REF	
R1	0.13	—	0.005	—
R2	0.15	0.25	0.006	0.010
e	0.65 REF		0.026 REF	
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-D227				

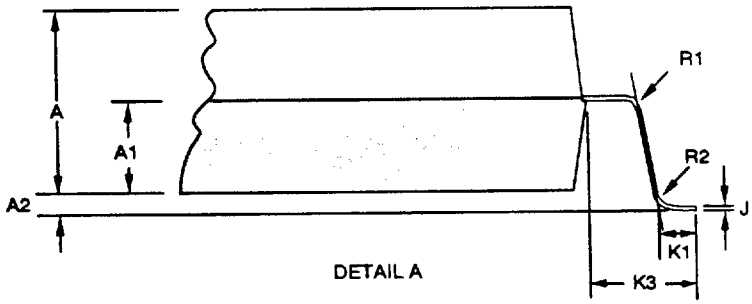
Figure 14a. Package Dimensions - 80-Pin PQFP



TOP VIEW



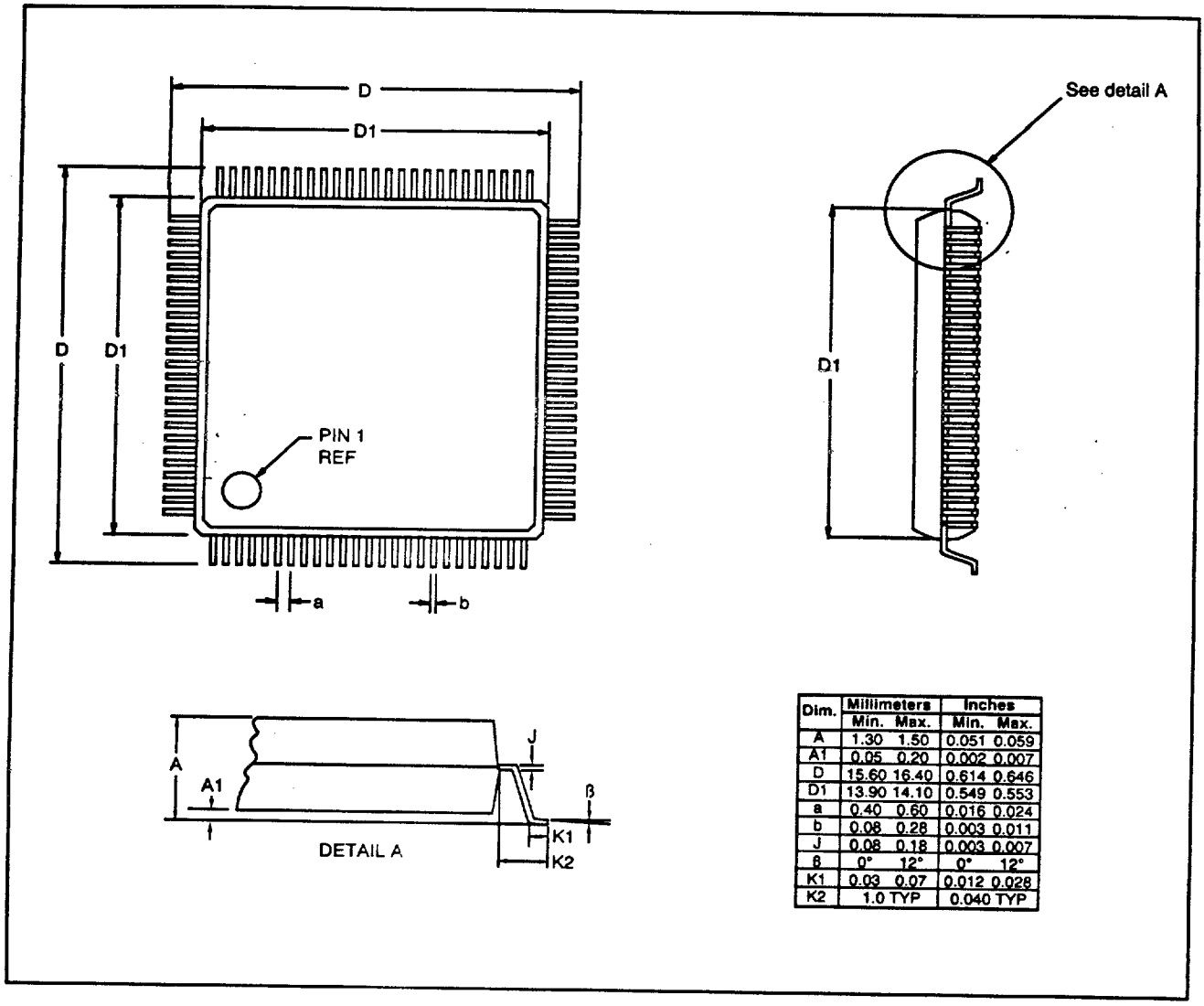
SIDE VIEW



DETAIL A

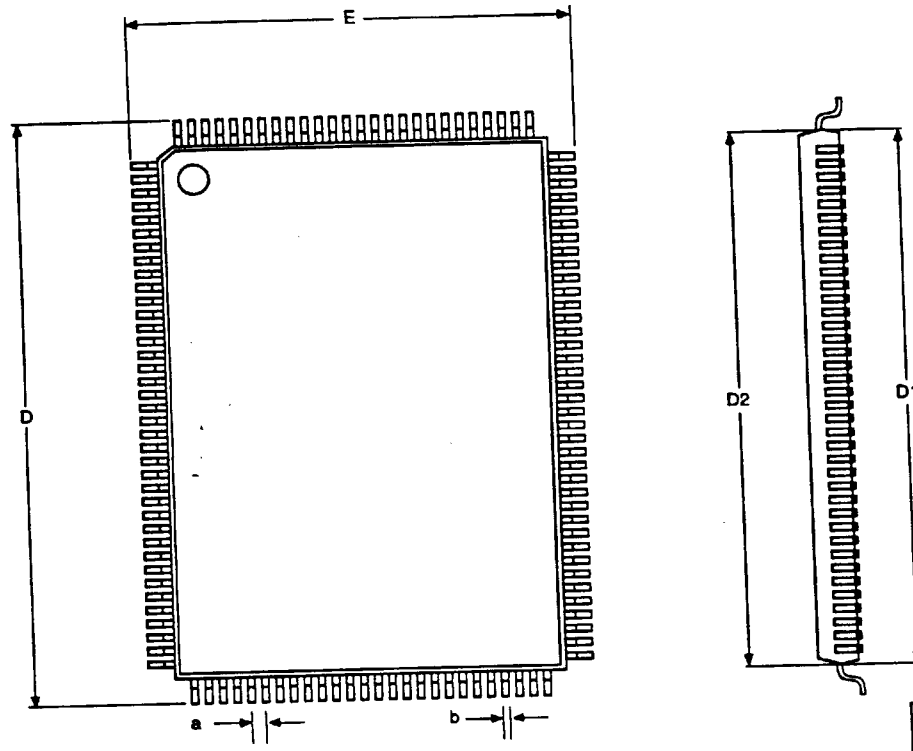
Dim.	Millimeters Min.	Millimeters Max.	Inches Min.	Inches Max.
A	1.95	2.05	0.077	0.081
A1	0.95	1.05	0.037	0.041
A2	0.25 REF		0.010 REF	
D	23.05	23.35	0.907	0.919
D1	19.95	20.05	0.785	0.789
D2	18.85 REF		0.742 REF	
E	17.05	17.35	0.671	0.683
E1	13.95	14.05	0.549	0.553
E2	12.35 REF		0.486 REF	
K1	0.70	0.90	0.028	0.035
K3	1.60 REF		0.063 REF	
R1	0.13	---	0.005	---
R2	0.15	0.25	0.006	0.010
a	0.65 REF		0.026 REF	
b	0.30 REF		0.012 REF	
h	--	0.50	--	0.020
J	0.1524 REF		0.006 REF	
Ref: GP00-D234-5/92				

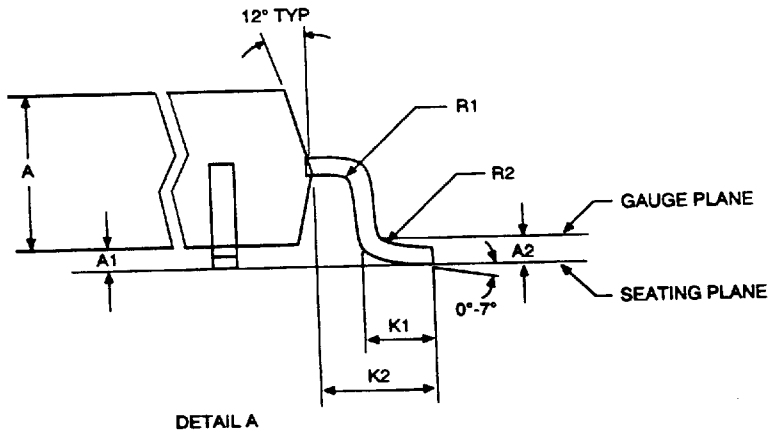
Figure 14b. Package Dimensions - 100-Pin PQFP



Dim.	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.30	1.50	0.051	0.059
A1	0.05	0.20	0.002	0.007
D	15.60	16.40	0.614	0.646
D1	13.90	14.10	0.549	0.553
a	0.40	0.60	0.016	0.024
b	0.08	0.28	0.003	0.011
J	0.08	0.18	0.003	0.007
ß	0°	12°	0°	12°
K1	0.03	0.07	0.012	0.028
K2	1.0 TYP		0.040 TYP	

Figure 14c. Package Dimensions - 100-Pin TQFP





Dim.	Millimeters Min.	Millimeters Max.	Inches* Min.	Inches* Max.
A	1.45	1.55	0.057	0.061
A1	0.05	0.15	0.002	0.006
A2	0.25 REF		0.0098	
D	21.85	22.15	0.860	0.872
D1	19.95	20.05	0.785	0.789
D2	19.82	19.92	0.780	0.784
E	15.85	16.15	0.624	0.636
E1	13.95	14.05	0.549	0.553
E2	13.82	13.92	0.544	0.548
K1	1.00 REF		0.039	
K2	0.50	0.75	0.020	0.030
R1	0.20 TYP		0.008TYP	
R2	0.20TYP		0.008TYP	
a	0.50 REF		0.020 REF	
b	0.22 REF		0.009 REF	
Ref: GP00-D264-11/29/93 (021894)				

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

Figure 14d. Package Dimensions - 128-Pin TQFP

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