Data Sheet
February 1993

AT&T Microelectronics

AT&T V32x-V42L V.32bis/V.32/FAX/V.42bis LapTop Complete Modem Chip Set

Introduction

The AT&T LapTop Complete Modem Chip Set enables the modem designer to build high-speed fully featured battery-powered pocket or notebook computer modems with minimal design effort. The LapTop Complete Modem Chip Set is a low-power, high-performance, two-wire, full-duplex modem that operates over the general switched telephone network with the appropriate line terminations.

For data mode operation, the modem conforms to CCITT recommendations V.32bis (V32FB-V42L only), V.32, V.22bis, V.22, V.23, V.21 and is compatible with Bell 212A and 103 modems. Data mode speeds of 300 bits/s to 14400 bits/s are supported (see complete list at right). And, with data compression, throughput up to 57600 bits/s can be achieved. CCITT V.42 error control and V.42bis data compression are provided, as well as *MNP* Classes 2, 3, and 4 error control and *MNP* 5 data compression.

For FAX operation, the modem supports Group 3 FAX modulation standards V.17 (V32FB-V42L only), V.29, V.27ter, and V.21 Channel 2. FAX data rates of 300 bits/s to 14400 bits/s are supported (see complete list of FAX modes at right).

An industry-standard AT command set interpreter and an EIA/TIA-578 Class 1 FAX Interface are provided, allowing operation with popular communications software packages.

The AT&T LapTop Complete Modem Chip Set consists of a DSP16A Digital Signal Processor, an interface device (V32-INTFC), an AT&T T7525 Linear Codec, a LapTop modem controller (LMC), and an optional LapTop modem power manager (LMPM) device. The LapTop Complete Modem Chip Set is targeted at low-power and restricted-size applications such as integral modems in laptop and notebook computers and battery-powered pocket modems.

Features

- Data modes:
  - — CCITT V.32bis (V32FB-V42L only): 14,400 (TCM), 12,000 (TCM), 7200 (TCM)
  - — CCITT V.32: 9600 (TCM), 4800 (QAM)
  - — CCITT V.22bis: 2400 (QAM)
  - — CCITT V.22: 1200 (DPSK)
  - — CCITT V.23: 1200/75 (FSK)
  - — CCITT V.21: 300 (FSK)
  - — Bell 212A: 1200 (DPSK)
  - — Bell 103: 300 (FSK)
- FAX modes:
  - — CCITT V.17: (V32FB-V42L only): 14,400 (TCM), 12,000 (TCM), 7200 (TCM)
  - — CCITT V.29: 9600 (QAM), 7200 (QAM)
  - — CCITT V.27ter: 4800 (DPSK), 2400 (DPSK)
  - — CCITT V.21 Channel 2: 300 (FSK)
- V.42 error correction (LAPM and *MNP*)
- V.42bis and *MNP* 5 data compression
- Extensive AT command set
- EIA/TIA 578 Class 1 FAX Interface
- Low power consumption (CMOS technology)
- Sleep mode
- Small footprint, surface-mount packaging
- *Autosync* operation
- Serial or parallel interface
- Single 5 V supply

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General Description

LapTop Complete Modem Power Dissipation

The LapTop Complete Modem Chip Set is intended for ultra low-power applications, such as battery-powered pocket or notebook computer modems. Tables 1 and 2 show the power dissipation for each chip set both with and without the optional LapTop modem power manager device.

Table 1. Power Dissipation Using the LMPM Device

	V32F-V42L						V32FB-V42L						
	Active		Idle		Sleep		Active		Idle		Sleep		
Device	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Unit
DSP16A	270	355	0	0	0	0	270	355	0	0	0	0	mW
V32-INTFC	120	185	0	0	0	0	120	185	0	0	0	0	mW
T7525	60	85	0	0	0	0	60	85	0	0	0	0	mW
LMC	150	200	25	30	0.1	0.3	180	250	25	30	0.2	0.5	mW
LMPM	4	5	4	5	4	5	4	5	4	5	4	5	mW
Total:	604	830	29	35	4.1	5.3	634	880	29	35	4.2	5.5	mW

Table 2. Power Dissipation Without the LMPM Device

	V32F-V42L						V32FB-V42L						
	Active		Idle		Sleep		Active		Idle		Sleep		
Device	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Unit
DSP16A	270	355	18	24	18	24	270	355	18	24	18	24	mW
V32-INTFC	120	185	25	34	25	34	120	185	25	34	25	34	mW
T7525	60	85	7	9	7	9	60	85	7	9	7	9	mW
LMC	150	200	25	30	0.1	0.3	180	250	25	30	0.2	0.5	mW
Total:	600	825	75	97	50.1	67.3	630	875	75	97	50.2	67.5	mW

DSP16A Digital Signal Processor

A ROM-coded DSP16A Digital Signal Processor is packaged in an 84-pin plastic quad flat package (JEDEC standard) and performs the signal processing and control functions needed to implement the CCITT signal modulations: V.32bis (V32FB-V42L only), V.32, V.22bis, V.22, V.21, V.23, Bell 212A, and Bell 103. It also implements Group 3 FAX modulations: V.17 (V32FB-V42L only), V.29, V.27ter, and V.21 ch. 2.

T7525 Codec

The AT&T T7525 Linear Codec comes in a 28-pin SOJ package. It is the analog front-end of the data pump and incorporates sigma-delta technology.

V.32 Interface Device

The V32-INTFC device is packaged in a 84-pin PQFP (JEDEC standard). It provides the V.24, microprocessor bus, clock generation, eye pattern, and line interfaces.

User Information (continued)

LapTop Modem Controller

The LMC (LapTop Modem Controller) is packaged in a 100-pin QFP. This device contains the oscillator circuitry, parallel I/O interface, dual channel serial I/O with HDLC capability, and timers. The LMC connects to the AT&T V.32 data pump via dedicated lines and an external bus. The external bus also connects to an OEM-supplied 64 Kbytes of read-only memory and 32 Kbytes of RAM. A 10 MHz LMC-10 is used in the V32F-V42L chip set, and a 16 MHz LMC-16 is used in the V32FB-V42L chip set.

LapTop Modem Power Manager

The optional Laptop Modem Power Manager (LMPM) is packaged in a 64-pin quad flat package. The LMPM device allows the data pump and LMC controller to enter an ultralow-power state when the modem is not in use.

LMC Firmware

The LMC firmware performs processing of general modem control, AT command set, error correction, data compression, host interface, and external memory interface functions. The firmware is provided by AT&T in object code for the OEM to program into 64 Kbytes of external ROM.

Serial Interface

The LapTop Complete Modem provides a V.24 (EIA-232-D) compatible serial interface to the DTE. The signals between the modem and computer are at CMOS levels. (See Figure 1, part A.)

Parallel Interface

The LapTop Complete Modem Chip Set is intended for low-power applications such as laptop computers and battery-powered pocket modems where serial communication is desired. However, a 16550-type UART may be used as the interface to a PC parallel bus. (See Figure 1, part B.)

Serial EEPROM

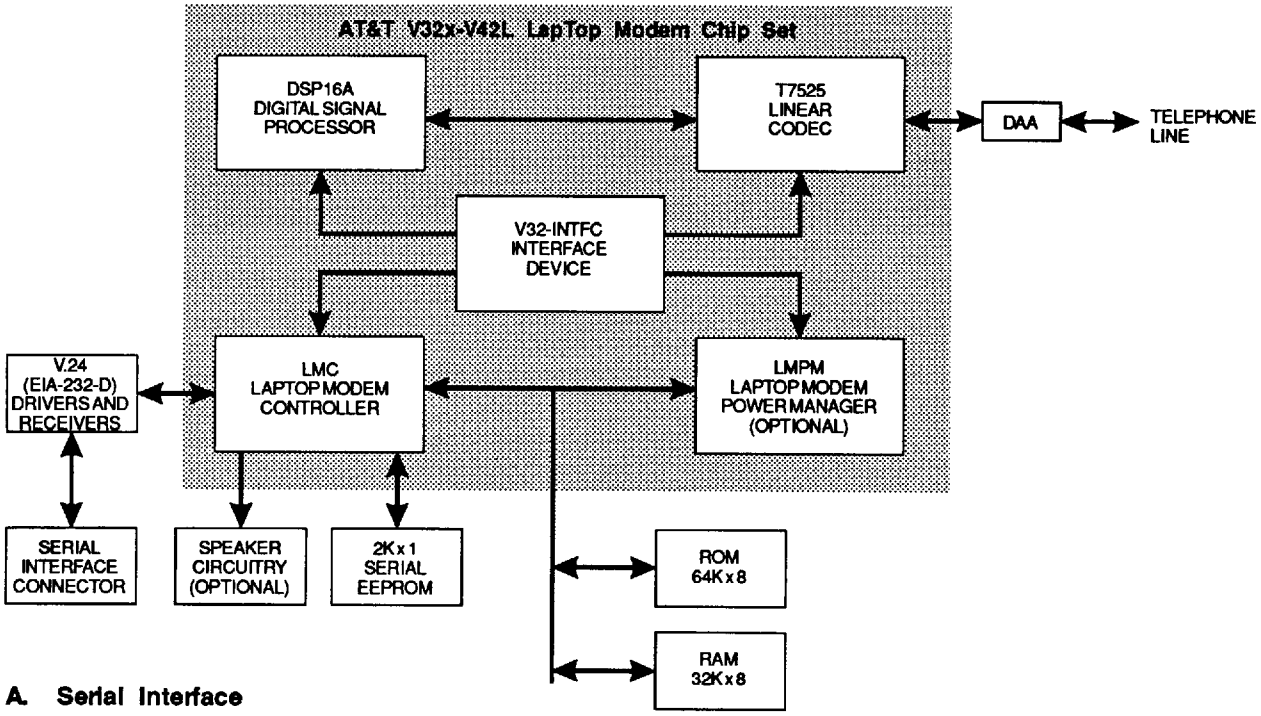
A 2K x 1 bit serial EEPROM (provided by the OEM) is used for nonvolatile storage.

Speaker Interface

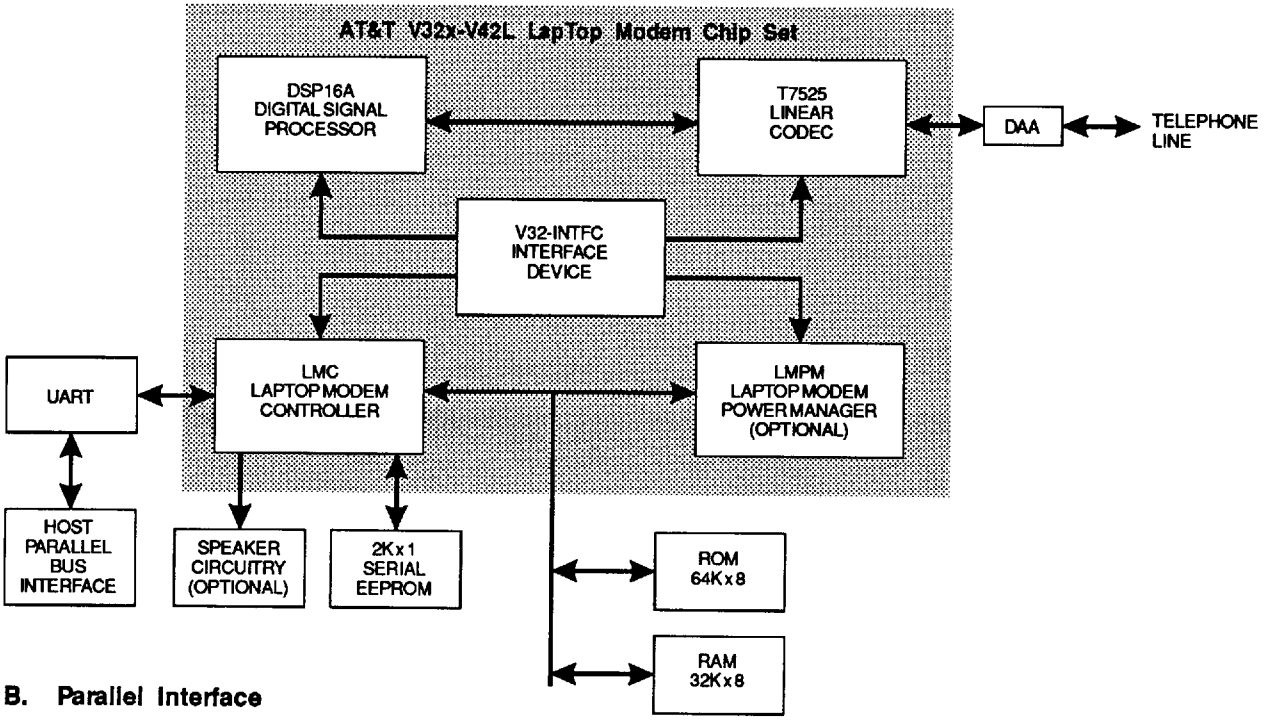
The LapTop Complete Modem Chip Set supplies three speaker interface output signals: Speaker Mute (MUTE), Volume Control 1 (VOL1), and Volume Control 2 (VOL2). A logic low from the Speaker Mute output turns the speaker off. Volume Control 1 and 2 control the speaker volume as follows:

Volume	VOL 1	VOL 2
Lowest	Low	Low
Low	Low	High
Medium	High	Low
High	High	High

User Information (continued)



A. Serial Interface



B. Parallel Interface

Figure 1. AT&T LapTop Complete Modem Block Diagram

User Information (continued)

Environmental Requirements

Parameter	Range
Operating Temperature	0 °C to +70 °C
Storage Temperature	–25 °C to +70 °C

AT Command Set

The LMC firmware includes an AT command set interpreter. Table 3 lists a summary of the command set. For detailed information on each command, refer to AT Command Set Reference starting on page L-31. Commands may be executed when the modem is in COMMAND mode. COMMAND mode is entered upon one of the following conditions:

- After powerup.
- At the termination of a connection.
- After the execution of a command other than dial or answer commands.
- Upon the receipt of the ESCAPE SEQUENCE (three contiguous characters matching the contents of register 2) while in on-line mode.
- Upon the on-to-off transition of DTR if &D1, &D2, or &D3 has been set.
- Upon the receipt of a break from the DTE if \K0, \K2, or \K4 has been set.

User Information (continued)

Table 3. AT Command Set Summary

Command	Description	Command	Description
A/	Repeat last command	&V	View active configuration/user profiles
A	Answer command	&Wn	Save active configuration
Bn	Communication standard option	&Yn	Recall user profile
Cn	Carrier control	&Zn=x	Store phone number x in location n
D	Dial command	\An	Block size
En	Off-line echo command	\Bn	Send break
Fn	On-line echo command	\Cn	Set autoreliable buffer
Hn	Switchhook control	\Gn	Set modem port flow control
In	Product ID	\Hn	HP ENQ/ACK protocol
Ln	Speaker volume	\Jn	Bits/s rate adjust
Mn	Speaker control	\Kn	Set BREAK control
On	Go on-line	\Nn	Set operating mode
P	Set pulse dialing	\Qn	Set serial port flow control
Qn	Result code display option	\Rn	Automatic fall-back and fall-forward
Sn	Selects an S register	\Tn	Set inactivity timer
Sn=x	Writes to an S register	\Vn	Modify result code form
Sn?	Read an S register	\Xn	Set XON/XOFF passthrough
T	Set tone dialing	\Z	Switch to normal mode
Vn	Result code form	%An	Set autoreliable fallback character
Wn	Select extended result code	%Bn	Modem port rate
Xn	Result code set/call progress	%Cn	Data compression
Yn	Long-space disconnect	%En	Autoretrain
Zn	Reset and recall user profile	%Mn	Minimum modem port rate
&Cn	DCD option	%V	Display firmware version
&Dn	DTR option	+FCLASS?	Service class indication
&Fn	Recall factory settings	+FCLASS=?	Service class capabilities
&Gn	Guard tone option	+FCLASS=1	Service class 1 selection
&Jn	Auxiliary relay control	+FTS=n	Transmission silence
&Mn	Asynchronous mode	+FRS=n	Receive silence
&Pn	Dial pulse ratio	+FTM=m	Transmit FAX data with m carrier
&Qn	Communications mode option	+FRM=m	Receive FAX data with m carrier
&Rn	CTS/RTS option	+FTH=m	Transmit HDLC data with m carrier
&Sn	DSR option	+FRH=m	Receive HDLC data with m carrier
&Tn	Self-test commands		

User Information (continued)

S Registers

Table 4 lists a summary of the modem registers. For detailed information on each register, refer to S Registers Reference on page 38.

Table 4. S Register Summary

Reg	Default	Description
0	000	Ring to answer on
1	000	Ring counter
2	043	Escape character (+) (disabled above 127)
3	013	Carriage return <CR> character code (decimal)
4	010	Line feed <LF> character code (decimal)
5	008	Back space <BS> character code (decimal)
6	002	Seconds to wait before blind dialing
7	050	Seconds to wait for carrier or dial tone
8	002	Seconds to delay for comma (,) dial modifier
9	006	Tenths of seconds to determine CD is true
10	014	Tenths of seconds to detect lost carrier
11	095	Milliseconds duration and spacing of DTMF tones
12	050	0.02 second escape sequence guard time (not used)
14	0AH	Read only bit mapped S register: 1 - command echo, 2 - result codes, 3 - verbose, 4 - dumb, 5 - pulse dial, 7 - originate mode
16	00H	Read only bit mapped test S register: 0 - local analog loop, 2 - local digital loop, 3 - local modem in RDL, 4 - RDL initiated, 5 - RDL with ST initiated, 6 - local analog loop with ST initiated
18	000	Modem test timer (seconds)
19	026	*Autosync* protocol support mode
20	000	*Autosync* sync/address character
21	00H	Read only bit mapped options: 0 - Telco Jack; 2 - &R; 3, 4 - &D; 5 - &C; 6 - &S; 7 - Y.
22	76H	Read only bit mapped options: 0,1 - L, 2,3 - M, 4-6 - X (0 = X0, 4 = X1, 5 = X2, 6 = X3, 7 = X4), 7 - &P.
23	1FH	Read only bit mapped options: 0 - obey RDL; 1—3 - rate (0 = 300, 1 = 600, 2 = 1200, 3 = 2400, 4 = 4800, 5 = 9600, 6 = 19200, 7 = 38400), 4—5 - parity (0 = even, 1 = space, 2 = odd, 3 = mark), 6—7 - &G.
25	005	DTR transition detect timer (0.1 seconds)
26	001	0.01 seconds delay from RTS true to CTS true (non-*MNP* modes).
27	40H	Read only bit mapped options: 6 - B (Bell)

User Information (continued)

Autobaud Operation

When the modem enters COMMAND mode, the autobaud operation is enabled. While autobaud is operating, the modem searches for the "A" or "a" which begins an AT command sequence. It determines the data rate from this character and tests the next character received to see if it is a "T" or "t". If the "AT" or "at" sequence is detected, parity and bit lengths are determined from the two, and the remainder of the command line is parsed after a carriage return is detected. If the command buffer overflows, or if a parity or framing error is detected, autobaud operation will resume.

The modem will autobaud to speeds of 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, and 57600 bits/s. The following character formats are valid:

Data Bits	Parity	Stop Bits
7	N	2
7	O	1
7	E	1
8	N	1

Establishing Modem Connections

Connection Speeds

The supported data modem to modem connection modes/speeds and FAX modem to modem connection modes/speeds are listed in Table 5.

Table 5. Supported Data/FAX Modes

Data/FAX	Mode	Data Rate (bits/s)
Data	CCITT V.32bis (V32FB-V42L only)	14400
		12000
		7200
	CCITT V.32	9600
		4800
	CCITT V.22bis	2400
	CCITT V.22	1200
	CCITT V.21	300
	CCITT V.23	1200/75
	Bell 212A	1200
	Bell 103	300
FAX	CCITT V.17 (V32FB-V42L only)	14400
		12000
		7200
	CCITT V.29	9600
		7200
	CCITT V.27ter	4800
		2400
	CCITT V.21 ch 2	300

User Information (continued)

Dial Tone Detection

The detection frequency range is from 340 Hz to 640 Hz, and the detection level is greater than or equal to –43 dBm.

DTMF Dialing

The following table lists the DTMF tone pairs used for tone dialing. All tones are generated within ±1.5%, conforming to Bell System Communications Technical Reference Publication 47001 dated August 1976.

Table 6. DTMF Tones

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

Pulse Dialing

The ATDP command designates that subsequent dialing operations will use pulse dialing. The modem pulse dials at a rate of 8—11 pulses/s. AT&P0 selects the default make/break ratio of 39% make to 61% break. AT&P1 selects an alternate ratio of 33% make to 67% break required in some countries.

Blind Dialing

Blind dialing allows the modem to not detect dial tone prior to dialing. The modem can be configured to dial from 2 seconds to 255 seconds after going off-hook by changing the value in S register 6. The default time, as well as minimum time, is 2 seconds.

Ring Detection

A ring signal between 15 Hz and 68 Hz will be detected.

Call Progress

Frequency:	340 Hz—640 Hz
Level:	On > –43 dBm
Busy Timing:	500 ms ± 10% (2 cycles) = Normal busy

Reference: Bell System Technical Reference PUB 61100.

Answer Tone Detection

The answer tone detection range for CCITT V.32bis, V.32, V.22bis, V.22, and V.21 is 2100 Hz ± 40 Hz. The detection range for Bell 212A and 103 is 2225 Hz ± 40 Hz. The detection level for both CCITT and Bell answer tones is greater than or equal to –43 dBm.

User Information (continued)

Billing Protection

The answering modem must remain silent for a period of time to allow the network administration to send billing information between central offices. After going off-hook, the modem must wait at least 2 seconds before sending answer tone.

Automode

Automode from V.32bis to V.22bis is implemented according to V.32 annex A (11/22/90), and automode to V.23, V.21, Bell 103, and Bell 212A is implemented according to the EIA/TIA draft standard from subcommittee TR-30.1.

Modem Handshaking Protocol

The calling modem aborts the call if it does not detect carrier after the time period defined in S register 7. The default time is 50 seconds.

Phone Number Dialing

The modem can dial numbers entered in the command buffer or dial stored numbers. When the **D** is detected in the command, the following characters in the command buffer are treated as digits or dial modifiers. The dial digits are 0—9, A, B, C, D, #, and *.

Dial Modifiers

Following is the list of dial-string modifiers:

P	Pulse dial
T	Tone dial (default)
,	Pause for number of seconds in S register 8
!	Hook-flash (on-hook for 1/2 second)
@	Wait for at least 1 ring followed by 5 seconds of silence
W	Wait for dial tone for number of seconds in S register 7
;	Return to COMMAND mode after dialing
S=n	Dial stored number in directory entry n
R	Originate in answer mode (go to answer mode after dialing)

Stored Numbers

The **AT&Z*n*=*x*** command sets the contents of directory entry ***n***, which can be 0 through 3, to be the dial string ***x***. Up to 32 characters can be stored in a directory entry. The only dial modifier which cannot be stored is **S**.

Answering

The modem will answer an incoming call when the ring counter (S register 1) equals the Ring to Answer On (S register 0), unless S register 0 = 0 or unless DTR is required and is not true. The **AT&D*n*** commands govern the use of DTR. **AT&D2** causes the modem to disable autoanswer on an on-to-off transition of DTR—and to re-enable autoanswer on an off-to-on transition of DTR. The other **AT&D*n*** commands cause DTR to not affect the autoanswer function. The modem may also be caused to answer manually with the **ATA** command.

User Information (continued)

Stored Profiles

After the user has set up the modem for a particular configuration, that configuration may be stored as one of two user profiles which can be recalled at any time. The **AT&W*n*** command will store the current modem configuration as user profile ***n***, where n can be 0 or 1. Either profile can be recalled at any time with the **ATZ*n*** command. Likewise, either profile can be designated to be the default configuration at powerup with the **AT&Y*n*** command. The **AT&V** command displays the active configuration and both stored profiles. The factory configuration can be made the active configuration with the **AT&F** command.

Data Mode

Flow Control

The modem provides the ability for the data terminal or computer port to pause the flow of data from the modem and for the modem to pause the flow of data from the data terminal or computer port. Flow control is required when a DTE cannot handle data as fast as it is received. Two types of flow control are provided: EIA flow control (RTS-CTS) and XON/XOFF flow control.

Escape Sequence Detection

S register 2 contains the decimal representation of the ASCII character used to enter COMMAND mode. The factory default is a decimal 043, the plus (+) character. A value of 128 or greater disables the escape function.

Break Detection

The modem detects BREAK signals from both the DTE and the remote modem. The following table summarizes the modem's response to a received BREAK signal depending on the **AT\Kn** command. The default is \K5.

AT\K	Modem Detects:	Modem Responds:
\K0	BREAK from DTE	Enter command mode, do not transmit BREAK
	BREAK command	Purge buffers and transmit BREAK
	BREAK from remote	Purge buffers, relay BREAK to DTE
\K1	BREAK from DTE	Purge buffers, transmit BREAK
	BREAK command	Purge buffers and transmit BREAK
	BREAK from remote	Purge buffers, relay BREAK to DTE
\K2	BREAK from DTE	Enter command mode, do not transmit BREAK
	BREAK command	Transmit BREAK immediately
	BREAK from remote	Relay BREAK to DTE immediately
\K3	BREAK from DTE	Transmit BREAK immediately
	BREAK command	Transmit BREAK immediately
	BREAK from remote	Relay BREAK to DTE immediately
\K4	BREAK from DTE	Enter command state, do not transmit BREAK
	BREAK command	Transmit BREAK in sequence with data
	BREAK from remote	Relay BREAK in sequence with data
\K5	BREAK from DTE	Transmit BREAK in sequence with data
	BREAK command	Transmit BREAK in sequence with data
	BREAK from remote	Relay BREAK to DTE in sequence with data

User Information (continued)

Telephone Line Monitoring

Loss of Carrier

S register 10 specifies the amount of time (0 to 255 in tenth of a second increments) needed to recognize the loss of carrier. The default value of S register 10 is 14 (1.4 seconds).

Long Space Disconnect

The **Y** command allows the user to control the operation of long-space disconnect. When enabled, the modem will terminate the connection if it receives a break 1.6 seconds in length. The modem will send a break four seconds in length prior to any controlled disconnect.

Retrain

In V.32bis, V.32, or V.22bis, the modem may initiate a retrain (useful, for example, if a received signal parameter indicates unacceptable performance). **ATO1** will retrain the remote modem and then return to DATA mode.

Error Control

At data speeds above 1200 bits/s, the modem operates in full compliance with CCITT V.42, the international standard for point-to-point modem error control. Link access procedure for modems, more commonly referred to as LAPM, is the primary protocol, and annex A, the alternate protocol, provides backward compatibility with *MNP* (Microcom Network Protocol) classes 2 through 4. *MNP* and V.42 selections are performed via the **\N** commands. *MNP* or V.42 negotiation, if enabled, is automatic when a call is placed or received. The communicating modems will arrive at the highest class of *MNP* supported by both before data transmission begins.

Data Compression

The AT&T LapTop Complete Modem Chip Set supports CCITT V.42bis, the international standard for data compression which provides compression capabilities up to 4:1, for use by modems incorporating the V.42 LAPM error control standard. *MNP* class 5 provides capabilities up to 2:1 compression. *MNP* 5 or V.42bis, depending upon the line protocol, is selected with the %C command. The **%C1** command enables data compression (V.42bis in LAPM, *MNP*5 in *MNP*).

Programmable Inactivity Timer

The inactivity timer is the length of time the modem will wait before disconnecting when no data is sent or received. This timer is set using the **\Tn** command. It is programmable between 0 and 90 minutes. The timer is disabled by default (\T=0).

User Information (continued)

Modem Testing

The following tests are available for testing the local modem and for testing a remote modem.

Analog Loopback Tests

These tests verify the operation of a local modem without use of a telephone line or a remote modem.

Local Analog Loopback

AT&T1 and AT&T2. These tests take characters from the local terminal and send them through the modem transmitter to the modem receiver, where they are echoed back to the terminal. The two tests are identical, except that AT&T1 tests the low-frequency channel of the modem and AT&T2 tests the high-frequency channel. Start the test with **AT&T1** or **AT&T2**. Type a few lines and see if what is typed comes back correctly. Return to COMMAND mode via the escape sequence. Issue the **AT&T0** command to stop the test.

Local Analog Loopback with Self-Test

AT&T8. Set the test timer to a number of seconds (1—255) to run the test. Start the test with **AT&T8**. The modem will generate a test message to its own receiver and verify its reception. At the end of the test, a number between 0 and 255 will be displayed indicating the number of errors during the test.

Digital Loopback Tests

These tests verify a local or remote modem's operation. By default, the modem will allow loopback tests ordered by a remote modem. This feature can be enabled and disabled by the user. The **AT&T5** command will cause the modem to deny remote digital loopback (RDL) requests from the remote modem. The **AT&T4** command will cause the modem to grant RDL requests from the remote modem.

Remote Digital Loopback

AT&T6. This test commands the remote modem to send back all of the data it receives. Initiate a connection with the remote modem, and then enter COMMAND mode and issue the **AT&T6** command. The data typed should echo back without error. Enter COMMAND mode and issue the **AT&T0** command to end the test.

Remote Digital Loopback with Self-Test

AT&T7. Set the test timer to a number of seconds (1—255) to run the test. Establish a connection with the remote modem, and start the test with **AT&T7**. The local modem will generate a test message and send it to the remote modem. The remote modem will send back the data it receives. The local modem will verify its reception. At the end of the test, a number between 0 and 255 is displayed indicating the numbers of errors during the test.

Local Digital Loopback

AT&T3. This test causes the local modem to send back everything it receives from the remote modem. Establish a connection with the remote modem, and then enter COMMAND mode and issue the **AT&T3** command. The operator at the remote modem should type some data and verify that it comes back properly. Enter COMMAND mode and issue **AT&T0** to end the test.

User Information (continued)

Power Switching

When the modem is on-hook and not processing a command or when the modem receives the AT\OFF command, it will enter the SLEEP mode after 3 seconds. In this mode, the power consumption is approximately 4 mW (using LMPM). From SLEEP mode, ring indicator or any data from the computer will cause the modem to enter the IDLE state. This transition is transparent to the user. In the IDLE state, the power consumption is approximately 29 mW. When the modem is off-hook or in TEST mode, the power consumption of the LapTop Complete Modem chip set is approximately 605 mW.

Autosync Operation

AT&Q4 selects *Autosync* mode. In this mode, the modem translates the asynchronous data from the computer port to BISYNC or SDLC (HDLC) NRZ on the communications link. NRZI is not supported. Software in the computer must be able to control the modem in this mode. Three S registers are used in *Autosync* mode:

- S register 19 — bit mapped protocol S register:

Bit	Use
1	0 = BISYNC, 1 = SDLC
2	1 = SDLC Address Detect On
4	0 = SDLC idle MARK, 1 = SDLC idle FLAG

- S register 20 in BISYNC mode contains the SYNC character. In SDLC mode, it contains the ADDRESS character if address detect is on.
- S register 25 contains the time in seconds that the modem will wait for DTR to come true after a connection has been made. This allows time for the computer to switch from async to *Autosync* mode.

Rate Negotiation (V.32bis and V.32 Modes Only)

Initial Rate Negotiation. The answering modem will negotiate the highest possible transmission rate based on line quality during the initial connection.

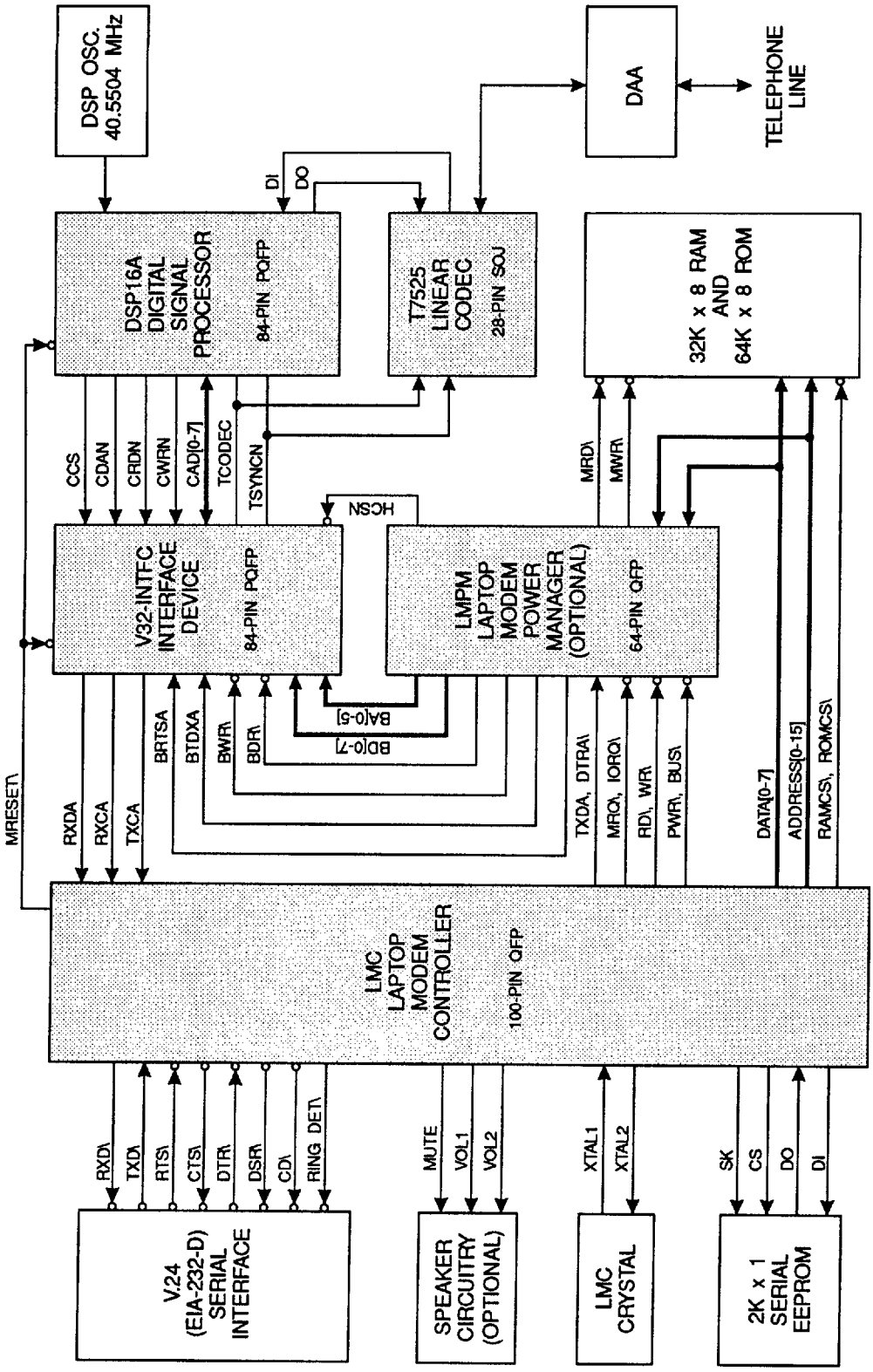
Automatic Fall-Back and Fall-Forward. The modem will fall back to a lower speed if line conditions deteriorate and fall forward to a higher speed if line conditions improve. The speed change is done with a fast rate change in V.32bis mode and with a retrain in V.32 mode. The command AT\Rn is used to disable or enable this feature (see \Rn command description on page 36).

Manual Rate Change. The connection speed can be changed while on-line in V.32 and V.32bis modes by using the command ATOn (see On command description on page 32).

Hardware Interface

The AT&T LapTop Complete Modem chip set hardware interface signals for the serial and parallel interfaces are shown in Figures 2 and 3, respectively.

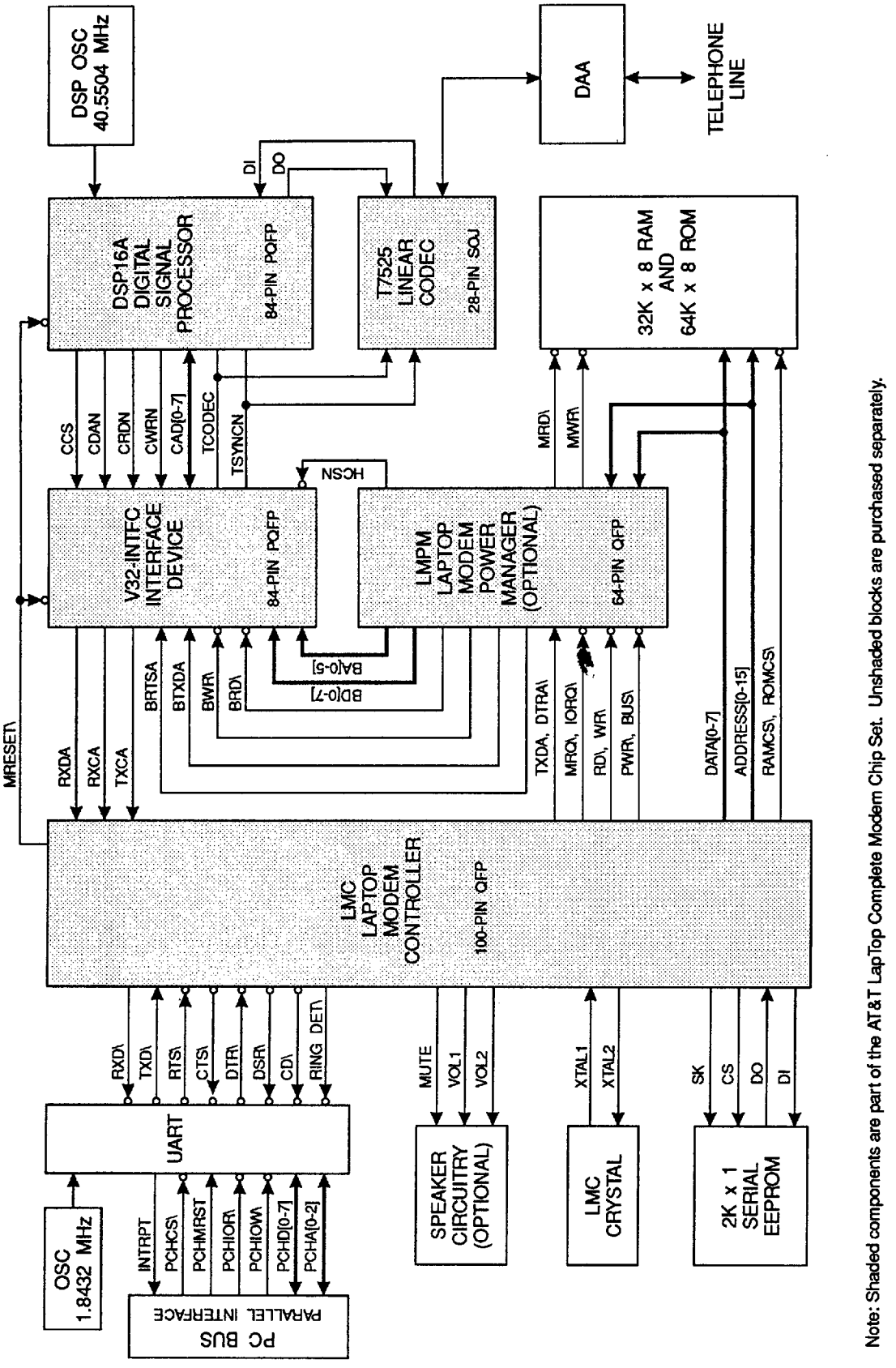
Hardware Interface (continued)



Note: Shaded components are part of the AT&T LapTop Complete Modem Chip Set. Unshaded blocks are purchased separately.

Figure 2. AT&T LapTop Complete Modem Interface Signals -- Serial Interface

Hardware Interface (continued)



Note: Shaded components are part of the AT&T LapTop Complete Modem Chip Set. Unshaded blocks are purchased separately.

Figure 3. AT&T LapTop Complete Modem Interface Signals -- Parallel Interface

Hardware Interface (continued)

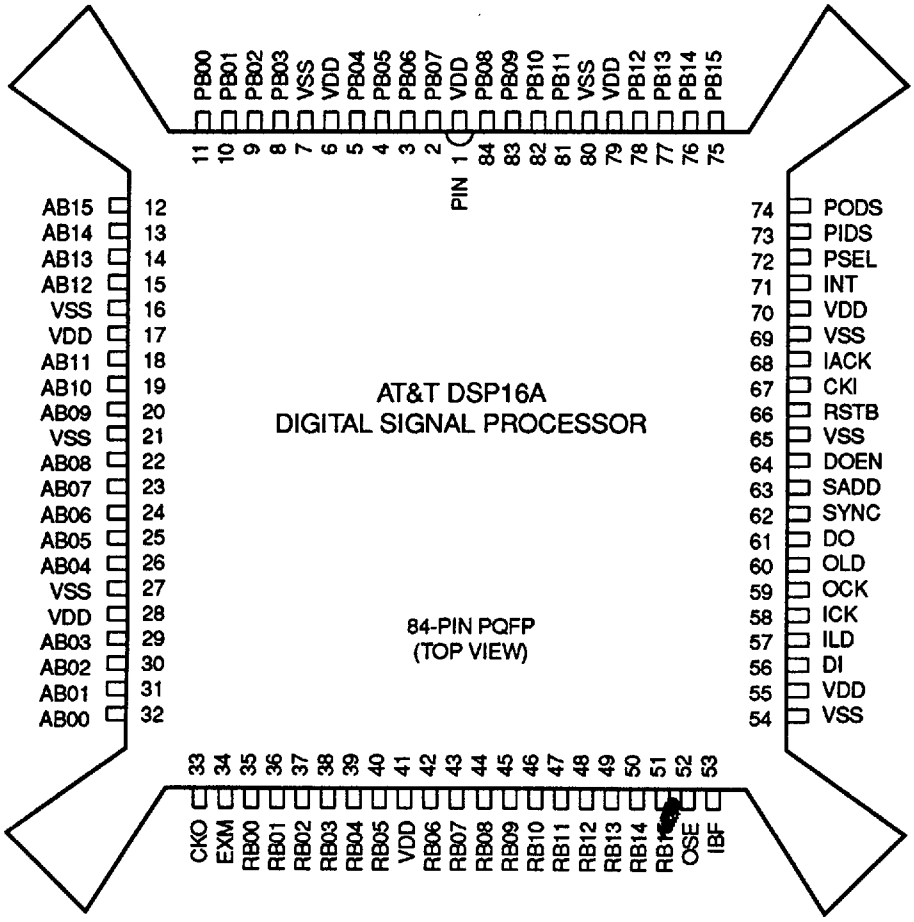


Figure 4. DSP16A Pin Locations

Hardware Interface (continued)

Table 7. DSP16A Signals

In the following table, I = input, O = output, and P = power.

Pin	Name	I/O	Pin	Name	I/O	Pin	Name	I/O
1	VDD	P	29	AB03	O	57	ILD	I/O
2	PB07	I/O	30	AB02	O	58	ICK	I/O
3	PB06	I/O	31	AB01	O	59	OCK	I/O
4	PB05	I/O	32	AB00	O	60	OLD	I/O
5	PB04	I/O	33	CK0	O	61	DO	O
6	VDD	P	34	EXM	I	62	SYNC	I/O
7	VSS	P	35	RB00	I	63	SADD	I/O
8	PB03	I/O	36	RB01	I	64	DOEN	I/O
9	PB02	I/O	37	RB02	I	65	VSS	P
10	PB01	I/O	38	RB03	I	66	RSTB	I
11	PB00	I/O	39	RB04	I	67	CKI	I
12	AB15	O	40	RB05	I	68	IACK	O
13	AB14	O	41	VDD	P	69	VSS	P
14	AB13	O	42	RB06	I	70	VDD	P
15	AB12	O	43	RB07	I	71	INT	I
16	VSS	P	44	RB08	I	72	PSEL	O
17	VDD	P	45	RB09	I	73	PIDS	I/O
18	AB11	O	46	RB10	I	74	PODS	I/O
19	AB10	O	47	RB11	I	75	PB15	I/O
20	AB09	O	48	RB12	I	76	PB14	I/O
21	VSS	P	49	RB13	I	77	PB13	I/O
22	AB08	O	50	RB14	I	78	PB12	I/O
23	AB07	O	51	RB15	I	79	VDD	P
24	AB06	O	52	OSE	O	80	VSS	P
25	AB05	O	53	IBF	O	81	PB11	I/O
26	AB04	O	54	VSS	P	82	PB10	I/O
27	VSS	P	55	VDD	P	83	PB09	I/O
28	VDD	P	56	DI	I	84	PB08	I/O

Note: AT&T PQFP package conforms to JEDEC standard for 84-pin device.

Hardware Interface (continued)

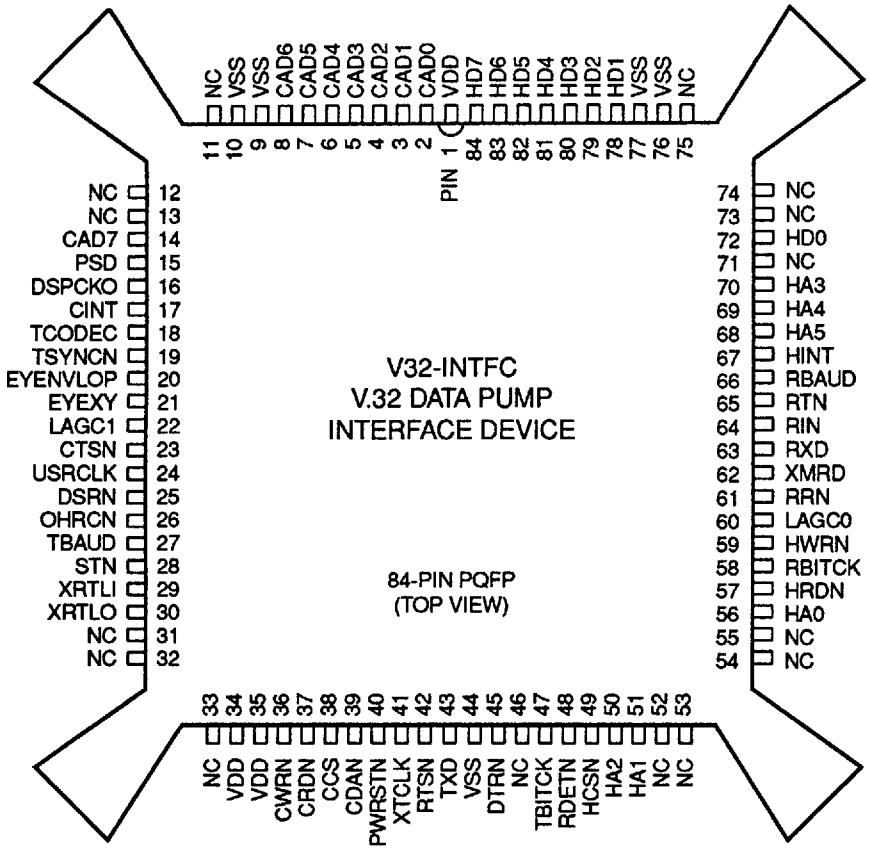


Figure 5. V32-INTFC Pin Locations

Hardware Interface (continued)

Table 8. V32-INTFC Signals

In the following table, I = input, O = output, and P = power.

Pin	Name	I/O	Pin	Name	I/O	Pin	Name	I/O
1	VDD	P	29	XRTLI	I	57	HRDN	I
2	CAD0	I/O	30	XRTLO	O	58	RBITCK	O
3	CAD1	I/O	31	NC	—	59	HWRN	I
4	CAD2	I/O	32	NC	—	60	LAGC0	O
5	CAD3	I/O	33	NC	—	61	RRN	O
6	CAD4	I/O	34	VDD	P	62	XMRD	O
7	CAD5	I/O	35	VDD	P	63	RXD	O
8	CAD6	I/O	36	CWRN	I	64	RIN	O
9	VSS	P	37	CRDN	I	65	RTN	O
10	VSS	P	38	CCS	I	66	RBAUD	O
11	NC	—	39	CDAN	I	67	HINT	O
12	NC	—	40	PWRSTN	I	68	HA5	I
13	NC	—	41	XTCLK	I	69	HA4	I
14	CAD7	I/O	42	RTSN	I	70	HA3	I
15	PSD	I	43	TXD	I	71	NC	—
16	DSPCK0	O	44	VSS	P	72	HD0	I/O
17	CINT	O	45	DTRN	I	73	NC	—
18	TCODEC	O	46	NC	—	74	NC	—
19	TSYNCN	I/O	47	TBITCK	O	75	NC	—
20	EYENVLOP	O	48	RDETN	I	76	VSS	P
21	EYEXY	O	49	HCSN	I	77	VSS	P
22	LAGC1	O	50	HA2	I	78	HD1	I/O
23	CTSN	O	51	HA1	I	79	HD2	I/O
24	USRCLK	O	52	NC	—	80	HD3	I/O
25	DSRN	O	53	NC	—	81	HD4	I/O
26	OHRCN	O	54	NC	—	82	HD5	I/O
27	TBAUD	O	55	NC	—	83	HD6	I/O
28	STN	O	56	HA0	I	84	HD7	I/O

Note: AT&T PQFP package conforms to JEDEC standard for 84-pin device.

Hardware Interface (continued)

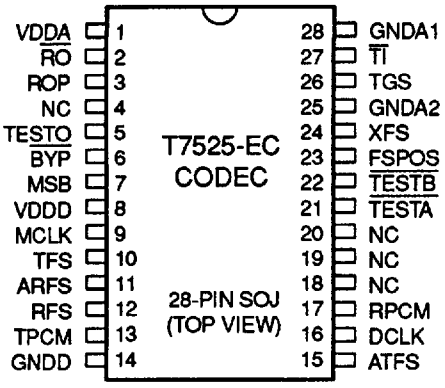


Figure 6. T7525 Pin Locations

Table 9. T7525 Codec Signals

In the following table, I = input, O = output, and P = power.

Pin	Name	I/O	Pin	Name	I/O
1	VDDA	P	15	ATFS	I
2	$\overline{RO}$	O	16	DCLK	I
3	ROP	O	17	RPCM	I
4	NC	—	18	NC	—
5	TESTO	O	19	NC	—
6	$\overline{BYP}$	I	20	NC	—
7	MSB	I	21	$\overline{TESTA}$	I
8	VDDD	P	22	$\overline{TESTB}$	I
9	MCLK	I	23	FSPOS	I
10	TFS	I	24	XFS	O
11	ARFS	I	25	GNDA1	P
12	RFS	I	26	TGS	O
13	TPCM	O	27	$\overline{TI}$	I
14	GNDD	P	28	GNDA2	P

Note: For pins marked NC (no connection), leave pin disconnected (open).

Hardware Interface (continued)

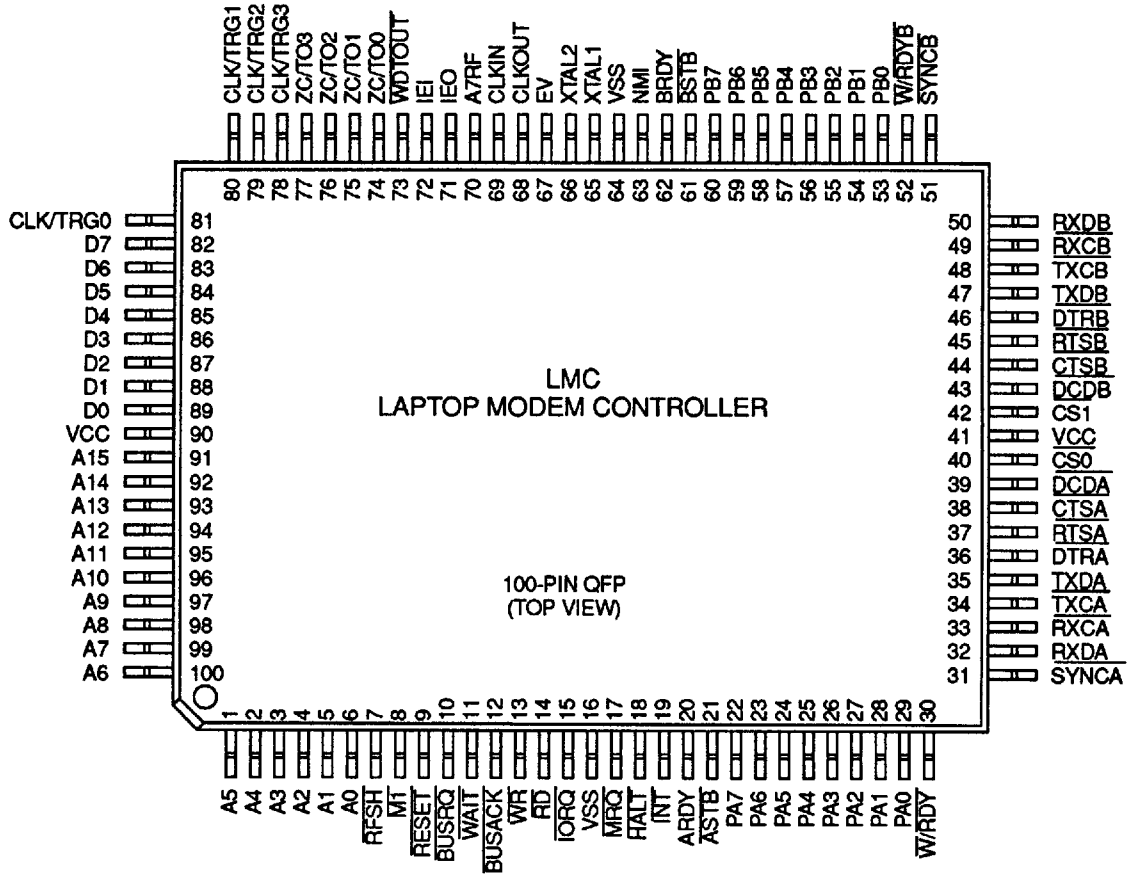


Figure 7. LMC Pin Locations

Hardware Interface (continued)

Table 10. LMC Signals

In the following table, I = input, O = output, P = power, 3 = 3-state, and D = open drain.

Pin	Name	I/O	Pin	Name	I/O	Pin	Name	I/O	Pin	Name	I/O
1	A5	I/O	26	PA3	I/O 3	51	$\overline{\text{SYNCB}}$	I/O	76	ZC/TO2	I/O
2	A4	I/O	27	PA2	I/O 3	52	$\overline{\text{W / RDYB}}$	O	77	ZC/TO3	I/O
3	A3	I/O	28	PA1	I/O 3	53	PB0	I/O 3	78	CLK/TRG3	I
4	A2	I/O	29	PA0	I/O 3	54	PB1	I/O 3	79	CLK/TRG2	I
5	A1	I/O	30	$\overline{\text{W}}$ / $\overline{\text{RDYA}}$	O	55	PB2	I/O 3	80	CLK/TRG1	I
6	A0	I/O	31	$\overline{\text{SYNCA}}$	I/O	56	PB3	I/O 3	81	CLK/TRG0	I
7	$\overline{\text{RFSH}}$	O 3	32	RXDA	I	57	PB4	I/O 3	82	D7	I/O
8	$\overline{\text{M1}}$	I/O	33	$\overline{\text{RXCA}}$	I	58	PB5	I/O 3	83	D6	I/O
9	$\overline{\text{RESET}}$	D	34	$\overline{\text{TXCA}}$	I	59	PB6	I/O 3	84	D5	I/O
10	$\overline{\text{BUSRQ}}$	I	35	TXDA	O	60	PB7	I/O 3	85	D4	I/O
11	$\overline{\text{WAIT}}$	I/O	36	$\overline{\text{DTRA}}$	O	61	$\overline{\text{BSTB}}$	I	86	D3	I/O
12	$\overline{\text{BUSACK}}$	O 3	37	$\overline{\text{RTSA}}$	O	62	BRDY	O	87	D2	I/O
13	$\overline{\text{WR}}$	I/O	38	$\overline{\text{CTSA}}$	I	63	NMI	I	88	D1	I/O
14	$\overline{\text{RD}}$	I/O	39	$\overline{\text{DCDA}}$	I	64	VSS	P	89	D0	I/O
15	$\overline{\text{IORQ}}$	I/O	40	$\overline{\text{CS0}}$	O	65	XTAL1	I	90	VCC	P
16	VSS	P	41	VCC	P	66	XTAL2	O	91	A15	I/O
17	$\overline{\text{MRQ}}$	I/O 3	42	$\overline{\text{CS1}}$	O	67	EV	I	92	A14	I/O
18	$\overline{\text{HALT}}$	O 3	43	$\overline{\text{DCDB}}$	I	68	CLKOUT	O	93	A13	I/O
19	$\overline{\text{INT}}$	D	44	$\overline{\text{CTSB}}$	I	69	CLKIN	I	94	A12	I/O
20	ARDY	O	45	$\overline{\text{RTSB}}$	O	70	A7RF	O	95	A11	I/O
21	$\overline{\text{ASTB}}$	I	46	$\overline{\text{DTRB}}$	O	71	IEO	O	96	A10	I/O
22	PA7	I/O 3	47	TXDB	O	72	IEI	I	97	A9	I/O
23	PA6	I/O 3	48	$\overline{\text{TXCB}}$	I	73	$\overline{\text{WDTOUT}}$	D	98	A8	I/O
24	PA5	I/O 3	49	$\overline{\text{RXCB}}$	I	74	ZC/TO0	I/O	99	A7	I/O
25	PA4	I/O 3	50	RXDB	I	75	ZC/TO1	I/O	100	A6	I/O

Hardware Interface (continued)

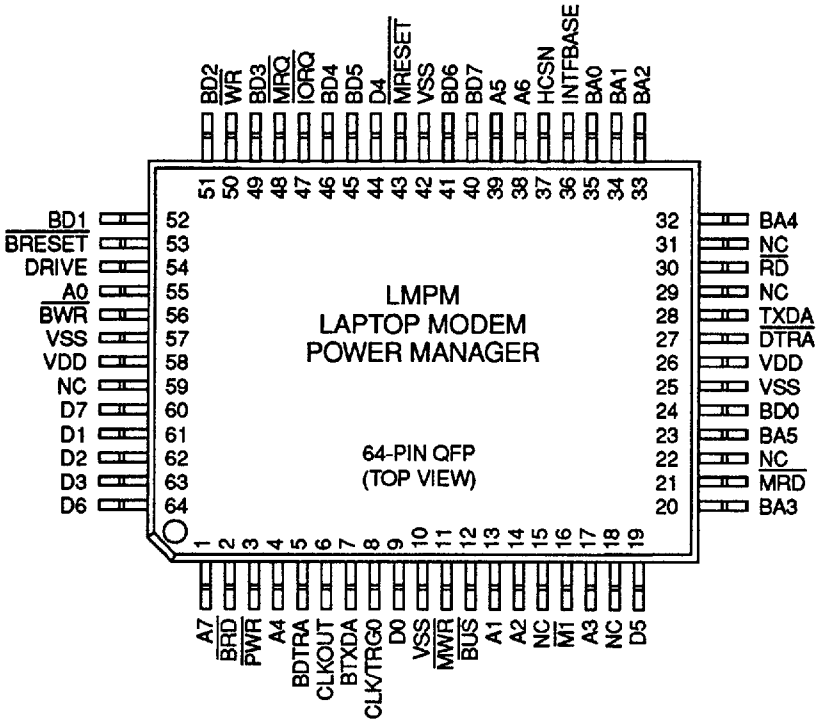


Figure 8. LMPM Pin Locations

Table 11. LMPM Signals

In the following table, I = input, O = output, and P = power.

Pin	Name	I/O	Pin	Name	I/O	Pin	Name	I/O	Pin	Name	I/O
1	A7	I	17	A3	I	33	BA2	O	49	BD3	I/O
2	$\overline{\text{BRD}}$	O	18	NC	—	34	BA1	O	50	$\overline{\text{WR}}$	I
3	$\overline{\text{PWR}}$	I	19	D5	I/O	35	BA0	O	51	BD2	I/O
4	A4	I	20	BA3	O	36	INTFBASE	I	52	BD1	I/O
5	BDTRA	O	21	$\overline{\text{MRD}}$	O	37	HCSN	O	53	$\overline{\text{BRESET}}$	O
6	CLKOUT	I	22	NC	—	38	A6	I	54	DRIVE	O
7	BTXDA	O	23	BA5	O	39	A5	I	55	A0	I
8	CLK/TRG0	O	24	BD0	I/O	40	BD7	I/O	56	$\overline{\text{BWR}}$	O
9	D0	I/O	25	VSS	P	41	BD6	I/O	57	VSS	P
10	VSS	P	26	VDD	P	42	VSS	P	58	VDD	P
11	$\overline{\text{MWR}}$	O	27	$\overline{\text{DTRA}}$	I	43	$\overline{\text{MRESET}}$	I	59	NC	—
12	$\overline{\text{BUS}}$	I	28	TXDA	I	44	D4	I/O	60	D7	I/O
13	A1	I	29	NC	—	45	BD5	I/O	61	D1	I/O
14	A2	I	30	$\overline{\text{RD}}$	I	46	BD4	I/O	62	D2	I/O
15	NC	—	31	NC	—	47	$\overline{\text{IORQ}}$	I	63	D3	I/O
16	$\overline{\text{M1}}$	I	32	BA4	O	48	$\overline{\text{MRQ}}$	I	64	D6	I/O

Hardware Interface (continued)

Table 12. V.24/RS232C Interface Pins

Symbol	Type	Name/Description
RXD\	O	**Receive Data (Active-Low EIA).** This output is for digital data to the DTE that was received from the analog telephone line.
TXD\	I	**Transmitted Data (Active-Low EIA).** This input is for digital data from the DTE to be transmitted over the analog telephone line.
RTS\	I	**Request to Send (Active-Low EIA).** This input is generated by the DTE and represents request to send to the modem.
CTS\	O	**Clear to Send (Active-Low EIA).** This output to the DTE indicates the modem is clear to send data.
DTR\	I	**Data Terminal Ready (Active-Low EIA).** This input indicates to the modem that the DTE is ready.
DSR\	O	**Data Set Ready (Active-Low EIA).** This output indicates to the DTE that the modem is ready.
CD\	O	**Carrier Detect (Active-Low EIA).** This output indicates the modem has detected carrier.
RING DET\	O	**Ring Detect (Active-Low EIA).** This output indicates the modem has detected a ring signal.

Table 13. Line Interface Pins

Symbol	Type	Name/Description
RON	O	**Receive Output (Negative).** Inverting output of the power amplifier.
ROP	O	**Receive Output (Positive).** Noninverting output of the power amplifier.
TIN	I	**Transmit Input (Negative).** Inverting analog input to the input operational amplifier.
TGS	O	**Transmit Gain Setting.** Output terminal of the input operational amplifier; should be connected to external gain control network of resistors.

Table 14. Speaker Interface

Symbol	Type	Name/Description
MUTE	O	**Speaker Mute.** This output turns the speaker off.
VOL1, VOL2	O	**Volume Control 1 & 2.** These outputs control the speaker volume as follows: **VOL1 VOL2** Lowest Low Low Low Low High Medium High Low High High High

Hardware Interface (continued)

Table 15. Memory Bus Interface

Symbol	Type	Name/Description
A0—A15	I/O	**Address Bus Lines 0—15.** Specifies I/O and memory addresses to be accessed.
D0—D7	I/O	**Data Bus Lines 0—7.** When the on-chip CPU is accessing on-chip peripherals, these lines are set to output and hold the data to/from on-chip peripherals.
RAMCS\	O	**RAM Chip Select (Active Low).** A low on this output selects the 32K x 8 static RAM.
ROMCS\	O	**ROM Chip Select (Active Low).** A low on this output selects the 64K x 8 ROM.
MRQ\	O	**Memory Request (Active Low).** A low on this output selects the memory.
RD\	O	**Memory Read (Active Low).** A low on this output enables data to be transferred from the address and data lines to the LMC.
WR\	O	**Memory Write (Active Low).** A low on this output enables data to be transferred from the LMC to the address and data lines.

Table 16. NVRAM Interface

Symbol	Type	Name/Description
SK	O	**Serial Data Clock.** This output is used to shift data to or from a serial EEPROM.
CS	O	**EEPROM Chip Select.** A high on this output selects the EEPROM.
DI	I	**Serial Data Output.** This serial output is used to write data into a serial EEPROM.
DO	I	**Serial Data Input.** This serial input is used to read data from a serial EEPROM.

Table 17. Miscellaneous Pins

Symbol	Type	Name/Description
XTAL1	I	**LMC Crystal Input.** Crystal connection. This input requires a 9.8304 MHz crystal.
XTAL2	O	**LMC Crystal Output.** Crystal output.
XRTLI	I	**Data Pump Oscillator Input.** This input requires a 40.5504 MHz crystal oscillator.

Electrical Characteristics

The electrical characteristics in this data sheet are preliminary and are subject to change.

Electrical characteristics are presented here for the data pump (DSP16A, V32-INTFC, and T7525), the LapTop modem controller (LMC), and the LapTop modem power manager (LMPM). Additional information regarding the DSP16A device and the T7525 Codec is available in their respective data sheets.

Data Pump Electrical Characteristics

These parameters are valid for the following conditions: T_A = 0 °C to 70 °C, V_{DD} = 5 V ± 5%, V_{SS} = GND = GND_A = 0 V.

Parameter	Symbol	Min	Max	Unit
Input Voltage, CMOS inputs:				
Low	V_{IL}	—	0.75	V
High	V_{IH}	V_{DD} – 0.75	—	V
Input Voltage, Schmitt Trigger* (V32-INTFC pins: RDET, RTSN):				
Low	V_{ILC}	—	0.5	V
High	V_{IHC}	V_{DD} – 0.5	—	V
Output Low Voltage	V_{OL}	—	0.5	V
Output Low Current				
All pins except those noted below:	I_{OL}	3	—	mA
DSPCKO/POP1, PIP0/POP0, C16XCLK, TCODEC, TSYNCN:	I_{OL}	11	—	mA
OHRCN:	I_{OL}	18	—	mA
OHRCN (@ V_{OL} = 0.4 V):	I_{OLT}	24	—	mA
Output High Voltage	V_{OH}	V_{DD} – 0.5	—	V
Output High Current				
All pins except those noted below:	I_{OH}	—	–3	mA
DSPCKO/POP1, PIP0/POP0, C16XCLK, TCODEC, TSYNCN:	I_{OH}	—	–11	mA
OHRCN:	I_{OH}	—	–11	mA
OHRCN (@ V_{OH} = 2.4 V):	I_{OHT}	—	–24	mA
Input Leakage (No Pullup):				
Low (V_{IL} = 0.0 V)	I_{IL}	–5	—	µA
High (V_{IH} = V_{DDMAX})	I_{IH}	—	5	µA
Input Loading (50 KΩ Pullup):				
Low (V_{IL} = 0.0 V)	I_{LL}	–110	—	µA
High (V_{IH} = V_{DDMAX})	I_{LH}	—	5	µA
Output Hi-Z Current:				
Low (V_{OL} = 0.0V)	I_{OZL}	–10	—	µA
High ($V_{APPLIED}$ = V_{DDMAX})	I_{OZH}	—	10	µA
Input Capacitance	C_{IN}	—	6	pF
IOput Capacitance	C_{IO}	—	10	pF

* Schmitt Trigger has a maximum of 1.8 V hysteresis at 5 Volts.

Electrical Characteristics (continued)

Absolute Maximum Ratings

Stresses in excess of the Absolute Maximum Ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to Absolute Maximum Ratings for extended periods can adversely affect device reliability.

Voltage Range on Any Pin with Respect to Ground ..... –0.3 to V_{DD} + 0.3 V
Ambient Temperature Range ..... 0°C to +70 °C
Storage Temperature Range ..... –40 °C to +125 °C

LMC Device Electrical Characteristics

The following electrical characteristics apply to the LapTop modem controller device. These parameters are valid for the following conditions: T_A = 0 °C to 70 °C, V_{CC} = 5 V ± 5%, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Max	Unit
Clock Output Voltage:					
High	V_{OHC}	–2.0 mA	V_{CC} – 0.6	—	V
Low	V_{OLC}	+2.0 mA	—	0.4	V
Clock Input Voltage:					
High	V_{IHC}	—	V_{CC} – 0.6	—	V
Low	V_{ILC}	—	—	0.4	V
Input Voltage:					
High	V_{IH}	—	2.2	V_{CC}	V
Low	V_{IL}	—	–0.3	0.8	V
Output Voltage:					
Low *	V_{OL}	I_{LO} = 2.0 mA	—	0.4	V
High1 †	V_{OL1}	I_{OH} = 1.6 mA	2.4	—	V
High2 *	V_{OL1}	I_{OH} = –250 µA	V_{CC} – 0.8	—	V
Power Supply Current: (XTAL$_{IN}$ = 10 MHz)					
Active Mode	I_{CC1}	V_{CC} = 5 V V_{IH} = V_{CC} – 0.2 V	—	50	mA
STOP Mode, IDLE Mode	I_{CC2}	V_{CC} = 5 V	—	50	µA
	I_{CC3}	V_{CC} = 5 V V_{IH} = V_{CC} – 0.2 V	—	6	mA
Input Leakage Current †	I_{LI}	V_{IN} = 0.4 V to V_{CC}	–10	10	µA
SYNC Pin Leakage Current	$I_{L(sy)}$	V_{OUT} = 0.4 V to V_{CC}	–40	10	µA
3-state Output Leakage Current in Float ‡	I_{LO}	V_{OUT} = 0.4 V to V_{CC}	–10	10	µA
Darlington Drive Current: (Port B and CTC Zc/To)	I_{OHD}	V_{OH} = 1.5 V R_{EXT} = 390 Ω	–1.5	–5.0	mA

* A15—A0, D7—D0, /MREQ, /IORQ, /RD, and /WR, /HALT, /M1, and /BUSACK.
† All pins except XTALI, where I_{LI} = ±25 µA
‡ A15—A0, D7—D0, /MREQ, /IORQ, /RD, and /WR.

Electrical Characteristics (continued)

LMPM Device Electrical Characteristics

These parameters are valid for the following conditions: T_A = 0 °C to 70 °C, Vcc = 5 V ± 5%, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Max	Unit
Power Supply Current	I_{DDS}	Steady State *	0	100	µA
Output Voltage for Normal Output:					
High (I_{OL} = 3 mA)	V_{OH}	I_{OH} = –2 mA	4.0	V_{DD}	V
Low (I_{OL} = 3.2 mA)	V_{OL}	I_{OL} = 3.2 mA	Vss	0.4	V
Output Voltage for Driver Output:					
High (I_{OL} = 8 mA)	V_{OH}	I_{OH} = –2 mA	4.0	V_{DD}	V
Low (I_{OL} = 8 mA)	V_{OL}	I_{OL} = 8 mA	Vss	0.4	V
Output Voltage for Driver Output:					
High (I_{OL} = 12 mA)	V_{OH}	I_{OH} = –4 mA	4.0	V_{DD}	V
Low (I_{OL} = 12 mA)	V_{OL}	I_{OL} = 12 mA	Vss	0.4	V
Output Voltage for Driver Output:					
High (I_{OL} = 24 mA)	V_{OH}	I_{OH} = –8 mA	4.0	V_{DD}	V
Low (I_{OL} = 24 mA)	V_{OL}	I_{OL} = 24 mA †	Vss	0.5	V
Input Voltage for Normal Input:					
High	V_{IH}	—	2.2	—	V
Low	V_{IL}	—	—	0.8	V
Input Voltage for CMOS Input:					
High	V_{IH}	—	V_{DD} × 0.7	—	V
Low	V_{IL}	—	—	V_{DD} × 0.3	V
Input Pull-Up/Down Resistor	RP	V_{IH} = V_{DD}, V_{IL} = Vss	25	100	kΩ

* V_{IH} = V_{DD}, V_{IL} = Vss

† With certain restrictions on pin assignments.

AT Command Set Reference

In the following command descriptions, the default setting for profile 0 is shown in bold.

Command **Description**

A/ Repeat last command (not preceded by AT).

A Answer command.

Bn Communication standard option.
- 0: Selects CCITT V.22 mode when the modem is at 1200 bits/s, and CCITT V.21 when the modem is at 300 bits/s.
- **1: Selects Bell 212A when the modem is at 1200 bits/s, and Bell 103 when the modem is at 300 bits/s.**
- 2: Selects V.23 receive 1200 bits/s, transmit 75 bits/s.
- 3: Selects V.23 transmit 1200 bits/s, receive 75 bits/s.

Cn Carrier control option. (dummy command)
- 0: Returns ERROR.
- 1: Normal transmit carrier switching.

D Dial command.

Dial modifiers:

P	Pulse.
R	Originate call in answer mode.
S=n	n = 0—3, Dial stored telephone number.
T	Tone.
W	Wait for dial tone.
,	Pause.
!	Flash hook.
@	Wait for quiet answer.
;	Return to idle state.

En Off-line echo command.
- 0: Echo disabled.
- **1: Echo enabled.**

Fn On-line echo command. (dummy command)
- 0: Returns ERROR.
- 1: On-line echo disabled.

Hn Switchhook control.
- 0: Go on-hook.
- 1: Go off-hook.

In Identification/checksum option.
- 0: Report product code.
- 1: ROM checksum.
- 2: Returns OK.

Design Guide (continued)

Ln Speaker volume.
- 0: Lowest speaker volume.
- 1: Low speaker volume.
- **2: Medium speaker volume.**
- 3: High speaker volume.

Mn Speaker Control.
- 0: Speaker always off.
- **1: Speaker on until carrier present.**
- 2: Speaker always on.
- 3: Speaker off during dialing and on until carrier.

On Go on-line.
- 0: Returns modem to a previously established state.
- 1: Begins an equalizer retrain sequence, then returns to on-line state.
- 48: Go back on-line with a speed of 4800 bits/s (only in V.32bis and V.32 modes).
- 72: Go back on-line with a speed of 7200 bits/s (only in V.32bis and V.32 modes).
- 96: Go back on-line with a speed of 9600 bits/s (only in V.32bis and V.32 modes).
- 120: Go back on-line with a speed of 12000 bits/s (only in V.32bis and V.32 modes).
- 144: Go back on-line with a speed of 14400 bits/s (only in V.32bis and V.32 modes).

P Enable pulse dialing.

Qn Result code display option.
- **0: Result codes enabled.**
- 1: Result codes disabled.
- 2: Result codes enabled in ORIGINATE mode only.

Sn Selects an S register.
n = 0—27

Sn=x Write to an S register.
n = 0—27
x = 0—255

Sn? Read an S register.
n = 0—27

T Enable tone dialing.

Vn Result code form.
- 0: Numeric form.
- **1: Verbose form.**

Wn Select extended result code.
- 0: CONNECT result code reports DTE speed; extended result codes based on \Vn option.
- 1: CONNECT result code reports DTE speed; enables the CARRIER and PROTOCOL extended result codes.
- **2: CONNECT result code reports DCE speed; extended result codes based on \Vn option.**

Design Guide (continued)

Xn Result code set/call progress.
- 0: Result codes 0—4 enabled. Busy and dial tone detect disabled.
- 1: Result codes 0—5, 10 enabled. Busy and dial tone detect disabled.
- 2: Result codes 0—6, 10 enabled. Busy detect disabled and dial tone detect enabled.
- 3: Result codes 0—5, 7, 10 enabled. Busy detect enabled and dial tone detect disabled.
- **4: Result codes 0—7, 10 enabled. Busy and dial tone detect enabled.**

Yn Long-space disconnect.
- **0: Disable long-space disconnect.**
- 1: Enable long-space disconnect.

Zn Recall stored profile.
- 0: Reset and recall user profile 0.
- 1: Reset and recall user profile 1.

&Cn Data carrier detect option.
- **0: State of carrier from remote modem is ignored. RLSD is always on.**
- 1: State of carrier from remote modem is tracked. RLSD reflects state of the carrier.

&Dn Data terminal ready option.
- **0: DTR ignored.**
- 1: Go to command mode on on-to-off DTR transition.
- 2: Hang up and go to command mode on on-to-off DTR transition. Autoanswer is disabled if DTR is low.
- 3: Reset on on-to-off DTR transition.
- 4: Deliver all buffered data before disconnecting on on-to-off DTR transition.

&Fn Load factory settings.
- 0: Recall factory settings as active configuration.
- 1: Recall second factory settings.

&Gn Guard tone option.
- **0: No guard tones.**
- 1: 550 Hz guard tone.
- 2: 1800 Hz guard tone.

&Jn Auxiliary relay control. (dummy command)
- 0: Returns ERROR.
- 1: Returns OK.

&Mn Asynchronous mode.

	On-Line State	Idle State
0:	Asynch	Normal

&Pn Dial pulse ratio.
- **0: Make = 39%, Break = 61% for use in the United States.**
- 1: Make = 33%, Break = 67% for use in certain other countries.

&Qn Communications mode option.
- **0: Asynchronous mode.**
- 1: Reserved.
- 2: Reserved.
- 3: Reserved.
- 4: *Autosync* mode.

Design Guide (continued)

&Rn CTS/RTS option (non-CTS flow control mode).
- **0, 1: CTS always true.**
- 2: CTS follows RTS.
- 3: CTS follows CCITT.

&Sn Data set ready option.
- **0: DSR circuit always on.**
- 1: DSR circuit on during handshaking and while connected. Off in test and idle mode, or when carrier is lost.

&Tn Self-test commands.
- 0: Terminate test.
- 1: Local analog loopback (transmit and receive in low channel).
- 2: Local analog loopback (transmit and receive in high channel).
- 3: Local activated remote digital loopback.
- **4: Grant request from remote for RDL.**
- 5: Deny request from remote for RDL test.
- 6: Remote digital loopback test.
- 7: Remote digital loopback with self-test.
- 8: Local analog loopback with self-test.

&V View active configuration and stored profile.

&Wn Store active profile.
- 0: Save active configuration as user profile 0.
- 1: Save active configuration as user profile 1.

&Yn Select stored profile on powerup.
- **0: Recall user profile 0 on powerup.**
- 1: Recall user profile 1 on powerup.

&Zn=x Store telephone number.
x = 0—9, A, B, C, D, #, *, T, P, R, W, @, comma, !, ;
n = 0—3

\An Block size.
- 0: Set maximum block size = 64 characters.
- 1: Set maximum block size = 128 characters.
- 2: Set maximum block size = 192 characters.
- **3: Set maximum block size = 256 characters.**

\Bn Transmit break.
0—9: BREAK length in 100 ms.
Default: 0 (BREAK of 300 ms is transmitted.)

\Cn Set autoreliable buffer.
- **0: Does not buffer.**
- 1: Buffers data on answering modem for 4 seconds, until 200 characters have been buffered, and then switches to normal mode and the buffered characters are passed to the serial port. If a SYN character is detected, reliable mode is attempted.
- 2: Does not buffer data on answering modem. Switches to normal mode upon receipt of autoreliable character and passes it to the serial port.

Design Guide (continued)

\Gn Set modem port flow control.
- **0: Disable port flow control.**
- 1: Enable port XON/XOFF flow control.

\Hn HP ENQ/ACK protocol.
- **0: Disable HP ENQ/ACK protocol.**
- 1: Enable HP ENQ/ACK emulating terminal.
- 2: Enable HP ENQ/ACK emulating host.

\Jn Bits/s rate adjust.
- 0: Disable port rate adjust. Serial port is independent of the connection.
- **1: Enable port rate adjust. After a connection is made, the serial port adjusts to the rate of the connection.**

\Kn Set break control.
- 0: BREAK from DTE = enter command mode, do not TX BREAK
  BREAK command = purge buffers and TX BREAK
  BREAK from remote = purge buffers, relay BREAK to DTE
- 1: BREAK from DTE = purge buffers, TX BREAK
  BREAK command = purge buffers and TX BREAK
  BREAK from remote = purge buffers, relay BREAK to DTE
- 2: BREAK from DTE = enter command mode, do not TX BREAK
  BREAK command = TX BREAK immediately
  BREAK from remote = relay BREAK to DTE immediately
- 3: BREAK from DTE = TX BREAK immediately
  BREAK command = TX BREAK immediately
  BREAK from remote = relay BREAK to port immediately
- 4: BREAK from DTE = enter command state, do not TX BREAK
  BREAK command = TX BREAK in sequence with data
  BREAK from remote = relay BREAK to DTE in sequence with data
- **5: BREAK from DTE = TX BREAK in sequence with data**
  BREAK command = TX BREAK in sequence with data
  BREAK from remote = relay BREAK to DTE in sequence with data

\Nn Set operating mode.
- **0: Normal mode.**
- 1: Normal mode.
- 2: Set reliable mode (*MNP* only).
- 3: Set autoreliable mode (*MNP* only).
- 4: Set reliable mode (LAPM only).
- 5: Set autoreliable mode (LAPM only).
- 6: Set reliable mode (LAPM with fall-back to *MNP*).
- 7: Set autoreliable mode (LAPM with fall-back to *MNP*).

\Qn Set serial port flow control.
- **0: Disable flow control.**
- 1: Enable bidirectional XON/XOFF flow control.
- 2: Enable unidirectional hardware flow control.
- 3: Enable bidirectional hardware flow control.
- 4: Enable unidirectional XON/XOFF flow control.
- 5: Enable unidirectional hardware flow control with CTS off until CONNECT.
- 6: Enable bidirectional hardware flow control with CTS off until CONNECT.

Design Guide (continued)

\Rn Automatic fall-back and fall-forward control.
- **0: Enabled.**
- 1: Disabled.

\Tn Set inactivity timer.
n = 0—90 Length in minutes.
Default: 000

\Vn Modify result code form.
- **0: Disable \REL connect codes.**
- 1: Enable \REL connect codes.
- 2: **–LAPM** and **–MNP** added to /REL connect codes.

\Xn Set XON/XOFF passthrough.
- **0: Process flow control characters.**
- 1: Process flow control characters and pass them through to the local or remote so they can process the characters.

\Z Switch to normal mode (*MNP* only).

%An Set autoreliable fall-back character.
n = 0—127 (ASCII character).
Default: 000

%Bn Modem port rate:
n = 300, 1200, 2400, 4800, 7200, 9600, 12000, 14400.
Default: 9600 (for V32F-V42L)
Default: 14400 (for V32FB-V42L)

%Cn Data compression.
- **0: No compression.**
- 1: Enable data compression (V.42bis in LAPM, *MNP* 5 in *MNP*).

%En Autoretrain.
- 0: Disable auto-retrain.
- **1: Enable auto-retrain.**

%Mn Minimum modem port rate:
n = 300, 1200, 2400, 4800, 7200, 9600, 12000, 14400.
Default: 300

%V Display firmware version.

Design Guide (continued)

+FCLASS? Service class indication.

+FCLASS=? Service class capabilities.

+FCLASS=1 Service class 1 selection.

+FTS=<n> Transmission silence. (n = 0—255; 10 ms intervals).

+FRS=<n> Receive silence. (n = 0—255; 10 ms intervals).

+FTM=<*m*> Transmit FAX data with <*m*> carrier. See Table 18, page 37, for values of *m*.

+FRM=<*m*> Receive FAX data with <*m*> carrier. See Table 18, page 37, for values of *m*.

+FTH=<*m*> Transmit HDLC data with <*m*> carrier. See Table 18, page 37, for values of *m*.

+FRH=<*m*> Receive HDLC data with <*m*> carrier. See Table 18, page 37, for values of *m*.

Table 18. Modulation/Speed Selection

m	Modulation	Speed
3	V.21 ch. 2	300
24	V.27ter	2400
48	V.27ter	4800
72	V.29	7200
96	V.29	9600
73	V.17	7200
74	V.17 (short train)	7200
97	V.17	9600
98	V.17 (short train)	9600
121	V.17	12000
122	V.17 (short train)	12000
145	V.17	14400
146	V.17 (short train)	14400

Design Guide (continued)

S Registers Reference

Reg	Description	Range	Default	Units
0	Ring to autoanswer on	0—255	000	rings
1	Ring count	0—255	000	rings
2	Escape character	0—255	043	ASCII
3	Carriage return character	0—127	013	ASCII
4	Line feed character	0—127	010	ASCII
5	Backspace character	0—127	008	ASCII
6	Wait before dialing	2—255	002	s
7	Wait for carrier	1—255	050	s
8	Pause time for comma dial modifier	0—255	002	s
9	Carrier recovery time	1—255	006	0.1 s
10	Lost carrier hang up delay	1—255	014	0.1 s
11	DTMF dialing speed	50—255	095	0.001 s
12	Guard time	0—255	050	0.02 s
14	Bit mapped options Bit 0 reserved Bit 1 0 E0 is selected 1 E1 is selected Bit 2 0 Q0 is selected 1 Q1 is selected Bit 3 0 V0 is selected 1 V1 is selected Bit 4 reserved Bit 5 0 T is selected 1 P is selected Bit 7 0 answer 1 originate	—	0AH	bits
16	Modem test options Bit 0 0 local ALB disabled 1 local ALB enabled (&T1) Bit 2 0 local DL disabled 1 local DL enabled (&T3) Bit 3 0 RDL off 1 RDL in progress (&T6) Bit 4 0 RDL not active 1 RDL request from distant end is in service Bit 5 0 RDL w/ self-test disabled 1 RDL w/ self-test enabled (&T7) Bit 6 0 ALB w/ self-test disabled 1 ALB w/ self-test enabled (&T8)	—	00H	bits

Design Guide (continued)

S Registers Reference (continued)

Reg	Description	Range	Default	Units
18	Modem test timer	0—255	000	s
19	*Autosync* protocol support mode Bit 1 0 Bisync 1 SDLC Bit 2 0 SDLC address detect off 1 SDLC address detect on Bit 4 0 SDLC idle MARK 1 SDLC idle FLAG	—	000	—
20	*Autosync* sync/address character	—	000	ASCII
21	Bit mapped options Bit 0 0 &J0 is selected 1 &J1 is selected Bit 2 0 &R0 is selected 1 &R1 is selected Bits 4, 3 00 &D0 is selected 01 &D1 is selected 10 &D2 is selected 11 &D3 is selected Bit 5 0 &C0 is selected 1 &C1 is selected Bit 6 0 &S0 is selected 1 &S1 is selected Bit 7 0 Y0 is selected 1 Y1 is selected	—	00H	bits
22	Bit mapped options Bits 1, 0 00 reserved 01 L1 is selected 10 L2 is selected 11 L3 is selected Bits 3, 2 00 M0 is selected 01 M1 is selected 10 M2 is selected 11 M3 is selected Bits 6, 5, 4 000 X0 is selected 001 reserved 010 reserved 011 reserved 100 X1 is selected 101 X2 is selected 110 X3 is selected 111 X4 is selected Bit 7 0 &P0 is selected 1 &P1 is selected	—	76H	bits

Design Guide (continued)

S Registers Reference (continued)

Reg	Description	Range	Dflt	Units
23	Bit mapped options Bit 0 0 &T5 is selected 1 &T4 is selected Bits 3, 2, 1 000 0—300 bits/s communications rate 001 1200 bits/s 010 2400 bits/s 011 4800 bits/s 100 7200 bits/s 101 9600 bits/s 110 19.2 Kbits/s 111 38.4 Kbits/s Bits 5, 4 00 even parity 01 space parity/no parity 10 odd parity 11 mark Bits 7, 6 00 &G0 is selected 01 &G1 is selected 10 &G2 is selected 11 reserved	—	1FH	—
25	Detect DTR change (on-line state) Detect DTR change	0—255 0—255	005 005	0.1 s s
26	RTS to CTS delay interval	0—255	001	0.01 s
27	Bit mapped options Bit 6 0 B0 is selected 1 B1 is selected	—	40H	bits

Design Guide (continued)

Result Codes

Numeric	Verbose	Description
0	OK	Command executed.
1	CONNECT	Connection at 0—300, 1200, 2400, 9600, or 19200 bits/s if X0 selected; otherwise, connection at 0—300 bits/s.
2	RING	Ring signal detected.
3	NO CARRIER	Carrier signal not detected or lost.
4	ERROR	Invalid command, checksum, error in command line, or command line too long.
5	CONNECT 1200	Connection at 1200 bits/s. Disabled by X0.
6	NO DIALTONE	No dial tone detected. Enabled by X2, X4, or W dial modifier.
7	BUSY	Busy detected. Enabled by X3 or X4.
8	NO ANSWER	No silence detected when dialing system not providing dial one. Enabled by @ dial modifier.
10	CONNECT 2400	Connection at 2400 bits/s.
11	CONNECT 4800	Connection at 4800 bits/s.
12	CONNECT 9600	Connection at 9600 bits/s.
14	CONNECT 19200	Connection at 19200 bits/s.
15	CONNECT 38400	Connection at 38400 bits/s.
16	CONNECT 1200/75	Connection at 1200 bits/s / 75 bits/s.
17	CONNECT 75/1200	Connection at 75 bits/s / 1200 bits/s.
18	CONNECT 57600	Connection at 57600 bits/s.
20	CONNECT/REL	Error protected connection at 300 bits/s. *
22	CONNECT 1200/REL	*MNP* or V.42 connection at 1200 bits/s. *
23	CONNECT 2400/REL	*MNP* or V.42 connection at 2400 bits/s. *
24	CONNECT 4800/REL	*MNP* or V.42 connection at 4800 bits/s. *
26	CONNECT 9600/REL	*MNP* or V.42 connection at 9600 bits/s. *
27	CONNECT 19200/REL	*MNP* or V.42 connection at 19200 bits/s. *
28	CONNECT 38400/REL	*MNP* or V.42 connection at 38400 bits/s. *
29	CONNECT 57600/REL	*MNP* or V.42 connection at 57600 bits/s. *
34	CONNECT 7200	Connection at 7200 bits/s.
35	CONNECT 12000	Connection at 12000 bits/s.
36	CONNECT 14400	Connection at 14400 bits/s.
37	CONNECT 7200/REL	*MNP* or V.42 connection at 7200 bits/s (V32FB-V42L only).*
38	CONNECT 12000/REL	*MNP* or V.42 connection at 12000 bits/s (V32FB-V42L only).*
39	CONNECT 14400/REL	*MNP* or V.42 connection at 14400 bits/s (V32FB-V42L only).*

*These codes are enabled by \V1 and ignored with W1.

Design Guide (continued)

Negotiation Progress Messages

(Displayed when W1 is set.)

Numeric	Verbose	Description
40	CARRIER 300	Carrier detected at 300 bits/s.
44	CARRIER 1200/75	V.23 carrier — TX 1200 bits/s, RX 75 bits/s.
45	CARRIER 75/1200	V.23 carrier — TX 75 bits/s, RX 1200 bits/s.
46	CARRIER 1200	Carrier detected at 1200 bits/s.
47	CARRIER 2400	Carrier detected at 2400 bits/s.
48	CARRIER 4800	Carrier detected at 4800 bits/s.
49	CARRIER 7200	Carrier detected at 7200 bits/s.
50	CARRIER 9600	Carrier detected at 9600 bits/s.
51	CARRIER 12000	Carrier detected at 12000 bits/s (V32FB-V342L only).
52	CARRIER 14400	Carrier detected at 14400 bits/s (V32FB-V342L only).
66	COMPRESSION:CLASS5	*MNP* compression negotiated.
67	COMPRESSION:V42BIS	V.42bis compression negotiated.
69	COMPRESSION:NONE	No compression negotiated.
70	PROTOCOL:NONE	Asynchronous mode.
77	PROTOCOL:LAP-M	V.42 LAPM.
80	PROTOCOL:ALT	Alternative protocol (*MNP* compatible).

Design Guide (continued)

Crystal/Oscillator Specifications

Table 19. LMC - Crystal Specifications

Parameter	LMC-10 (V32F-V42L)	LMC-16 (V32FB-V42L)
Frequency	9.830400 MHz	14.7456 MHz
Type of Crystal	Parallel Resonant	Parallel Resonant
Clock Accuracy	±100 ppm	±100 ppm
C_L, Load Capacitance	≅ 22 pF (20 — 30 pF acceptable)	≅ 22 pF (20 — 30 pF acceptable)
RS, Equivalent Series Resistance	≤150 Ω	≤150 Ω
Suggested Manufacturer	FOX	GED
Part Number	FOX #098-20-9.8304	GED #HC49S-147456

Table 20. Data Pump Oscillator Specification

Parameter	Value
Frequency	40.5504 MHz
Type	CMOS
Clock Stability and Tolerance	±50 ppm
Suggested Manufacturer	EPSON
Part Number	SG-615H-40.5504MC3

Table 21. UART Crystal Specification (Only Required for Parallel Interface)

Parameter	Value
Frequency	1.8432 MHz
Type	Parallel Resonant
Clock Accuracy	±100 ppm
Suggested Manufacturer	FOX
Part Number	FOX 018S-1.8432

Bill of Materials for LapTop Complete Modem Using LMPM Device

Note: It is not recommended that modifications be made to this parts list without prior consultation with the AT&T DSP Modem Marketing Group. Any substitutions to the parts list are made at the customer's risk.

Table 22. AT&T LapTop Complete Modem Chip Set (Sheets 1—2)

Item	Quantity	(Sheet #) Reference	Part
1	1	(1) U1	LapTop Modem Controller, LMC
2	1	(2) U6	V.32 Interface Device, AT&T V32-INTFC
3	1	(2) U7	Digital Signal Processor, AT&T DSP16A
4	1	(2) U8	Linear Codec, AT&T T7525
5	1	(1) U3	LapTop Modem Power Manager, LMPM

Design Guide (continued)

Table 23. Memory Devices (Sheet 1)

Item	Quantity	(Sheet #) Reference	Part
1	1	(1) U4	64K x 8 ROM 100 ns, AMD 28F512LC or equivalent ROM
2	1	(1) U5	32K x 8 SRAM 100 ns, MOSEL 55257
3	1	(1) U2	2K x 1bit serial EEPROM, EXEL 93C56J

Table 24. Crystal, Oscillator (Sheets 1—2)

Item	Quantity	(Sheet #) Reference	Part
1	1	(2) OSC1	Oscillator, 40.5504 MHz, 50 ppm
2	1	(1) Y1	Crystal, Parallel Resonant (See Table 19.)

Table 25. Capacitors, Resistors, Diodes, Transistors (Sheets 1—2)

Item	Quantity	(Sheet #) Reference	Part
1	21	(1)-C1B, C1A, C2, C3B, C3A, C4, C5, C36, C37, C38, C39; (2)-C68, C6A, C88, C8A, C42; (4) C11B, C11A, C12B, C12A, C13	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
2	2	(1)-C34, C35	Capacitor, 33 pF, 0805, 25 V, 5%, NPO
3	1	(1)-C40; (2)-C43	Capacitor, 10 µF/16 V, 6032, Tantalum
4	4	(2)-C7D, C7C, C7B, C7A	Capacitor, 0.047 µF, 0805, 25 V, 5%, NPO
5	1	(2)-C41	Capacitor, 18 pF, 0805, 25 V, 5%, NPO
6	2	(1)-D1, D2	Diode, 200 mA, 100 V, MOT #MMBD7000LT1
7	1	(1)-Q2	Power JFET N-channel, MOT #MTD5N05
8	1	(1)-Q3	NPN Transistor, MOT #MMBT2222ALT1
9	1	(1)-RP1	Resistor Pack, 20K, Resistor Network
10	2	(1)-R1, R4	Resistor, 20K, 0805, 5%, 0.1 W, Carbon
11	2	(1)-R2, R3	Resistor, 100K, 0805, 5%, 0.1 W, Carbon
12	1	(1)-R5	Resistor, 100, 0805, 5%, 0.1 W, Carbon
13	2	(2)-R6, R10	Resistor, 10, 2512, 5%, 1 W, Carbon
14	3	(2)-R7, R8, R9	Resistor, 2K, 0805, 5%, 0.1 W, Carbon
15	2	(2)-R11, R12	Resistor, 10K, 0805, 1%, 0.1 W, Metal-film

Design Guide (continued)

Table 26. Data Access Arrangement (Sheet 3)

Item	Quantity	(Sheet #) Reference	Part
1	1	(3) U9	Quad Opamp Line Driver, NS #LMC660AIM
2	1	(3) T1	V.32 Transformer, AT&T #2769A or #2770A
3	1	(3) SSR1	Solid-State Relay, AT&T #LH1516AAB
4	3	(3) C9, C44, C45	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
5	1	(3) C46	Capacitor, 4.7 nF, 0805, 50 V, 10%, X7R
6	3	(3) C47C, C47B, C47A	Cap, 3.3 µF, 1825, 50 V, 20%, nonpolar, Z5U
7	1	(3) C48	Capacitor, 0.47 µF, 1812, 50 V, 10%, X7R
8	1	(3) C49	Capacitor, 150 pF, 0805, 25 V, 5%, X7R
9	1	(3) C52	Capacitor, 0.47 µF, 2225, 250 V, 10%, X7R
10	1	(3) C56	Capacitor, 6.8 µF, T491, 10 V, 10%, Tantalum
11	2	(3) D4, D5	Diode, 3.9 VZ/225 mW, MOT #MMBZ5228BLT1
12	4	(3) D6, D7, D8, D9	1N4003, 800 mA/240 V, ROHM #RLR4003
13	1	(3) D10	Zener 36 V/225 mW, MOT #MMBZ5258BLT1
14	2	(3) D11, D12	Zener 24 V/225 mW, MOT #MMBZ5252BLT1
15	1	(3) D15	1N4148, LL34, 100 V/0.5 W, ROHM #RLS4148
16	3	(3) R13, R14, R27	Resistor, 10K, 0805, 1%, 0.1 W, Metal-film
17	2	(3) R15, R16	Resistor, 22.1K, 0805, 1%, 0.1 W, Metal-film
18	1	(3) R17	Resistor, 33.2K, 0805, 1%, 0.1 W, Metal-film
19	1	(3) R18	Resistor, 464, 1206, 1%, 1/8 W, Metal-film
20	1	(3) R19	Resistor, 17.8K, 0805, 1%, 0.1 W, Metal-film
21	2	(3) R20, R21	Resistor, 14.7K, 0805, 1%, 0.1 W, Metal-film
22	1	(3) R22	Resistor, 42.2K, 0805, 1%, 0.1 W, Metal-film
23	1	(3) R23	Resistor, 27.4K, 0805, 1%, 0.1 W, Metal-film
24	1	(3) R24	Resistor, 1K, 1206, 5%, 1/8 W, Carbon
25	2	(3) R26, R40	Resistor, 10, 2512, 5%, 1 W, Carbon
26	1	(3) R32	Resistor, 20K, 1210, 1%, 1/4 W, Metal-film
27	1	(3) R33	Resistor, 7.5K, 1210, 1%, 1/4 W, Metal-film
28	1	(3) R34	Resistor, 100K, 0805, 1%, 0.1 W, Metal-film
29	1	(3) R35	Resistor, 20.5K, 0805, 1%, 0.1 W, Metal-film
30	1	(3) R36	Resistor, 7.5K, 2512, 5%, 1 W, Carbon
31	1	(3) R39	Resistor, 18.7K, 0805, 1%, 0.1 W, Metal-film
32	1	(3) R41	Resistor, 40.2K, 0805, 1%, 0.1 W, Metal-film
33	1	(3) Z1	Opto-isolator, MOT 4N35
34	1	(3) Q6	Darlington Trans NPN, MOT #MMBT6427LT1
35	1	(3) MOV	MOV, 250—260 Vdc, 1.2 KA/300 Vdc, SIEMENS #CU4032K230G
36	1	(3) F1	Fuse, 250 mA/125 V, LITTELFUSE #R459.250
37	1	(3) CNT1	RJ-11 Phone Jack

Design Guide (continued)

Table 27. Speaker Circuitry (Schematic Sheet 3)

Item	Quantity	(Sheet #) Reference	Part
1	1	(3) LS1	Speaker, 0.4 W, 8 Ω, FUJI TS-30
2	1	(3) U10	Audio Power Amp, NS #LM386M-1
3	3	(3) C10, C50, C51	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
4	1	(3) C55	Capacitor, 220 µF, 10 V, 20%, Aluminum Electrolytic, ILLINOIS # 227RSS010M
5	1	(3) C69	Capacitor, 10 µF, Tantalum, 1810, 16 V
6	1	(3) C70	Capacitor, 10 nF, 0805, 25 V, 10%, X7R
7	1	(3) Q4	NPN Digital Transistor, ROHM, #DTC143XK
8	1	(3) R28	Resistor, 10K, 0805, 1%, 0.1 W, Metal-film
9	1	(3) R31	Resistor, 10, 0805, 5%, 0.1 W, Metal-film
10	1	(3) R29	Resistor, 390, 0805, 5%, 0.1 W, Carbon
11	1	(3) R30	Resistor, 1K, 0805, 1%, 0.1 W, Metal-film
12	1	(3) R56	Resistor, 750, 0805, 5%, 0.1 W, Metal-film

Table 28. Serial Interface (Sheet 4)

Item	Quantity	(Sheet #) Reference	Part
1	2	(4) U11, U12	Quad Line Driver, MOT #MC1488D
2	1	(4) U13	Quad Line Receivers, MOT #MC1489AD
3	1	(4) P1	Connector DB25, AMP

Design Guide (continued)

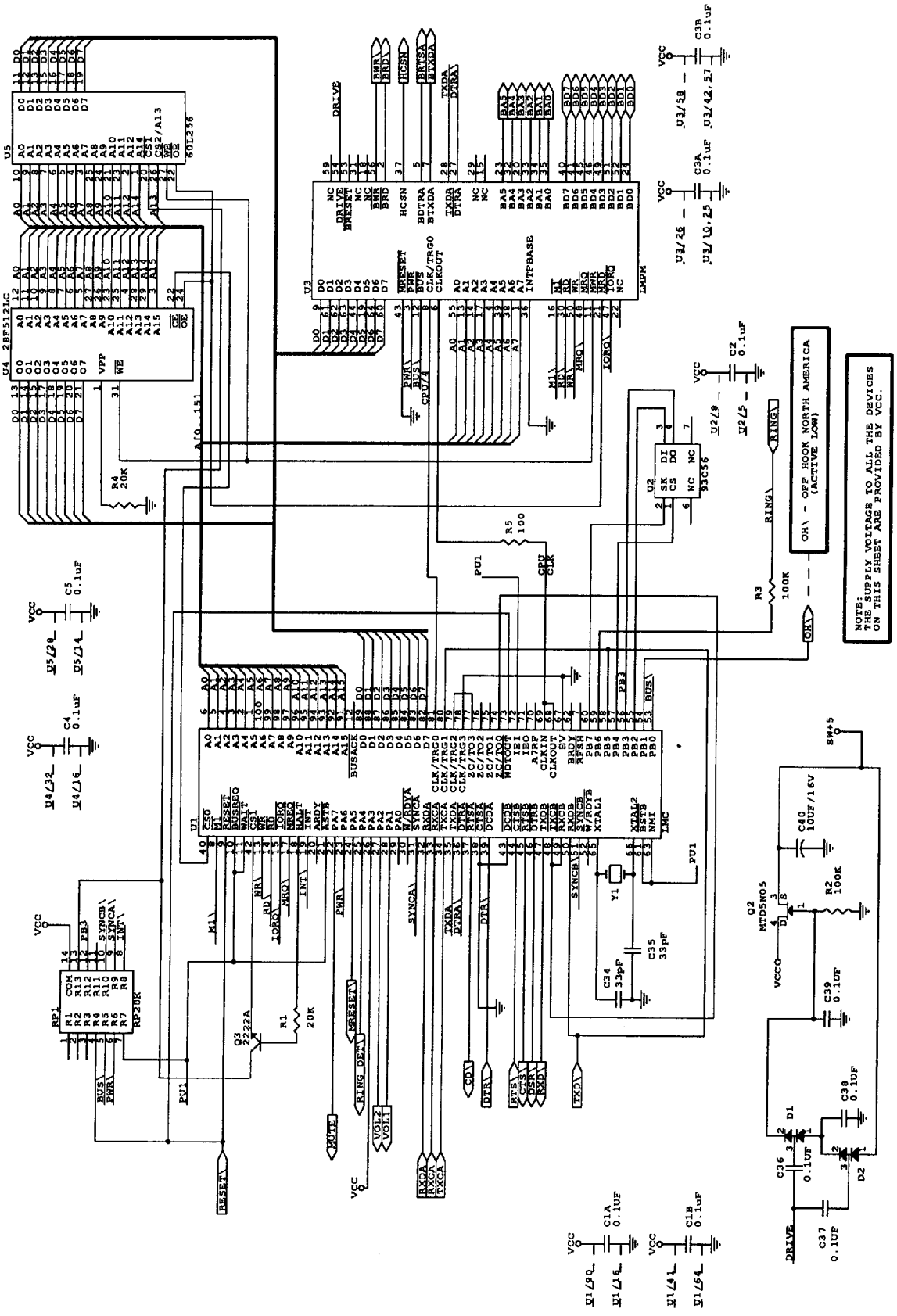
Table 29. Parallel Interface (Sheet 5)

Item	Quantity	(Sheet #) Reference	Part
1	1	(5) U15	Octal Bus Transceiver, MOT #MC74HCT245A
2	1	(5) U16	16550 UART, NS #NS16550AV
3	1	(5) U17	8-bit Comparator, NS #NS74AC520SC
4	1	(5) U18	3-state Quad Buffer, MOT#MC74HCT125D
5	1	(5) U19	3-state Octal Driver, MOT #MC74HCT244A
6	1	(5) U20	Hex Inverter, TI #SN74HCT04D
7	1	(5) U21	Quad 2-Input Pos-OR Gate, TI#SN74HCT32D
8	1	(5) Y3	Crystal, 1.8432 MHz
9	12	(5) C15, C16, C17, C18, C19, C20, C21, C22, C57, C58, C59, C60	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
10	1	(5) C61	Capacitor, 10 µF/16 V, 6032, 10%, Tantalum
11	1	(5) C61	Capacitor, 18 pF, 0805, 25 V, 5%
12	1	(5) C63	Capacitor, 39 pF, 0805, 25 V, 5%
13	3	(5) C64, C65, C66	Capacitor, 10 µF, 491, 25 V, 10%, Polarized
14	1	(5) D24	Diode, MOT #MMBD914LT1
15	1	(5) R42	Resistor, 1.0K, 0805, 5%, 0.1 W, Carbon
16	1	(5) R43	Resistor, 1M, 5%, 0.1 W, Carbon

Schematics for LapTop Complete Modem Using LMPM Device

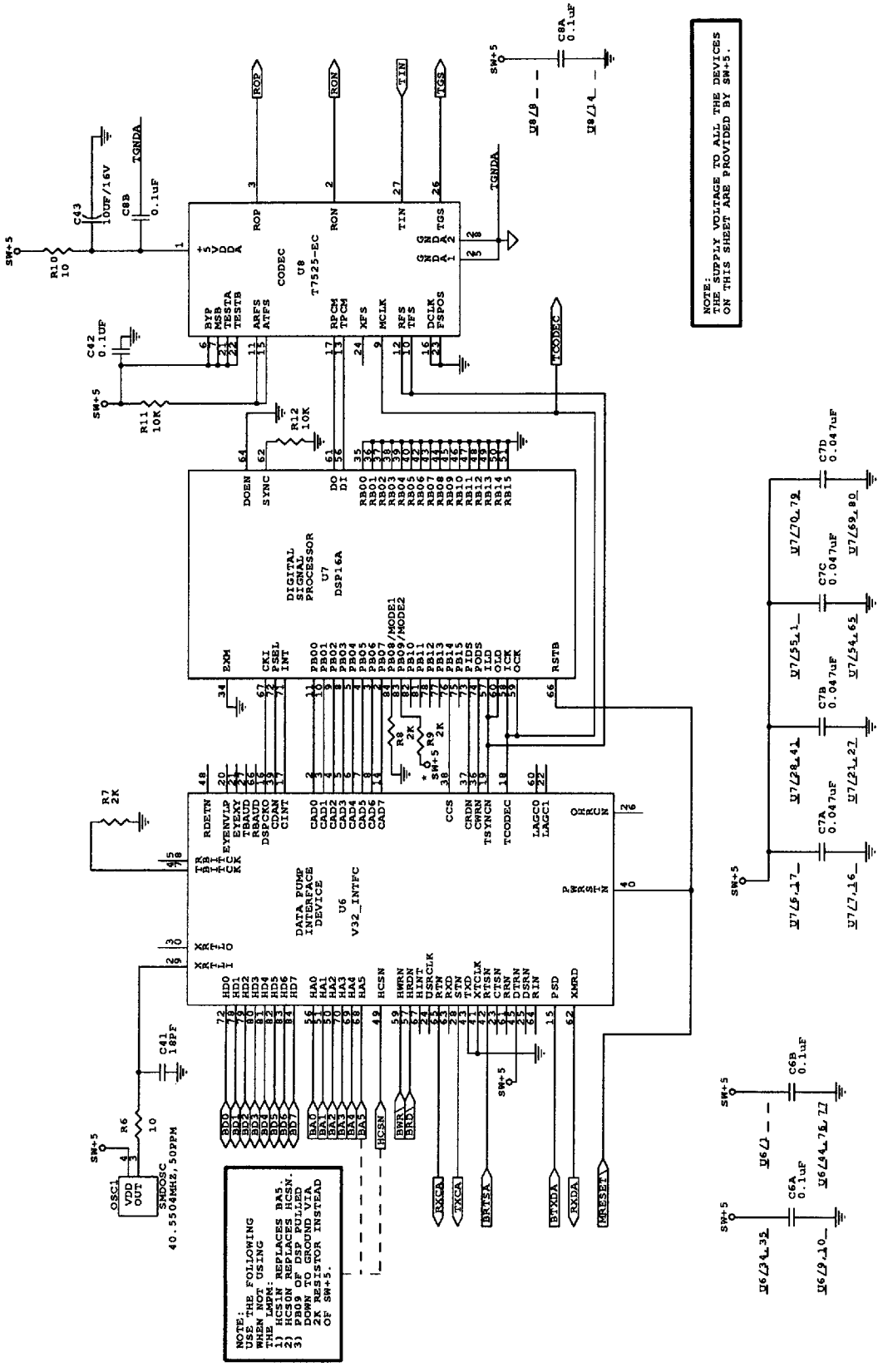
The schematics for the LapTop Complete Modem utilizing the LapTop modem power manager are on the following five pages. Sheets 1—2 consist of essential modem circuitry. Sheet 3 contains the LapTop DAA requiring a single +5 V supply and the optional speaker circuitry. Sheet 4 contains the serial interface circuitry, and sheet 5 contains the parallel interface circuitry.

Design Guide (continued)



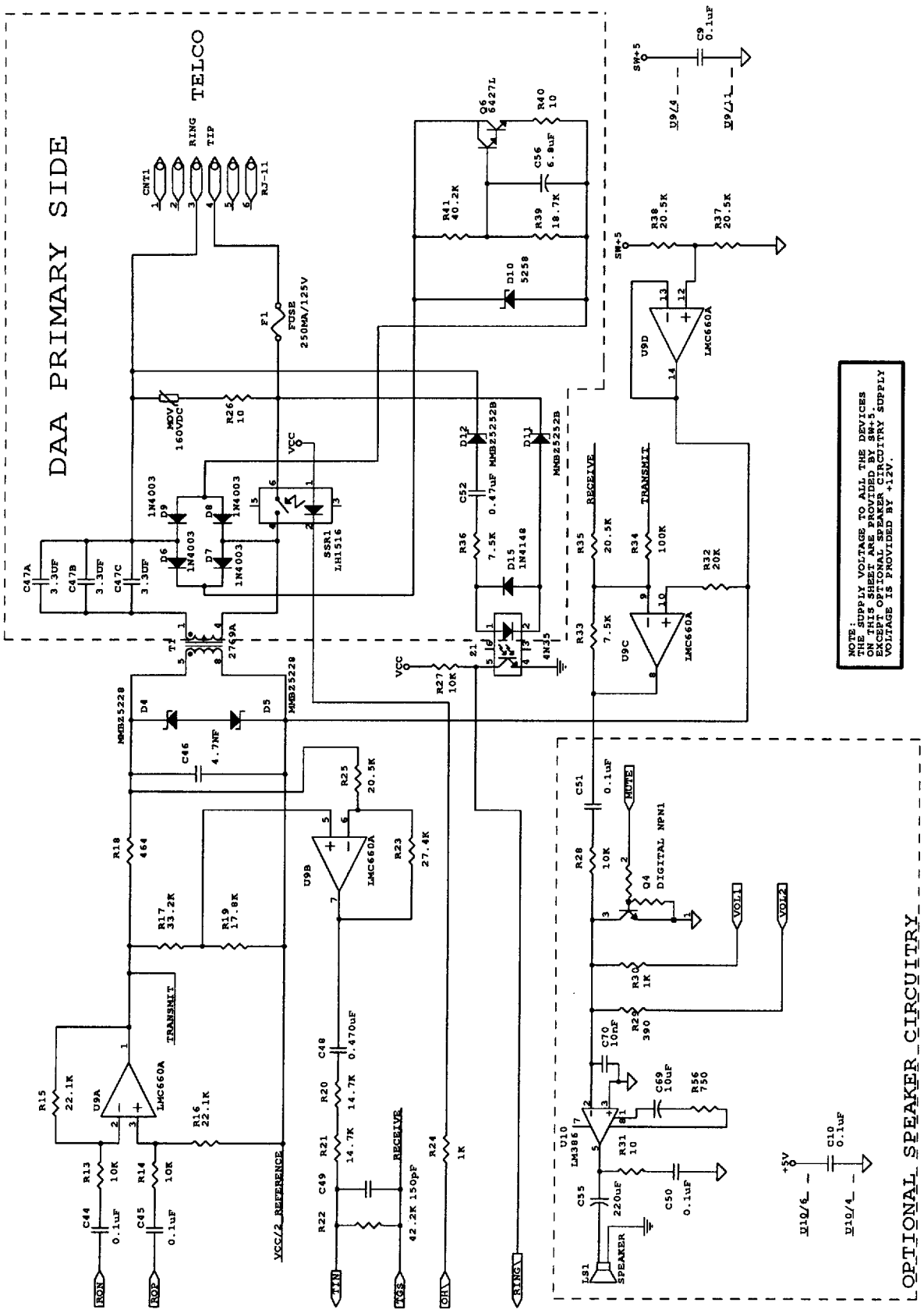
LapTop Complete Modem Schematics — Sheet 1: LapTop Modem Controller

Design Guide (continued)



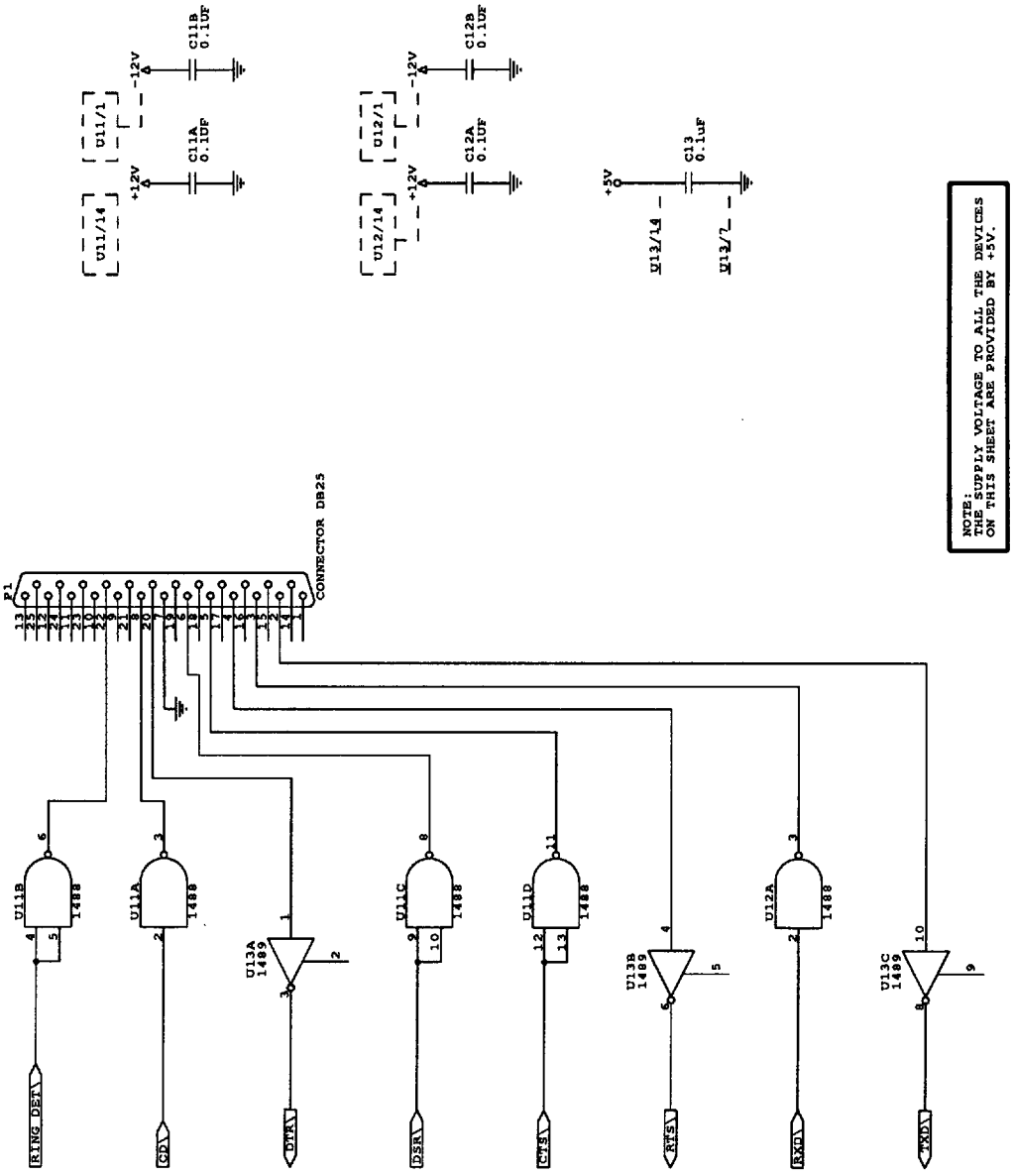
LapTop Complete Modem Schematics — Sheet 2: Data Pump

Design Guide (continued)



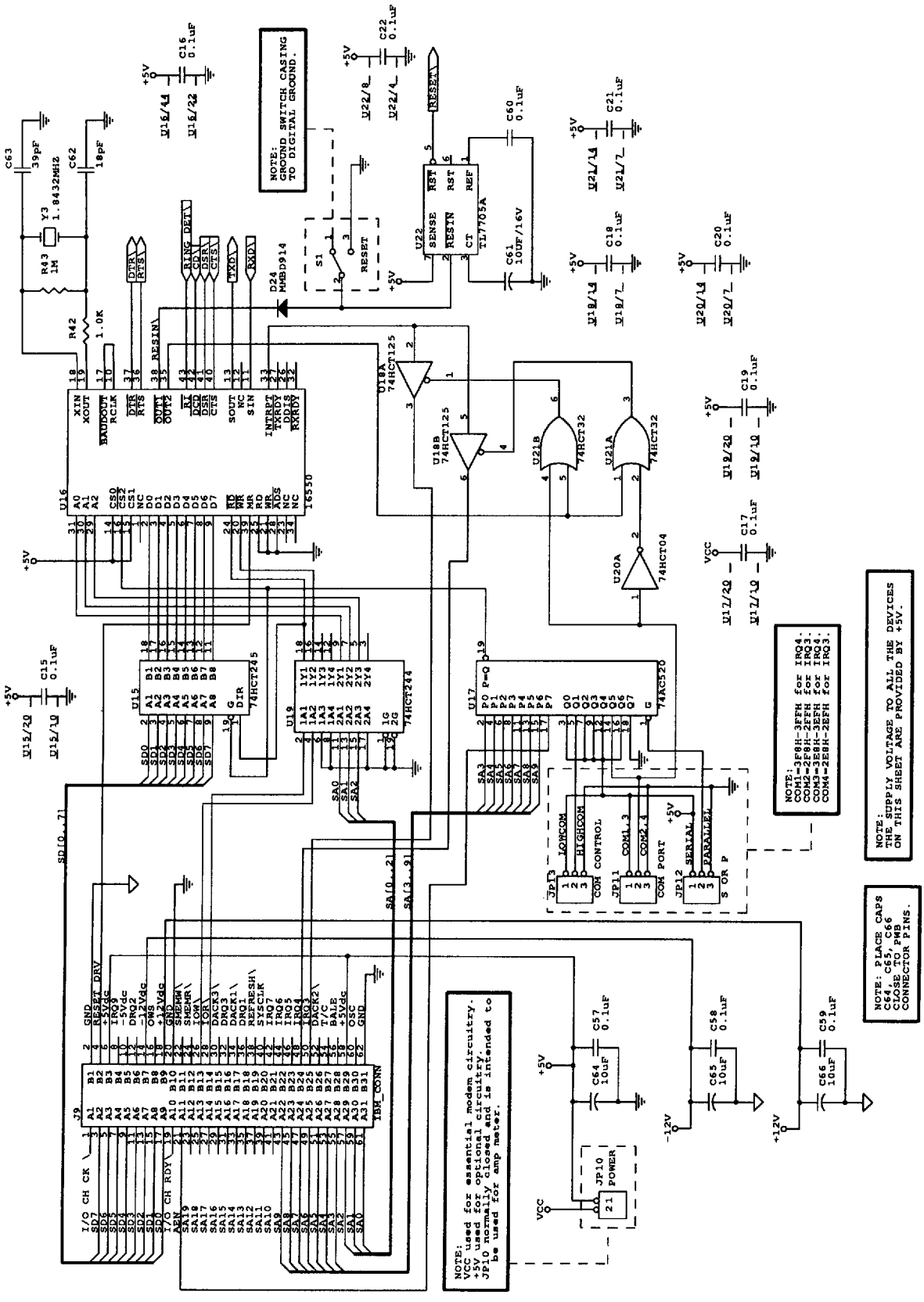
LapTop Complete Modem Schematics — Sheet 3: DAA

Design Guide (continued)



LapTop Complete Modem Schematics — Sheet 4: Serial Interface (optional)

Design Guide (continued)



LapTop Complete Modem Schematics — Sheet 5: Parallel Interface (optional)

Design Guide (continued)

Bill of Materials for LapTop Complete Modem Without the LMPM Device

This design reduces the chip count of the LapTop Complete Modem to four chips: DSP16A, T7525 Codec, V32-INTFC, and LMC. This implementation replaces the 64-pin QFP LapTop modem power manager with discrete components. Without the LMPM chip, the sleep power is between 50 mW and 70 mW.

Note: It is not recommended that modifications be made to this parts list without prior consultation with the AT&T DSP Modem Marketing Group. Any substitutions to the parts list are made at the customer's risk.

Table 30. AT&T LapTop Complete Modem Chip Set and Discretes

Item	Quantity	(Sheet #) Reference	Part
1	1	(1) U1	LapTop Modem Controller, LMC
2	1	(2) U6	V.32 Interface Device, AT&T V32-INTFC
3	1	(2) U7	Digital Signal Processor, AT&T DSP16A
4	1	(2) U8	Linear Codec, AT&T T7525
5	1	(1) U3	74HCT138
6	1	(1) U23	74HCT32
7	1	(1) U24	74HCT74

Table 31. Memory Devices

Item	Quantity	(Sheet #) Reference	Part
1	1	(1) U4	64K x 8 ROM 100 ns, AMD 28F512LC, or equivalent ROM
2	1	(1) U5	32K x 8 SRAM 100 ns, MOSEL 55257
3	1	(1) U2	2K x 1 bit serial EEPROM, EXEL 93C56J

Table 32. Crystal, Oscillator

Item	Quantity	(Sheet #) Reference	Part
1	1	(2) OSC1	Oscillator, 40.5504 MHz, 50 ppm
2	1	(1) Y1	Crystal, Parallel Resonant (See Table 19.)

Design Guide (continued)

Table 33. Capacitors, Resistors, Diodes, Transistors

Item	Quantity	(Sheet #) Reference	Part
1	18	(1)-C1B, C1A, C2, C3A, C4, C5, C23, C24; (2)-C68, C6A, C88, C8A, C42; (4) C11B, C11A, C12B, C12A, C13	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
2	2	(1)-C34, C35	Capacitor, 33 pF, 0805, 25 V, 5%, NPO
4	4	(2)-C7D, C7C, C7B, C7A	Capacitor, 0.047 µF, 0805, 25 V, 5%, NPO
5	1	(2)-C41	Capacitor, 18 pF, 0805, 25 V, 5%, NPO
8	1	(1)-Q3	NPN Transistor, MOT #MMBT2222ALT1
9	1	(1)-RP1	Resistor Pack, 20K, Resistor Network
10	2	(1)-R1, R4	Resistor, 20K, 0805, 5%, 0.1 W, Carbon
11	1	(1)-R3	Resistor, 100K, 0805, 5%, 0.1 W, Carbon
12	1	(1)-R5	Resistor, 100, 0805, 5%, 0.1 W, Carbon
13	2	(2)-R6, R10	Resistor, 10, 2512, 5%, 1 W, Carbon
14	3	(2)-R7, R8, R9	Resistor, 2K, 0805, 5%, 0.1 W, Carbon
15	2	(2)-R11, R12	Resistor, 10K, 0805, 1%, 0.1 W, Metal-film

Table 34. Speaker Circuitry (Sheet 3)

Item	Quantity	(Sheet #) Reference	Part
1	1	(3) LS1	Speaker, 0.4 W, 8 Ω, FUJI TS-30
2	1	(3) U10	Audio Power Amp, NS #LM386M-1
3	3	(3) C10, C50, C51	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
4	1	(3) C55	Capacitor, 220 µF, 10 V, 20%, Aluminum Electrolytic, ILLINOIS # 227RSS010M
5	1	(3) C69	Capacitor, 10 µF, Tantalum, 1810, 16 V
6	1	(3) C70	Capacitor, 10 nF, 0805, 25 V, 10%, X7R
7	1	(3) Q4	NPN Digital Transistor, ROHM, #DTC143XK
8	1	(3) R28	Resistor, 10K, 0805, 1%, 0.1 W, Metal-film
9	1	(3) R31	Resistor, 10, 0805, 5%, 0.1 W, Metal-film
10	1	(3) R29	Resistor, 390, 0805, 5%, 0.1 W, Carbon
11	1	(3) R30	Resistor, 1K, 0805, 1%, 0.1 W, Metal-film
12	1	(3) R56	Resistor, 750, 0805, 5%, 0.1W, Metal-film

Design Guide (continued)

Table 35. Data Access Arrangement (Sheet 3)

Item	Quantity	(Sheet #) Reference	Part
1	1	(3) U9	Quad Opamp Line Driver, NS #LMC660AIM
2	1	(3) T1	V.32 Transformer, AT&T #2769A or #2770A
3	1	(3) SSR1	Solid-State Relay, AT&T #LH1516AAB
4	3	(3) C9, C44, C45	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
5	1	(3) C46	Capacitor, 4.7 nF, 0805, 50 V, 10%, X7R
6	3	(3) C47C, C47B, C47A	Cap, 3.3 µF, 1825, 50 V, 20%, nonpolar, Z5U
7	1	(3) C48	Capacitor, 0.47 µF, 1812, 50 V, 10%, X7R
8	1	(3) C49	Capacitor, 150 pF, 0805, 25 V, 5%, X7R
9	1	(3) C52	Capacitor, 0.47 µF, 2225, 250 V, 10%, X7R
10	1	(3) C56	Capacitor, 6.8 µF, T491, 10 V, 10%, Tantalum
11	2	(3) D4, D5	Diode, 3.9 VZ/225 mW, MOT #MMBZ5228BLT1
12	4	(3) D6, D7, D8, D9	1N4003, 800 mA/240 V, ROHM #RLR4003
13	1	(3) D10	Zener 36 V/225 mW, MOT #MMBZ5258BLT1
14	2	(3) D11, D12	Zener 24 V/225 mW, MOT #MMBZ5252BLT1
15	1	(3) D15	1N4148, LL34, 100 V/0.5 W, ROHM #RLS4148
16	3	(3) R13, R14, R27	Resistor, 10K, 0805, 1%, 0.1 W, Metal-film
17	2	(3) R15, R16	Resistor, 22.1K, 0805, 1%, 0.1 W, Metal-film
18	1	(3) R17	Resistor, 33.2K, 0805, 1%, 0.1 W, Metal-film
19	1	(3) R18	Resistor, 464, 1206, 1%, 1/8 W, Metal-film
20	1	(3) R19	Resistor, 17.8K, 0805, 1%, 0.1 W, Metal-film
21	2	(3) R20, R21	Resistor, 14.7K, 0805, 1%, 0.1 W, Metal-film
22	1	(3) R22	Resistor, 42.2K, 0805, 1%, 0.1 W, Metal-film
23	1	(3) R23	Resistor, 27.4K, 0805, 1%, 0.1 W, Metal-film
24	1	(3) R24	Resistor, 1K, 1206, 5%, 1/8 W, Carbon
25	2	(3) R26, R40	Resistor, 10, 2512, 5%, 1 W, Carbon
26	1	(3) R32	Resistor, 20K, 1210, 1%, 1/4 W, Metal-film
27	1	(3) R33	Resistor, 7.5K, 1210, 1%, 1/4 W, Metal-film
28	1	(3) R34	Resistor, 100K, 0805, 1%, 0.1 W, Metal-film
29	1	(3) R35	Resistor, 20.5K, 0805, 1%, 0.1 W, Metal-film
30	1	(3) R36	Resistor, 7.5K, 2512, 5%, 1 W, Carbon
31	1	(3) R39	Resistor, 18.7K, 0805, 1%, 0.1 W, Metal-film
32	1	(3) R41	Resistor, 40.2K, 0805, 1%, 0.1 W, Metal-film
33	1	(3) Z1	Opto-isolator, MOT 4N35
34	1	(3) Q6	Darlington Trans NPN, MOT #MMBT6427LT1
35	1	(3) MOV	MOV, 250—260 Vdc, 1.2 KA/300 Vdc, SIEMENS #CU4032K230G
36	1	(3) F1	Fuse, 250 mA/125 V, LITTELFUSE #R459.250
37	1	(3) CNT1	RJ-11 Phone Jack

Table 36. Serial Interface (Sheet 4)

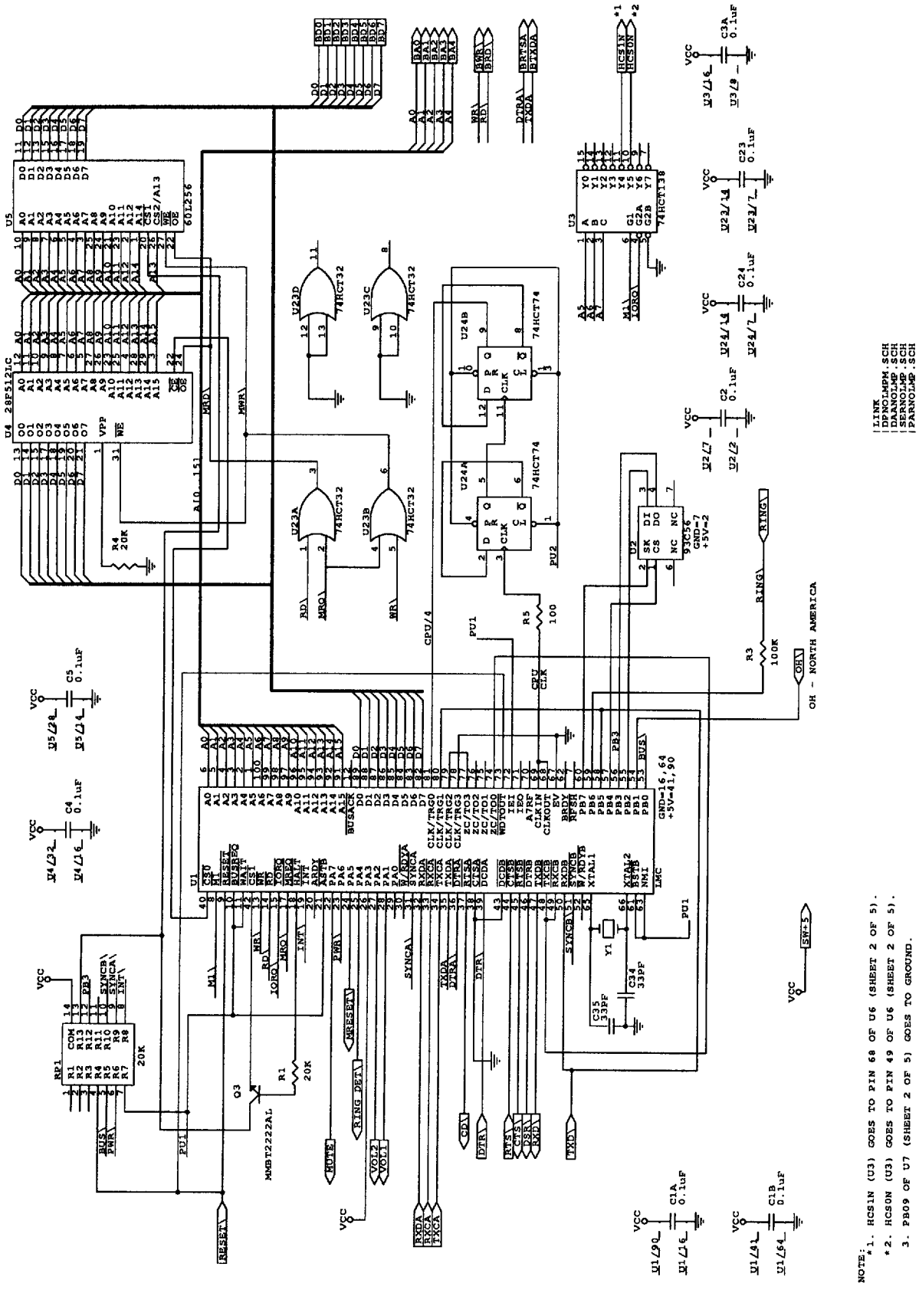
Item	Quantity	(Sheet #) Reference	Part
1	2	(4) U11, U12	Quad Line Driver, MOT #MC1488D
2	1	(4) U13	Quad Line Receivers, MOT #MC1489AD
3	1	(4) P1	Connector DB25, AMP

Table 37. Parallel Interface (Sheet 5)

Item	Quantity	(Sheet #) Reference	Part
1	1	(5) U15	Octal Bus Transceiver, MOT #MC74HCT245A
2	1	(5) U16	16550 UART, NS #NS16550AV
3	1	(5) U17	8-bit Comparator, NS #NS74AC520SC
4	1	(5) U18	3-state Quad Buffer, MOT#MC74HCT125D
5	1	(5) U19	3-state Octal Driver, MOT #MC74HCT244A
6	1	(5) U20	Hex Inverter, TI #SN74HCT04D
7	1	(5) U21	Quad 2-Input Pos-OR Gate, TI#SN74HCT32D
8	1	(5) Y3	Crystal, 1.8432 MHz
9	12	(5) C15, C16, C17, C18, C19, C20, C21, C22, C57, C58, C59, C60	Capacitor, 0.1 µF, 1206, 50 V, 10%, X7R
10	1	(5) C61	Capacitor, 10 µF/16 V, 6032, 10%, Tantalum
11	1	(5) C61	Capacitor, 18 pF, 0805, 25 V, 5%
12	1	(5) C63	Capacitor, 39 pF, 0805, 25 V, 5%
13	3	(5) C64, C65, C66	Capacitor, 10 µF, T491, 25 V, 10%, Polarized
14	1	(5) D24	Diode, MOT #MMBD914LT1
15	1	(5) R42	Resistor, 1.0K, 0805, 5%, 0.1 W, Carbon
16	1	(5) R43	Resistor, 1M, 5%, 0.1 W, Carbon

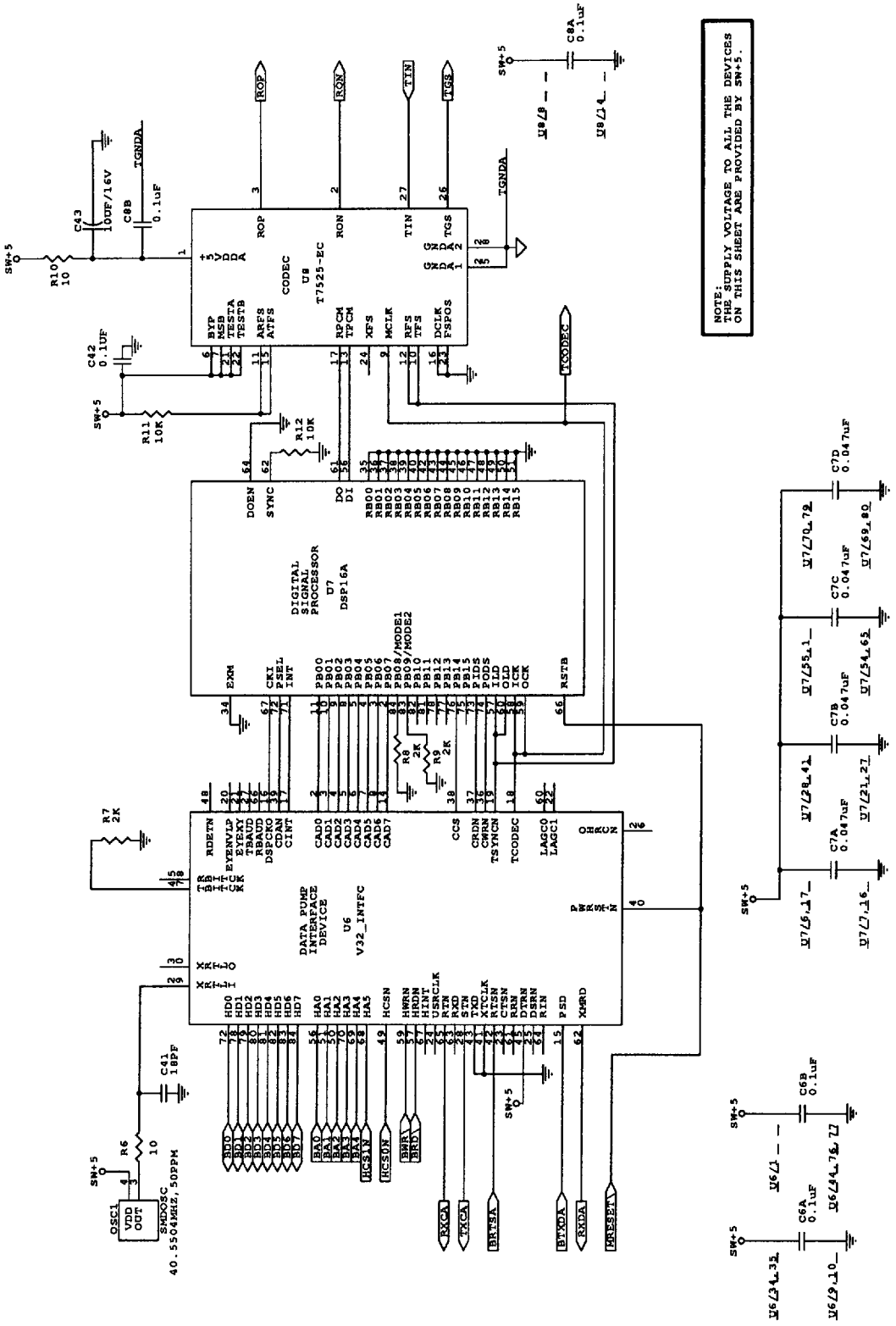
LapTop Complete Modem Schematics

The schematics for the LapTop Complete Modem without the LapTop modem power manager are on the following five pages. Sheets 1—2 consist of essential modem circuitry. Sheet 3 contains the LapTop DAA requiring a single +5 V supply and the optional speaker circuitry. Sheet 4 contains the serial interface circuitry, and sheet 5 contains the parallel interface circuitry.



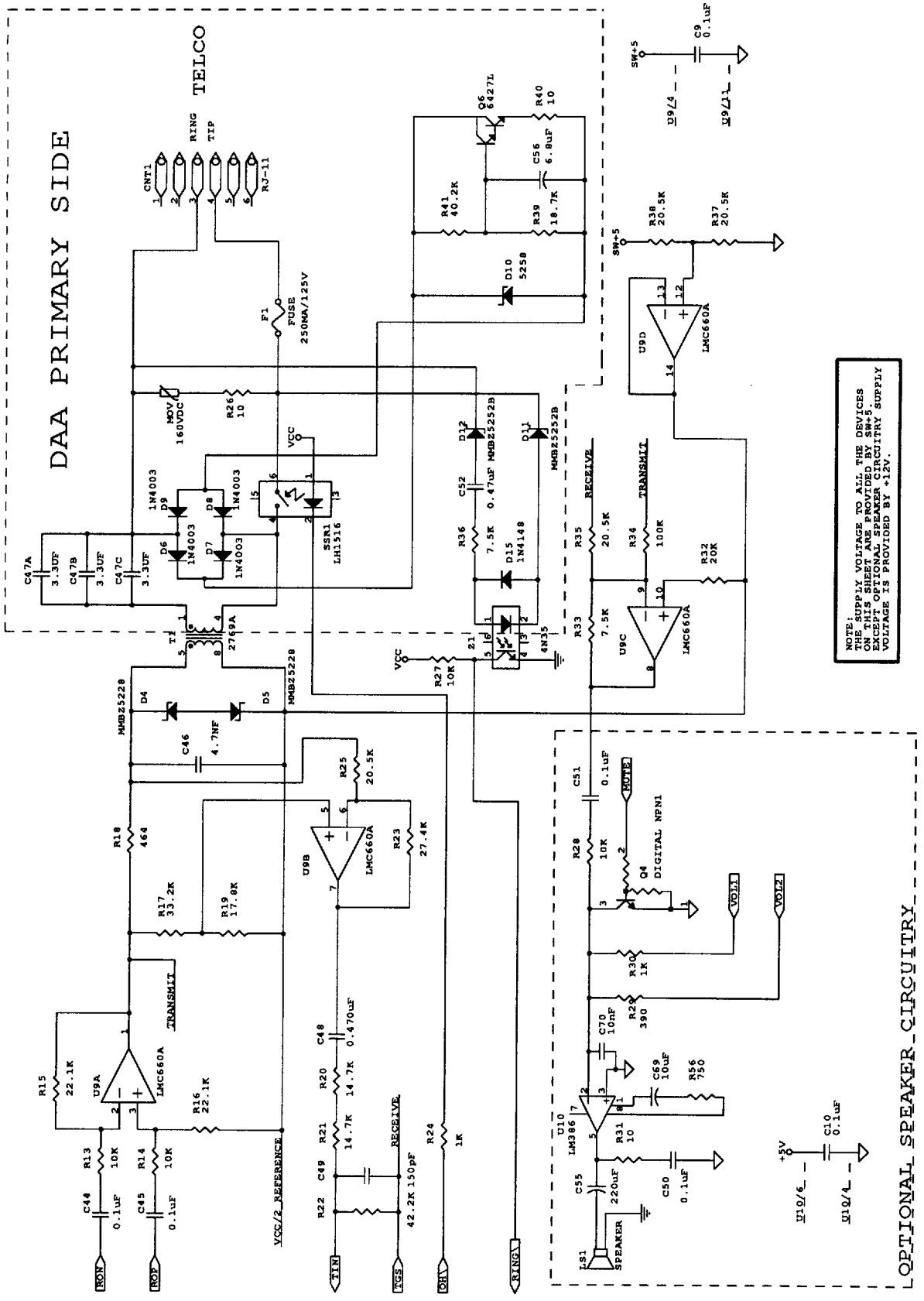
NOTE:
*1. HCS1N (U3) GOES TO PIN 68 OF U6 (SHEET 2 OF 5).
*2. HCSON (U3) GOES TO PIN 49 OF U6 (SHEET 2 OF 5).
3. PB09 OF U7 (SHEET 2 OF 5) GOES TO GROUND.

LapTop Complete Modem Schematics (Without LMPM) — Sheet 1: LapTop Modem Controller



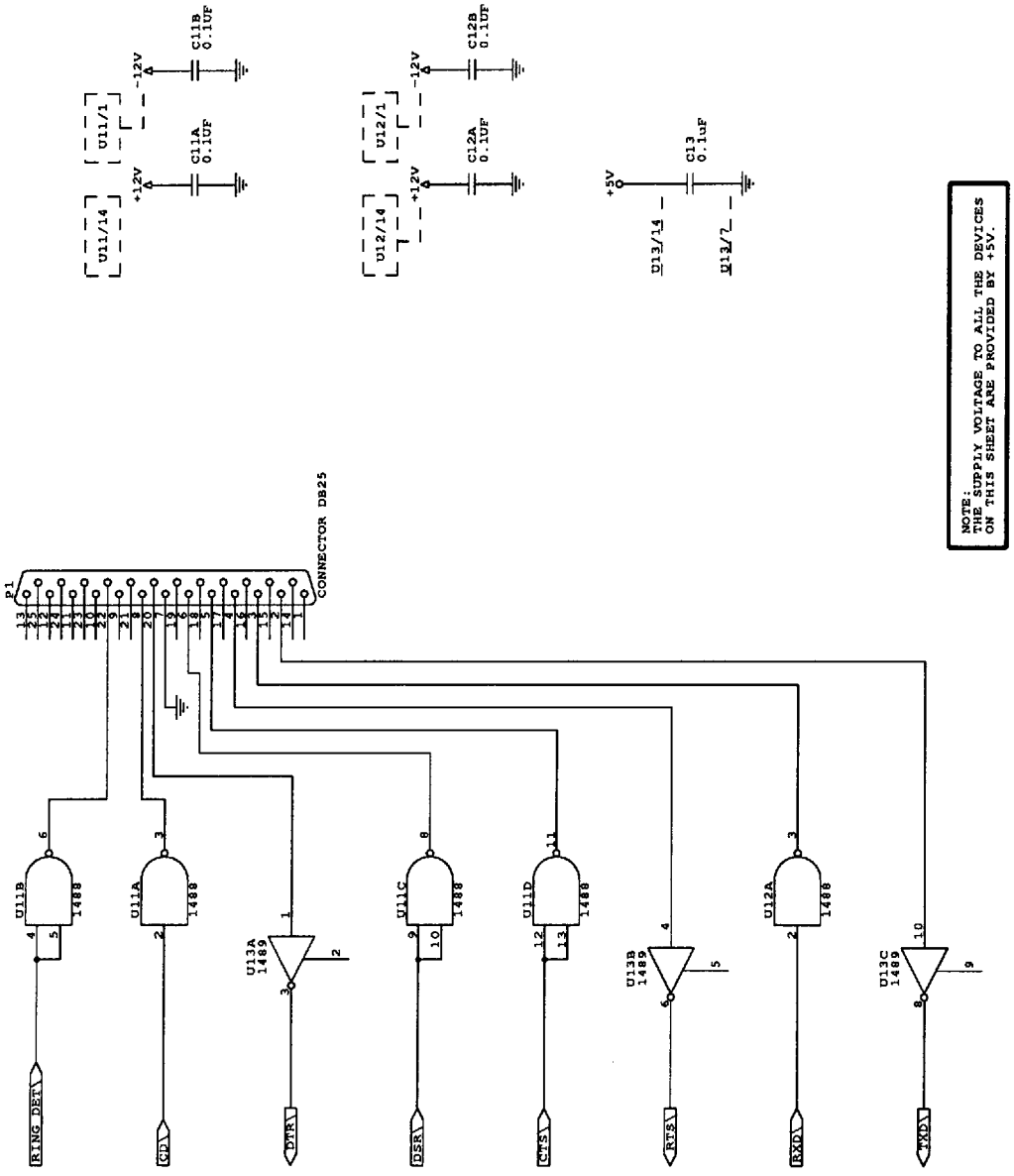
LapTop Complete Modem Schematics (Without LMPM) — Sheet 2: Data Pump

Design Guide (continued)



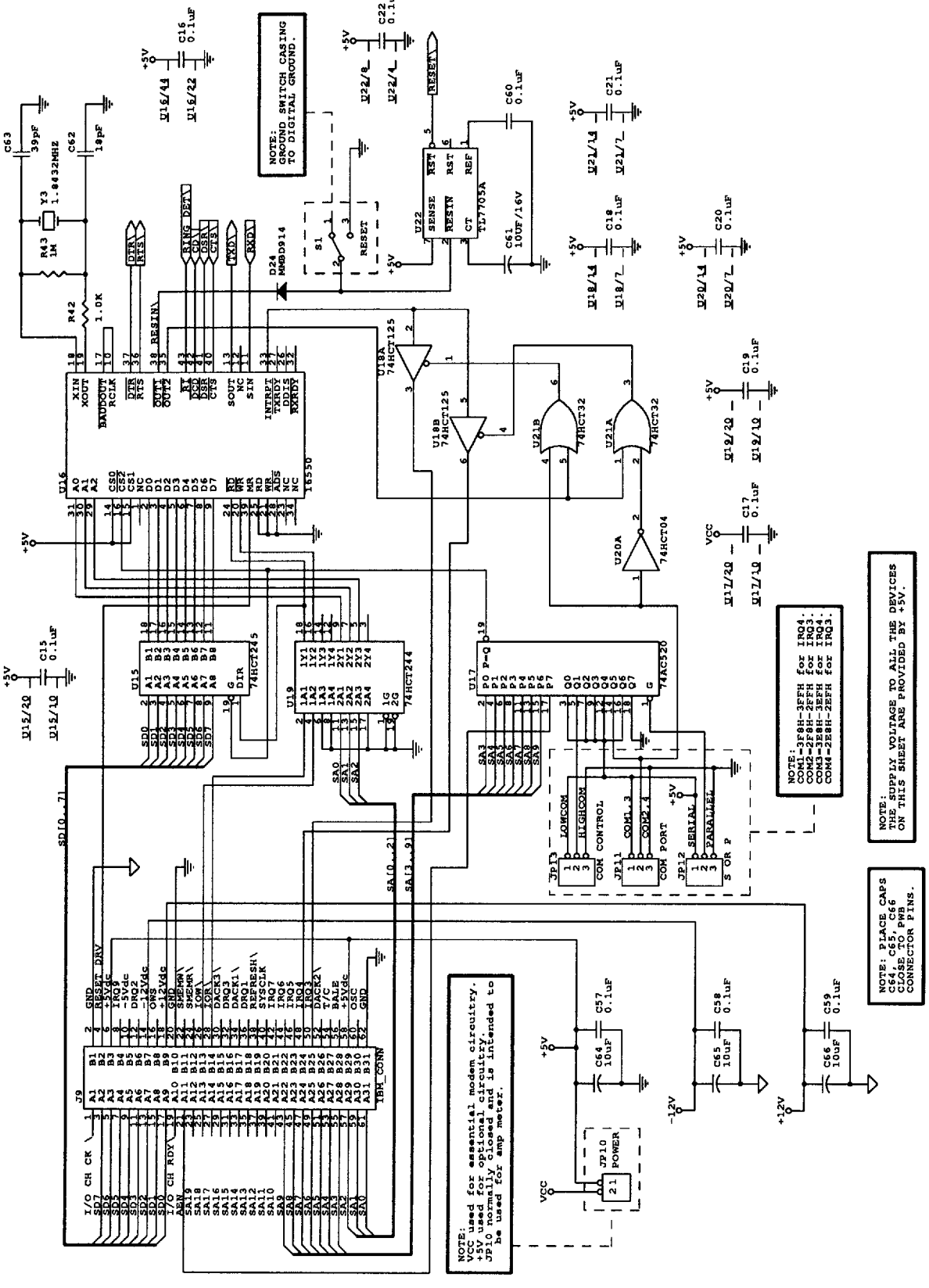
LapTop Complete Modem Schematics (Without LMPM) — Sheet 3: DAA

Design Guide (continued)



LapTop Complete Modem Schematics (Without LMPM) — Sheet 4: Serial Interface (optional)

Design Guide (continued)

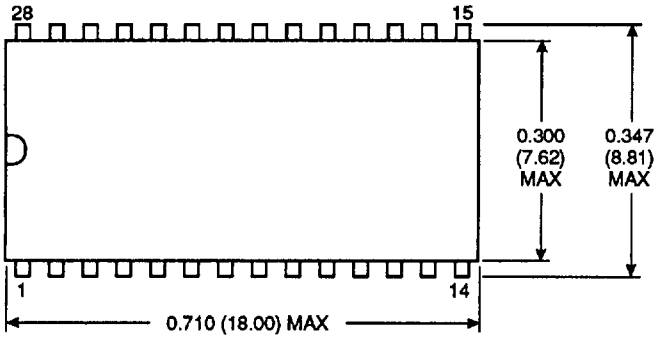


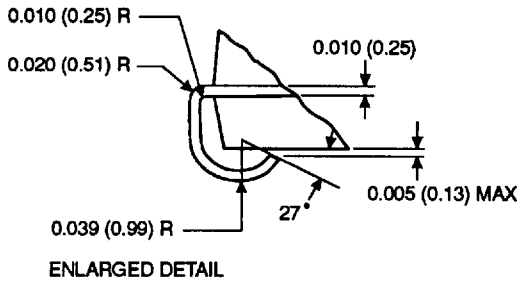
LapTop Complete Modem Schematics (Without LMPM) — Sheet 5: Parallel Interface (optional)

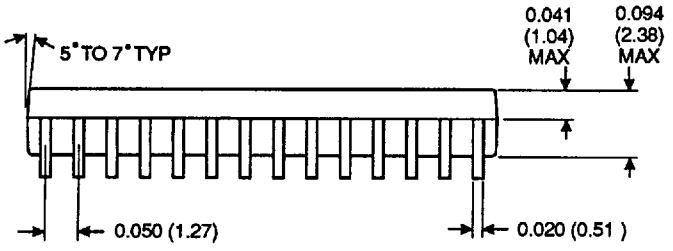
Package Outline Diagrams

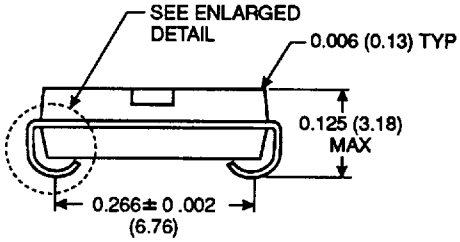
28-Pin, Plastic SOJ

Dimensions are in inches and (millimeters).







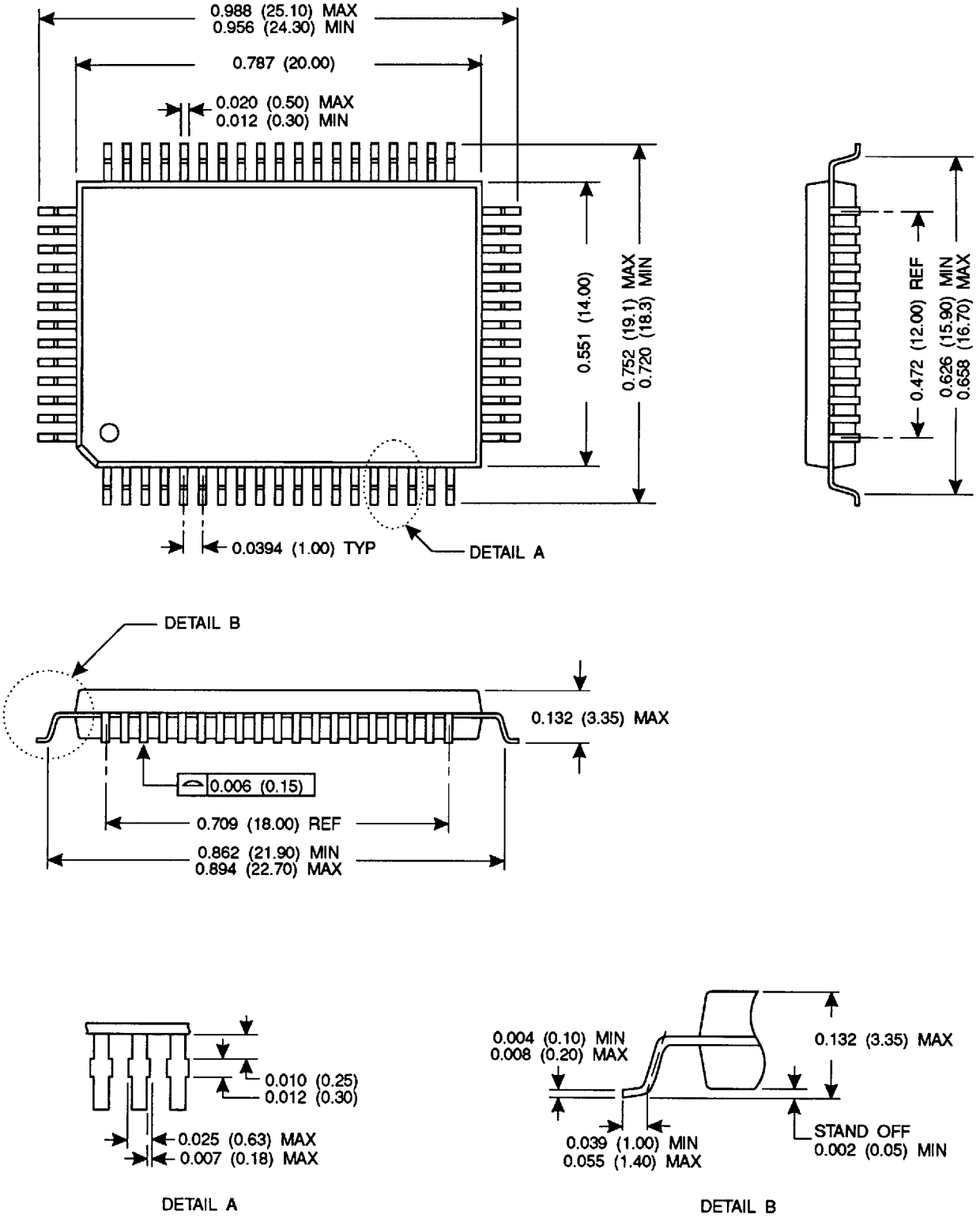


Note: Chip die to ambient thermal resistance is 75°C/W.

Package Outline Diagrams (continued)

64-Pin, QFP

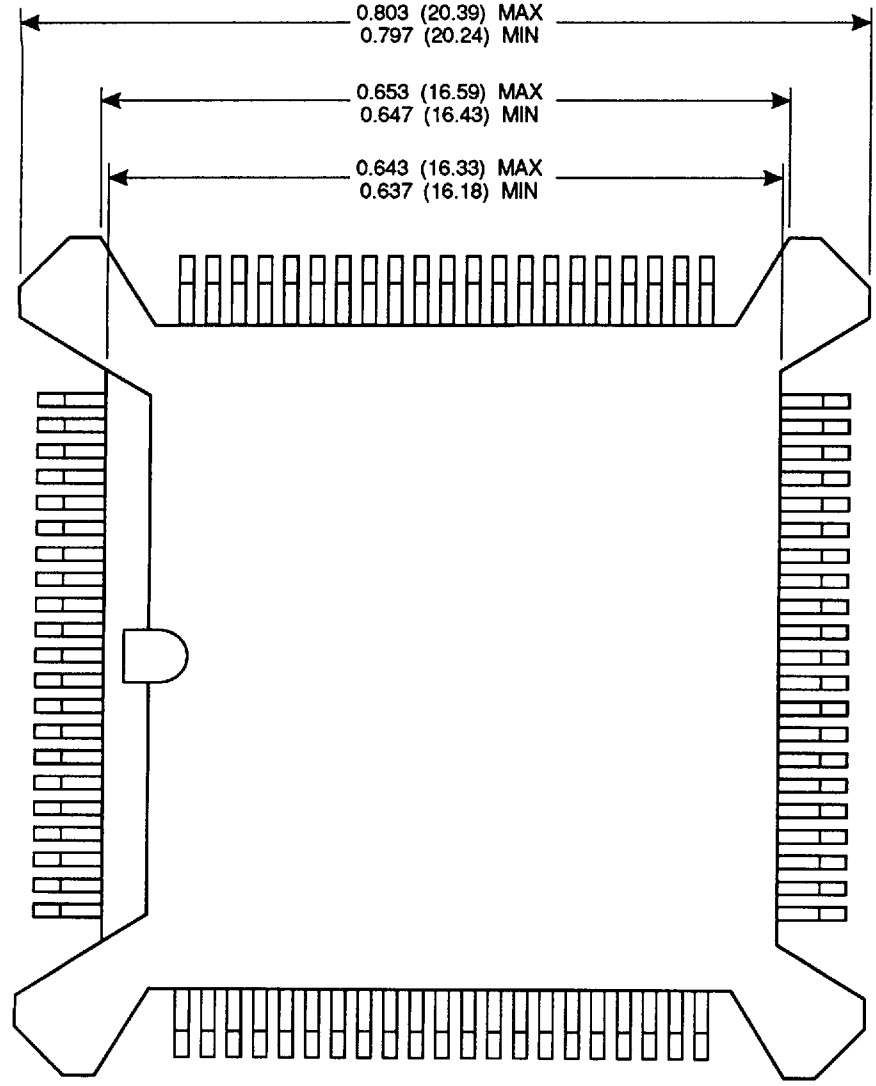
Dimensions are in inches and (millimeters).

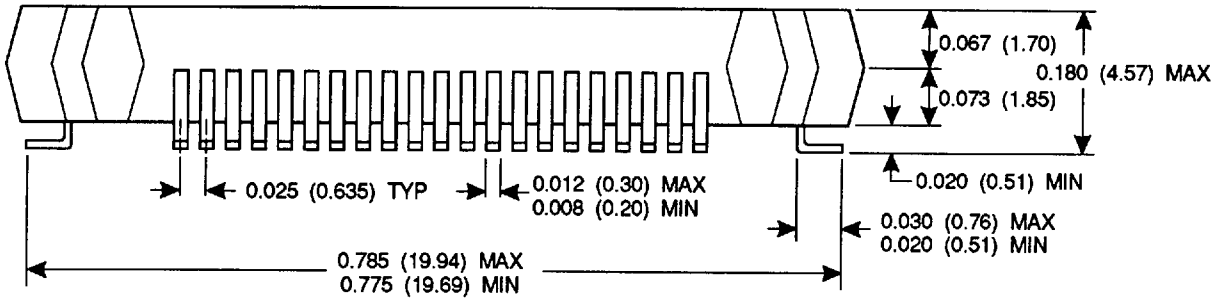


Package Outline Diagrams (continued)

84-Pin, PQFP

Dimensions are in inches and (millimeters).

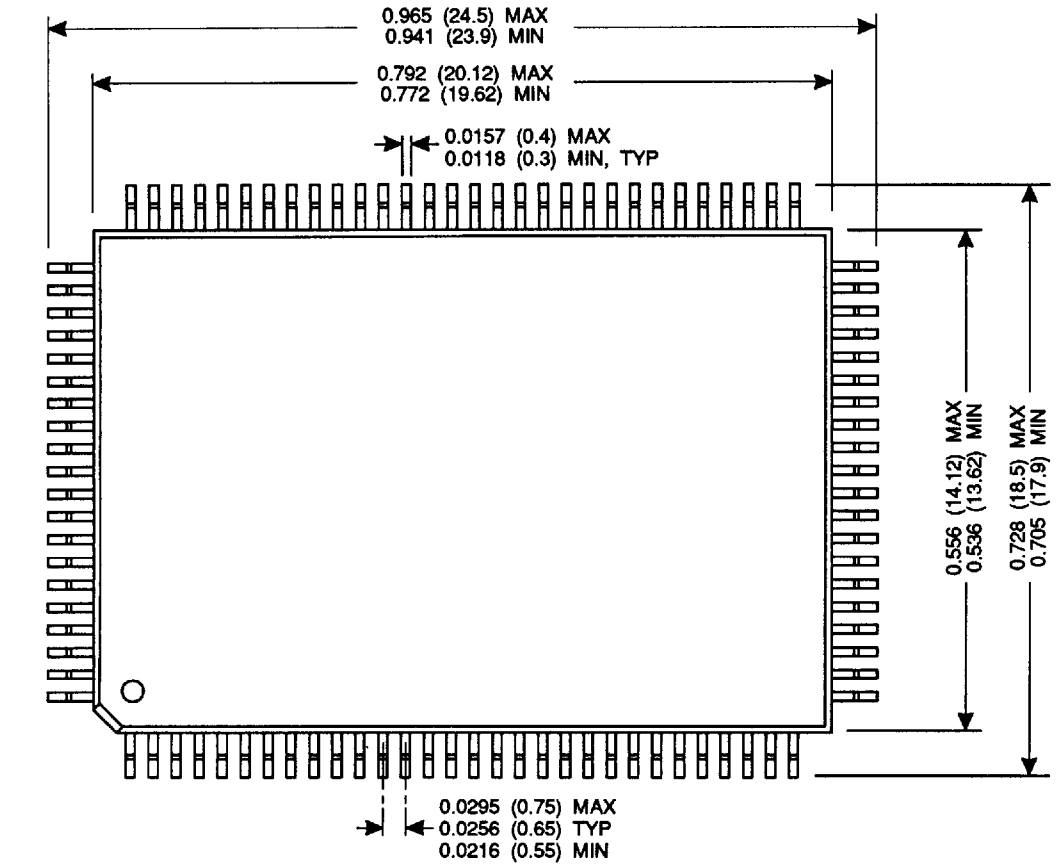


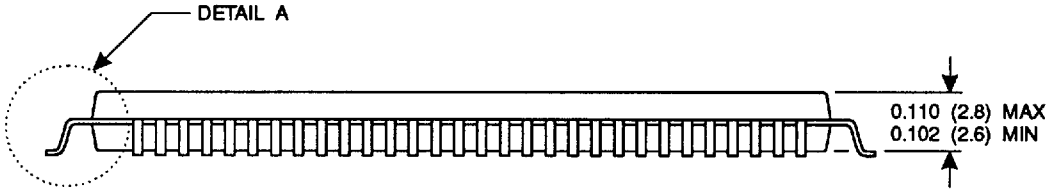


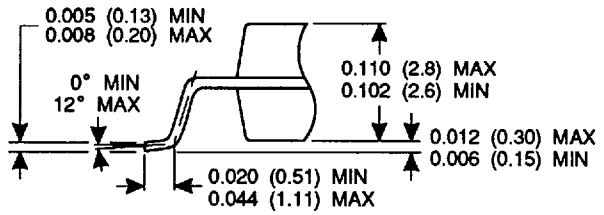
Package Outline Diagrams (continued)

100-Pin, QFP

Dimensions are in inches and (millimeters).







DETAIL A