CH1784—2400 bps Modem Module with International Telephone Interface

T-75-33-90

INTRODUCTION

The CH1784 modem module offers perhaps the fastest and easiest way of integrating a high performance modem into a product. Integration consists of mounting the module on the product's circuit card, connecting it to power, the host UART/ USART, and to the phone line through an RJ-11C jack. The component module is a fully assembled and tested sub-assembly ready to plug in and use.

In addition to resident international telephone interface or data access arrangement, the CH1784 has been designed to meet stringent international standards to accelerate approval by international telephone authorities.

The CH1784 is pin similar to the CH1780 which has FCC Part 68 approval and is DOC approvable. Both units are interchangeable to provide a single world solution.

The CH1784 complies with CCITT V.22 bis and V.22 A/B recommendations, and meets Bell 212A and 103 standards for asynchronous communication. The CH1784 implements a 2400/ 2400B "AT" command set, and as such it is compatible with all popular communications software.

The CH1784 has two principal interfaces. The host interface is a serial CCITT V.24 compatible with TTL levels. The Telco interface goes directly to RING and TIP of the telephone line.

The CH1784 is a low power device with a standby power mode to further reduce power when the modem is not in operation. An automatic sleep and wake-up capability is included.

GENERAL DESCRIPTION

The functional block diagram of the CH1784 is illustrated in Figure 1 and described below.

FEATURES

- CCITT V.22 bis, V.22 A/B, Bell 212A and 103 standards
- International 4.5KV isolation, telephone line interface - suitable for Europe
- FCC Part 68 approved and DOC approvable
- AT Command Set supports 2400B and 2400
- Non-volatile storage of set-up configuration and four 36 Digit Dialing Strings
- DTE interface supports CCITT V.24
- Low power operation with automatic Sleep Mode and Wake-up
- Call Progress and Dialing features
- Automatic Adaptive and Fixed Compromise Equalization
- Small size: 9.5 square inches

Functional Blocks

DSP MODEM CONTROL

The DSP is a medium speed modem engine offering a high speed central processing rate. The DSP performs the modem digital signal processing, command set interpreting, line control, and modem control processing.

MODEM ANALOG FUNCTION

The integrated analog function is divided into three sections: transmitter, receiver, and telephone line interface. The transmitter section contains a digital-to-analog (D/A) converter, bandsplit and lowpass attenuator. The receiver section implements variable gain control, bandsplit filters, and an analog-to-digital (A/D) converter. The telephone interface circuitry provides relay drivers for off-hook and isolation.

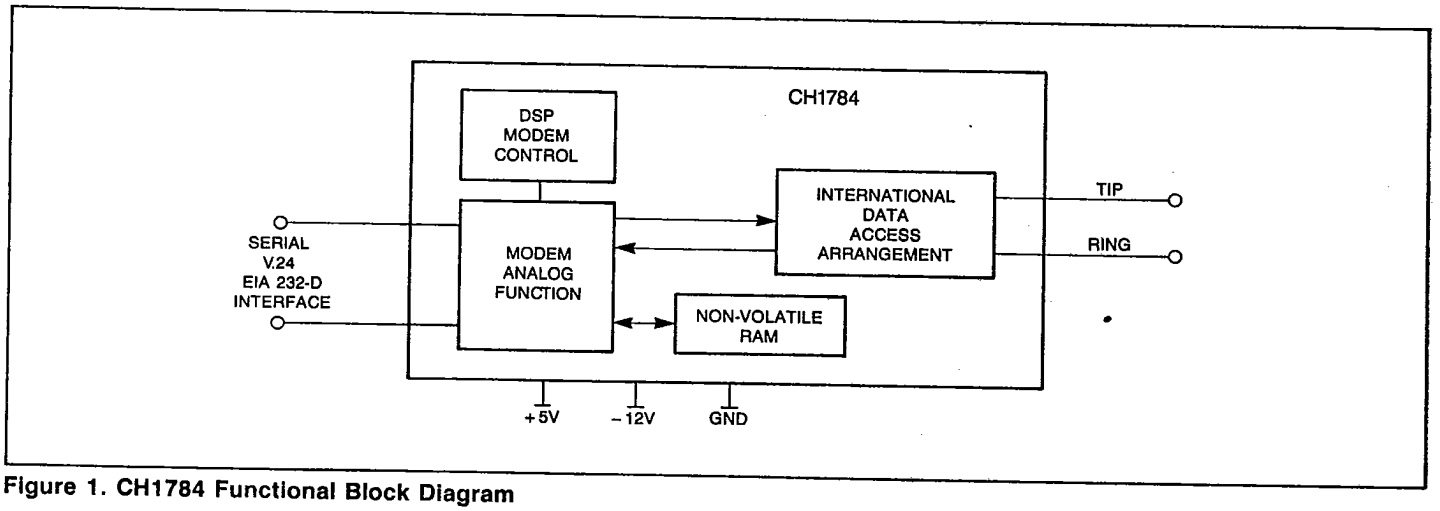

Figure 1. CH1784 Functional Block Diagram

NVRAM Interface

A 1024-bit non-volatile RAM (NVRAM) is provided. The NVRAM can store up to two user-selected configurations which can take precedence over the factory default setting, and can store up to four 36-digit strings.

DAA

The CH1784 module incorporates both capabilities for an international Data Access Arrangement (DAA), and FCC Part 68 registered DAA to make phone line connection easy. The DAA includes circuits that couple the modem signals to the phone line and provides FCC required isolation and protection. The modem's FCC registration may be used by the host product without re-registration provided that the following guidelines are followed.

SUPPORTED FEATURES

"AT" Command

A 40-character command line is provided. The command line starts with AT and may contain several commands. The commands are compatible with EIA document TR30.2.2/88-08006. A separator is not required between the commands. The AT prefix and the terminating CR prefix are not counted in the character total. Spaces are counted, as are left and right parentheses. See Table 3 for Summary.

Serial Host Interface

The serial interface is V.24 (EIA-232-D) compatible interface. Four signals are output by the CH1784 to the indicator interface ($\overline{DCDL}$ $\overline{MR}$/TEST, $\overline{AAE}$, and OHO). The CH1784 also outputs the DTR signal.

Speaker Interface

An interface to an externally supplied speaker circuit is provided. The speaker can be used to monitor call progress. The AT Ln command can be used to adjust the volume in suitable steps. (See Figure 3).

Sleep (Power Down) Mode

To minimize the modem power consumption, the CH1784 includes a sleep (power down) mode which may be enabled or disabled. If enabled the CH1784 enters sleep mode whenever the modem has been inactive from 30 seconds to one minute. (Note that the modem never enters power down mode while in data mode.) The modem returns to full operation whenever a ring signal occurs, or the host writes to the DSP, or the DTR input is asserted. Note the V.24 outputs are forced high in the sleep mode to save power.

TECHNICAL SPECIFICATIONS

The selectable modem configurations, along with the corresponding signaling (baud) rates and data rates, are listed in Table 4.

Tone Generation

DTMF TONE

A DTMF tone pair can be generated with a frequency accuracy of ±1.5%. The dial digit tone pairs are:

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

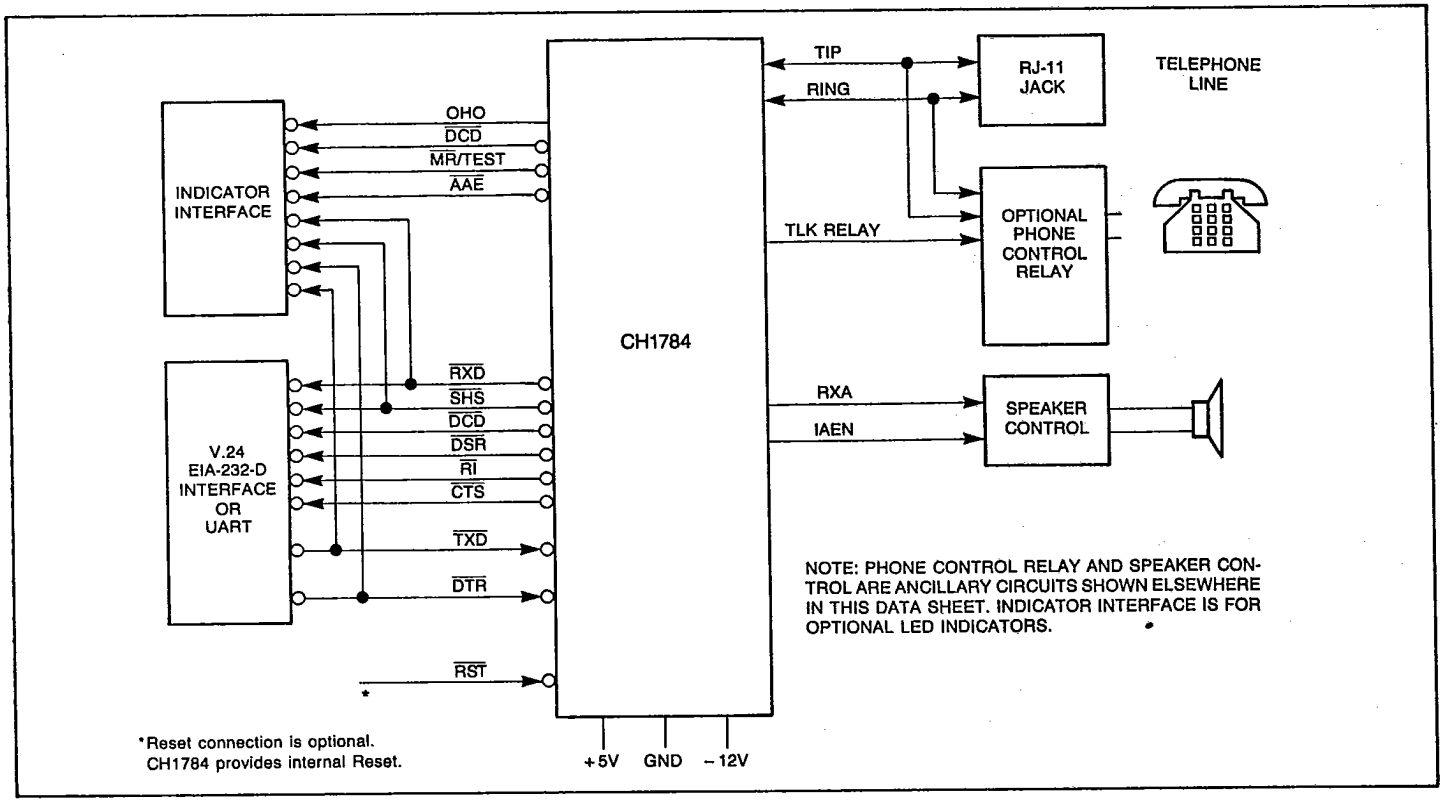

Figure 2. CH1784 Application Diagram.

Table 1. CH1784 Pin Descriptions

T-75-33-90

Pin	Name	I/O	Function
1	RING*	I/O	Directly connects to the telephone line's Ring lead through a user supplied RJ-11C jack.
5	TIP*	I/O	Directly connects to the telephone line's TIP lead through a user supplied RJ-11C jack.
11	OHI*	I	**OFF-HOOK INPUT.** A HIGH takes the telephone line interface OFF-HOOK.
14	RST*	I	**RESET** input (active HIGH). After each power-up cycle, this input can be asserted HIGH for at least 1 ms after the +5V supply is stable. RESET is then returned LOW for normal operation. The CH1784 has a built-in power up RESET. The use of this pin is optional. It should be grounded if not used.
15	5V*	I	Power supply, +5.0V ±5%
16	$\overline{HS}$*	O	LOW indicates modem connection at 2400 bps.
20	−12V*	I	Power supply, −12.0V ±5%
21	GND*	I	Signal and power ground.
22	RXA*	O	Receive data audio output - requires speaker circuit shown (Figure 3) to monitor call progress.
23	$\overline{RI}$*	O	**RING INDICATION.** A LOW indicates that the local telephone line is ringing. This signal follows the envelope of the ringing signal (normally 2 seconds LOW, 4 seconds HIGH).
24	OHO*	O	**OFF HOOK OUTPUT.** A HIGH indicates the modem is OFF-HOOK. If pulse dialing is initiated, this pin will follow the dial pulses.
25	$\overline{CTS}$*	O	**CLEAR-TO-SEND** output. When LOW, the modem has set up the data call and is ready to transmit data.
26	$\overline{DSR}$*	O	**DATA SET READY** output. A LOW indicates the modem is OFF-HOOK.
27	IAEN	O	**OUTPUT HIGH** indicates CH1784 is operating in normal power mode. A LOW indicates power down, or sleep mode.
28	$\overline{MR}$/TEST*	O	**MODEM READY ACTIVE LOW** - Modem is ready and not in the test mode. In the test mode, the output pulses to flash the test mode indicator.
29	$\overline{DCD}$	O	**DATA CARRIER DETECT** output. When asserted LOW, the received data carrier is present.
30	$\overline{AAE}$	O	LOW indicates that the modem auto answer mode has been enabled.
32	RXD*	O	**RECEIVE DATA.** Serial receive data output. Received MARKING or a binary 1 condition is indicated by a HIGH.
33	$\overline{DCDL}$	O	**DCDL** indicator output follows DCD. Can be used for an LED indicator.
35	TXD*	I	**TRANSMIT DATA.** Serial transmit data input. Marking or a binary 1 condition is transmitted when a HIGH is asserted.
36	$\overline{DTR}$*	I	**DATA TERMINAL READY** input. Must be asserted LOW before the modem can interpret commands, answer or initiate calls. Once a call is established, $\overline{DTR}$ can disconnect the call by asserting it HIGH for greater than 50 ms.
39	TLKRELAY	O	**TALK/DATA** relay driver used to disable an optional appended telephone when in the data mode. See circuit diagram.

*These pins are in common with CH1780 and support basic asynchronous modem operation.

GUARD TONE
A guard tone of 550 ±20 Hz or 1800 ±20 Hz can be generated at 3 ±1 dB or 6 ±1 dB below the transmit level, respectively.

ANSWER TONE
A CCITT (2100 ±15Hz) or Bell (2225 ±10 Hz) answer tone is generated depending on the selected configuration.

Data Encoding
The data encoding conforms to CCITT Recommendations V.22 bis or V.22, or to Bell 212A or 103, depending on the selected configuration.

Line Equalization
Transmitter and receiver digital filters compensate for delay and amplitude distortion during operation on nominal phone lines. In addition, automatic adaptive equalization in the receiver minimizes the effects of intersymbol interference.

Transmission Speed
The transmission rate of the host computer must be 300, 1200, or 2400 bps. The modem will connect at the selected speed or will fallback to the speed set by the remote modem with the serial interface, the DTE transmission speed is speed sensed.

When the modem answers a call, it determines the transmission speed from the carrier signal of the originating modem. V.22 bis ORG can also adapt so that the setting of the modem is matched to the remote system.

Speed and Parity Selection
Before a call, the modem adjusts to the host speed (2400, 1200, 300 or 110 bps) and parity (odd, even, mark, space or none) via a host-initiated training sequence. This also selects the speed of the data call for originate calls. The modem automatically adapts to the caller's speed on answer calls.

The modem matches the host's parity when it returns status messages to the host. During a data connection, however, the modem passes parity through without interpretation or alteration.

Power Supply
The modem module is a complex sub-system that may be treated as any other component. Special attention should be paid to the power supply connections. The modem decodes analog signals from the telephone line that are in the millivolt range and even though the modem is designed to withstand significant induced power supply noise, there is a limit. Steps must be taken to guarantee that power supply noise on all supply lines including ground does not exceed 50mV peak to peak. Failure to provide such operating conditions could cause the modem to malfunction.

The CH1784 requires a single +5V ±5% supply and a −12V ±5% supply. It is recommended that by-pass capacitors be placed on the power supply line as close to the modem's supply input as practical. It is recommended that a 220 μF Electrolitic capacitor in parallel with a 0.01 μF disc capacitor be used.

MODEM CONTROL
The CH1784 modem may be controlled by sending serial ASCII command sequences. The commands are sent to the modem serially on TXD. After execution of the command, the modem returns a serial status message on RXD, to indicate the completion status of the command.

Initializing the Modem
Before commands may be sent to the modem, the modem must be initialized. This consists of two events: 1) after power-up, a hardware reset pulse can be applied to the modem, and 2) the modem must be trained to the host's speed (2400, 1200, 300, 110 bps) and parity (odd, even, mark, space or none).

Power-Up Reset
After applying power to the modem, a high-going reset pulse can be applied on RST for at least 1 ms. after the ±5V power supply has stabilized. The modem has a built-in power up reset pulse generator which can be overridden by the external reset pulse.

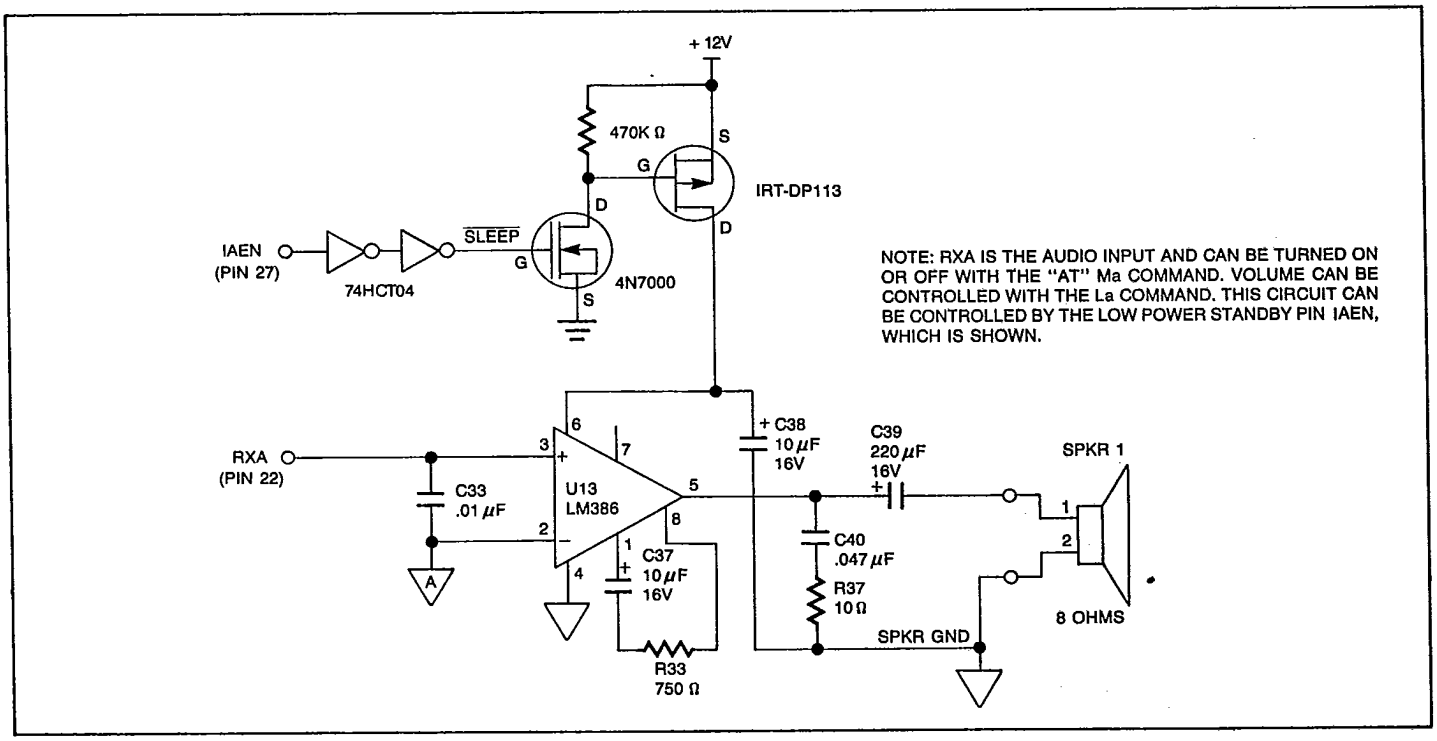

Figure 3. Speaker Control Circuit — optional to allow for call progress monitoring.

Training the Modem

The modem must be trained to match the host's speed and parity so that it is able to recognize serial asynchronous commands sent to it by the host UART. The host must retrain the modem each time a reset signal is applied on RST or after a RESET serial command. The modem is trained by sending it the following three character sequence:

AT[CR]
where: **A** and **T** must be upper case or lower case
[CR] represents carriage return

The modem will respond with either one of the following status messages, depending on whether it is optioned for abbreviated or English status messages.

0[CR] (abbreviated form)
[CR][LF]OK[CR][LF] (English form)
where: **[CR]** represents carriage return (ASCII 13)
[LF] represents line feed (ASCII 10)

The modem may be retrained any time while it is idle.

Another attention sequence "A/" is much like the "AT" sequence except it repeats the previously entered command specified with an "AT" prefix. When given, it must also be in upper case ASCII. No carriage return is needed.

The Command Format

Typical commands consist of three elements, the attention sequence, the commands themselves, and a terminating carriage return.

AT[commands][CR]
where: **[CR]** represents carriage return (ASCII 13)

When entering commands to the modem, the backspace character—control-H (ASCII 8)—can be used to edit mistakes. "AT" and "A/" may not be edited however. Multiple commands may be placed in the command line. A command line may be as long as 40 characters, excluding AT. The command below instructs the modem to configure itself to not echo characters in the command mode (E0) and then go to answer mode.

ATE0A[CR]

AT Command Data Rate

With the serial interface, the rate is speed sensed for parity and format.

AT Command Set

The AT command set is 2400B compliant. The commands are divided into three types; basic commands, dial modifiers, and ampersand commands as listed in Table 3. The supporting S registers are listed in Table 2.

Table 2.
CH1784 Register Summary*

Register	Function
S0*	Ring to Answer On
S1	Ring Count
S2	Escape Code Character
S3	Carriage Return Character
S4	Line Feed Character
S5	Back Space Character
S6	Wait For Dial Tone
S7	Wait Time for Data Carrier
S8	Pause Time for Comma
S9	Carrier Detect Response Time
S10	Lost Carrier to Hang-up Delay
S11	DTMF Dialing Speed
S12	Escape Code Guard Time
S14*	Bit Mapped Options Register
S16	Modem Test Options
S18*	Test Timer
S21*	Bit Mapped Options Register
S22*	Bit Mapped Options Register
S23*	Bit Mapped Options Register
S25*	Delay to DTR
S26*	RTS to CTS Delay Interval
S27*	Bit Mapped Options Register

Notes:
*This S-Register is stored in the modem NVRAM upon receipt of the &W command so that the contents are preserved when modem power is removed.

Table 3.
CH1784 "AT" Command Set Summary*

Basic Commands	Function
AT	Attention Code
A	Answer Command
A/	Repeat Last Command
Bn	Communications Standard Option
C1	Carrier Control Option
D	Dial Command
En	Off-line Character Echo Option
F1	On-line Character Echo Option
Hn	Switch Hook Control Option
In	Identification/Checksum Option
Ln	Speaker Volume Option
Mn	Speaker Control Option
On	On-line Command
P	Pulse Dial
Qn	Result Code Display Option
Sn	Select an S Register
Sn=	Write to an S Register
Sn?	Read an S Register
T	Touch Tone Dial
Vn	Result Code Form Option
Xn	Result Code Set/Call Progress Option
Yn	Long Space Disconnect Option
Zn	Recall Stored Profile Command
+++	Escape Code Sequence
,	Pause
?	Returns Last Addressed S Register

(continued)

Table 3. (cont'd.)
CH1784 "AT" Command Set Summary*

Dial Modifiers	Function
P	Pulse Dial
R	Originate Call in Answer Mode
S=n	Dial Stored Number (n=0:3)*
T	Touch Tone Dial
W	Wait for Dial Tone
;	Return to Idle State
@	Wait for Quiet Answer Command
!	Flash Hook
,	Pause
0-9	Dial Digits/Characters
A,B,C,D	
#,*	

Ampersand Commands	Function
&Cn	Data Carrier Detect Option
&Dn	Data Terminal Ready Option
&F	Load Factory Defaults
&Gn	Guard Tone Option
&Jn	Auxiliary Relay Control
&Mn	Communications Mode Option
&Pn	Make to Break Ratio Selection
&Qn	Communications Mode Option
&Sn	Data Set Ready Option
&Tn	Test Command Selection
&V	View Active Configuration and User Profiles*
&Wn	Store Active Profile*
&Xn	Synchronous Transmit Clock Source Option
&Yn	Select Stored Profile on Powerup Option*
&Zn=x	Store Telephone Number (n=0-3)*

Note: A detailed definition of all commands and registers is available from Cermetek Microelectronics, Inc.

The Status Messages

The modem responds with a status message after each command is executed. This status message may either be a single digit followed by a carriage return or it may be a carriage return and line feed with a message in English followed by a carriage return and line feed.

The basic status code subsets are enabled with the Xn command. Where n = 0, 1, 2, 3, 4 the status codes can be in message form or result code form. The following are the result codes selected for the five Xn commands:

X0 - Result Codes 0, 1, 2, 3, 4
X1 - Result Codes 0, 1, 2, 3, 4, 5, 10
X2 - Result Codes 0, 1, 2, 3, 4, 5, 6, 10
X3 - Result Codes 0, 1, 2, 3, 4, 5, 7, 10
X4 - Result Codes 0, 1, 2, 3, 4, 5, 6, 7, 10 (factory default)

Result Codes, or Status Messages	Meaning
0 or DK	Command executed
1 or Connect	Carrier detected at 300 bps
2 or Ring	Ring detected
3 or No Carrier	Did not detect carrier
4 or Error	Entry error
5 or Connect 1200	Carrier detected at 1200 bps
6 or No Dial Tone	Off-Hook, but no response after 5 seconds
7 or busy	Busy signal detected
10 or Connect 2400	Carrier detected at 2400 bps

Modem States

The modem can be in either a command state or a data mode state. When the modem is idle, it is in the command state. When a data call is in progress it is in the data mode state. The modem does not recognize commands when in the data state. To recognize commands, the computer must send an "escape sequence" to the modem that forces it out of the data mode and into the command mode.

The escape sequence consists of a "guard time" (a period where no characters are sent to the modem) followed by 3 escape characters followed by a "guard time" again. At power-up, the guard time is set to 1 second minimum and the escape character is set as "+". These two parameters can be modified via registers S2 and S12.

The modem will stay off-hook with its carrier on after the escape sequence is received. It returns an OK status message when it is ready to accept commands. You may re-enter the data mode by issuing the ONLINE command **ATO[enter].**

"AT" COMMAND APPLICATIONS

Pause ","

When placing a call from an office with a telephone connected to a PBX, it may be necessary to dial an access code (usually the digit 9) to get an outside line. Inserting a comma in the telephone number commands the modem to pause for a specific length of time. The factory default pause time is 2 seconds.

Example: Dial 9, pause, dial number.

Enter: AT DT9, 1234567

Multiple commas may be used for a greater delay time.

Touch Tone and Pulse Dialing "T and P"

The modem can use DTMF (touch-tones) or dial pulses when dialing a telephone number. If the dial command does not specify which type to use, the modem defaults to the type last specified. The power-on default value is P.

Example: Pulse dial 9, pause, touch-tone dial number.

Enter: AT DP9, T1234567

Originate a Call in Answer Mode "R"

The D command forces the modem into originate mode. To call an originate-only modem, dial the number and set the modem to answer mode via the R (reverse originate). Enter the R command at the end of the telephone number.

Example: Dial number in answer mode.

Enter: AT D1234567R

Redial Last Number "A/"

Use A/, the repeat command, to redial the last telephone number dialed when a busy signal is received.

Return to Command State ";"

The modem can be forced to reenter the command state after dialing (without hanging up) by ending the dial command with a semicolon. This is useful when using the modem as an auto dialer.

Example: Touch-tone dial 9, pause, dial number, return for command.

Enter: AT DT9, 1234567;
Result: OK

Automatic Answering

The S0 register controls the number of rings that must occur before

the modem answers a call. The register may range in value from 0-255.

S0 = 0 DO NOT ANSWER TELEPHONE
S0 = 1 ANSWER ON RING 1
S0 = 2 ANSWER ON RING 2
S0 = 3 ANSWER ON RING 3
S0 = 255 ANSWER ON RING 255

When S0 is set to 0, the modem will not auto-answer.

Example: Assign the value "6" to S0 to set the modem to answer on the sixth ring.

Enter: AT S0 = 6

Result: OK

Dial a Number "D"
The Dial Command takes the form Dn, where n is a string of characters. In the simplest form, n will be only the digits of the phone number to be dialed.

Example: Dial number.
Enter: AT D1234567

In response to this command, the modem dials the telephone number "123-4567" and then waits for carrier from a distant modem. If no carrier is detected within a given time (the default time is 30 seconds), the modem automatically releases the line and sends a NO CARRIER result code. If carrier is detected, the modem gives a CONNECT result code and goes on-line, permitting communication with the distant modem.

The Dial Command may also be issued without a telephone number. ATD causes the modem to pick up the telephone line without dialing a number.

Connecting to the Host UART/USART

Since a modem communicates data serially and most host products handle data in a parallel format, a UART or USART is needed to make parallel-to-serial and serial-to-parallel translations.

The Serial Interface Lines

The module supports a full RS-232C/V.24 serial interface. Signal levels are TTL rather than RS-232C level compatible, which allows you to directly connect the modem to your host's UART/USART without level translating circuitry. A complete description of each signal follows under Pin Description.

Three of these lines must be utilized for proper modem operation; TXD, RXD and $\overline{DTR}$. The modem is controlled by sending it serial commands over TXD and can be monitored by serial status messages returned on RXD. $\overline{DTR}$ must be asserted ON (LOW) for the modem to interpret commands sent to it on TXD and will disconnect a call if $\overline{DTR}$ is asserted OFF (HIGH) during a call.

All other serial interface lines may be utilized for the convenience of your application but are not required by the modem. Unused outputs (from modem) should be left unconnected. Unused inputs should be tied to the proper logic level.

Phone Line Connection Guidelines

1) The mounting of the CH1784 in the final assembly must be made so that it is isolated from exposure to any hazardous voltages within the assembly. Adequate separation and restraint of cables and cords must be provided.
2) The circuitry from the CH1784 to the telephone line interface must be provided in wiring that carries no other circuitry than that specifically allowed in the rules (such as A and A1 leads).
3) Connection to the phone line should be made through an RJ-11C jack.
4) Traces from the modem's RING and TIP pins to the RJ-11C jack must exceed 0.1 inch spacing to one another and 0.2 inch spacing to all other traces. The traces should have a nominal width of 0.020 inches or greater.
5) The RING and TIP traces should be as short as possible and oriented to prevent coupling other high speed or high frequency signals onto the host circuit card.
6) No additional circuitry other than that shown in the following Figure may be connected between the modem module and the RJ-11C jack.
7) The supplied FCC registration label must be applied visibly on the outside of the host product.
8) The host product's User Manual must provide the user with instructions for connection and use as recommended in Section FCC Registration.

International Approvals

The CH1784 can additionally be approved for many international telephone connections. This must be done, however, after the modem is installed in the host product. The entire host product must then be submitted to the international country's Telephone Network for approval.

The CH1784 has been designed to meet the high isolation voltage requirements of PTTs, such as the U.K.'s Reinforced Barrier, specified in BS6301. The 4.5KVrms isolation exceeds the most stringent PTT requirements.

Mounting the Modem

The modem contains static sensitive devices and should only be handled by personnel and in areas that are properly protected against static discharge.

There are two popular mounting techniques that are recommended for physically connecting the modem to your circuit card; 1) sockets, and 2) direct soldering. Each approach has its own set of benefits and challenges.

The direct soldering approach solders the modem directly into the host circuit card. This approach provides the most sound mechanical mounting and also the best electrical connection. However, it does present a couple of challenges.

If the modem is wave soldered on a circuit card, flux and other corrosive chemicals can be left inside the modem's plastic housing. Care should be taken during the freon rinse cycle to fully wash the chemical residue away. Ideally, the modem should be soldered in by hand after the rest of the card is wave soldered to minimize this problem. Also, soldering can present a sizable challenge if the modem ever needs to be removed from the card. Unsoldering 44 contacts can damage the circuit card unless proper desoldering equipment is used.

If the direct soldering approach is selected, it is recommended that 0.040 inch diameter plated through holes be used with 0.060 inch minimum diameter pads.

The socketing approach to mounting eliminates cleaning and desoldering concerns. When a socket is used, it must make a solid connection to all modem pins. Failure to do so will cause unreliable modem operation. Also, steps should be taken to assure that the module remains tightly seated in the socket after the host product is shipped.

If you decide to select the socket approach, make sure that the socket is designed to accept square 0.025 inch pins. Single-in-

line sockets may be purchased from manufacturers such as SAMTEC or Augat.

FCC REGISTRATION

The CH1784 is registered with the FCC (Federal Communications Commission) under Part 68. To maintain the validity of the registration, you must serve notice to the end user of the product that contains the modem of several restrictions the FCC places on the modem and its use. The following notice is recommended and should be included in the host product's USER MANUAL. Also, the FCC requires that Cermetek make all repairs to the modem. If repair is necessary after the modem is installed in your product and has been delivered to your customer, the modem must be returned to you where it can be removed from the host product and then forwarded to Cermetek for repair.

FOR YOUR USER'S MANUAL

The Part 68 rules require the following or the equivalent information be provided to the end user of equipment containing a DAA:

Type of Service: The (insert your product name) is designed to be used on standard device telephone lines. It connects to the telephone line by means of a standard jack called the USOC RJ-11C (or USOC FJ45S). Connection to telephone company-provided coin service (central office implemented systems) is prohibited. Connection to party lines service is subject to state tariffs.

Telephone Company Procedures: The goal of the telephone company is to provide you with the best service it can. In order to do this, it may occasionally be necessary for them to make changes in their equipment, operations or procedures. If these changes might affect your service or the operation of your equipment, the telephone company will give you notice, in writing, to allow you to make any changes necessary to maintain uninterrupted service.

If you have any questions about your telephone line, such as how many pieces of equipment you can connect to it, the telephone company will provide this information upon request.

In certain circumstances, it may be necessary for the telephone company to request information from you concerning the equipment which you have connected to your telephone line.

Upon request of the telephone company, provide the FCC registration number and the ringer equivalence number (REN) of the equipment which is connected to your line; both of these items are listed on the equipment label. The sum of all of the REN's on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be usable on a given line.

If Problems Arise: If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line, as it may cause harm to the telephone network. If the telephone company notes a problem, they may temporarily discontinue service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified, you will be given the opportunity to correct the problem and informed of your right to file a complaint with the FCC.

In the event repairs are ever needed on the (insert your product name), they should be performed by (insert your company name) or an authorized representative of (insert your company name). For information contact: (insert your company address).

DIAGNOSTIC TESTS

The CH1784 supports the following tests to help diagnose the source of data communications problems that may be encountered.

Analog Loop Test

In an analog loop test, transmitted characters are looped back to the sending terminal or computer. This allows verification of the modem's analog circuits. These circuits modulate and demodulate the host's data. Since the modem uses different circuits to originate and answer calls, it is important to test both answer and originate modes.

An analog loop self test can also be performed. In a self test the modem automatically generates characters back as before. In addition, the modem transmits a character stream and compares it with the received character stream for accuracy. This is a more rigorous test than is possible with the basic analog loop set-up.

Digital Loop Test

In a digital loop test, data that is received from the remote modem is looped back or re-sent to the remote modem. This test is performed after a data connection has been established and after the local modem is enabled to enter this test mode. To go back on line and return to the data mode, type ATO.

If the remote terminal or computer is having trouble exchanging data with the local host, the problem is usually related to either a poor modem-to-modem connection or incompatible communication settings (parity, data bits, etc.). If a digital loop test is performed and the remote modem receives exactly what is sent, then the data exchange difficulties are probably due to incompatible communication settings.

Remote Digital Loop Test

Once a connection has been established, this command makes it possible for a local operator to put the remote modem into Digital Loop. When this is done, characters sent to the remote modem are looped back to the local modem.

Default Configuration Profile

V.22 bis operation at 2400 bps
Even parity
Auto answer disabled
Command echo ON
All result codes enabled
Wait for dial tone before dialing
Detects busy signal
Full word result codes
Pulse dial make/break ratio = 39/61
Test timer set to 0 seconds
Long space disconnect disabled
Ring count — 00
Escape code character = 43
Carriage return character = 13
Line feed character = 10
Back space character = 08
Duration of wait for dial tone = 02 seconds
Duration of wait for carrier after dialing = 30 seconds
Duration of dial pause (comma) = 02 seconds
Carrier detect response time = 0.6 seconds
Escape code guard time = 01 seconds

Table 4. System Compatibility Specifications

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Parameter	Specification
Asynchronous	2400, 1200, 600 bps, character asynchronous. 0 - 300 bps asynchronous
Asynchronous Speed Range	+2.3% - 2.5%, extended range option of CCITT standards in character asynchronous mode.
Asynchronous Format	8, 9, 10, 11 bits, including start, stop, parity
Telephone Line Interface	Two wire full duplex over public switched network. On-chip hybrid and billing delay timers. Output level −10dBm ±1dB.
Modulation	V.22 bis QAM V.22 and 212A, DPSK 103, FSK
Output Spectral Shaping	Square root of 75% raised cosine, QAM/PSK.
Transmit Carrier Frequencies V.22 bis, V.22, 212A	Originate 1200 Hz ±.01% Answer 2400 Hz ±.01%
V.21 at 300 bps	Originate 'space' 1180 Hz ±.01% Originate 'mark' 980 Hz ±.01% Answer 'space' 1850 Hz ±.01% Answer 'mark' 1650 Hz ±.01%
Bell 103 mode	Originate 'space' 1070 Hz ±.01% Originate 'mark' 1270 Hz ±.01% Answer 'space' 2020 Hz ±.01% Answer 'mark' 2225 Hz ±.01%
Receive Carrier Frequencies V.22 bis, V.22, 212A	Originate 2400 Hz ±7 Hz Answer 1200 Hz ±7 Hz
V.21	Originate 'space' 1850 Hz ±12 Hz Originate 'mark' 1650 Hz ±12 Hz Answer 'space' 1180 Hz ±12 Hz Answer 'mark' 980 Hz ±12 Hz
Bell 103	Originate 'space' 2020 Hz ±12 Hz Originate 'mark' 2225 Hz ±12 Hz Answer 'space' 1070 Hz ±12 Hz Answer 'mark' 1270 Hz ±12 Hz
Receiver Sensitivity	OFF to ON threshold −43 dBm ON to OFF threshold −48 dBm
Line Equalization	Fixed compromise equalization, transmit. Adaptive equalizer for PSK/QAM, receive.
Diagnostics Available	Local analog loopback. Local digital loopback. Remote digital loopback.

Table 4. System Compatibility Specifications—continued

Parameter	Specification
Self Test Pattern Generator	Alternate 'ones' and 'zeros' and error detector, to be used along with most loopbacks. A number indicating the bit errors detected is sent to DTE.
Call Progress Tones Detected:	Screen messages (no dial tone, busy, modem answer tone).
Computer Interface:	V.24 serial interface

Table 5. Transmission Performance Specifications

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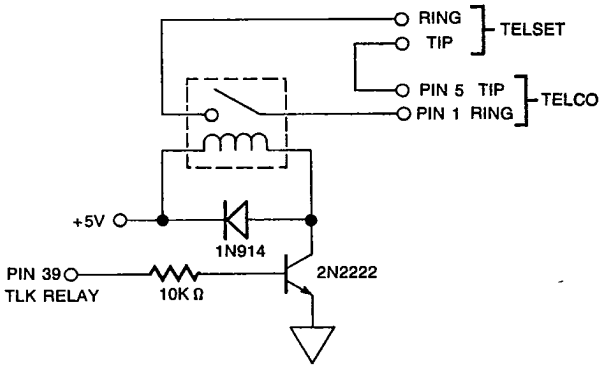
Parameter	Specification
Test condition: Unconditioned 3002 line, across the full dynamic range. The noise bandwidth is 3 KHz flat.	
Random Noise	Bit Error rate of 1 in 100,000 or better at 9 dB SNR at 300 bps, 12 dB SNR at 1200 bps, 15 dB SNR at 2400 bps.
Frequency Offsets (1)	±7 Hz.
Phase Jitter (1)	1200 bps −45° peak to peak, at up to 300 Hz.

Table 6. Other Performance Specifications

Parameter	Min.	Typ.	Max.	Units	Comments
High Channel Transmit Amplitude		−1		dB	Referenced to Low channel, Guard Tone enabled.
Tone Detection Passband Frequency	290		665	Hz	3 dB Point
Tone Detection OFF to ON Threshold	−33			dBM	Into 600 Ω
Tone Detection ON to OFF Threshold	−35			dBM	Into 600 Ω
Dial Tone Detect Duration	5			sec	
Busy Tone Detect Duration Cadence	 0.2 0.67		 1.5	sec	 Off/On Ratio
Power:	+5V ± 5% −12V ± 5%				
Temperature:	Operating 0°-55°C Storage −20°C to +70°C				
Weight:					
Size:	See Figure 5.				



NOTE: TLKRELAY PIN IS USED TO CREATE SEPARATE PORT FOR TELEPHONE CONNECTION SHARING THE TELCO TIP AND RING. TLKRELAY IS TTL COMPATIBLE (I_{OL} = 1.6mn, V_{OL} =0.4V) AND IS ACTIVE DURING DATA CONNECTION WHICH ISOLATES THE TELEPHONE FROM THE TELCO. (THE RELAY CHOSEN MUST MEET THE APPROPRIATE REGULATORY AGENCY.)

Figure 4. TLKRELAY

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Table 7
CH1784 Electrical Specifications
T_A = 0°C to 55°C UNLESS OTHERWISE SPECIFIED

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
LOGIC I/O LINES						
Input high*	V_{IH}		2.0			V
Input low	V_{IL}		−.3		.8	V
Input current high	I_{IH}				500	μA
Input current low	I_{IL}				−500	μA
Output high	V_{OH}	I_{OH} = .1mA	2.4	3.5		V
Output low	V_{OL}	I_{OL} = 1.6mA	0.0	.2	.45	V
Telephone Line Interface AC Impedance	Z_{LINE}			600		Ohms
Surge Protection		Conforms to all FCC Part 68 and most international surge, hazardous voltage, and leakage requirements				
Carrier Transmit Level	P_{TX}	600 Ohm line termination	−11	−10	−9	dBm
Carrier Receive Sensitivity	R_{CAR}	OFF to ON detection ON to OFF drop out		−43 −48		dBm dBm
On-Hook Impedance	Z_{ONHK}		20M			Ohms
Loop Current	I_{LOOP}		20		100	mA
Ringer Equivalence				0.3A		REN
DIALING						
DTMF level			−8	−6	−4	dBm
DTMF freq. acc.			−1.5		+1.5	%
DTMF on time		Default = 95 ms	50	95	255	ms
DTMF off time		Default = 95 ms	50	95	255	ms
Pulse speed				10		pps
Pulse ratio		Make/break ratio		39/61		%
Pulse interdigit time				789		ms
HOST INTERFACE TIMING Carrier Detect	T_{CD}		150	—	300	ms
Billing Delay	T_{BD}		2.0	2.5	3.0	sec

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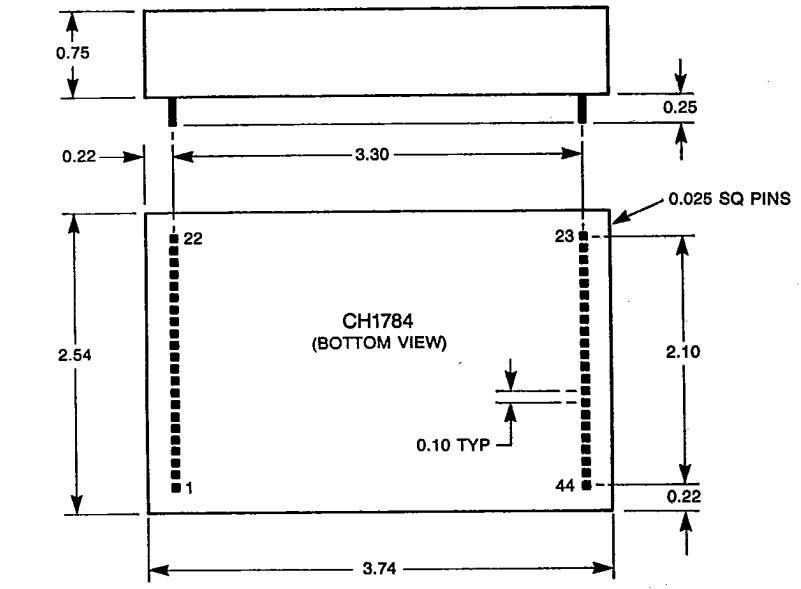
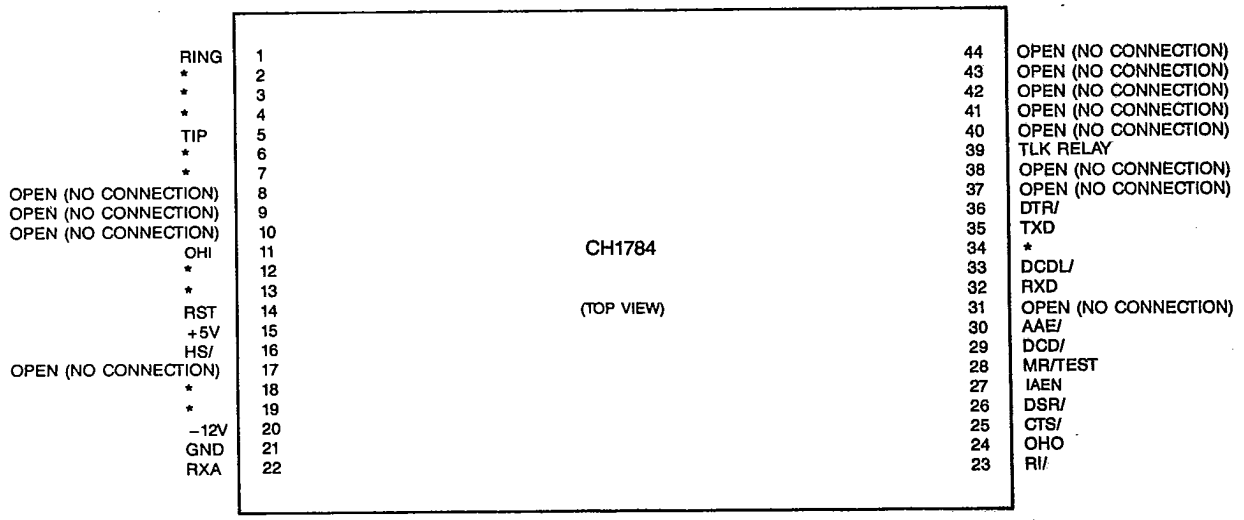


NOTES: 1) ALL DIMENSIONS ARE IN INCHES
2) 0.025 SQUARE POST PINS ARE USED FOR MODULE CONNECTION. ROUND TYPE 0.025 DIAMETER PINS ARE AVAILABLE UPON SPECIAL REQUEST.
3) SKYLINE PROFILE: NO COVER ON MODULE, MAXIMUM HEIGHT AS INDICATED.

Figure 5. Physical Dimensions



NOTE 1) AN ASTERISK INDICATES A FACTORY TEST POINT. MAKE NO CONNECTION TO THESE PINS.

Figure 6. Pin Configuration