T-75-33-90

CH1775 Modem Module

INTRODUCTION

The Cermetek CH1775 Modem Module offers the design engineer a quick and easy way of integrating a high performance modem into a product. Integration consists of mounting the module on the host's Printed Wiring Board (PWB) which connects the modem to power and to the host UART/USART and out to the phone line through an RJ-11C jack. The module is a fully assembled and tested component that can be plugged in and used right away.

In addition to conserving engineering design and integration time, the Cermetek CH1775 Modem Module is already FCC Part 68 (Federal Communications Commission) registered for phone line connection, and eliminates the three to six month time period normally needed to obtain FCC Part 68 registration, shortening the product introduction cycle.

Every effort has been made to ease the integration of the CH1775 modem into your product. The size of the module is a compact 4.60" x 1.85" x 0.69", which includes the built-in FCC Part 68 registered telephone line interface (DAA). The CH1775 modem requires only a single +5 volt power supply and is 'AT' commands compatible and works with popular software.

The CH1775 features include call progress detection, asynchronous data formats and extensive built-in diagnostic test modes. These parameters can be altered by serial 'AT' commands as well.

The Cermetek CH1775 Modem Module is a Bell 212A/103 and CCITT V.22 compatible modem that can communicate with the vast majority of 1200, 300 and 110 bps full duplex modems installed today.

FEATURES
- Full Duplex 1200/300/110 bps
- Bell 212A/103 and CCITT V.22 standards
- 'AT' command set compatible
- FCC Part 68 registered DAA built-in
- Automatic - answer, speed, parity
- Single +5 volt supply
- Low power consumption
- Operates over dial-up lines
- Call progress tone detection
- Compact size: 4.60" x 1.85" x 0.69"
- Occupies only 8.51 square inches of board space.

OPERATION and USE

The Cermetek CH1775 Modem Component Module integrates easily into most 1200, 300, and 110 bps full duplex modem applications. Each application requires the user to connect it to the phone line, to the host product through a UART (Universal Asynchronous Receiver Transmitter) or USART (Universal Synchronous Asynchronous Receiver Transmitter), and to the power supply. The following discussion will guide you through these connections, give you design examples, and also make recommendations for printed circuit board layout.

Connecting to the Phone Line

The CH1775 module incorporates an 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 registra-
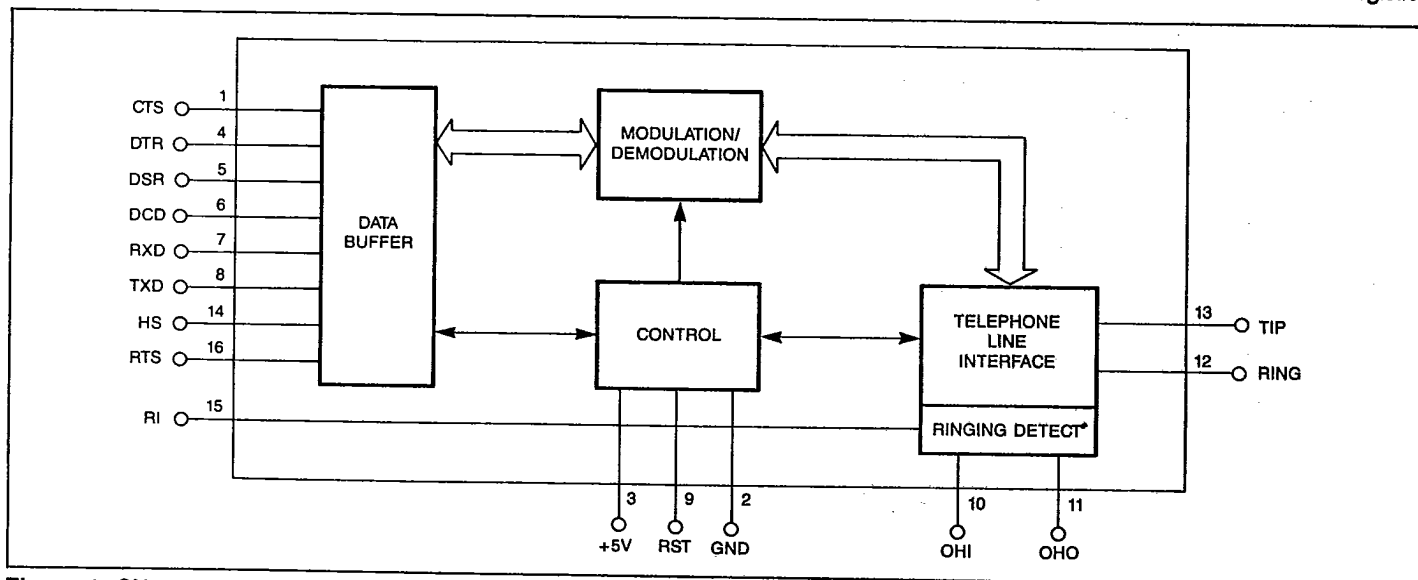

Figure 1. CH1775 Block Diagram

tion may be used by the host product without re-registration provided that the following guidelines are followed.

Phone Use Connection Guidelines

1) The mounting of the CH1775 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 CH1775 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 a 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 Figure 2 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.

Canadian Approval

The CH1775 can additionally be approved for Canadian telephone connection. This must be done, however, after the modem is installed in the host. The entire host system must then be submitted to Canada's DOC, Department of Communications, for approval. Because the DOC requires additional protection, the following additional telephone line interface circuitry, shown in the dotted box, is needed. This circuitry is optional for FCC Part 68 registration in the U.S.A.
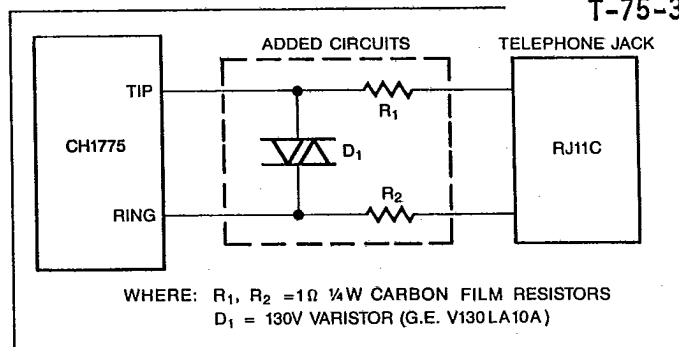

WHERE: R_1, R_2 = 1Ω ¼W CARBON FILM RESISTORS
D_1 = 130V VARISTOR (G.E. V130LA10A)

Figure 2. Additional Circuitry Needed for Canadian DOC Registration

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 16 contacts can damage the circuit card unless proper desoldering equipment is used.
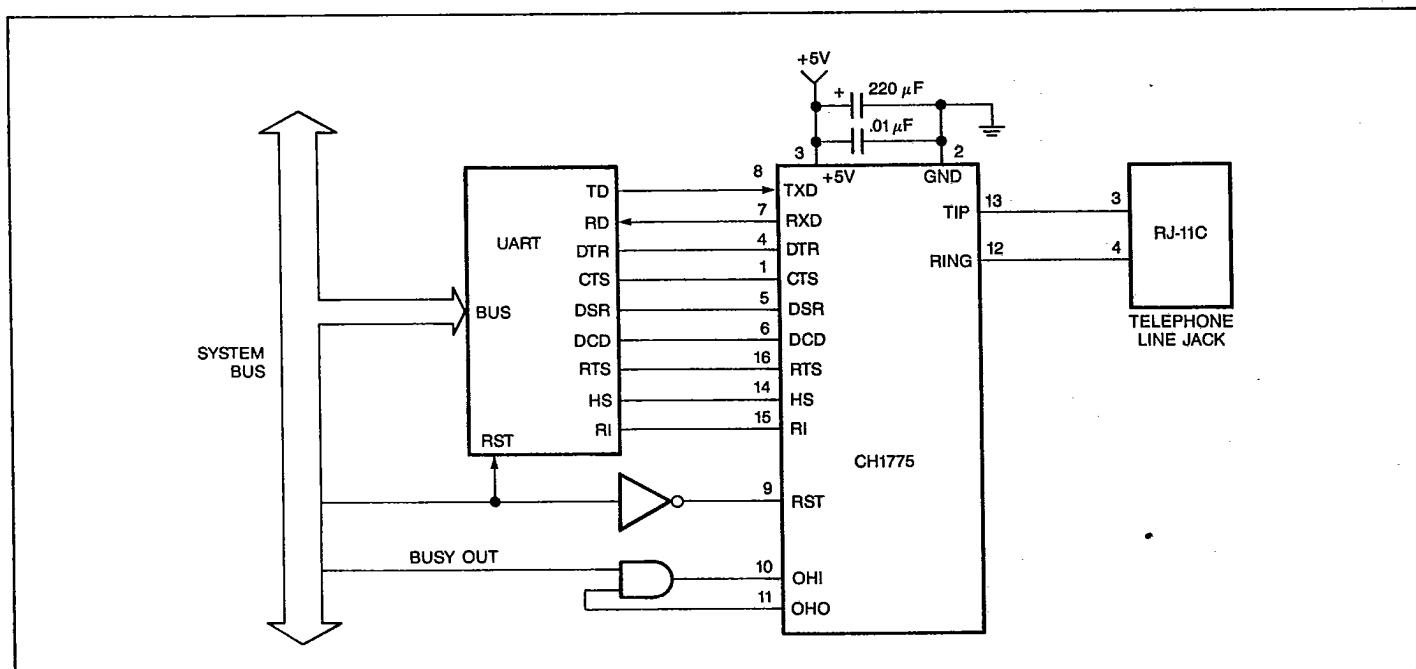

Figure 3. Typical Application

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. One method of achieving this is to use a cable wrap fastened around the module to hold it to the circuit card.

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.

Design Example

The best way to provide application information for a modem is by example. The following example will briefly show how the modem module is utilized in a common application.

Speed and Parity Selection

Before a call, the modem adjusts to the host speed (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 CH1775 requires only a single +5V ±5% supply. It is recommended that by-pass capacitors be placed on the +5V power supply line as close to the modem's supply input as practical. It is recommended that a 220 μF Electrolytic capacitor in parallel with a 0.01 μF disc capacitor be used.

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 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 DTR. The modem is controlled by sending it serial commands over TXD and can be monitored by serial status messages returned on RXD. DTR must be asserted ON (LOW) for the modem to interpret commands sent to it on TXD and will disconnect a call if 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.

MODEM CONTROL   T-75-33-90

The CH1775 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 must be applied to the modem, and 2) the modem must be trained to the host UART/USART's speed (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 must be applied on RST for at least 10 ms after the +5V power supply has stabilized.

No commands should be sent to the modem for a minimum of 1 second after releasing the reset signal.

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 (EO) and then go to answer mode.

ATEOA[CR]

Table 1. Pin Descriptions

PIN	NAME	I/O	FUNCTION
1	$\overline{\text{CTS}}$	O	**CLEAR-TO-SEND** output. When LOW, the modem has set up the data call and is ready to transmit data.
2	GND	I	Signal and power ground.
3	+5V	I	Power supply input, +5.0V ±5%
4	$\overline{\text{DTR}}$	I	**DATA TERMINAL READY** input. Must be asserted LOW before the modem can interpret commands, answer or initiate calls. Once a call is established, $\overline{\text{DTR}}$ can disconnect the call by asserting it HIGH for greater than 50 ms.
5	$\overline{\text{DSR}}$	O	**DATA SET READY** output. A LOW indicates the modem is OFF-HOOK.
6	$\overline{\text{DCD}}$	O	**DATA CARRIER DETECT** output. When asserted LOW, the received data carrier is present.
7	RXD	O	**RECEIVE DATA.** Serial receive data output. Received MARKING or a binary 1 condition is indicated by a HIGH.
8	TXD	I	**TRANSMIT DATA.** Serial transmit data input. Marking or a binary 1 condition is transmitted when a HIGH is asserted.
9	RST	I	**RESET** input (active HIGH). After each power-up cycle, this input should be asserted HIGH for at least 10 ms after the +5V supply is stable. RESET is then returned LOW for normal operation.
10	OHI	I	**OFF-HOOK INPUT.** A HIGH takes the telephone line interface OFF-HOOK. It should be directly connected to OHO.
11	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.
12	RING	I/O	Directly connects to the telephone line's Ring lead through a user supplied RJ-11C jack.
13	TIP	I/O	Directly connects to the telephone line's Tip lead through a user supplied RJ-11C jack.
14	$\overline{\text{HS}}$	O	**SPEED INDICATION.** High speed select output. A LOW indicates the modem is operating at 1200 bps. If $\overline{\text{HS}}$ is HIGH, 110/300 bps is supported. $\overline{\text{HS}}$ follows the host speed. (Default is low)
15	$\overline{\text{RI}}$	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).
16	$\overline{\text{RTS}}$	I	**REQUEST TO SEND.** A LOW on this input is used to condition the local DCE for data transmission.

Command Description

AT	:	Command line prefix (ATtention code); precedes command lines except +++ (escape) and A/ (repeat) commands
A	:	Go off-hook in answer mode
A/	:	Re-execute last command line; (A/ is not followed by a carriage return)
B	:	Selects CCITT V.22 operation when communicating at 1200 bps
B1	:	Selects Bell 212A operation when communicating at 1200 bps
C0	:	Disable set transmit carrier signal
C1	:	Enable set transmit carrier signal
D	:	Dial number which follows D in the command line
E	:	Modem does not "echo" commands back to terminal
E1	:	Modem "echos" commands back to terminal
F0	:	Half duplex
F1	:	Full duplex
H	:	On Hook (hang up)
H1	:	Off Hook
I	:	Request product Identification Code
I1	:	Performs checksum on firmware ROM; returns checksum
I2	:	Test internal memory
O	:	Return to on-line state
O1	:	Remote digital loopback off
O2	:	Remote digital loopback request
P	:	Pulse Dial
Q	:	Modem returns result codes
Q1	:	Modem does not return result codes
R	:	Connect in reverse mode
Sr=n	:	Set register r to value n
Sr?	:	Request contents of register r
T	:	Tone Dial
V	:	Short form numeric result codes (Abbreviated)
V1	:	Full word result codes (Verbose)
W	:	Wait for dial tone
X	:	CONNECT result code enabled
X1	:	Modem blind dials; all CONNECT XXXX result codes enabled; busy signal not detected
X2	:	Modem waits for dial tone before dialing; ALL CONNECT XXXX result codes enabled; busy signal not detected
X3	:	Modem blind dials; all CONNECT XXXX result codes enabled; modem sends BUSY result code if busy signal detected
X4	:	Modem waits for dial tone before dialing; all CONNECT XXXX result codes enabled, modem sends BUSY result code if busy signal detected
Y	:	Long space disconnect disabled
Y1	:	Long space disconnect enabled
Z0	:	Reset, use factory default setting
Z1	:	Reset, don't change setting
+++	:	The default escape code
,	:	Pause before continuing (2 seconds)
;	:	Return to command mode after dial
@	:	Wait for quiet answer
!	:	Flash

The Registers

The modem accesses registers to execute a variety of operations. The function of each of these registers is explained below. The value of each register must be 0-255.

Register Description

S0	:	Number of rings before auto-answering a call. If set to 0, the modem will not auto-answer.
S1	:	Counts incoming rings. If no ring occurs for 8 seconds, the counter is cleared to 0. The register only counts when the modem is set to auto-answer (S0 greater than 0).
S2	:	Escape code character. Can be ASCII 0-127. Default is +. If S2 is greater than 127 then the escape code is completely disabled and only a call disconnection will return the modem to the command mode.
S3	:	End-of-line character. This character is used to terminate commands and status messages. Defaults to carriage return (ASCII 13).
S4	:	Line feed character. This character is transmitted following the end-of-line character after English status messages. Defaults to line feed (ASCII 10).
S5	:	Backspace character. This character is typed to erase one command character and move the cursor back one space on the host screen. To erase a character, the modem first transmits a backspace, then a space and then another backspace to move over the blank. Default is backspace (ASCII 8).
S6	:	Dial tone wait. Defines the pause after going off-hook (in seconds). Can't be less than 2 due to FCC regulations. Default is 2.
S7	:	Time, in seconds, to wait for carrier before aborting a connection attempt. Default is 30 seconds.
S8	:	Length of pause, in seconds, produced by the comma command. Default is 2 seconds.
S9	:	Time, in 1/10 seconds, that carrier must be present to be detected. Default is 600 milliseconds.
S10	:	Time, in 1/10 seconds, between loss of carrier and disconnect. Default is 700 milliseconds. If S10 is set to 255, then the modem acts as if a carrier is always present.
S11	:	Duration and spacing of DTMF tones, default is 70 mSec.
S12	:	Time delay, in 1/50 seconds, required before and after an escape code. The time between the characters of the escape code must be less than the value of S12. (See guard time in the Modem States Section) If S12 is 0, then timing is not a factor in recognizing the escape code. Default is 1 second.
S16	:	Select Test mode
S16=0	;	Exit test mode
S16=1A	;	Local analog loopback (High Band)
S16=1D	;	Local analog loopback (Low Band)
S16=3A	;	Local analog loopback self test (High Band)
S16=3D	;	Local analog loopback self test (Low Band)
S16=4	;	Local digital loopback

NOTE: Registers not indicated are not used.

1-11

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.

Basic Status Code Set
(enabled with the X1, X2, X3, X4 commands)

Status Message	Meaning
0 or OK	Command executed
1 or CONNECT	Carrier detected
2 or RING	Ring detected on the phone line
3 or NO CARRIER	Did not detect a carrier
4 or ERROR	Entry error
5 or CONNECT 1200	Carrier detected at 1200 bps

The status codes have 2 extensions. The first extension indicates a 1200 bps connection. The second extension is used to indicate call progress conditions after dialing to the host. Both the extensions are enabled via the "Extended Status Message Select" command. The extended status messages are disabled at power-up.

Extended Call Progress Monitoring Set
(enabled with the X2 and X4 commands)

6 or NO DIAL TONE	Off-hook but no response after 5 seconds

(enabled with the X3 and X4 commands)

7 or BUSY	Busy signal detected
8 or NO ANSWER	No silent answer detected when using @ command
9 or RINGING	Remote line is ringing (Ringback)

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].

FCC REGISTRATION

The CH1775 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.

FCC Requirements

This equipment complies with Part 68 of the FCC rules. On the (bottom/back) of this equipment is a label that contains, among other information, the FCC Registration Number and Ringer Equivalence Number (REN) for this equipment. You must, upon request, provide this information to your telephone company.

The REN is useful to determine the quantity of devices you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most, but not all areas, the sum of the REN's of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices you may connect to your line, as determined by the REN, you should contact your local telephone company to determine the maximum REN for your calling area.

If your telephone equipment causes harm to the telephone network, the Telephone Company may discontinue your service temporarily. If possible, they will notify you in advance. But if advance notice isn't practical, you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC.

Your telephone company may make changes in its facilities, equipment, operations or procedures that could affect the proper functioning of your equipment. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If you experience trouble with this telephone equipment, please contact (company name/service center, phone number, etc.) for information on obtaining service or repairs. The telephone company may ask that you disconnect this equipment from the network until the problem has been corrected or until you are sure that the equipment is not malfunctioning. (Include repairs that customer can make—replacing fuses, plug-in cards, etc.)

This equipment may not be used on coin service provided by the telephone company. Connection to party lines is subject to state tariffs.

DIAGNOSTIC TESTS

The CH1775 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, command (S16=1A, 1D), 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, command (S16=3A, 3D), can also be performed. In a self test the modem automatically generates characters back as before. In addition, the modem transmits an "alternate 0, 1 bit pattern" 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.

An error accumulator inside the modem counts errors (up to 15). The error count is displayed as a status message at the end of the analog loop self test.

Digital Loop Test

In a digital loop test, (S16=4)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

Bell 212A operation at 1200 bps
Even parity
Auto answer enabled
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
Minimum DTR pulse width = .05 seconds
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 = 01.4 seconds
Escape code guard time = 01 seconds

Table 3. System Compatibility Specifications

Parameter	Specification
Asynchronous	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 and 212A, DPSK 103, FSK
Output Spectral Shaping	Square root of 75% raised cosine, QAM/PSK.
Transmit Carrier Frequencies 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, 212A V.21 Bell 103	Originate 2400 Hz ±7 Hz Answer 1200 Hz ±7 Hz Originate 'space' 1850 Hz ±12 Hz Originate 'mark' 1650 Hz ±12 Hz Answer 'space' 1180 Hz ±12 Hz Answer 'mark' 980 Hz ±12 Hz 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 −45 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. Local interface loopback modem.

Table 3. 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, ringback, modem answer tone).
Computer Interface:	IBM PC/XT/AT bus compatible with an INS8250 UART as a serial controller.

Table 4. Transmission Performance Specifications

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.
Frequency Offsets	±7 Hz.
Phase Jitter	1200 bps −45° peak to peak, at up to 300 Hz.

Table 5. Other Performance Specifications

Parameter	Min.	Typ.	Max.	Units	Comments
Tone 2nd Harmonic Distortion			−35	dB	HYB enabled into 600 Ω
DTMF Twist (Balance)		0	3	dB	
DTMF Tone Duration	50	70	255	ms	
Default Duration		70		ms	
Pulse Dialing Rate		10		pps	
Pulse Dialing Make/Break		39/61		%	
Pulse Interdigit Interval		700		ms	
Billing Delay Interval	2.0	2.5	3.0	sec	
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	3.0			sec	
Ringback Tone Detect Duration Cadence	0.75 1.5			sec	Off/On Ratio
Busy Tone Detect Duration Cadence	0.2 0.67		1.5	sec	Off/On Ratio
Power:	+5V ±5%, 180 mA typical				
Temperature:	Operating 0°C to +55°C Storage −20°C to +70°C				
Weight:	0.23 Kg (8.0 oz.)				
Size:	4.60" x 1.85" x 0.69"				

Table 6
CH1775 Electrical Specifications
T_A = 0ºC to 55ºC 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} = 2mA	0.0	.2	.45	V
Telephone Line Interface AC Impedance	Z_{LINE}			600		Ohms
Surge Protection		Conforms to all FCC Part 68 surge, hazardous voltage, and leakage				
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
Trans-hybrid loss	G_{TH}	600 Ω ±30% between TIP and RING	10	15		dB
On-Hook Impedance	Z_{ONHK}		20M			Ohms
Loop Current	I_{LOOP}		20		100	mA
FCC Registration Number		Provided on stickers included with modem				
Ringer Equivalence				0.3A		REN
DIALING						
DTMF level			−8	−6	−4	dBm
DTMF freq. acc.			−0.5		+0.5	%
DTMF on time				70		ms
DTMF off time				70		ms
Pulse speed				10		pps
Pulse ratio		Make/break ratio		39/61		%
Pulse interdigit time				700		ms
HOST INTERFACE TIMING Carrier Detect	T_{CD}		150	—	300	ms
Clear to Send Delay (Answer)	T_{ENA}	110 or 300 bps	175	200	225	ms
		1200 bps	750	775	800	ms
Clear to Send Delay (Originate)	T_{ENO}	110 or 300 bps	125	150	175	ms
		1200 bps	1400	1475	1500	ms
Billing Delay	T_{BD}		2.0	2.5	3.0	sec
DISCONNECT TIMING $\overline{DTR}$ Forced	T_{DTR}	$\overline{DTR}$ asserted OFF (HIGH)	50			ms
Long Received Space	T_{LRS}	Optional	1.6			sec
Loss of Carrier	T_{LC}	Carrier drop out, Optional	77			ms
Send Long Space	T_{SLS}	Optional	4		4.5	sec
SIGNALING Rate		1200 bps Asynch. PSK	−2.5		+2.3	%
		110 or 300 bps, FSK	−2.5		+2.5	%

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Figure 4. Pin Configuration and Physical Dimensions

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