

# **HCS-DTMF**

**Telephone Interface DTMF Encoder/Decoder  
with DAA for the HCS**

**Rev. 1.0**

**\*\*\*\*\* CAUTION \*\*\*\*\***

PLEASE READ THE ENTIRE MANUAL \*\* BEFORE \*\* ATTEMPTING ASSEMBLY !!  
*Understand the significance of each component and jumper setting*  
\* BEFORE \* assembly and applying power. CHECK AND RECHECK !!  
FAILURE TO DO SO WILL PUT YOUR WARRANTY AT RISK !!

**CIRCUIT CELLAR INC.**

**4 Park Street • Vernon, CT 06066**

**TECHNICAL MANUAL**

**HCS-DTMF**

Telephone Interface  
DTMF Encoder/Decoder  
with DAA for the HCS

**Technical Manual**

Release 1.0  
8/20/93

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4 Park St.  
Vernon, CT 06066

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Occasionally in this manual we refer to other manufacturers' products. Such references do not constitute an endorsement of these products, but are included for the purpose of illustration or clarification. We do not intend such technical information and interface data to supersede information provided by individual manufacturers.

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REV. 5/93

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### HCS-DTMF Board Overview

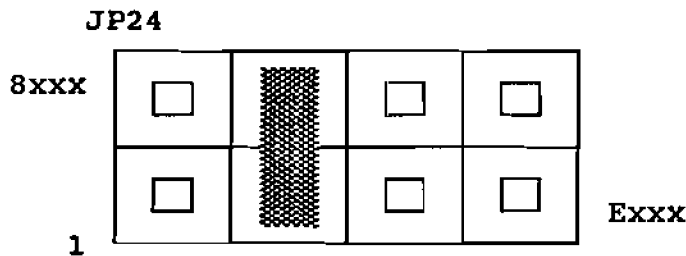
The HCS-DTMF board is designed as an I/O expansion board for the HCS stacking bus. Its I/O capabilities consist of two sections. The first section is a telephone line interface which controls hook status (on/off) and monitors for a ring signal. The last section sends and receives DTMF signals through the telephone interface.

### Addressing the HCS-DTMF Board

All HCS I/O devices must be mapped into a nonconflicting address space. The HCS supervisory controller expects to find the HCS-DTMF board at a particular address. Since all HCS expansion boards have multiple address possibilities to avoid potential address conflicts, make sure yours is set correctly.

#### Base Address

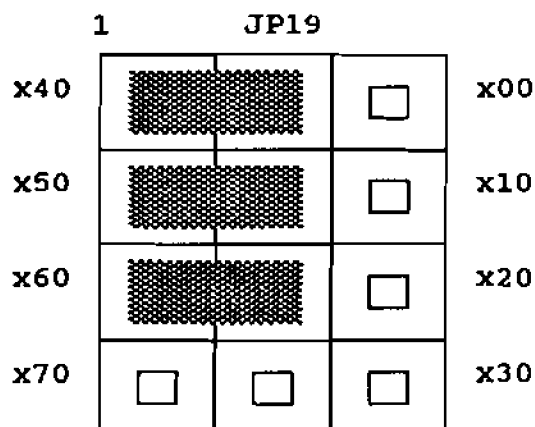
The Base Address choice for the HCS-DTMF board is Axxx (A000H-BFFFH).



A jumper on JP24 is shown selecting Base Address Axxx (A000H-BFFFH).

### Offset Address

The Offset Addresses for the HCS-DTMF board are x40 for the output controls, x50 for ring status, and x60 for DTMF controls (x70 is not used).



Jumpers on JP19 are shown selecting Offset Addresses x40, x50, and x60.

The Base address plus the Offset address equals the actual address. Therefore, when using the examples above for JP19 and JP24, the actual addresses for this board are as follows:

JP24	JP19	Actual Address	Function
Axxx + x40 =	Ax40	(A040H)	Outputs and hook control
Axxx + x50 =	Ax50	(A050H)	Inputs and ring status
Axxx + x60 =	Ax60	(A060H)	DTMF

### Data Access Arrangement (DAA)

The FCC, in an attempt to protect both the phone company and the public from harm, requires any equipment which directly interfaces to the phone lines be registered. The registration process includes rigorous testing of the interface to assure compliance with performance standards and filing registration with the FCC. Basically, your equipment is not allowed to interfere with the normal operation of the phone system. You can pay a testing lab to submit your equipment to the destructive testing necessary in the hopes of passing or use a preregistered interface. The DTMF board uses a pre-registered device to avoid this costly and lengthy procedure.

The CH1840 DAA from Cermetek is registered for both Voice and Data transmission. The Voice/Data input informs the DAA of the intended use of Voice/non-Voice transmissions. This enables a two-second billing delay (an FCC requirement). This delay prevents signalling tones from interfering with those used by the phone company upon an initial connection.

The off-hook input controls the state of the connection, that is, connection to (off hook) or isolation from (on hook) the phone line, akin to picking the handset up from or placing it back in the cradle.

The DAA also provides two status outputs. The TTL-level ring indicator signals the presence of an incoming call by following the switching characteristics of the high voltage AC ring signal when it is present on the phone line. To ensure that processors with only level detection do not miss a ring signal, this signal is latched. Both the latched and unlatched signals are available.

An additional output, the power squelch, provides feedback on the audio level the user is applying to the interface. The FCC requires the audio be limited. The DAA monitors audio levels and squelches it when necessary. The squelch output identifies this operation (billing delay is handled with a squelch operation).

### Phone Line Connection

The HCS-DTMF board connects directly to a standard modular phone jack receptacle using a standard cable with modular phone plugs attached to each end. Plug one cable end into J1, the modular phone jack mounted on the HCS-DTMF board, and the opposite end into an available TELCO phone jack receptacle. (You may want to have an extra modular phone receptacle added for this purpose. The phone company can assist in this process.)

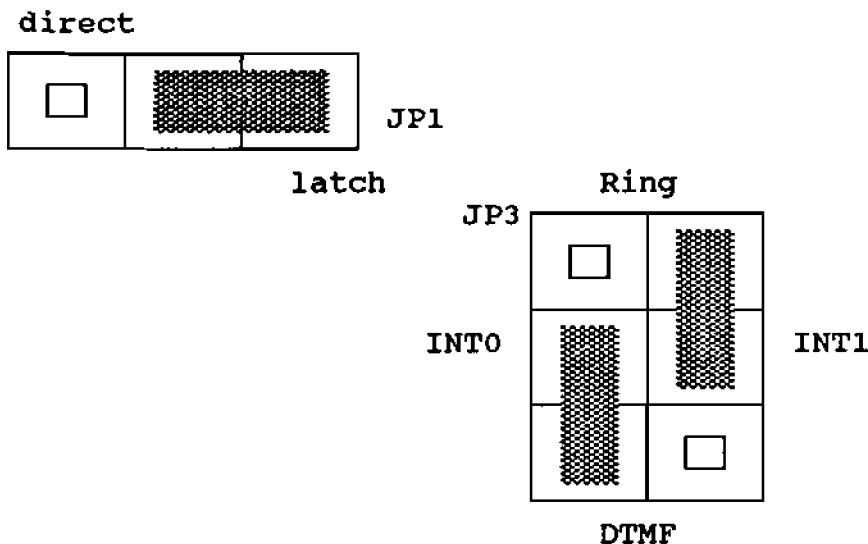
**DTMF Encoder/Decoder**

Now that we have control of an interface to the local phone system, we need a way of sending and receiving information. Dual Tone Multi Frequency, DTMF technology, was developed by the phone company for use with its existing equipment. With the DTMF Encoder/Decoder on this expansion board, DTMF tones can "dial" phone numbers. Then, once a connection is established, the same tones can be exchanged representing a transfer of Data.

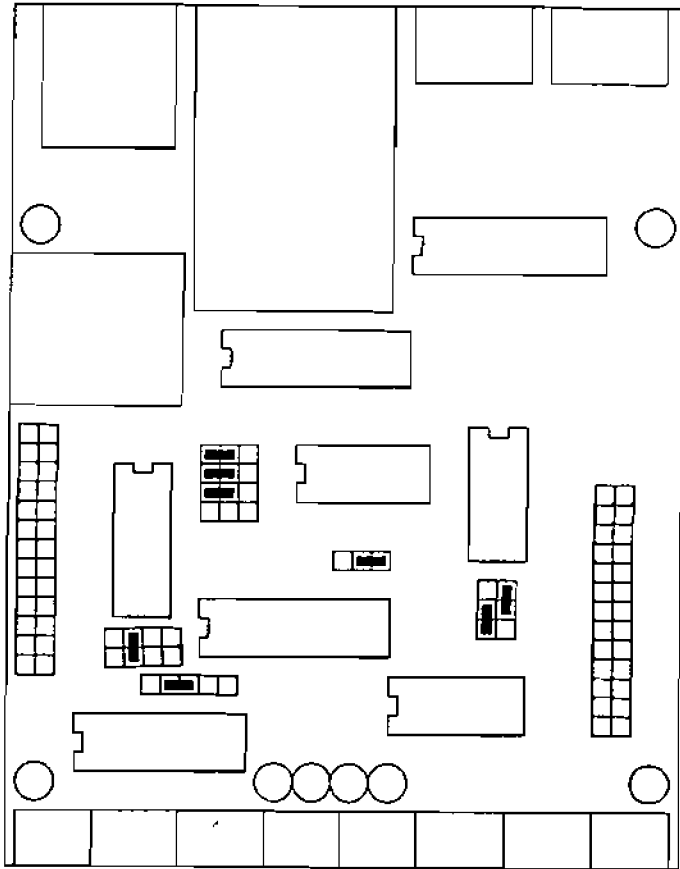
DTMF tones are composed of two frequencies, one of four possible low frequencies and one of four possible higher frequencies. These are usually associated with a four-by-four matrix keypad. Each of the four rows 1, 2, 3, A; 4, 5, 6, B; 7, 8, 9, C; and \*, 0, #, D corresponds to the frequencies 697 Hz, 770 Hz, 852 Hz, and 941 Hz. Each of the four columns 1, 4, 7, \*; 2, 5, 8, 0; 3, 6, 9, #; and A, B, C, D correspond to the four frequencies 1209 Hz, 1336 Hz, 1477 Hz, and 1633 Hz. When a key is pressed, the two frequencies associated with that row and column are combined into a single output signal. The frequencies' values all fall within the telephone's bandwidth and are separated so that their harmonics can not be confused with another tone. This makes it possible for the decoder section to easily determine which pair is being received.

**DTMF Interrupts**

There are two sources of interrupts on the DTMF board: ring indication from the DAA and transmit empty/receiver full from the DTMF chip. The supervisory controller is expecting to use the latched ring detect on INT1 and the DTMF interrupt on INT0.



This example shows JP1 using the latched Ring Detect signal as the source for INT1 on JP3. The DTMF interrupt is selected for the source of INT0.



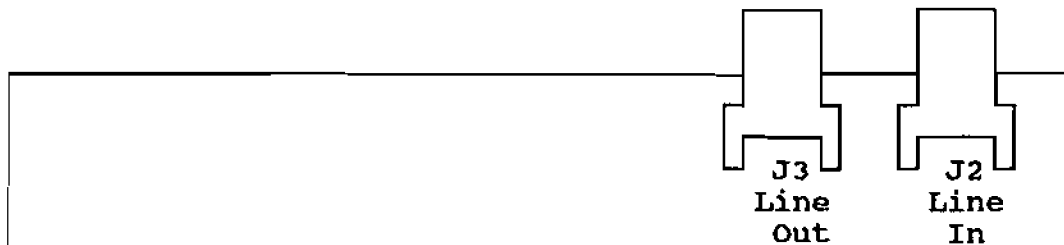
Default Jumper Configuration (HCS-DTMF)

### Audio Connections

Two audio connections are found on the HCS-DTMF board.

Use the Line In (J2 connection) for injecting audio into the HCS-DTMF board. This may come from the HCS-Voice (text to speech) board or other audio source. Nominal Input is about 1 V (peak to peak). The DAA will automatically squelch the audio if it exceeds a preset level, so adjust the audio input to keep the audio below this limit.

Audio from the Off-Hook telephone line can be monitored through the Line Output (J3). This must be amplified externally and cannot be used to drive a speaker directly.



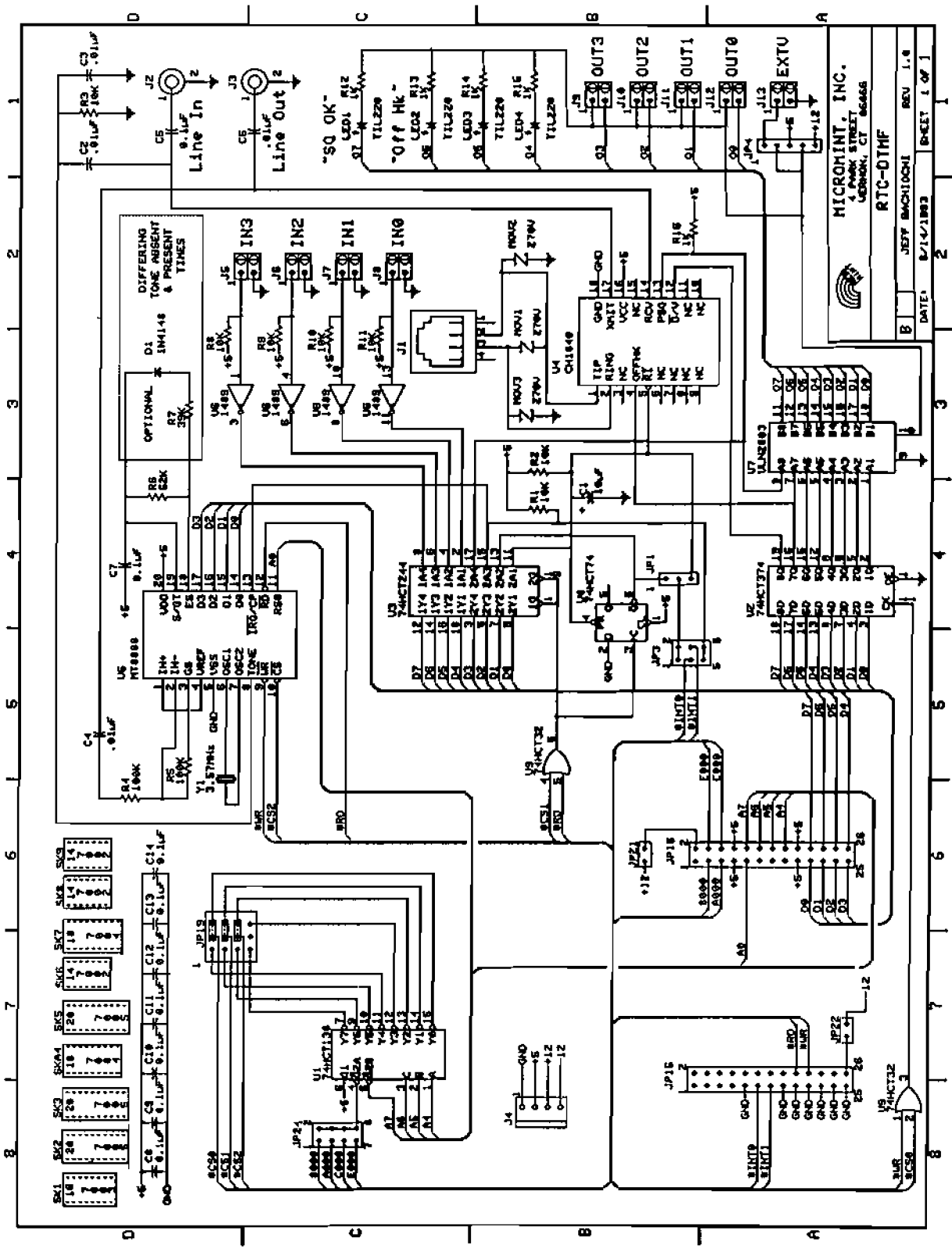
**Adding the HCS-DTMF board to your supervisory controller.**

In an effort to prevent misalignment of the HCS-DTMF board on the supervisory controller's expansion headers, a universal keying system has been implemented. The expansion headers, JP15 and JP16, each have pin missing, pin 18 on JP16 and pin 23 on JP15. Corresponding holes are blocked on the expansion sockets on the solder side of the HCS-DTMF board. Carefully match these keyed positions between the HCS and HCS-DTMF board. When properly mated, the four 1/8 inch mounting holes in the HCS-DTMF board will exactly match four mounting holes on the board below.

Boards permanently mounted (and not subjected to vibration) will not need standoffs between boards, the expansion connectors will act as electrical and mechanical connections. If standoffs are used, 5/8 inch #4 nylon are recommended (older boards may use 1/2 inch #4 spacers, measure your boards to be sure).

9/27/93

HCS-DTMF Schematic

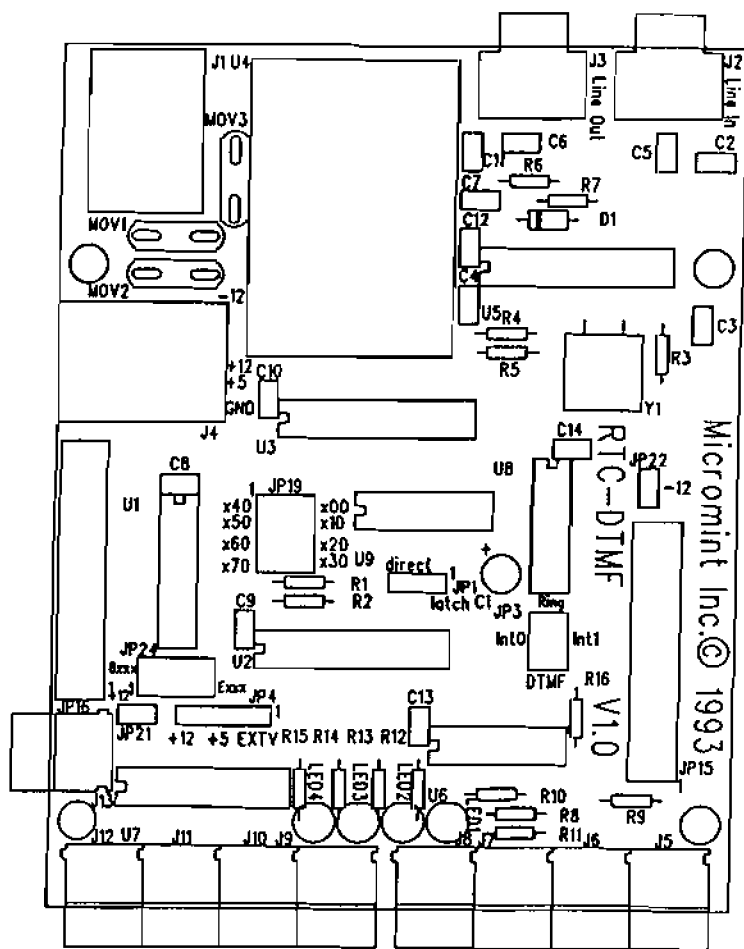


HCS-DTMF

MICROMINT, INC.  
4 PARK STREET  
GERRISON, CT 06038

DATE: 8/14/1993 REV: 1.0  
JEFF BACHIOCHI SHEET 1 OF 1

RTC-DTMF



Silkscreen for the HCS-DTMF

## Parts List for the DTMF Board

DESIGNATION	PART#	DESCRIPTION
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Printed Circuit Board

PB1	DTMF	RTC style Printed Circuit Board
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Integrated Circuits

U1	74HCT138	3 to 8 Decoder
U2	74HCT374	Octal Tristate Latch
U3	74HCT244	Octal Tristate Buffer
U4	CH1840	Data Access Arrangement
U5	MT8888	DTMF Transceiver
U6	MC1489	Quad Level Shifter
U7	ULN2803A	Octal O/C Driver
U8	74HCT74	Quad D-Latch
U9	74HCT32	Quad OR

Resistors

R1-R3	10K	1/4W, 5%, (brn-blk-org)
R4-R5	100K	1/4W, 5%, (brn-blk-yel)
R6	62K	1/4W, 5%, (blu-red-org)
R7	not used	
R8-R11	4.7K	1/4W, 5%, (yel-vio-red)
R12-R16	1K	1/4W, 5%, (brn-blk-red)

Capacitors

C1	10 $\mu$ F	Tantalum
C2-C4, C6	.01 $\mu$ F	Monolithic
C5, C7-C14	0.1 $\mu$ F	Monolithic

Semiconductors

D1	not used	
LED1-LED4	TIL220	Visible LED
MOV1-MOV3	S10K95	Metal Oxide Varister

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## Parts List for the DTMF Board (continued)

DESIGNATION	PART#	DESCRIPTION
<u>Connectors</u>		
J1		Modular Phone Jack
J2-J3		Phone Jack
J4		Molex 4-PIN rt/angle Header
J5-J13	1x2	Screw Terminal Blocks
JP1	1x3	Square Pin Header
JP3	2x3	Square Pin Header
JP4	1x5	Square Pin Header
JP15-JP16	2x13	.630 Vertical Stacking Header
JP19	3x4	Square Pin Header
JP21-JP22	not used	
JP24	2x4	Square Pin Header

Sockets

SK1	16-Pin	IC Socket
SK2-SK3, SK5	20-Pin	IC Socket
SK4a-SK4b	9-Pin	Strip Socket
SK6, SK8-SK9	14-Pin	IC Socket
SK7	18-Pin	IC Socket

Miscellaneous

Y1	3.57MHz	Crystal
5		Wire Pins
1		Molex 4-Pin Socket
SJ1-8		Shorting Jumper

NOTE: Highlighted items are not accessible by HCS supervisory controller and can therefore be left off the HCS-DTMF board.

**Generic Instructions for Kit Assembly****Tools Required for Assembly:**

Low Wattage or Temperature Controlled Soldering Iron  
Rosin Core Solder  
Lead Cutters

**Additional Tools to Ease the Assembly:**

Needle-Nose Pliers  
Lead Bender  
Solvent for removing Rosin (flux)  
Screwdriver

**Tools for trouble-shooting (and their use):**

Oscilloscope	Viewing AC/DC signals
Logic Probe	Indicating Logic Levels (activity)
Continuity Checker	Determining Shorted or Open Traces
Volt/Ohm Meter	Checking Power Supply, Logic Levels, or continuity

Familiarize yourself with all of the parts included in the kit. Pay particular attention to proper orientation of parts. Markings might include a bump, hole, number, arrow, or notch indicating pin 1 (or the pin 1 end) of ICs, sockets, and other devices. A stripe may indicate a plus or minus potential lead of a capacitor or the cathode of a diode. An LED might indicate the cathode by a notch or flat side on the girth of the component.

Inspect the PC Board prior to installing any parts. If held up to a lamp, you can usually see the signal traces fairly clearly. Eye each trace for defects, a copper short between adjacent traces or pads, or a break in the copper trace. Verify any traces that look shorted by first looking at the schematic to verify they should not be connected and then checking for continuity between the traces. You should check traces which seem to be broken for continuity as well. Circuit Cellar Inc. inspects each and every board for manufacturing defects; we feel confident that the components packaged for you are free from defects. However, discovering a PCB defect is much easier before any parts are inserted which would obscure a defect from view.

This is a generic overview of the construction process. At this time, please read the Kit Specific Instructions if any are packaged with the kit. These explain any special requirements or mounting procedures necessary for individual components. Place these parts aside until the rest of the kit is completed.

The best approach to use in building a kit is to choose the smallest (or shortest) parts to install first. Start with any small signal diodes. Use the FOIBSAT method on each part or group of parts. Find, Orient, Insert, Bend, Solder, And Trim each part. Find the part, verify it using the parts list and silkscreen layout. Orient the part correctly using markings on the part and the silkscreen layout. Insert the part into its designated location, forming the component leads as necessary. Bend over the component leads to prevent the part from falling out, preferably in the direction of the connecting circuit board trace. Solder each lead filling in the area between the lead and its plated through hole. And finally, Trim the leads to prevent shorting between traces, components, or holes.

Continue with the 1/4 watt resistors, IC sockets, and smaller monolithic capacitors. Next, insert all the square pin headers and jumpers. These can't be easily bent and will simply fall out if not handled one at a time. Start by soldering only one or two pins, flipping over the board to check that the header isn't tilted. Fix, if necessary, by reheating the soldered pin and/or complete by soldering the rest of the header's pins.

Finally, the taller, odd-shaped components are added, transistors, LEDs, crystals, potentiometers, connectors, heatsinks, etc.

Now it's time to add those items listed in the Kit Specific Instructions (if attached). This is where you may be given special instructions on placement or a choice on how components are oriented according to your application.

Prior to installing the ICs, it is a good idea to give the PCB another inspection. Look for unsoldered or untrimmed leads. Cleaning the solder side of the PCB with a flux remover will make inspection easier, not to mention less sticky.

Another suggestion is to use a volt-ohm meter and measure the resistance between ground and any power supply input. A short circuit here could ruin your power supply and won't allow your board to operate properly. Power-up the board before inserting the ICs and check for voltages according to POWER TABLE listed in the schematics.

Refer to the parts list and silkscreen for proper IC orientation and insertion. This concludes the assembly instructions.

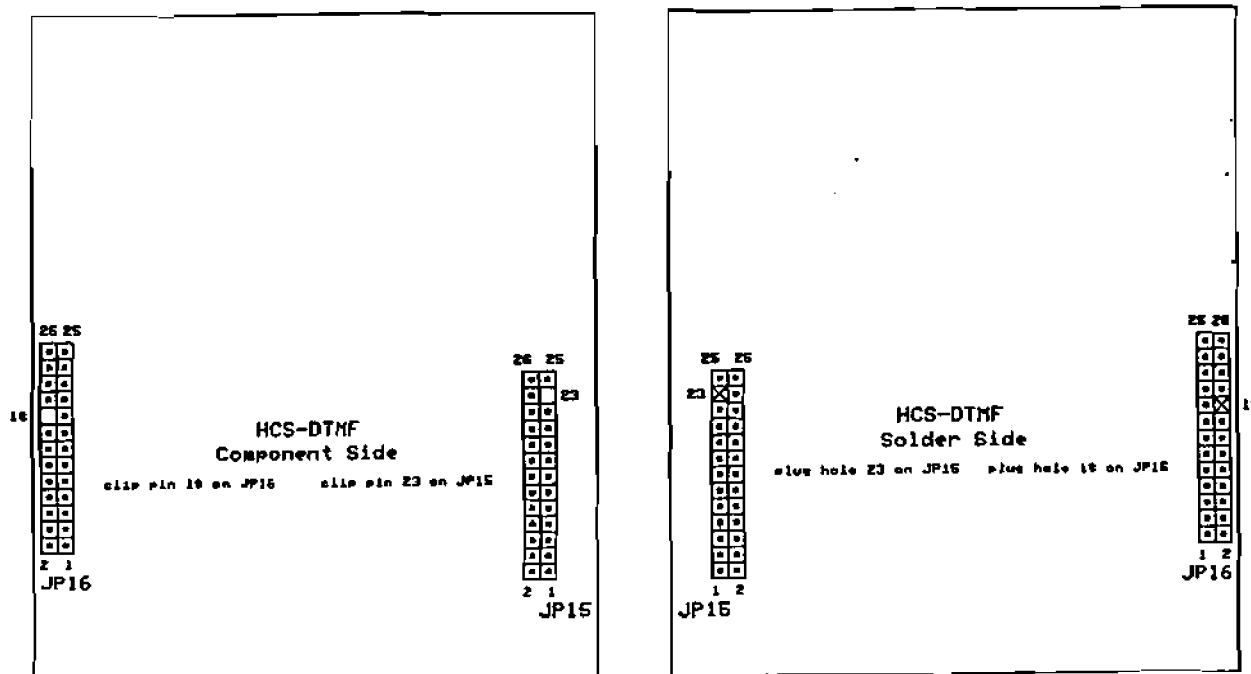
### Kit Specific Instructions for the HCS-DTMF Board

Please note the Supervisory Controller does not support the direct digital I/O on this board. Parts not supplied in this kit are NOT needed when used with the HCS system (see parts list).

JP15 and JP16 are vertical stacking connectors. These are inserted from the solder side up through the component side and are the only components that must be soldered on the component side of the PCB. Once inserted, solder only one or two pins and check to make sure the vertical stacking connector is NOT tilted and is snug with the solder side's surface. Once you are sure these are mounted correctly solder the rest of the pins.

Use extreme care in applying solder to the header's pins on the component side of the PCB, DO NOT let the solder cover the gold plating on the pins more than 1/4 inch from the component side's surface.

Once the expansion headers are soldered you need to key them correctly. This will help ensure proper mating between the HCS and the HCS-DTMF board. Carefully study the diagram below. Find pin 23 on JP15 and pin 18 on JP16. Verify you have the correct pins and clip them off on the component side of the HCS-DTMF board. Turn the board over and insert the tiny clear plastic plugs into the corresponding holes of the expansion headers.



U4, the registered DAA, uses a wide 0.600 inch spacing. Use the single strip connectors for DAA socket. As with all multi-pin parts, solder one or two leads and verify the part is straight before permanently soldering all the leads.

# HCS–DTMF Addendum

8/3/94

Please note the following information which was inadvertently left out of the HCS–DTMF manual.

## LED1 – Power Squelch OK

LED1, the power squelch indicator, will be on whenever the squelch circuitry is NOT active. The squelch is activated whenever the level of the audio to be transmitted is greater than a preset level. Audio equipment should be adjusted to its highest level that will not trigger the squelch and thus turn the LED off.

## LED2 – Off Hook

LED2 is used as an Off Hook indicator. The LED will be on whenever the line is put into the Off Hook condition.

## LED3 – LED4

When your HCS II system is active, LED3 and LED4 should be quickly flashing on and off. These LEDs are used by the system to show activity and cannot be controlled by the user.

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4. Ship the merchandise (pre-paid) to the address below. Using the original packaging, safely repack with all original accessories included.

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RMA# \_\_\_\_\_

Date \_\_\_\_\_ Invoice # \_\_\_\_\_ P.O.# \_\_\_\_\_ Daytime Phone \_\_\_\_\_

Customer # \_\_\_\_\_ Account Name \_\_\_\_\_

Contact Name \_\_\_\_\_

**METHOD OF PAYMENT:**

Check                       Charge                       Company Purchase Order (please attach copy)

Credit Card # \_\_\_\_\_ Expiration Date \_\_\_\_\_

Signature of Cardholder \_\_\_\_\_ Purchase Order # \_\_\_\_\_

**ITEM(S) RETURNED**

**REASON(S)**

(Use additional paper to be as explicit as possible on your reason(s) for return)

What action would you like us to take? (Repair or Replace item, Refund or Credit your account):

Is Shipping Data on Invoice correct?                      Yes \_\_\_\_\_ No \_\_\_\_\_

If not, please provide correct information: \_\_\_\_\_

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