

## **Section 1**

### **Introduction**

The Communication Systems Model CSI-32 is a community repeater tone panel for use with repeater stations utilizing multiple users on a shared basis. The flexible microprocessor design allows for a number of unique features previously not available. The CSI-32 is totally self contained in a single compact 19 X 5 X 1.7 inch rack mount assembly. All circuitry is on two printed circuit boards which utilizes both analog and digital logic circuitry. The advanced design provides for a lower total parts count alleviating the need for plug-in tone cards. The CSI-32 is immune to RF and contains static and lightning protection to insure reliable service in remote locations. Figure 1.1 shows a typical application for the CSI-32 and the basic interface requirements.

#### **1.1 Standard Features**

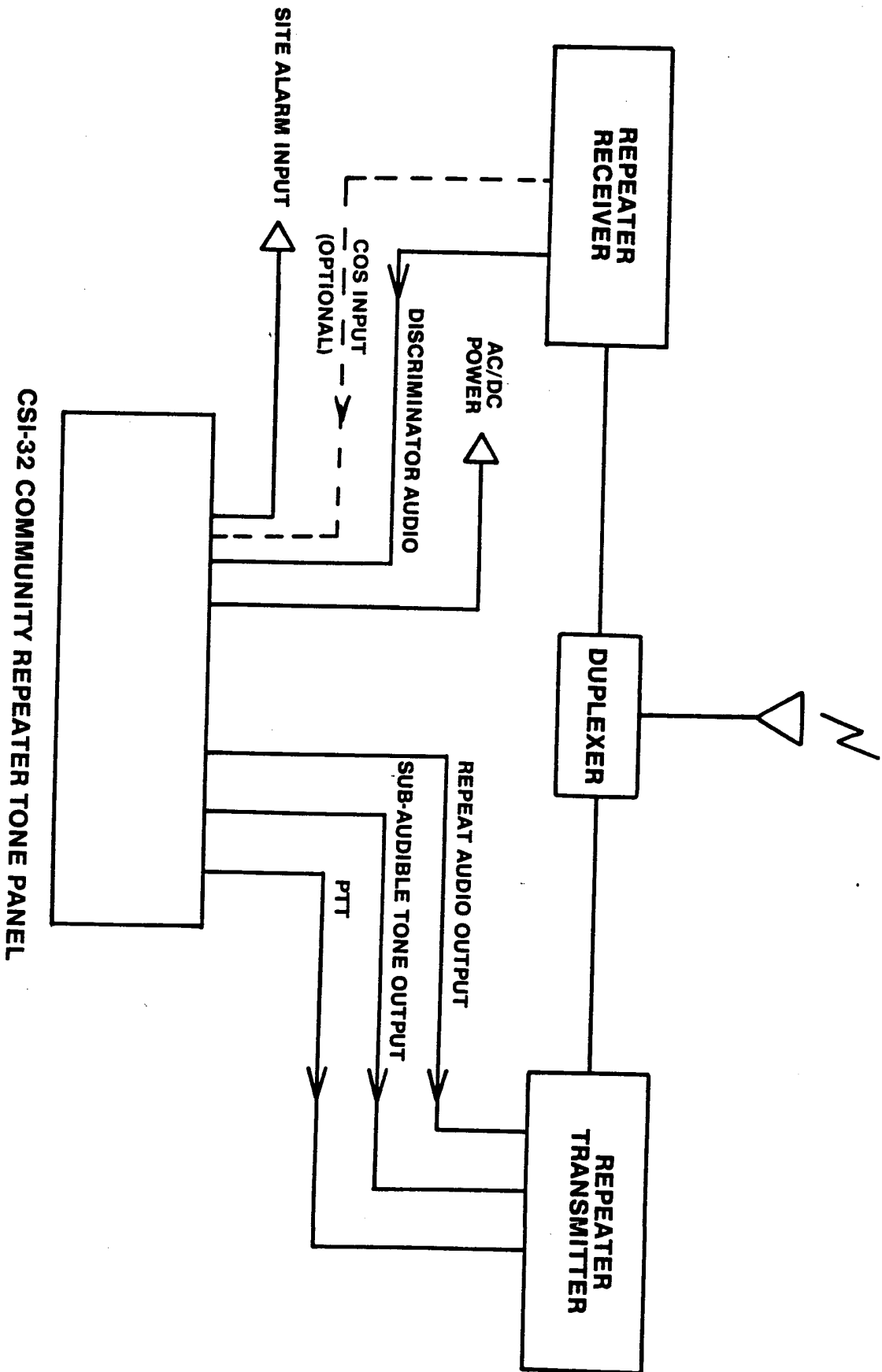
The CSI-32 Community Repeater Tone Panel is equipped with the following standard features:

- Available on any EIA tone frequency from 67.0hz to 250.3hz.
- Repeat audio processing.
- Re-generated CTCSS tone.
- Adjustable transmitter carrier delay.
- Adjustable transmitter time-out timer.
- Automatic self-test and diagnostic tests.
- Four digit LED readout with indicators.
- DC Operation.
- 5 sub-audible tone frequencies.
- Local on/off control of all tone frequencies.
- Relay transmitter keying.

#### **1.2 Optional Features**

The CSI-32 can be configured at the factory, or on site with the following optional features:

- Remote control of all panel operations.
- Time accumulator of individual tone use.
- Tone "hit" accumulator.
- Up to 32 EIA tone frequencies.
- Special non-EIA tone frequencies.
- AC operation with auto-revert to DC operation.
- Cross tone encoding (tone translation).



CSI-32 System Block Diagram  
Figure 1.1

## **Section 2 Specifications**

<b>DECODER</b>	Frequency Range	67hz to 250.3hz
	Number of Sub-audible Tones	Up to 32
	Tone Sensitivity	10 Mv. — 2 Vrms
	Decoder Bandwidth	1.5% Typical
	Decoder Pick-up Time	150 ms.
	Decoder Drop-out Time	300 ms.
	Input Impedance	100K ohms
<b>ENCODER (re-generated tone)</b>	Frequency Accuracy	Within .1 hz
	Frequency Stability	.01 hz Maximum
	Output Amplitude	0-4V pk-pk
	Output Variation	±0.5 dB
	Output Impedance	4.7K ohms
	Distortion	Less than 1.0%
	Cross Tone Encoding	Yes
<b>GENERAL</b>	Repeat Audio Processing (jumper selection)	1. Flat 2. Pre-emphasized 3. De-emphasized
	Repeat Audio Filtering	Sub-audible tone down 30 dB @ 200 hz
	Output Impedance	4.7K ohms
	Remote Control	By DTMF Signaling on the Repeater Channel
	Local Control	Front Panel Keyboard
	Programming Access Code	5 Digit Number (User Programmable)
	Input/Output Connections	Type "D" Connector
	PTT Output	SPST Relay Contact to Ground
	Time Accumulator	0 to 99 hr. 59 min.
	Hit Accumulator	0 to 9999 Hits
	Total Transmitter Time Accumulator	0 to 99 hr. 59 min.
	Time-out Timer	Adjustable from 1 to 9 min., in 1 min. intervals
	Transmit Delay Timer	Adjustable from 0 to 9 sec., in 1 sec. intervals
	Level Adjustment	From Rear Panel
	Site Alarm Input	Sends a 4 digit DTMF address on the repeater transmit frequency upon a closure to ground
	LED Display	Displays sub-audible tone received

Power Supply	115 VAC $\pm 20\%$ 50/60 hz 13.6 VDC $\pm 20\%$ @ 0.500 A
Operating Temperature	-30°C to +65°C
Humidity	0 to 90% — Non Condensing
Weight	3.5 lbs.
Dimensions	Rack Mount 19"W X 5"D X 1.7"H
Compliance	Meets FCC Part 15 for Class B Computing Devices; Exceeds EIA Spec. RS-220A

**Standard  
Tones  
Available**

All EIA sub-audible tones

Group A		Group B		Group C
67.0	151.4	71.9	146.2	74.4
77.0	162.2	82.5	156.7	79.7
88.5	173.8	94.8	167.9	85.4
100.0	186.2	103.5	179.9	91.5
107.2	203.5	110.9	192.8	
114.8	218.1	118.8	210.7	
123.0	233.6	127.8	225.7	
131.8	250.3	136.5	241.8	
141.3				

Also Available: 97.4 (not EIA)

## **Section 3**

### **Operating Instructions**

#### **3.1 Introduction**

This section describes the basic operation of the CSI-32 in the normal repeat mode. Also described are the front panel operating controls and indicators. Please read this entire section before operating the CSI-32. For special applications not described in this manual, please write or call the factory.

#### **3.2 Initial Turn On**

When the CSI-32 is first powered up, the front panel LED's will display the software copyright notice. The CSI-32 is totally field programmable and will be initialized in the following state:

1. All sub-audible tones are invalid (turned off).
2. The transmitter carrier delay timer is set to three (3) seconds.
3. The transmitter time-out timer is set to three (3) minutes.
4. No cross tone encoding is programmed.
5. All time and hit accumulators are reset to zero (0).
6. The site alarm address is set to 0683.
7. The last two (2) digits of the program access code are set to 87.
8. DTMF transponder is off.

To turn on particular sub-audible tones, please refer to Section 5 on Programming the CSI-32. The tones need to be turned on so that a received tone will actuate the repeater station.

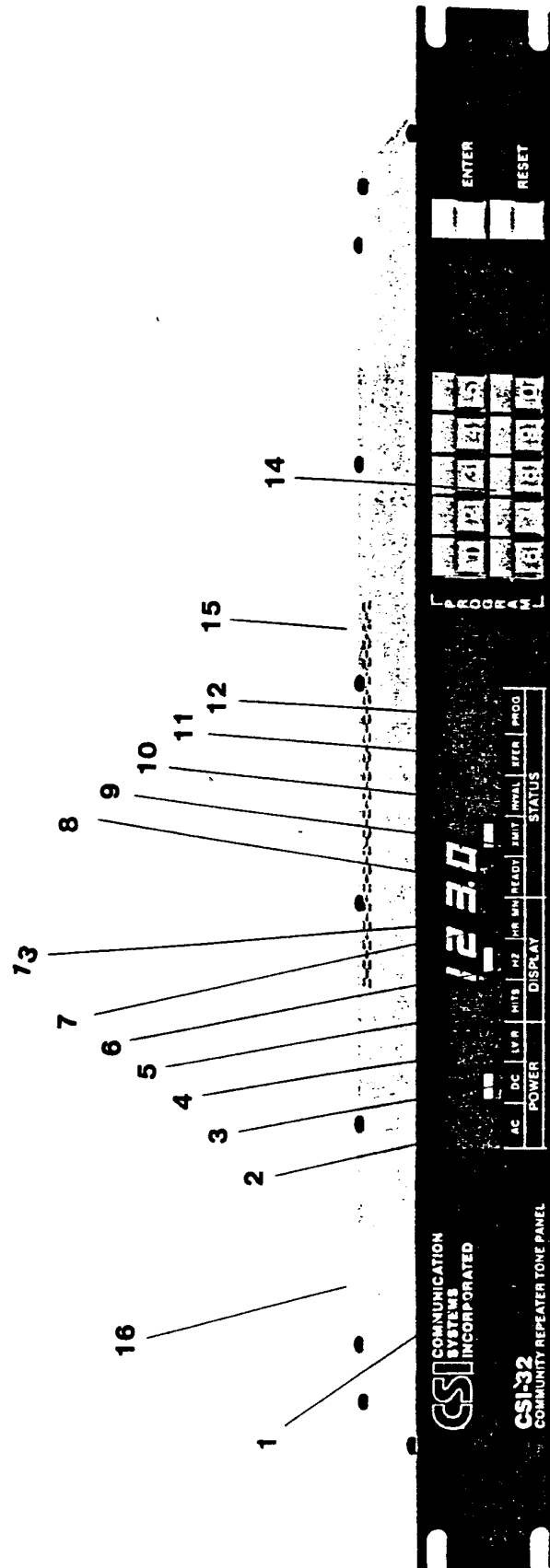
When properly connected and programmed, the CSI-32 will automatically decode an incoming sub-audible tone, key the associated repeater transmitter and repeat the incoming audio modulated with a new sub-audible tone. The status of the repeater can be identified by viewing the front panel display. Since the CSI-32 uses non-volatile memories for storing all programming information, no battery back-up is required to maintain programming information. Thus, a power loss to the CSI-32 will in no way affect the operation of the unit.

#### **3.3 Operating Controls and Indicators**

This section describes all of the operating controls and indicators. Please refer to Figure 3.1 for additional information.

- |                      |  |
|----------------------|--|
| 1. Enclosure         | Sturdy 19 X 5 X 1.7 inch metal enclosure.  |
| 2. AC Power          | This LED indicates that the CSI-32 is powered from a 115 VAC source.   |
| 3. DC Power          | This LED indicates that the CSI-32 is powered from a DC source.  |
| 4. Low Voltage/RESET | This LED illuminates if the power source to the CSI-32 is not to specification. It will also illuminate when the "RESET" button is pushed. |

- |                                    |   |
|------------------------------------|---|
| 5. Number of Hits                  | This LED illuminates when the CSI-32 is reading out the number of times a particular tone has been activated on the LED display over a period of time.  |
| 6. Frequency in hertz              | This LED illuminates when the CSI-32 is reading out a received tone frequency, or when a tone frequency is entered on the keyboard.   |
| 7. Number of Hours and Minutes     | This LED illuminates when the CSI-32 is displaying the time duration of a particular tone frequency that has been activated over a period of time.  |
| 8. Normal Repeat Mode              | The "READY" LED is illuminated whenever the CSI-32 is ready to operate in the normal repeat mode.   |
| 9. Transmitter ON                  | The "XMIT" LED illuminates when the associated repeater transmitter is put in the transmit mode by the CSI-32.  |
| 10. Invalid Tone Frequency         | This LED illuminates when the decoded tone is not turned on (invalid) in the CSI-32. Thus an invalid tone will not be repeated; it will, however, be displayed on the front panel.                              |
| 11. Cross Tone Encoding (transfer) | This LED will illuminate if the received tone on the repeater receiver is different than the sub-audible tone to be re-transmitted on the repeater output channel. The LED display will show the received tone. |
| 12. Programming Mode               | This LED will illuminate when the CSI-32 is in the program mode (normal repeat operation is inhibited). To gain access to the programming mode, the program access code must first be entered.                  |
| 13. LED Display                    | This four (4) digit LED display reads out the tone frequency directly that is being received by the repeater receiver in the normal repeat mode. The display is also active in the programming mode.            |
| 14. Front Panel Keyboard           | The keyboard is used for local programming of all the tone panel functions which include the ON/OFF of all tone frequencies, timer programming, etc.  |
| 15. Rear Panel Connector           | All connections are made through the rear panel connector.  |
| 16. Level Adjustments              | All level adjustments are accessible from the rear panel.   |



CSI-32 Community Repeater Tone Panel  
Figure 3.1

### 3.4 Interconnect and the CSI-32

An interconnect can be used on the same RF channel as the CSI-32 without any operational problems. However, it is possible that a telephone number could have the same sequence of numbers as the programming access code on the CSI-32. This problem can be eliminated by using the "fourth row" on a 16 button DTMF encoder, and re-programming the 5 digit programming access code to include these digits.

### 3.5 Transponding Data with the CSI-32

The CSI-32 can be programmed to transpond data from the repeater site down to the radio shop via the repeater channel. Information that can be recalled includes the time and hit accumulation of all 37 EIA CTCSS tones, total transmitter usage time, and the tone frequencies of the validated subscribers on the repeater. This information can then be used for finding unused CTCSS tones for new repeater subscribers, billing customers on a time usage basis, or conducting RF channel loading studies.

Data recall is accomplished by using a DTMF encoder and a DTMF display decoder connected to a simplex control station on the repeater channel.

Data recall is performed as follows:

1. Place the CSI-32 into the program mode by sending the 5-digit DTMF programming access number.
2. Turn on the DTMF Transponder (if not already done) as described in section 5-17. This operation needs to be performed only one time.
3. Now interrogate the CSI-32 for one of the functions that transponds data (see section 5-18).
4. Within 2 seconds after the last keystroke has been entered, the CSI-32 will put the repeater into transmit mode, and then transpond the DTMF data down the output channel of the repeater. The transpond time for the DTMF data is approximately 1 second.
5. The DTMF data should now be shown on your DTMF display decoder.

Example:

DTMF encoder:	<b>35687</b>
CSI-32:	program mode
DTMF encoder:	<b>18 ENTER</b>
CSI-32:	The DTMF transponder is now enabled.
DTMF encoder:	<b>06 ENTER 1230 ENTER</b>
CSI-32:	The CSI-32 has been interrogated for the time accumulated for 123.0 Hz. Within 2 seconds after the last <b>ENTER</b> key, the CSI-32 will send the DTMF data corresponding to the time accumulated.
Transpond data:	<b>A1234</b> (the leading digit <b>A</b> illuminates a status LED on the Remote Display Unit)
DTMF display decoder:	The display will read out 12.34 corresponding to 12 hours and 34 minutes.



## Section 4 Installation

This section describes in detail how to interface the CSI-32 Community Repeater Tone Panel to the repeater receiver and transmitter. Installation should be done by a qualified technician. In order to ensure proper operation, be sure to use shielded audio cable where specified. The CSI-32 tone panel should be located as close to the transmitter/receiver combination as possible. All connections to the CSI-32 are made at the "D" type subminiature connector on the rear panel. Before rack mounting the CSI-32, be sure to configure the internal jumpers for your particular system.

### WARNING



This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class B computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

#### 4.1 Jumper Configurations

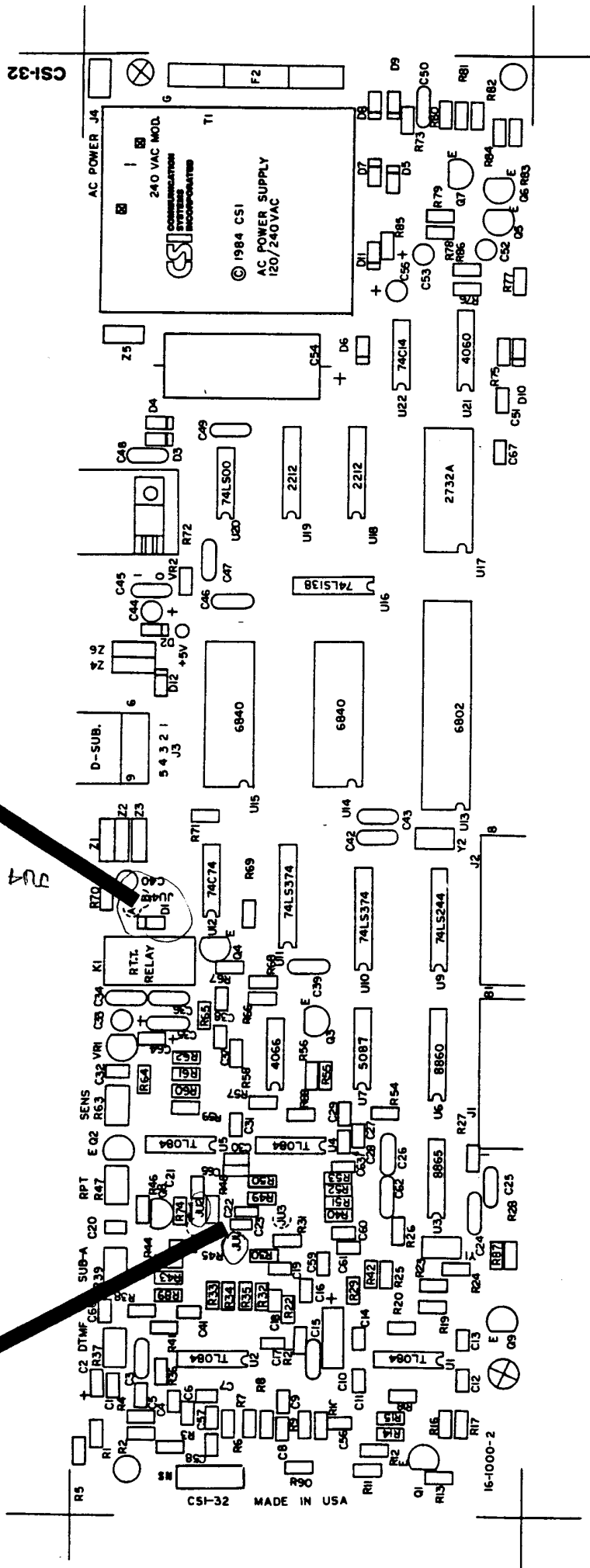
Prior to rack mounting the CSI-32, remove the top cover of the tone panel, with power disconnected, by removing the ten (10) screws and configure the internal jumpers as indicated below. Please refer to Figure 4.1 for jumper locations on the main circuit board. If the AC power supply option is used, caution should be observed near the 115 VAC supply.

##### 4.1.1 Repeat Audio Processing

In order to provide for proper repeat audio processing, the CSI-32 tone panel must be configured to provide flat, pre-emphasized, or de-emphasized repeat audio to the repeater transmitter. Use the following table to configure JU-1 and JU-2.

	JU-1	JU-2
Repeat Audio De-emphasized*		
Repeat Audio Flat	IN	REMOVE
Repeat Audio Pre-emphasized	REMOVE	REMOVE

\*As shipped from the factory. This is the most common configuration with the CSI-32 connected directly to the receiver discriminator and the repeat audio output connected to the MIC input on the transmitter. If the repeat audio sounds tinny, or lacks high frequency components, use one of the other jumper configurations to suit your requirements.



### CSI-32 Printed Circuit Board Showing Jumper Locations

#### 4.1.2 Sub-audible Tone Output Jumper JU-3

The CSI-32 normally provides a sub-audible tone output which has a constant level output from 67.0hz to 250.3hz (JU-3 removed). However, if the transmitter sub-audible tone deviation varies significantly across the range as measured on a service monitor, then install JU-3 to provide a flat transmitter output response. If a variation is noted, it will be evident by a deviation change of approximately 3:1 from 67.0hz to 203.5hz.

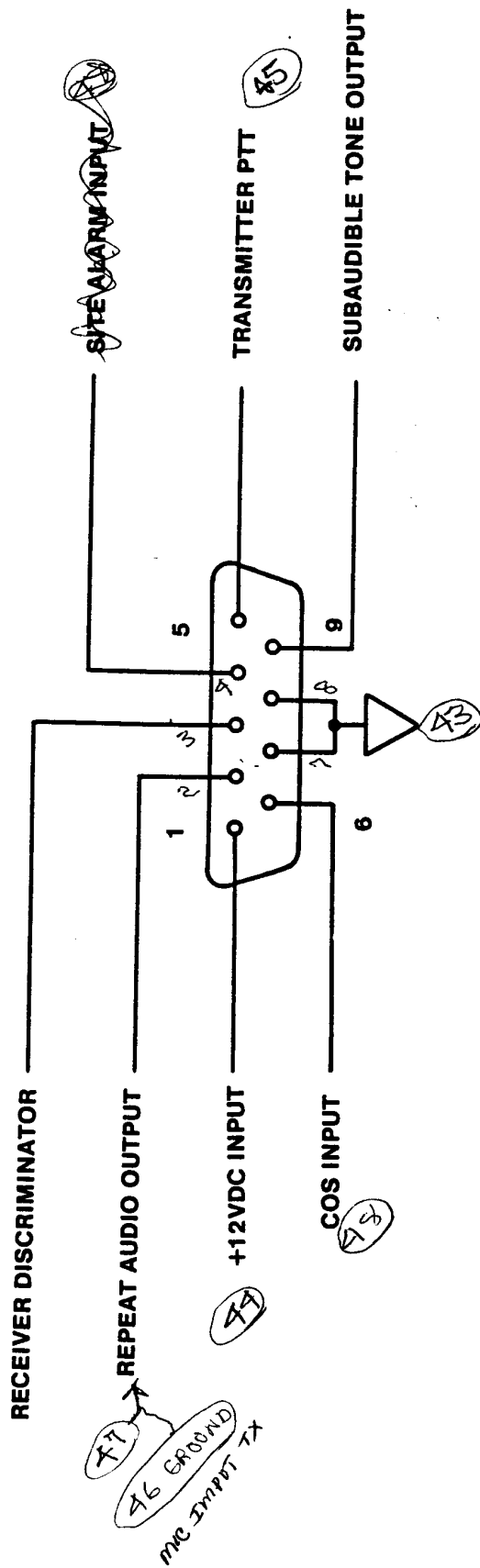
#### 4.2 Wiring Instructions

The following table provides the information required for connection of the CSI-32 to the repeater station. Use a low wattage soldering iron for all connections. Be careful not to short out adjacent pins on the "D-sub" connector. Use the cable supplied with the CSI-32 for all connections.

Refer to hook-up Figure 4.2 or to the CSI-32 back panel for the proper connections. If the CSI-32 installation is to be done at the repeater site, it is suggested that the cable assembly be first constructed at the radio shop to reduce the installation time. Use the "D-sub" connector supplied, and be sure to leave enough cable length on all pins to make the proper connections to the repeater transmitter and receiver.

### CONNECTION TABLE

PIN NUMBER	DESCRIPTION
1	<b>DC Power Supply</b> — Connect continuous 13.6 VDC $\pm 10\%$ from the repeater supply to this pin. No connection is required to this pin if the AC power supply option is used. If auto revert to DC is required should AC power be lost, connect this pin to the repeater DC power supply, or to the backup DC power supply.
2	<b>Repeat Audio Output</b> — Using the shielded cable supplied, connect this pin to the voice audio input (MIC input) on the repeater transmitter. Terminate the shield at both ends of the cable.
3	<b>RX Discriminator Input</b> — Using a shielded cable, connect the unscelched audio from the repeater receiver to this pin. Audio should be picked up directly off the discriminator before the de-emphasis network. Terminate the shield at both ends of the cable to reduce hum pick-up.
4	<b>Alarm Input</b> — This pin requires a ground to trigger the alarm. Be sure to use a ground return from the CSI-32. If the alarm is not used, no connection is necessary. (Available with remote control only. See Section 4.5 for further details.)



Rear Panel Connector  
Figure 4.2

- 5 **PTT Output** — Connect this pin to the PTT line on the repeater transmitter. This pin is strapped by JU-4A to provide a relay contact to ground to key the transmitter. If keying voltage is required to key the transmitter (pull to A+), then move the jumper JU-4A to JU-4B. JU4 is located next to the PTT relay.
- 6 **COS INPUT** (Optional Connection) — the normal squelch tail duration of the CSI-32 is between 250 to 300 ms. to eliminate audio muting when a mobile carrier fades (i.e., picket fencing). If this duration is excessive for an application, then connect the **COS Input** to an active high carrier indicator in the repeater receiver. If this is not available, connection can be made to the collector of the squelch transistor in the repeater receiver. Thus, when no signal is received the **COS Input** will be forced low by the repeater receiver, and when a signal is received the **COS Input** will be forced high, and the duration of the squelch tail will be reduced to that of the repeater receiver squelch circuit (less than 50ms.).
- 7, 8 **System Ground** — Use these pins for all ground connections and cable shield connections from the CSI-32 to the repeater receiver, transmitter and power supply.
- 9 **Sub-audible Tone Output** — Using a shielded cable, connect this pin to the sub-audible tone input on the repeater transmitter. Be sure to terminate the shield to ground at both ends to reduce hum pick-up.

#### 4.3 Alignment Procedure

First enter the programming mode as described in Section 5.2 "Accessing the Program Mode." Next, with the front panel **PROGRAM** LED illuminated, use the following instructions for all level adjustments and alignments. Enter the alignment program by pressing the following on the keyboard: **10 ENTER**. The display will now show **AP** for alignment program. Now use the following table for adjusting the sub-audible tone deviation, and the repeat audio deviation.

#### Keyboard Entry      Function

- |                |  |
|----------------|--|
| <b>1 ENTER</b> | Key Transmitter  |
| <b>2 ENTER</b> | Unkey transmitter  |
| <b>3 ENTER</b> | Generate a sub-audible tone. Enter in the tone frequency to be generated.<br>Example:<br><b>3 ENTER 1230 ENTER</b><br>This will generate 123.0hz.<br>Now adjust the sub-audible tone output adjustment R39 for .75 khz to 1.0 khz deviation on the repeater transmitter. |

- 4 ENTER** Open repeat audio path. Now adjust the repeat level adjustment R47 for the proper system deviation. Be sure to use a properly calibrated input signal to the repeater receiver.
- 5 ENTER** Generate a DTMF tone. Adjust R37 for 3 khz deviation on the repeater transmitter. The DTMF encoder is operational only if the remote control option is ordered, and if the site alarm or the DTMF transponder is used.
- 0 ENTER** Exit alignment program. This will put the CSI-32 back into the program mode.
- RESET** To resume normal repeat operation, press the **RESET** key.

The alignment program can also be used to talk directly to any subscriber on the community repeater from the repeater site. For example, it is possible to contact a particular subscriber on, say, 123.0hz sub-audible tone by first entering the alignment program, and then entering on the keyboard **3 ENTER 1230 ENTER** and then using an external microphone connected to the repeater transmitter. It is now possible to speak directly to that subscriber.

This can also be accomplished from a remote location by using the cross tone encoding option. Thus by programming in a tone transfer from the tone generated by the radio shop, to the subscriber's tone, the radio shop can then speak directly to the subscriber. See Section 5.7 on cross tone encoding for more details.

#### **4.4 Decoder Sensitivity Adjustment (Normal Repeat Mode)**

Push the **RESET** key and with a sub-audible tone generated on the repeater input frequency set between .75 khz to 1.0 khz deviation, adjust the decoder sensitivity adjustment, R63, from the fully counter-clockwise position until the front panel display shows the correct tone being generated; then advance the adjustment an additional ¼ turn clockwise.

#### **4.5 Site Alarm**

The CSI-32 configured with remote control also includes the site alarm feature. The site alarm sends a four-digit DTMF address code on the repeater output channel upon a closure to ground on the rear panel Alarm Input connection (J3-4).

This connection should be connected to a switch which closes when the alarm is to be activated. The other side of the switch connection should be returned to the ground connection of the CSI-32. The site alarm will send the DTMF address only once upon the switch closure, but will repeat the DTMF address whenever the switch closure is sensed. The site alarm is only active in the normal repeat mode of operation. The alarm address is set to send out the numbers "0683." This address can be changed if desired (see Section 5.10, "Changing the Site Alarm Address"). The DTMF digits are sent out at a rate of 100 milliseconds per digit, with a 100 millisecond gap between digits. Thus the total send time for the site alarm is less than a second.

In addition, when the site alarm is activated, the site alarm address number will be displayed on the front panel. After the site alarm address is sent, the CSI-32 will revert back to the normal repeat mode of operation.

The site alarm is useful for detecting unauthorized entry to the repeater site, high VSWR alarm, or RF power output fault.

## **Section 5**

### **Programming the CSI-32**

#### **5.1 Introduction**

The following operations can be programmed in the CSI-32 by either the front panel keyboard, or optionally by any standard twelve (12) button DTMF encoder on the repeater input frequency:

1. ON/OFF control of any tone frequency
2. Programming the transmitter time-out timer
3. Programming the transmitter carrier delay timer
4. Cross tone encoding
5. Interrogating the tone time accumulator
6. Interrogating the tone hit accumulator
7. Interrogating the total time transmitter usage accumulator
8. Site Alarm DTMF address
9. Programming Access Number change.
10. Alignment Program.
11. Transponding data to the radio shop.

#### **5.2 Accessing the Program Mode**

To gain access to the programming mode of the CSI-32 enter the following number on the front panel keyboard or by the remote DTMF encoder:

##### **Programming Access Number - 35687**

A time interval of five (5) seconds is provided for the completion of the Programming Access Number entry. The CSI-32 is now in the programming mode as indicated by the front panel "PROG" LED. Please note that when the CSI-32 is in the program mode, the repeat function is disabled, and all programming tones will not be re-transmitted. Any of the following operations may now be performed on the CSI-32 while in the programming mode. When the CSI-32 is at the "top" of the programming mode, i.e., waiting for a program ID code, the front panel will show **ID** in the LED display.

##### **IMPORTANT**

The following text refers to **ENTER** and **RESET** keys on the CSI-32 front panel. If the CSI-32 is being programmed from a remote location using a twelve (12) button DTMF encoder, replace the references of the **ENTER** key with the DTMF **# (pound)** key and the **RESET** key with the DTMF **"\*" asterisk** key.

Local Control		Remote Control
<b>ENTER</b>	=	<b># (Pound)</b>
<b>RESET</b>	=	<b>* (Asterisk)</b>

To EXIT the programming mode, and return the CSI-32 to normal repeater operation, press the **"RESET"** (\*) key.

Invalid keyboard entries will be displayed by a special error message on the display. See Section 7, "Error Messages."

### 5.3 Programming the Transmitter Carrier Delay Timer (Factory Set to Three (3) Seconds)

While in the program mode, as indicated by the front panel program LED, enter the program ID number **03**, followed by the **ENTER** key, and then the time interval between zero (0) seconds and nine (9) seconds for the delay time that the CSI-32 will hold the transmitter on the air after the mobile carrier has dropped. Follow this number by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **03 ENTER**  
**3 ENTER**

The transmitter timer is now set to three (3) seconds and will hold the transmitter on the air for three (3) seconds after the mobile carrier drops.

### 5.4 Programming the Transmitter Time-Out Timer (Factory Set to Three (3) Minutes)

While in the program mode, as indicated by the front panel program LED, enter the program ID number **04**, followed by the **ENTER** key, and then enter the time interval between one (1) minute and nine (9) minutes for the transmitter time-out timer duration. Follow this by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **04 ENTER**  
**3 ENTER**

The transmitter time-out timer is now set for three (3) minutes, and transmitter operation will terminate after three (3) minutes should a mobile carrier exceed this time duration.

### 5.5 Validating Sub-audible Tones

While in the program mode, enter the program ID number **01**, followed by the **ENTER** key and then the tone frequency in hertz of the tone to be turned on or validated. Follow this by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **01 ENTER**  
**1230 ENTER**

The tone frequency 123.0hz is now validated and will actuate the repeater. To validate additional tone frequencies, repeat the above sequence with as many tone frequencies as permitted by the number of tones ordered with the CSI-32. Additional tones beyond this number will be rejected and produce the appropriate error code on the display. See Section 7, "Error Messages."



### 5.6 Invalidating Sub-audible Tones

While in the program mode, enter the program ID number **02**, followed by the **ENTER** key and then the tone frequency in hertz to be turned off or invalidated. Follow this by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **02 ENTER**  
**1000 ENTER**

The tone frequency 100.0hz is now invalidated and will not activate the repeater. The tone frequency will, however, be displayed if received and the status LED will show **INVAL** (invalid). To invalidate or turn off additional tone frequencies, repeat the above sequence. Please note that the CSI-32 is shipped from the factory with all tones already invalidated.

### 5.7 Cross Tone Encoding (Tone Translation)

Cross tone encoding is used when a different sub-audible tone is required to be transmitted than the tone received on the repeater input. As an example, the CSI-32 can decode a tone on 131.8hz and retransmit a different tone such as 203.5hz on the repeater output channel.

To program the CSI-32 for cross tone encoding, enter the program mode, and then enter the program ID number **05**, followed by the **ENTER** key. Now enter in the tone frequency to be decoded by the repeater and follow this with the **ENTER** key, then the tone frequency to be retransmitted by the repeater transmitter to the mobile, followed by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **05 ENTER**  
**1318 ENTER**  
**2035 ENTER**

The CSI-32 is now programmed to receive the tone frequency 131.8hz and retransmit 203.5hz. If cross tone encoding is used, then the transfer "XFER" LED will illuminate during cross tone encoding. To cancel the cross tone encoding, enter the same tone frequency to be received, as transmitted.

### 5.8 Interrogating the Tone Time Accumulator

With this option, the CSI-32 will automatically record the time duration of all EIA sub-audible tones and special non-EIA tones used on the repeater channel. This includes all valid subscribers on the repeater, plus all subscribers on other repeater systems on the same RF channel. Thus, a complete record of time accumulation is kept of all sub-audible tone activity on the RF channel.

The time accumulated for a particular tone frequency (subscriber) can be recalled from memory by first entering the program mode, and then entering the program ID number **06** followed by the **ENTER** key, and then the tone frequency in hertz of the tone to be interrogated.

Example:  
LED Status: Program Mode  
Keystrokes: **06 ENTER**  
**1072 ENTER**

The CSI-32 will now display the time accumulated for the tone frequency of 107.2hz in hours and minutes. Repeat this sequence to interrogate additional tones.

### 5.9 Interrogating the Hit Accumulator

The CSI-32 can be optionally configured with the hit accumulator. The hit accumulator counts the number of times a particular sub-audible tone is used over a period of time. Each time a mobile carrier is keyed, the hit accumulator is incremented one time.

To interrogate the hit accumulator, enter the program mode, and then enter the program ID number **07** followed by the **ENTER** key, and then the sub-audible tone to be interrogated.

Example:  
LED Status: Program Mode  
Keystrokes: **07 ENTER**  
**670 ENTER**

The CSI-32 will now display the number of times the tone frequency 67.0hz has been activated over a period of time.

### 5.10 Changing the Site Alarm Address

The site alarm address is programmed to send out a four digit DTMF address on the repeater output channel in the event of a contact closure to ground. This address is pre-programmed at the factory to send out the DTMF number **0683**.

The site alarm address can be altered by entering the program ID number **08** followed by the **ENTER** key and then a four digit number corresponding to the new address to be sent by the site alarm.

Example:  
LED Status: Program Mode  
Keystrokes: **08 ENTER**  
**1234 ENTER**

The site alarm when activated, will now send the DTMF address number "1234."

### 5.11 Changing the Programming Access Number

The programming access number as shipped from the factory is preset to **35687**. The last two digits of the access number can be changed (**356XX**). To change the last two digits of the programming access number, enter the program ID number **09** followed by the **ENTER** key and then a two digit

number which will replace the last two digits of the programming access number.

Example:

LED Status: Program Mode

Keystrokes: **09 ENTER**

**12 ENTER**

The programming access number has now been altered from "35687" to "35612." Please note that the "fourth row" on a 16 button DTMF encoder can also be used in the programming access number for security purposes. To program the last two digits from the "fourth row," follow the procedure as shown. Be sure to write down the new programming access number. **Do not** use the DTMF digits, C, \*, #, for the access number.

### **5.12 Interrogating the Transmitter Usage Accumulator**

With this option, the CSI-32 will automatically record the total time duration that the repeater transmitter is in the transmit mode over a period of time. To recall this information, first enter the program mode, and then enter in the program ID number **12** followed by the **ENTER** key. The LED display will then show the total amount of time accumulated on the repeater transmitter.

Example:

LED Status: Program Mode

Keystrokes: **12 ENTER**

### **5.13 LED Display Disable**

The four digit LED display can be disabled to conserve power, if necessary, by entering the program mode and then entering the program ID number **13** followed by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **13 ENTER**

The LED display will now be disabled and will reduce the power consumption of the CSI-32.

### **5.14 LED Display Enable**

If the LED display has been previously disabled, the display can be reactivated by entering the program mode, and then entering the program ID number **14** followed by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **14 ENTER**

The LED display will now be reactivated.

### 5.15 Display Valid Tones

The subaudible tones that are currently validated can be displayed on the front panel by entering in the program ID number **16** and then pressing the **ENTER** key. The LED display will then cycle through all of the validated tones.

Example:

LED Status: Program Mode

Keystrokes: **16 ENTER**

### 5.16 Clear Time and Hit Accumulators

All of the time and hit accumulators can be reset to zero with one keystroke by entering the program mode, and then entering the program ID number **17** followed by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **17 ENTER**

### 5.17 DTMF Transponder ON/OFF

The CSI-32 will transpond information regarding time and hit accumulation and the validated tones in a DTMF format on the output channel of the repeater when enabled by program code ID number **18** followed by the **ENTER** key. To disable the DTMF transponder, use ID number **19** followed by the **ENTER** key.

Example:

LED Status: Program Mode

Keystrokes: **18 ENTER**

The DTMF transponder is now enabled.

### 5.18 Programming Summary

The following table summarizes all of the programmable features of the CSI-32 Community Repeater Tone Panel.

Program ID Number	Description
01	Validating sub-audible tones
02	Invalidating sub-audible tones
03	Programming the transmitter carrier delay timer
04	Programming the transmitter time-out timer
05	Cross tone encoding
06	Interrogating the tone time accumulator <sup>1</sup>
07	Interrogating the tone hit accumulator <sup>1</sup>
08	Changing the site alarm address
09	Changing the programming access number
10	Alignment procedure

- 12 Interrogating the total transmitter time used<sup>1</sup>
- 13 Display disable
- 14 Display enable
- 16 Display valid tones<sup>1</sup>
- 17 Clear all time and hit accumulators
- 18 DTMF transponder ON
- 19 DTMF transponder OFF

<sup>1</sup>These functions transpond data.

## **Section 6**

### **Theory of Operation**

#### **6.1 Introduction**

The Communications Systems Model CSI-32 is an advanced state of the art Community Repeater Tone Panel using both analog and digital logic circuitry. The tone panel consists of six (6) basic parts:

1. The microprocessor unit
2. The sub-audible tone decoder
3. The sub-audible tone encoder
4. The remote control system and keyboard
5. Repeat audio processing
6. The power supply.

Each of these parts will be described in detail to follow. As each section is described, please refer to the block diagram (figure 6.1) and the schematic diagrams at the end of this section.

#### **6.2 The Microprocessor Unit**

The control center for the CSI-32 is based on the 6800 Family of micro-computer components. All operations of the CSI-32 originate at the microprocessor unit, U13. The microprocessor communicates with the outside world through its peripherals by addressing a selected device through the 16 bit address buss. Data is passed to and from the microprocessor through the 8 bit data buss. A particular device is selected by the device decoder, U16. Thus a device is selected by enabling its select input. By reading data to and from a particular device, the microprocessor can determine the status of the system.

In order to function properly, the microprocessor must have a set of instructions to execute. This set of unique instructions is known as the operating program. The operating program is fetched by the microprocessor from the program memory, U17. The program memory is located in a single erasable programmable read-only memory (EPROM). The EPROM provides the vehicle through which each CSI-32 tone panel can be custom programmed to meet the need of each individual repeater station. The EPROM also provides for the basic operating system of the tone panel. Since each EPROM is erasable, and therefore reusable, a CSI-32 tone panel can be quickly upgraded to include any of the available options by simply reprogramming U17.

At any given instance, the microprocessor unit is involved in making tens of thousands of decisions each second. These decisions must then be stored in temporary memory for use at a later time. This temporary memory consists of the two static ram chips U18 and U19. These static random access memory chips (SRAM) are the latest technological development in non-volatile memory chips. This means that if the main power is removed from the CSI-32 tone panel for any length of time, the SRAM's U18 and U19 will remember all of the data that was currently in them prior to the loss of power. This eliminates the need for any type of battery back-up power to the chips.

Also controlled by the microprocessor is the display circuitry. The display circuitry consists of a 4 digit, 7 segment red LED display. The display segments are driven directly by the display driver chip, U1. Data for display is fed in serial form to the display driver where it is then buffered and gated to the 7 segment displays in a parallel format. During information exchange between the microprocessor and the display driver U1, the device decoder, U16, controls the chip select line on the display driver preparing it for data to be received. The additional LEDs are either driven by the display driver in a similar manner, or are controlled from other logic signals or peripherals within the system. The master clock signal is divided down from a 4 Mhz crystal to a highly stable 1.000 Mhz reference, and this results in very accurate tone frequencies.

### **6.3 Sub-audible Tone Decoder**

Low level signals are fed into the CSI-32 tone panel through the rear panel connector, J3. Audio signals from the Repeater Receiver are fed into a High Z buffer amplifier U2. This buffered signal is processed through a band-pass filter which sharply limits the audio spectrum outside of the range of 67.0hz to 250.3hz. This processing is accomplished by the active filters U1, U2, and U5. The resultant output of these filters provides for a very high level of "talk-off" protection, and the high sensitivity of the digital tone decoder. This filtered output is then amplified and fed into a schmit trigger U22 to further decrease the decoder's sensitivity to noise and phase jitter. The output of the schmit trigger is then fed into a "D" type flip-flop U12 where it is connected directly to the digital decoder chip U14. The decoder chip, U14, also known as a Programmable Timer Module, is in essence the equivalent to a typical frequency counter in a single chip. The decoder chip reads the frequency of the incoming signal, and feeds the frequency information to the microprocessor unit for evaluation. The microprocessor then decides whether or not the signal received constitutes a valid sub-audible tone. If the signal received is valid, then the microprocessor will display the received tone on the front panel display. If the signal is invalid, the system will continue to look for a valid tone.

### **6.4 Sub-audible Tone Encoder**

The sub-audible tone is generated by the tone encoder chip, U15. The tone generated by U15 is determined by the microprocessor unit U13. The generated tone is fetched from program memory by U13, and then communicated via the address buss and data buss directly to U15. Square wave output of the fundamental frequency is located on pin 3 of U15. This square wave is fed into the 4 pole low-pass filter stage consisting of U4 and U8. The output of U4 pin 7 results in a very low distortion level sine wave which is the sub-audible tone to be retransmitted. This tone may be the same, or different than the tone received by the decoder chip. This low level sine wave is buffered and amplified by the last stage of U4 just prior to being connected back into the rear panel connector, J3. For transmitters not having a flat frequency response of the sub-audible tone input, 6db of de-emphasis is provided by jumper selection JU-3 on the output stage of the last amplifier. Since the sub-audible tone is derived from the 1.000 Mhz crystal reference, the resultant output tone is highly stable with temperature, and accurate to within 1/10 of a hertz.

## **6.5 Remote Control System and Keyboard**

The CSI-32 can be operated in two different modes. The first mode is by local control directly from the keyboard on the front panel. The second method is by any DTMF equipped control station.

The microprocessor unit senses keyboard closures via the input port device U9. During the continuous keyboard scanning, the microprocessor will decode any key closures from the front panel. As can be seen from the schematic diagram of the keyboard and display (See Figure 6.3), this part of the system is located on a separate circuit board mounted against the front panel. The diode matrix on this board converts the eleven key closures (reset key not included) down to a 6 line input code to the input port device U9. Since each key closure produces a different 6 line code to the input port, the microprocessor unit can detect the various keys being pressed.

The second mode of operation via a DTMF equipped control station requires the additional DTMF components and special software to be installed in the CSI-32. Audio signals from the repeater receiver are first fed into the CSI-32 via the rear panel connector. These signals are buffered and fed into a 6 pole high pass filter to eliminate the sub-audible tone. This processed audio is further amplified and fed directly into U3, which is a DTMF Bandsplit filter. This filter separates the DTMF high group tones from the low group tones in order to produce signals for decoding. The output of the DTMF filter, U3, is connected to the DTMF decoder chip, U6. U6 processes the audio signals from U3 to determine if a valid DTMF pair exists at its input. If a valid pair is detected, the DTMF decoder chip will output a 4 bit binary code of the decoded tones to the input port device, U9. Decoded signals from U9 are then interpreted by the microprocessor unit in a similar fashion to the front panel keyboard.

## **6.6 Repeat Audio Processing**

Audio from the repeater receiver is connected to J3-3. This audio signal is fed into a high-Z input amplifier U2 to reduce loading to the repeater receiver discriminator. The output of this buffer is connected to a 6 pole high pass filter that removes all audio signals below 300hz. This prevents the sub-audible tone transmitted from the mobile radio from mixing with the re-encoded tone from the CSI-32 tone panel. The processed audio is then fed into an amplifier stage, U5, which can further process the received audio in one of 3 ways:

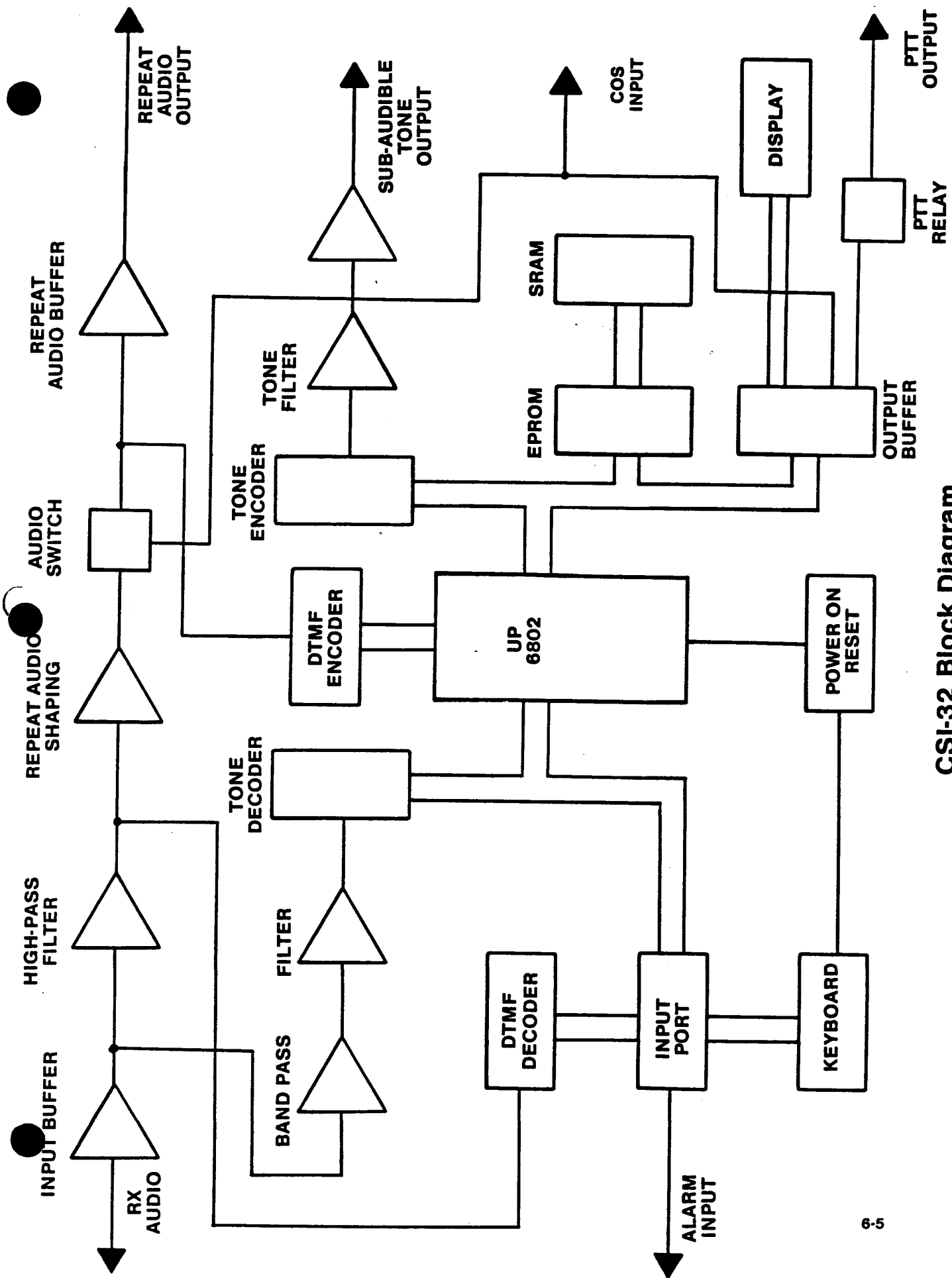
1. Flat repeat audio
2. Pre-emphasized repeat audio
3. De-emphasized repeat audio

These are selected by means of jumper wires located on the main circuit board (see Figure 4.2). Audio signals are then switched on and off by the FET switch transistor, Q7. This switch is controlled from the output port device, U11. The fully processed repeat audio is then fed into the final amplifier stage U5, where the level can be adjusted into the repeater transmitter by R47. The audio is AC coupled to reduce loading effects to the transmitter.



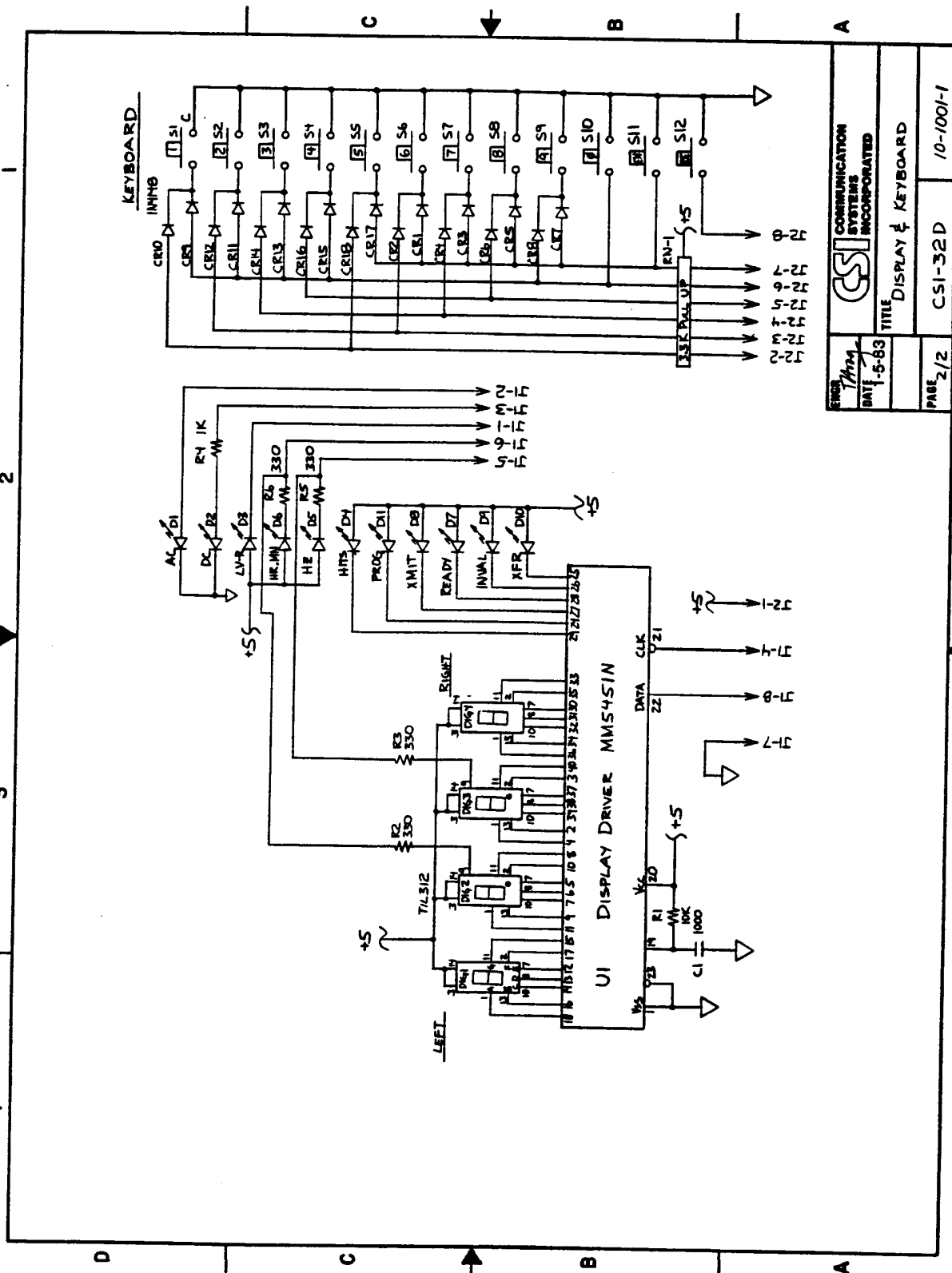
## **6.7 Power Supply**

The CSI-32 Community Repeater Tone Panel can be operated from 120VAC power, or from a 12.0 VDC power source. In the event of AC power loss, the CSI-32 can be wired to auto revert to DC operation. Power source indication is provided on the front panel for AC operation, or DC operation. Surge and lightning protection is provided on all inputs. If the supply feeding the CSI-32 is below specification to maintain operation, the Low Voltage Indicator (LV-R) will illuminate indicating a problem. Power for the op-amps is derived from the 8.0V regulator VR-1. The main power regulator, VR-2 produces 5.0 VDC for all other components. All supplies are filtered and bypassed to reduce system noise and provide for reliable and stable operation in harsh mountain top environments.



CSI-32 Block Diagram  
Figure 6-1





COMMUNICATION SYSTEMS INCORPORATED  
MODEL CSI-32 COMMUNITY REPEATER TONE PANEL  
COMPONENT PARTS LIST REV 1-10-84

DESIGNATION	DISCRIPTION	MANUFACTURER	P/N
U13	MICROPROCESSOR	MOT	MC6802P
U14,U15	PTM	MOT	MC6840P
U17	4KX8 EPROM	INTEL	I2732A-4
U18,U19	256X4 NOVRAM	ZICOR	XD2212
U16	3 TO 8 LINE DECODER	TI	74LS138N
U10,U11	OCTAL LATCH	TI	74LS374N
U9	OCTAL DRIVER	TI	74LS244N
U12	DUAL D FLIP-FLOP	TI	74LS74N
U20	QUAD NAND	TI	74LS00N
U22	SCHMITT TRIGGER	NAT	MC14584BCP
U21	14 STAGE COUNTER	MOT	MC14060BCP
U8	ANALOG SWITCH	MOT	MC14066BCP
U1,U2,U4,U5	FET OP-AMP	NAT	LF347N
U6	DTMF DECODER	MITEL	MT8860F
U3	DTMF BANDSPLIT	MITEL	MT8865P
U7	DTMF ENCODER	MITEL	MT5087P
U1*	DISPLAY DRIVER	NAT	MM5450N
VR1	8.0V REGULATOR TO-92	TI	78L08
VR-2	5.0V REGULATOR TO-220	TI	LM340T-5
Q1-Q7,Q9	NPN TRANSISTOR TO-92	MOT	2N3904
Q8	N-FET TRANSISTOR	MOT	J201
D1-D18*	SI DIODE	MOT	1N4148
D3,D6,D7,D8,D9	SI DIODE 200 PIV	MOT	1N4002
D1,D10,D11,D12			
D2	6.2V ZENER 1WT 5%	MOT	1N4735A
D4	18.0V ZENER 1WT 10%	MOT	1N4746
D5	8.2V ZENER 1/2WT 5%	MOT	1N5237B
Y1	3.58MHZ CRYSTAL	FOX	FOX036S
Y2	4.00MHZ CRYSTAL	FOX	FOX040
K1	SPDT RELAY 12V 2A	AROMAT	HB1-DC-12V
F1	.40A AMP FUSE	BEL FUSE	5SF400
F2	1A FUSE SLOW BLOW	BUSSMAN	MDL1
T1	TRANSFORMER 24V CT	SIGNAL	LP24-500
Z6	RFI FILTER	POWER DYNAMIC	FN365-2/01
Z1-Z6	TRANSIENT PROTECTOR	GE	V33MA1A
LED1-11*	RECTANGULAR RED LED	PACOM	L-102HDT
LED12-15*	.3" 7 SEG. RED	GI	MAN71A
	DISPLAY		
S1-S12*	KEYBOARD SWITCH	ITT SCHADOW	SERU-AU
C54	2200UF 25V AXIAL AL	PAN	ECEB1EV2225
	ELECTRO		
C10	100UF 25V AXIAL AL.	PAN	ECEB1EV101S
	ELECTRO		
C44,C33,C53,C55	10UF 25V RADIAL AL.	PAN	ECEA1EV100S
	ELECTRO		
C52,C40	1UF 25V RADIAL NON-POLAR	PACCOM	EVN-1UF-25V

**6-9**

R56,R88	220K	FILM-R	FR 1/4-
R51,R59,R50,R62	680K	FILM-R	FR 1/4-
R76,R27,R12			
R8,R10	820K	FILM-R	FR 1/4-
R24	1.5M	FILM-R	FR 1/4-
RN-1*	R-PAK (SIP) 3.3K	MURATA	RSC7X332M
	6 PARALLEL		
R37,R39	5K POT	VRN	760-40X-5K
R63	1.0 MEG POT	VRN	760-40X-1M
R47	50K POT	VRN	760-40X-50K
	LINE CORD 3 COND 7.5'	ELECTRO-CORD	E1015(7.5)
	KEYTOP-GRAY 0-9	ITT SCHADOW	SRK-GRY
	KEYTOP-ORANGE	ITT SCHADOW	SRK-ORG
	40 PIN IC SOCKET	AMP	640379-3
	28 PIN IC SOCKET	AMP	640362-3
	24 PIN IC SOCKET	AMP	640361-3
	20 PIN IC SOCKET	AMP	640464-3
	18 PIN IC SOCKET	AMP	640359-3
	16 PIN IC SOCKET	AMP	640358-3
	14 PIN IC SOCKET	AMP	640357-3
	FUSEHOLDER	BUSSMAN	1A1119-05
J1,J2	8 POS FEMALE CONN.	MOLEX	09-52-3081
P1,P2	8 POS MALE CONN	MOLEX	09-64-1081
J3	9 POS SUB-D PIN	CINCH	DEP-9P-CA
P3	9 POS SUB-D SOCKET	CINCH	DE-9S
	CONTACTS		
	HOOD FOR P3 PLASTIC	CINCH	DE-51218-1
	MAIN PCB	CIR ENGR	15-1000-2
	DISPLAY PCB	CIR ENGR	15-1001-1
	RED DISPLAY LENS	TREND	90-1004-2
	HEATSINK	PRECISION MT.	90-1005-3
	FRONT PANEL	COASTAL MFG	90-1001-3
	CHASSIS	COASTAL MFG	90-1000-3
	TOP COVER	COASTAL MFG	90-1002-3
	BOTTOM COVER	COASTAL MFG	90-1003-4
	REAR PANEL COVER	COASTAL MFG	90-1007-2
	PLATE		
	SPACERS 4-40 .25"	H.H. SMITH	4006
	NYLON		
	BLK OXIDE PHILLIPS	SEA-TAC N/B	
	PDN HEAD 4-40 MACHINE		
	SCREW 5/16"		
	CEPS NUT 4-40 W/LOCK	SEA-TAC N/B	4-40 CEPS NUT
	WASHER		
	INSTRUCTION MANUAL		40-1000-1

## **Section 7**

### **Error Messages**

#### **7.1 Programming Error Messages**

While in the programming mode, certain error messages may appear on the front panel display. These are caused by improper entries made on the keyboard. If any error messages are displayed, read the error message description and re-enter the correct keyboard input.

<b>Display</b>	<b>Description</b>
<b>E10</b>	The current number of validated tone frequencies (subscribers) is the maximum number permitted by the configuration of the CSI-32. Additional subscribers may be added by field upgrading the CSI-32. Contact the factory for further information.
<b>E11</b>	The tone frequency entered is not one programmed in the CSI-32. If special tones are required, contact the factory.
<b>E12</b>	Illegal keyboard input.
<b>E13</b>	This option is not programmed in the CSI-32. Consult factory to upgrade.

#### **7.2 Hardware Error Messages**

<b>Display</b>	<b>Description</b>
<b>E01</b>	Serial number error in EPROM (U17). Replace.
<b>E02</b>	Bad microprocessor (U13). Replace.
<b>E03</b>	Bad EEPROM (U18). Replace.
<b>E04</b>	Bad EEPROM (U19). Replace.
<b>E05</b>	Invalid input port data.
<b>E06</b>	Site alarm/PTT failure.
<b>E07</b>	DTMF loop test failure.
<b>E08</b>	SRAM (U18, U19) initialization. All programming contents have been reinitialized to the values shown at the beginning of the operating section. See Section 5.1.
<b>E09</b>	Bad store disable hardware.



## **Section 9**

### **Remote Display Unit**

#### **9.1 Operation**

When the Remote Display Unit is first powered up, the LED display will show all zeros. The Remote Display Unit is now ready to transpond with the CSI-32.

First, enter the Programming Access Number on the front panel of the Remote Display Unit. **Note that the LED display will not indicate what keys are pressed**, but the transmit indicator will be illuminated showing that the transmitter is keyed and tones are being transmitted. Next, interrogate the CSI-32 for one of the functions that will transpond data. After the last keystroke, the Remote Display Unit will unkey the transmitter and then decode and display the data which will transpond from the CSI-32. Since the data will transpond from the CSI-32 within 2 seconds after the last keystroke, do not hold the last keystroke down for very long. This will allow the Remote Display Unit to unkey the transmitter in time to receive the transponded data from the CSI-32.

The Remote Display Unit also has additional LEDs on the front panel. These include the HR.MN LED, HZ LED, and the HITS LED. When the CSI-32 transponds data to the Remote Display Unit, the appropriate LED will illuminate indicating what information is received. For example, when interrogating for the number of hits for a particular tone, the HITS LED will illuminate.

#### **9.2 Installation**

The following table provides the information required for connection of the Remote Display Unit to a simplex base station:

**Connection Table**

<b>Terminal Block pin number</b>	<b>Description</b>
<b>4, 5</b>	<b>9VAC Power.</b> Connect the AC wall transformer supplied to these pins. DC voltage may also be used between 9VDC and 16 VDC at 250 ma. Connect +DC to pin 4.
<b>6, 7</b>	<b>Receiver Audio Input.</b> Connect audio from the receiver speaker to these pins. If one side of the receiver speaker is grounded, connect the speaker hi to pin 6. No connection to pin 7 is required.
<b>2</b>	<b>DTMF Tone Output.</b> Connect this pin to the microphone input on the simplex base station. If the microphone input is hi-Z, then a 100K series resistor may be required for proper adjustment. Use shielded cable.

- 1      **System Ground.** Use this connection for the main system ground back to the base station. Use the shield connection from the DTMF Tone Output.
- 3      **PTT Output.** The PTT Output provides an open collector pull to ground to transmit. Connect this pin to the simplex base station.
- 8      No connection.

## 9.21 Adjustments

**DTMF Encoder.** With power connected to the Remote Display Unit, press a number on the front panel keyboard. And with a service monitor on the output frequency of the base station transmitter, adjust the DTMF tone deviation with R1 to 4.0 khz maximum.

**DTMF Decoder.** With power connected, interrogate the CSI-32 Repeater Tone Panel for one of the functions which will transpond data (see section 5.18). If the transponded data is not decoded and displayed on the Remote Display Unit, adjust R2 until proper operation is achieved.

## 9.3 Theory of Operation

### 9.31 Encoder

The DTMF encoder chip receives 2 of 8 keyboard data from KY-1. This data is then converted directly to DTMF tones by U1. R1 controls the level of the DTMF tones to the transmitter. The mute output of U1 is used for the PTT delay circuit. The PTT function is controlled by an open collector transistor, Q1, to the transmitter.

### 9.32 Decoder

DTMF tones from the receiver are decoded by the DTMF decoder chip U9, or U3 and U10. The tones are converted to 4 bit binary numbers which are strobed into the shift registers and feed the binary to 7-segment display drivers U5—U8. The display drivers are connected to the 7-segment LEDs DS4, DS5, DS6, and DS7. The Remote Display Unit can be self tested if required by jumpering the DTMF tone output (TBI-2) to the receiver audio input (TBI-6). Thus, when a key is pressed on the Remote Display Unit, that key will appear on the 4 digit LED display. Please note that the only digits which will be displayed correctly are the numbers 1 through 9.

## 9.4 Computer Interface

A communications link can be established between a personal computer and the CSI-32 Community Repeater Tone Panel. This can be done by using the Remote Display Unit connected directly to an I/O port on a personal computer. All of the connections in the Remote Display Unit are made on the computer Input/Output connector. This connector consists of a 16 pin DIP socket, and includes a 2 of 8 input to the Remote Display Unit for generating DTMF to the CSI-32, and a 4-line binary with strobe output to the personal computer for recording the transponded data from the CSI-32. All logic signals are at 5 volts (TTL compatible). Consult CSI Engineering for additional information regarding interface to your model computer.

COMMUNICATION SYSTEMS INCORPORATED  
MODEL - REMOTE DISPLAY UNIT  
COMPONENTS PARTS LIST REV 9-1-83  
17-1020-1

DESIGNATION	DISCRIPTION	MANUFACTURER	P/N
U1	DTMF ENCODER	TI	TCM5087N
U3	DTMF BANDSPLIT	GTE	G8865XPI
U4	NAND SCHMITT TRIGGER	MOT	MC14093BCP
U5,U6,U7,U8	7 SEG. LED DRIVER	MOT	74LS47
U9*	DTMF DECODER	SSI	SSI-202P
U10	DTMF DECODER	GTE	G8860XPI
U11	NAND GATE	MOT	74LS00N
U12,U13,U14	OCTAL LATCH	MOT	74LS374N
VR-1	5.0V REGULATOR TO-220	MOT	LM340T-5
Q1	NPN TRANSISTOR TO-220	MOT	TIP29
CR1-6	SI DIODE 200PIV	MOT	1N4002
CR7	3.4V 1 WT. ZENER	MOT	1N4728
Y1*,Y2	3.58MHZ CRYSTAL	SEIKO	DS-357
F1	1A FUSE	BUSSMAN	MDL1
DS1,DS2,DS3	RECTANGULAR RED LED	PACOM	L-102HDT
DS4,DS5,DS6,DS7	.3" 7 SEG. RED DISPLAY	GI	MAN71A
C19	470 UF 25V AXIAL AL ELECTRO	PAN	ECEB1EV471S
C20	100UF 25V AXIAL AL. ELECTRO	PAN	ECEB1EV101S
C2,C3,C8,C9	10UF 25V RADIAL AL. ELECTRO	PAN	ECEA1EV100S
C14	.047UF 10% X7R	CENTRALAB	CW20C473K
C1,C16,C18,C21	.01UF CERAMIC DISK	CENTRALAB	CK-103
C4,C5,C17			
C6,C7,C12,C13	1000PF CERAMIC DISK	CENTRALAB	DD-102
C15	24PF CERAMIC DISK	CENTRALAB	DD-240
R5,R6	330	FILM-R	FR 1/4-
R4,R9	1.0K	FILM-R	FR 1/4-
R19	3.3K	FILM-R	FR 1/4-
R3,R9	15K	FILM-R	FR 1/4-
R14	100K	FILM-R	FR 1/4-
R11	100K	FILM-R	FR 1/4-
R12	220K	FILM-R	FR 1/4-
R18	330K	FILM-R	FR 1/4-
R10	680K	FILM-R	FR 1/4-
R16,R17*	1.5M	FILM-R	FR 1/4-
R2,R1	5K POT	VRN	760-40X-5K
TB-1	8 POS. TERMINAL BLK	BUCHANAN	SSB4S08S
KY-1	16 BUTTON KEYBOARD	ECG	PK-1600 2 0F 8
	20 PIN IC SOCKET	AMP	640464-3
	18 PIN IC SOCKET	AMP	640359-3
	16 PIN IC SOCKET	AMP	640358-3
	14 PIN IC SOCKET	AMP	640357-3

T1

FUSEHOLDER	BUSSMAN	1A1119-05
PCB	CIR. ENGR	15-1020-1
FRONT PANEL	COASTAL	90-1020-1
CHASSIS	COASTAL	90-1021-1
AC WALL XFMR	EDS	
RED DISPLAY LENS	TREND	90-1023-1
RDU BRACKET	PRECISION MT.	90-1022-1
RUBBER FOOT	H.H. SMITH	2192
CABLE CLAMP	H.H. SMITH	8944
.25 THREADED 4-40	AMATOM	8152-A-0440
AL ROUND SPACER		
PLASTIC BUSHING	HEYCO	2030/2020
4-40 5/16" PAN HEAD	SEA-TAC N/B	
CEPS NUT 4-40 W/LOCK	SEA-TAC N/B	4-40 CEPS NUT
4-40 3/8" PAN HEAD	H.H. SMITH	2501
NYLON SCREW		
MICA INSULATOR	THERMALLOY	56-77-11
4-40 1/4" FLAT HEAD		
INSTRUCTION MANUAL		40-1000-1

\* NOT USED WITH U3 AND U10 COMBINATION

