Transmitter Steering Audio Matrix
Installation & Maintenance Manual

S2-60477-210

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68-11097-210

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Manual Revisions

S2-60477-210 Added gender of P101 and P102 connectors

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Default Programmable Options Changes Version 1.60

Programming Option	Previous Default Value	Rev 1.60 Default Value
High Level Guard Tone Duration	60 ms	120 ms
Steering Rules	First RX	Integrated Vote
Transmitter Revert Time	Off	15 seconds

Default Programmable Options Changes in Version 1.70

Programming Option	Previous Default Value	Rev 1.60 Default Value
Free-Vote Time	230 ms	50 ms
Fade Hold Time	300 ms	50 ms

1. System Description

Transmitter steering radio systems consist of multiple strategically located transmitters and receivers. When a mobile or portable calls the dispatcher, the system comparator selects the receiver with the best signal. The CTI Transmitter Steering Audio Matrix (TSAM) monitors this information to determine the best site for the next transmission. After selecting the proper transmitter site, the TSAM routes the transmit audio to the selected transmitter and provides a steered transmitter indication for display on the radio control console.

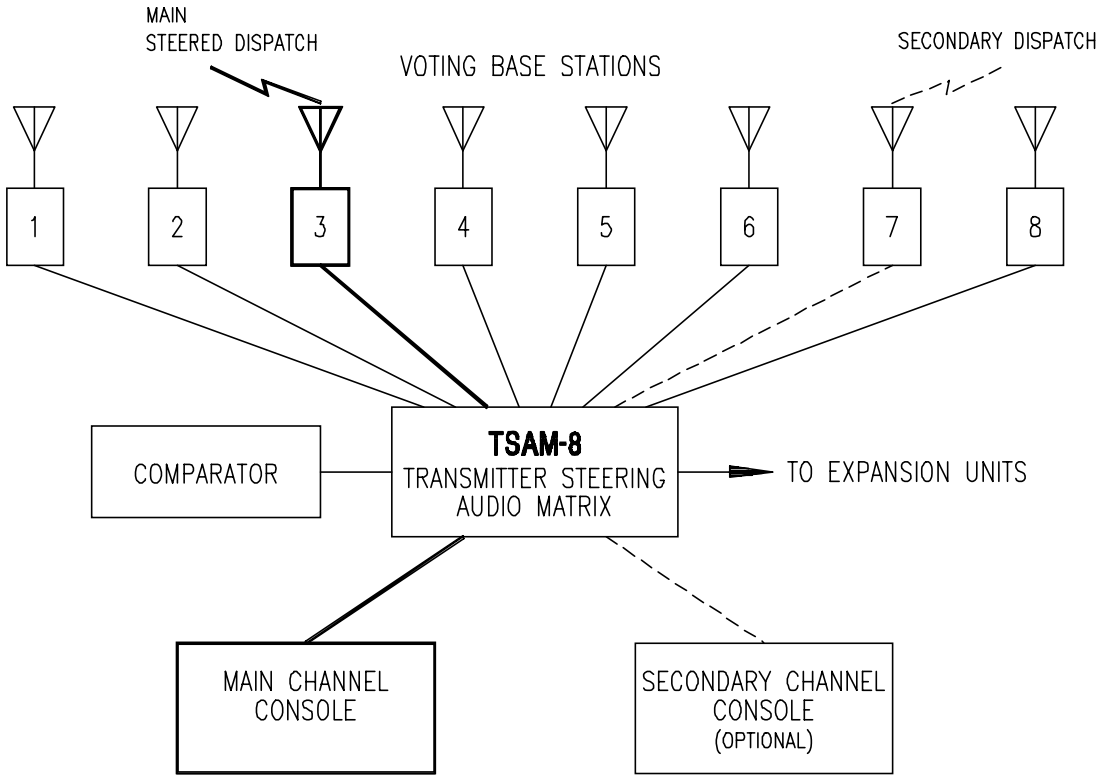


Figure 1 Typical System Diagram

The TSAM is a microprocessor-controlled unit that is field programmable and incorporates electronic audio switching for high reliability. The TSAM generates all necessary transmitter keying and control tones.

1.1 TSAM Features

The TSAM provides the following functions:

- Routes audio between up to eight transmitters and eight receivers, with expansion capabilities allowing up to eight TSAM units to be interconnected. For a maximum capacity of 64 transmitters.
- Provides several (selectable) steering decision algorithms.
- Generates Positive Mode Control (PMC) keying tones.

- A transmitter may be manually selected via a "force" override.
- Optional Secondary Mode operation, which removes a single base station site from the voting scheme and locks it on an alternate frequency, using internally generated frequency select tones. Audio is automatically routed to a secondary base station interface.
- Two tone generators, one for main and one for secondary mode operation.
- A number of key operational parameters are field programmable.
- PTT relay outputs for both Main and Secondary channels.
- Repeater Operation

1.2 Model Description

Two basic model numbers exist for the TSAM units:

- S1-60165-xxx TSAM -- 8 Transmitters -- No Secondary
  This unit has just the Transmit Control Board.
- S1-60006-xxx TSAM -- 8 Transmitters -- With Secondary
  This unit has the Transmit Control Board
  and the Receive (secondary) control board.

1.3 Accessories

The following accessories are available as separate line items for the TSAM unit:

Part Number	Description
31-10354	Punch Block, Dual 25 Pair
S1-60216	Cable Assy Tel 50 Pin Female to Male 25FT (1) req'd for each Non-Secondary TSAM unit. (2) for each Secondary unit
81-10397	POWER SUPPLY 120VAC TO 20 VAC TSAM (1 req'd for each TSAM unit).
S2-60740	TSAM Diode Matrix Plug (50 pin - 25 diodes)
S1-60838	Expansion cable kit (2 TSAMs Total)
S1-60839	Expansion cable kit (3 TSAMs Total)
S1-60840	Expansion cable kit (4 TSAMs Total)
S1-60841	Expansion cable kit (5 TSAMs Total)
S1-60842	Expansion cable kit (6 TSAMs Total)
S1-60843	Expansion cable kit (7 TSAMs Total)
S1-60844	Expansion cable kit (8 TSAMs Total)

Table 1 TSAM Accessories

1.4 Feature Breakdown

The "xxx" in the model number indicates the version number of the unit. Various features have been added to the newer units as shown below:

Feature	S1-60165-xxx No Secondary	S1-60006-xxx With Secondary
First RX Steering Mode	Y	Y
Smart-Steer™ Steering Mode	Y	Y
Instant Update Mode	Y	Y
End of Receive Update Mode	Y	Y
Secondary Mode	N	Y
Expandable to 8 TSAMs	Y	Y
TX Select Indication	Y	Y
Force Select	Y	Y
Positive Mode Control (PMC) for Coded/Clear	Y	Y
Home Transmitter & TX Revert Timer	Rev 120 & up	Rev 120 & up
Dynamic Update Mode	Rev 120 & up	Rev 120 & up
Repeater Operation	Rev 150 & up	Rev 150 & up
Fast Steer on Console 1 PTT	Rev 160 & up	Rev 160 & up
Simplex PTT Release Mask timer	Rev 162 & up	Rev 162 & up
Multicast Mode	N	Rev 170 & up
Multicast Dynamic Mode	N	Rev 170 & up
PL Monitor (Secondary Channel)	N	Rev 170 & up
Single-Function Tone Encrypted Mode	Rev 170 & up	Rev 170 & up

1.5 TSAM Audio Switching

Transmit Audio from the radio control console microphone enters the TSAM through the Console 1 (Main--Steered Channel) and Console 2 (Secondary Channel) audio line inputs. A PTT signal for both Console 1 and 2 is also connected to the TSAM.

When an operator keys the Main channel, transmit audio from the console is routed through the TSAM to the steered transmitter line output. The proper keying tones are sent to the steered transmitter, thereby keying the transmitter and passing console audio. The TSAM routes the console transmit audio to any one of 8 audio line outputs. Audio is also routed out the expansion bus to other TSAMs, for systems with more than 8 transmitters.

For Main channel operation, the comparator selects the best receive audio source and routes this audio to the console Main channel RX audio port.

For TSAM units with Secondary Mode operation, receive audio also connects to the TSAM. The TSAM routes secondary audio from the selected secondary site to the console secondary channel RX audio port.

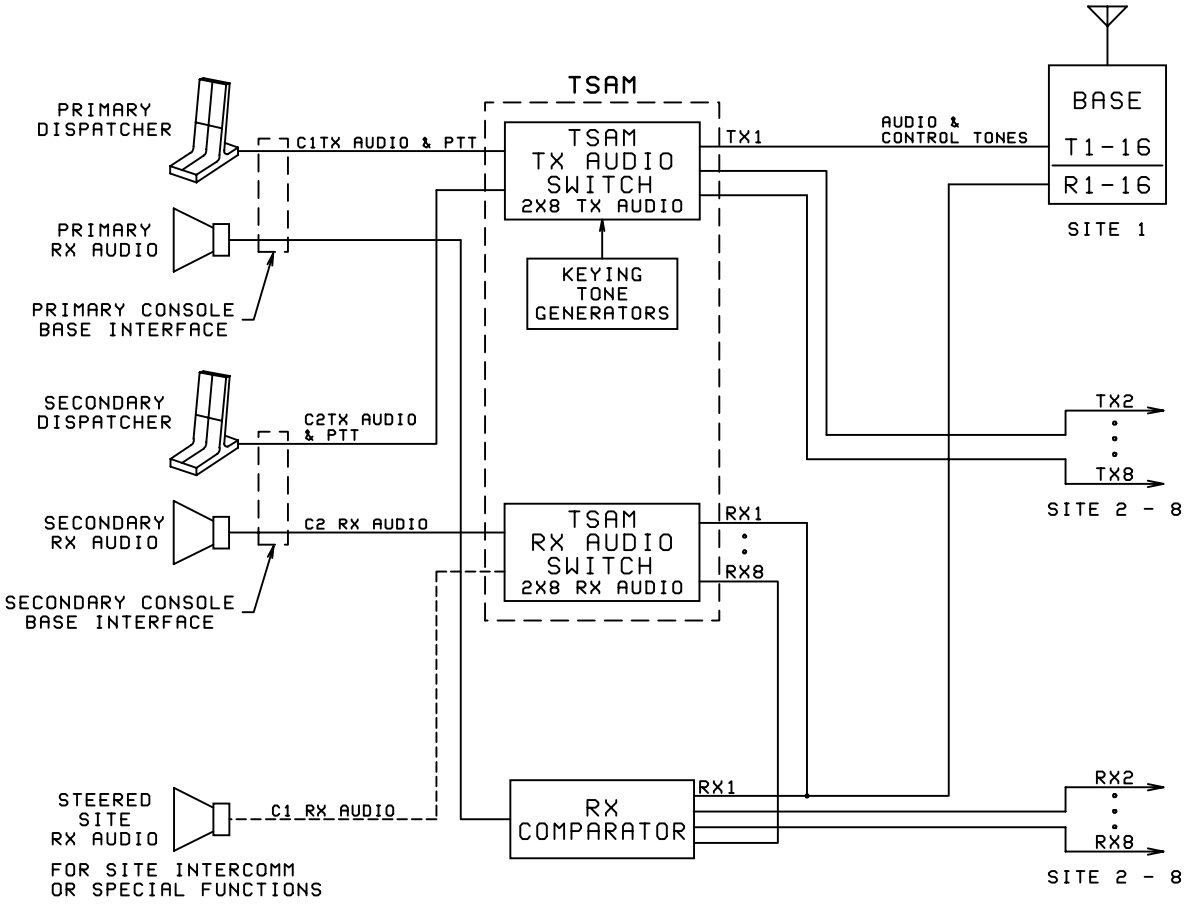


Figure 2 TSAM Audio Path Diagram

2. Main Channel Operation

The Main radio channel is the steered radio channel. The TSAM has inputs to monitor the receiver *Vote* or *Select* lines from the radio system comparator. The *Vote* indications are processed to determine the start and end of transmissions from field radios. The TSAM then determines the best site for the next dispatcher or repeater transmission, based on the criteria outlined in subsequent sections. Upon site selection, audio from the C1 (Console 1) input line is switched to the steered site line driver.

2.1 Steering Algorithms

Steering algorithms determine how transmitter selection or "steering" occurs. An algorithm processes the receiver vote information to determine the best transmitter site available. Once determined, the TSAM activates the steered site. *When* a site is activated is different from *how* the site is selected. The *Steering Algorithm* determines *which* site to select, and the *Update Mode* determines *when* that site becomes active.

2.1.1 First Receiver Voted Selection Algorithm

One mode for making the steering decision is to select a site based upon the first voted site during a particular mobile/portable transmission. This mode has the advantage of being able to make a steering decision before the mobile/portable transmission is complete. However, since the mobile or portable can change between receive sites during a transmission, the First Received algorithm does not necessarily reflect the best site to answer the unit at the end its transmission.

2.1.2 Smart-Steer™ Intelligent Selection Algorithm

The Smart-Steer Algorithm watches the voting activity and choses the site that was voted the longest at the end of the mobile or portable transmission. This gives the benefit of selecting the site closest to the field unit towards the end of its transmission.

It is not sufficient to make the decision based on the last site voted. On receivers with dual level squelch circuits, this causes problems. Dual squelch receivers lengthen the squelch tail on weak signals. A receiver with a slow closing squelch circuit could be voted momentarily at the end of a reception. Picking the last site voted actually picks a site with poorer reception.

The Smart-Steer selection mode eliminates these problems by picking the site voted for the longest total time over a programmable period. The TSAM unit offers the benefits of a last-voted steering mode without the problems caused by slow squelching and dual-level squelch receivers.

2.2 Basic Transmit Site Update Modes & Controls

Update Modes determine *when* the TSAM *selects* the transmitter based upon the results of the steering algorithm. Two basic Update Modes are available:

1. **Instant Update Mode** allows the new transmit site to be activated as soon as the steering algorithm is complete.

2. **End of Receive Update Mode** delays the update till the completion of a portable or mobile transmission.

The operation of these update modes can be changed by advanced options such as Home Site Revert and Dynamic Update Mode.

2.2.1 Instant Update Mode

Instant Update Mode updates the steered transmitter as soon as the Free-vote timer has expired at the beginning of a portable/mobile transmission. It is used only with the First Receiver Vote option enabled.

This mode mode is cannot be used with the Smart-Steer™ voting algorithm.

If you have a repeater system and the units will be talking between sites, the Instant update mode has limitations. In this case, the unit will transmit from the transmitter *closest to himself*, not necessarily from the transmitter closest to the person to whom he is talking.

2.2.2 End of Receive (EOR) Update Mode / Ping-Pong Repeater Operation

As described above, instant update of the steered site may be undesirable for repeater systems. When a portable/mobile is repeated, it would ideally be transmitted on the site *closest to the person to whom he is talking*. The End of Receive Update Mode allows this. In this mode, the TSAM switches to a unit's closest transmitter at the *end of his transmission*. Thus, the response to him will come over his transmitter. This will allow a "ping-pong" selection of transmitters with two mobiles in different areas as shown in Figure 3.

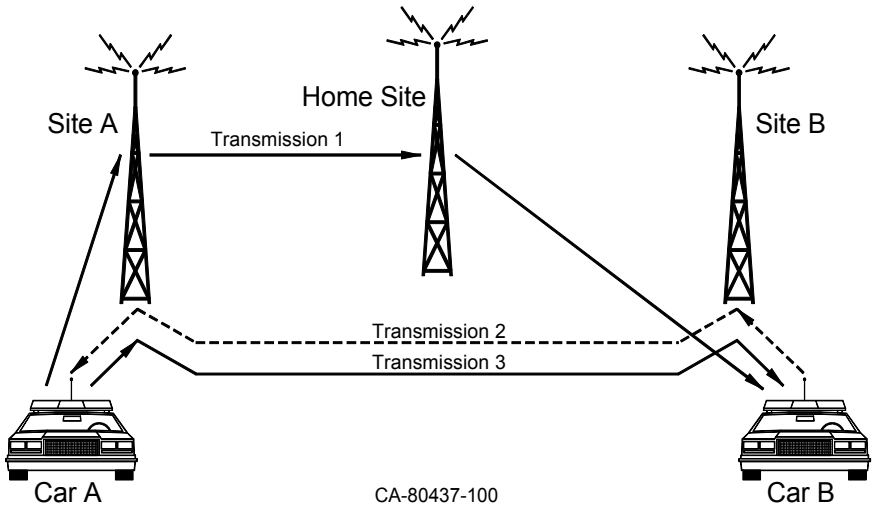


Figure 3 Repeater Ping-Pong Operation with End of Receive Mode

In this example, the following happens:

1. Car A transmits and is received on Receiver A.
   Car A is repeated over the Home Site (which has the best coverage).
   (Home site Revert will be discussed in section 2.3, Initial Transmitter Selection Options.)

   When Car A finishes his transmission, the TSAM unit steers to Transmitter A.

2. Car B answers through Receiver B and is repeated over Transmitter A.
   When Car B finishes his transmission, the TSAM unit steers to Transmitter B.

3. Car A answers. It is received through Receiver A and repeated through Transmitter B.

Since the Smart-Steer™ algorithm does not complete vote processing until the end of current receiver activity, it must use the End of Receive Update Mode.

2.2.3 Instant Update Input

This input can be used to switch between End of Receive Update Mode and Instant Update Mode from the console. To do this, program the TSAM for End of Receive Update Mode. When the Instant Update Input is active (low), the TSAM unit will use the First Receiver instant update steering mode on the next reception. If the TSAM is already programmed for First Receive instant update steering, the input has no effect.

2.2.4 Fast Steer On Console 1 PTT

TSAM firmware versions 1.60 and later provide a feature that allows the TSAM to steer when Console 1 PTT becomes active, even if receivers are active. This feature is functional only when the steering method is programmed for Integrated Vote and the Fast Steer option is enabled. This feature allows faster console transmit operation. The default setting for the Fast Steer option is enabled. It can be programmed in the TX Steering Menu Integrated Vote section. It is recommended that this option be used whenever the Smart-Steer™ Integrated Vote algorithm is used.

2.3 Initial Transmitter Selection Options

If you have made it this far in the manual, you're probably saying, "Okay, I understand how the Instant Update and End of Receive Update Modes work, but what happens after the system has been quiet for a while? Which transmitter is used?" (At least I thought I heard you say that.)

The Initial Transmitter Selection Update Options determine which transmitter is selected on an initial transmission:

1. **Home Transmitter** selects a customer-programmed Home transmitter after a period of inactivity. This is usually selected as the central transmitter or the transmitter with the best coverage.

2. **Dynamic Update Mode** is a combination of Instant Update/First Receive Mode and End of Receive/Smart-Steer™ mode. It works well for repeater systems in which the mobiles units will be talking primarily with units in the same area.

3. **Dynamic Multicast Mode** is a combination of Multicast Mode and End of Receive/Smart-Steer™ mode. This is only available with TSAM units that have Secondary capability. It can be used in very wide-area systems, especially in repeater systems in which the mobiles will be talking with widely dispersed mobiles. The first transmission (from the console or a mobile) is transmitted over many (or all) transmitters. Normal steering will be done on subsequent transmissions.

4. **Force Selection:** Although this is not a programmed mode in the TSAM, the dispatcher can always manually force select a transmitter from the console. See section 4.6, TX Select Console Wiring -- Diode Matrix Plug / Schematic for console connections.

2.3.1 Home Transmitter / Transmit Revert Timer

(TSAM Version 1.20 and up)
Using this mode, the first transmission (from a mobile or console) will be made over a customer-programmed default "Home" transmitter. Subsequent transmissions are steered normally.

After a customer-programmed period of inactivity has passed, the system will again revert to the Home transmitter. A period of inactivity is any period when there are no Voted signals, Forced Site Selections, or Console/Repeater PTTs.

The Revert Timer starts to run at the end of the last detected activity. If any new activity occurs, the timer is reset and held until the activity ceases. When the timer expires, the TSAM then steers the to the HOME A transmitter. If secondary operation is used and the HOME A transmitter is being used in the secondary mode, the TSAM reverts to the HOME B transmitter. After the end of activity, the revert timer starts running again. On the next expiration of the revert timer, the TSAM checks for the availability of the HOME A transmitter. If HOME A is available, the TSAM the reverts from HOME B to HOME A. If HOME A is unavailable, the TSAM remains on HOME B. This cycle continues until HOME A becomes available.

Transmit Revert Timer Programming

The revert timer is accessed through the TSAMs steering options menu. See section 4, *Setting Programmable Options* of the TSAM Maintenance and Installation Manual, for information on accessing the programming menus.

The Revert Timer can be programmed from 5 seconds to 32,767 seconds (9 hours 6 minutes and 7 seconds). Additionally, the timer can be programmed to *revert off*. With revert off, the TSAM remains on the last steered site indefinitely. The TSAM is shipped with the revert timer set to 15 seconds. To program the timer to off, enter any number between 32768 and 65535 into the timer. Any number in this

range is interpreted as off and will display as *revert off* on the screen. Numbers outside the range of 5 to 65535 will produce an out of range error, and you will be prompted again to enter a value in the correct range.

2.3.2 Dynamic Update Mode

(TSAM Version 1.20 and up)
Dynamic update mode is used in conjunction with the EOR (End of Receive Update Mode) and Integrated Vote mode. Using this mode, the first transmission from a mobile will be made over his transmitter (First Receive/Instant Update Mode). Subsequent transmissions are steered normally. The first transmission from a console will be made from either the last transmitter selected or from the Home Transmitter (if it is programmed and the Revert Timer has timed out).

After a period of inactivity, the dynamic mode timer times out and switches the Update mode to First receive for the next voted signal. After this, the update mode returns to the Smart-Steer™ Integrated Vote / EOR update mode.

Dynamic update allows an EOR update mode system to use a more appropriate steered site when a new conversation starts. If EOR mode is used alone, a new conversation started on an idle channel would be transmitted over the last used site. The dynamic update mode selects the site with the best coverage for the new user. This assumes the new user desires best transmitter coverage in the area near him (as opposed to across town). After the initial transmit site selection, subsequent sites are steered at the end of portable/mobile transmissions (EOR update mode).

The Dynamic Mode Timer is programmable from 5 to 32,767 seconds. When programmed for 32,768 to 65,535 seconds the timer is turned off

2.3.3 Dynamic Multicast Mode

Dynamic Multicast Mode is available only on units with the Secondary Mode Option. It is similar to the Dynamic Mode, but it uses Multicast Mode for the first mobile transmission after the Dynamic Mode Timer has expired. On subsequent transmissions, the TSAM will use Smart-Steer™ Integrated Vote / EOR update mode. This allows the first transmission (from the console or a mobile) to be transmitted over many (or all) transmitters. Normal steering will be done on subsequent transmissions.

2.3.4 Transmitter Revert and Dynamic Mode Timer Resets

The Transmit Revert and Dynamic Mode timers run during periods of inactivity. When a timer is reset, it is held in the reset state and not allowed to run until the activity has ended. The following types of activity will reset the timer:

- Vote activity (or internally generated Repeater PTT)
- Console 1 PTT
- Force Select

2.4 Simplex Operation

In simplex systems, the voting receivers will hear the base station transmitters. If the comparator is active during this time, the TSAM must be instructed to ignore any voting activity. This is done by programming the **‘ Sense RX activity during Console 1 PTT’** option is set to **‘ N’** This is found under the TX Steering menu.

The receivers (and comparator Voted output) will still be active for a short time after the console PTT is released. TSAM units with version 1.62 firmware and later include a **Simplex PTT Release Mask Timer.** This tells the TSAM unit to ignore any Voted activity for a period after C1PTT is released.

The **Simplex PTT Release Mask Timer** is only enabled when the **‘ Sense RX activity during Console 1 PTT’** option is set to **‘ N’** . If this option is set to ‘Y’, this timer has no effect, since the TSAM assumes that it a repeater or split-frequency system.

The **‘ Sense RX activity during Console 1 PTT’** option and the **Simplex PTT Release Mask Timer** are programmed under the TX Steering menu.

2.5 Repeater Operation

TSAM firmware versions 1.50 and later provide repeater operation for the TSAM unit. In a simplex system, the TSAM only keys the steered transmitter when a console PTT is activated. In a repeater system, the TSAM must also key the steered transmitter whenever a received signal is present and repeat operation is enabled. The TSAM unit will generate its own internal Repeater PTT based upon activity on the Voted inputs. Repeater transmitters normally remain keyed for a fixed amount of time after the received signal drops. This time is the Repeater Hang Time.

Hang Time has several purposes, the main purpose is to minimize system access time. When using tone keying and CTCSS or DCS, various system delays add up. This forces a repeater user to key for a significant period of time before audio is repeated to receiving stations. By keeping the repeater transmitter keyed after an initial transmission several of these access delays are eliminated. Hang time also provides other benefits, such as eliminating some of the squelch bursts on carrier squelch systems and providing an audible indication that a user accessed the system and keyed the repeater transmitter.

In a repeater system with transmitter steering, access time and hang time are far more complex than in a single site repeater system. There are some access time tradeoffs to be considered in a steered system. These are issues that must be addressed in the system design. The TSAM employs several steering algorithms and is fully programmable which provides maximum flexibility when designing the steering system.

2.5.1 Repeater Operation with various Steering Algorithms

The steering update mode used determines how repeater keying takes place in the TSAM. The TSAM uses Instant and End of Receive Update modes. The Smart-Steer™ algorithm always uses the EOR update mode. First RX steering uses either Instant update or EOR update modes. Repeater keying in each of these modes is described in the following sections.

2.5.1.1 Repeater Keying with Instant Update Mode

For repeater mode operation, the TSAM will key the steered transmitter when the Free Vote time period expires. The Free Vote time starts running the instant vote activity is detected on the TSAM inputs.

If the TSAM is in instant update mode, the proper site is steered just before the keying starts. Console 1 TX audio is then routed to the steered site. Repeat audio from the comparator must be routed to the C1 TX audio port. This is accomplished by taking the repeat audio output of a comparator with console priority capability, or by means of an external relay which will switch between repeat and console audio.

One disadvantage of instant update keying is that the repeater transmitter is not keyed until after the Free Vote timer expires. If Free Vote is set to a high value, to give the comparator time to make a better voting decision, the initial part of a transmission will not be repeated. Care must be taken when setting Free Vote to balance steering performance with system access time. Only repeat audio is effected by Free Vote. Console audio is not cut off by Free Vote.

2.5.1.2 Repeater Keying with EOR Update Mode

In this mode, new vote activity is repeated over the last used transmitter site (a new site is not immediately steered). Repeater keying is initiated at the time Free Vote expires. With EOR Update mode, Free Vote can be set very short or to 0 msec with no degradation of steering performance. This is because the steering decision is made at the end of vote activity (not at the beginning). After EOR, a steering decision is made and the new TX site is steered. The next voted signal is then repeated on this site.

2.5.2 Repeater Hang Time

Repeater Hang Time is used on conventional repeater systems to improve system access time. During hang time, the repeater transmitter remains keyed. Subsequent transmissions due not incur the delays encountered when re-keying the repeater transmitter. These delays consist of 160ms typical tone keying delay, and 200ms typical PL decode delay for the receiving field radio.

In a transmitter steering system, the repeater transmitter may change sites on each retransmission, requiring that a new transmitter be keyed each time. This makes it more difficult to provide the same quick access of a single transmitter repeater system.

To minimize system access the TSAM uses the following system hang time algorithm.

2.5.2.1 Repeater Hang Time with Instant Update Mode

In Instant Update Mode, when repeat traffic ends, the TSAM keeps the current system transmitter keyed. When the next transmission begins, the TSAM steers to the site for that transmission. If no site change occurred, the transmission can proceed over the current transmitter that is still keyed due to system hang time. In this case, system access time is reduced. If a site change is required to repeat the next transmission, then the TSAM unkeys the current site and keys the new site. In this case, additional system access time is added for a new site key-up and PL decoding in the field radio.

2.5.2.2 Repeater Hang Time with EOR Update Mode

For EOR updated modes, the TSAM steers to the proper site for the next transmission when the current transmission ends. If no site change occurs, the current site remains keyed for the duration of hang time. If a site change does occur, the current site is unkeyed and the new site is keyed. It remains keyed for the duration of hang time. When subsequent vote activity starts a repeater transmission, the proper site will be already keyed. This improves system access time.

2.5.3 RPT Disable Input

When activated, the RPT DISABLE input knocks down any ongoing repeater transmission (including hang time) and prevents any further repeater transmissions from taking place. When inactive, any vote activity generates a repeater transmission and keys the steered site. If RPT DISABLE goes inactive after vote activity ends but during the normal hang time period, hang time is not generated. If RPT DISABLE is activated during hang time and deactivated before hang time expires, no further hang time is generated.

2.5.4 RPT KEY Output

The TSAM generates a RPT KEY signal for use in systems where transmitter keying is done with external hardware. In these systems, the RPT KEY signal can be used as the PTT signal for the external transmitter keying hardware. The TSAM generates this signal so that it has control of the hang time keying generation.

2.5.5 Repeater Keying Programming Options

Enable Repeater Operation

When this option is enabled, the TSAM generates keying tones whenever vote activity is detected. The TSAM also generates repeater hang time. If keying tones are disabled, then only the RPT KEY output becomes active when repeater operation is enabled. Secondary channel operation is not supported with Repeater Operation enabled.

Enable TSAM Internal Tone Keying

When internal keying tones are disabled, tones are not generated for any Main channel function. Secondary channel functions still generate all required secondary channel control tones.

Repeater Hang Time

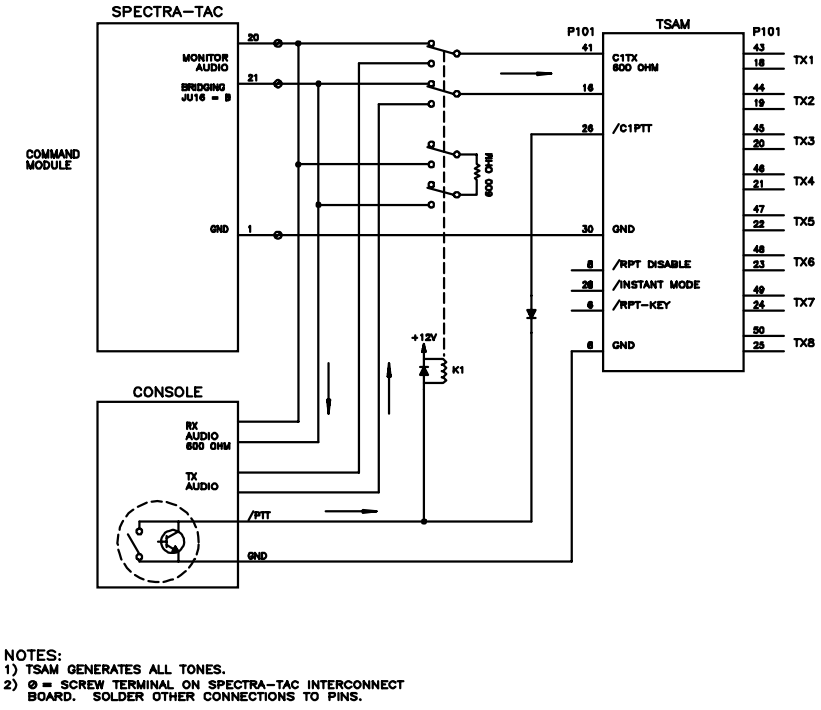
Repeater hang time can be programmed for 0 to 32767 milliseconds, and is normally set so the repeater transmitter is not dropped during a conversation. For more detail on the operation of Repeater Hang Time, see section 2.5.2 on page 11.

Resteer Key-up Delay Time

Resteer Key-up Delay forces a delay time between unkeying a base station and then resteering and keying a new base station. It is programmable from 0-2000 milliseconds. The key-up delay is set long enough so that the first base completes its unkey sequence. Typically, this delay is as long as 200 milliseconds. This allows for LLGT detect time and the time for PL reverse burst to be transmitted from the base being unkeyed. This time can be set to zero if key-up of the second transmitter takes around 200 milliseconds or if the interference from having two transmitters keyed simultaneously is not objectionable.

2.5.6 Console Priority with Repeater Systems

In a typical transmitter steering repeater system, a transmitter is keyed from two different sources. Detection of a received signal will key a transmitter so it can be "repeated", and the systems dispatcher will key the transmitter from the dispatch console. In many systems, it is required for the dispatcher to have priority access to the steered transmitter.



NOTES:
1) TSAM GENERATES ALL TONES.
2) ⌀ = SCREW TERMINAL ON SPECTRA–TAC INTERCONNECT BOARD. SOLDER OTHER CONNECTIONS TO PINS.

Figure 4 TSAM Console Priority Connections

To provide console priority, an external audio switching relay is added as shown in Figure 4. The console PTT line is connected to the C1PTT input of the TSAM. Note there is no PTT connection from the receiver comparator. This is because the TSAM monitors the comparators vote indicate lines and generates an internal repeater PTT when vote activity is detected.

Since priority is given to console PTT, the TSAMs keying is different when a console keys than when a repeater PTT keys. These differences are as follows:

- There is no hang time generated when the console unkeys.
- Force Site selects cannot be made while the console is keyed.
- Resteering during console PTT in normally disabled.

If a Force Site Select is activated during a repeater PTT, the current transmitter is immediately unkeyed and the forced transmitter is keyed. Depending on the timing requirements of the system base stations, a small portion of a transmission is lost while a station is unkeyed and a new station keyed. If a Force Site Select is activated during console PTT, it is ignored.

Since resteering during console PTT is normally disabled, any receive activity that occurs while the console is transmitting will not effect transmitter steering. With resteering enabled during console PTT, receive activity that steers to a new site is remembered and the new site is updated when console PTT is released.

Application Notes are available to describe Console Priority with a number of other comparators.

2.6 Multicast Options

Unit Versions 1.70 and up / Units with Secondary System Capability Only

The Multicast feature allows the dispatcher to key a number of transmitters simultaneously on the main channel for system-wide announcements. When the latched Multicast input is active and the console is keyed, the Transmitter Steering System keys all transmitters that are programmed for Multicast operation. If a transmitter (if any) is in Secondary mode, it will not be used in Multicast mode..

When the Multicast input goes inactive, the TSAM will return to the normal steered operation on the main channel.

> ***Caution:***
>
> *The Multicast option is not intended to serve as a Simulcast controller. There is no simulcast gain, phase, or delay optimization in the TSAM unit.*
>
> *If the installed system does not have simulcast transmitters and appropriate simulcast optimized control lines with controlled amplitude, delay and phase, the system will experience (possibly severe) distortion in RF coverage overlap areas.*
>
> *The customer shall accept any and all responsibility and risks associated with the operation of the system in multicast mode.*

Depending upon your system coverage, you may want all or just some of the transmitters to be enabled for Multicast Mode.

Example 1: If you have a very large system area with minimal overlap between transmitters, you would probably want to enable all transmitters for Multicast.

Example 2: If you have 8 relatively closely spaced transmitters, you may find that 3 or 4 of these will cover well enough for an initial call-up without causing too much distortion in the overlap area.

The transmitters are enabled through the Multicast menu.

2.6.1 Multicast Operation and Secondary Transmitters

If a transmitter is selected for Secondary operation and the Multicast input becomes active, that transmitter will not be eligible for Multicast operation while it is selected as a Secondary Transmitter. When that transmitter becomes de-selected, it will when then be used in Multicast operation on the next transmission if it was enabled in the Multicast Menu.

If Multicast Mode is turned on and the operator tries to select one of the Multicast transmitters for Secondary operation, he will hear a warning tone on the Secondary channel.

2.6.2 Dynamic Mode with Multicast Operation

Multicast Mode can be used on the first transmission in a conversation under Dynamic Mode. This replaces the "First Receive" Dynamic Mode option. See the programming under Transmitter Steering / Dynamic Mode section.

3. Secondary Channel Operation

Only available on TSAM units with Secondary Option

One unique feature of the TSAM is that it allows a properly equipped steered base station (receiver/transmitter pair) to be removed from the transmitter steering system and operate as an independent base/repeater on a second channel. The secondary TSAM channel looks like and additional channel to the system console. The TSAM supports the selection of up to 15 frequencies for the secondary base.

Secondary Mode is useful for allowing a wide area coverage system to be used to handle a local incident without tying up the main channel over the whole coverage area.

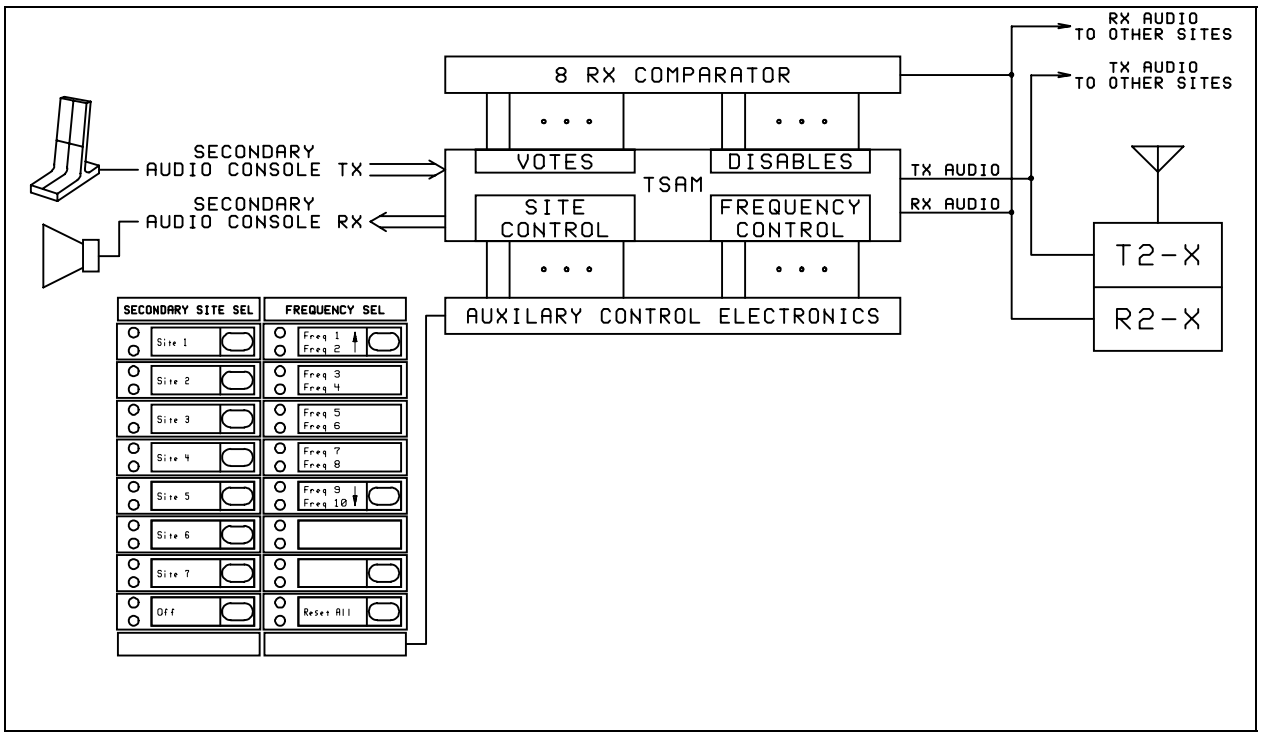


Figure 5 Typical secondary channel control

3.1 Secondary Site Selection

The TSAM automatically completes the following steps when a dispatcher selects a secondary site.

Secondary Operation is initiated when the TSAM detects a non-zero secondary site on the binary active low Site Select inputs. If the site is currently voted, the receiver is immediately disabled, forcing the receive comparator to re-vote. If the site is currently keyed or steered, the transmitter is disabled and the TSAM steers to the HOME A or the HOME B site. (If the HOME A site was selected for secondary operation the TSAM steers to HOME B). Any interlocking required to prevent the TSAM from disabling active sites is done externally.

The Secondary Site Select Sequence

1. TSAM C2 RX audio is normally muted and remains so. This prevents the secondary dispatcher from hearing F1 comparator status tone.

2. The TSAM disables the secondary base RX at the receive comparator by forcing its Disable line low and marking the transmitter as being unavailable for transmitter steering in internal memory.

3. The TSAM sends the currently selected secondary frequency select tones. The secondary frequency is determined by 4 binary Secondary Frequency Inputs (SF1-SF8). These control lines are set by dispatcher using the console Frequency Select control. The TSAM uses a programmable debounce time to allow the inputs to settle before reading the final frequency value. The debounce time allows the operator to scroll the frequency list without sending frequency select control tones for every frequency. This time is programmable in 1 ms increments from 0 to 65.535 seconds (due to the 20 ms scanning latency, the exact debounce is ± 20 ms).

4. If C2 PTT is detected before the debounce time expires, the transmitter is keyed immediately using the most current frequency select input values. To allow for adequate debounce of the secondary site select inputs, the inputs are scanned 20ms after the detection of C2 PTT.

5. Secondary Base RX audio outputs and TX audio inputs are routed to the secondary channel control card in the dispatch console, and the audio paths are unmuted.

6. TSAM monitors Secondary PTT to initiate a secondary transmission.

7. Operator is free to use the Secondary channel or to change the frequency if required.

8. If interlocking of secondary site or frequency control is required, it must be done in the console.

3.2 Secondary Site Select "Off"

1. This function terminates secondary operation and returns the secondary base to the Main steered channel.

2. Secondary Operation is terminated when all secondary select inputs return high (active low inputs).

3. The TSAM mutes C2 RX Audio.

4. The TSAM sends the F1 frequency change tone sequence to the secondary base.

5. The TSAM re-enables the receiver by releasing the Disable line to the receive comparator. The TSAM marks the reverted transmitter as being available for transmitter steering in internal memory.

3.3 Alert Tone Generation

If an attempt is made to transmit on the secondary channel when no secondary site is selected, a warning tone is sent to the console. The warning tone is generated by the secondary keying tone generator and routed through the cross-point audio switch to the secondary console RX audio line driver circuit.

3.4 Secondary Channel PL Monitor Control

Unit Versions 1.70 and up / Secondary System Only

The TSAM can control PL Monitor on the Secondary system. One of two modes may be selected, Momentary Mode or Sustained Mode.

Momentary PL Monitor is used to check for activity on a Secondary channel before transmitting. It functions much like a PL monitor on a typical remote control unit. The operator presses a momentary PL Monitor button, and the base station remains in monitor mode until the next transmission.

Sustained PL Monitor is used to operate a Secondary station in a pseudo carrier squelch mode. This allows the operator to hear traffic from mobile units that do not transmit the proper PL tones. It requires a latched console output. The TSAM will generate a PL Monitor tone sequence after each transmission as long as the PL Monitor input is active.

The PL Monitor function is sent out as two tones:
HLGT + PL Monitor Tone.

Some stations will not decode a new tone command immediately after a transmission or another tone command. The PL Monitor Delay time is a dead time that allows the station tone decoder to reset before the PL Monitor tone is sent.

When an operator de-selects a secondary station, the TSAM sends the F1 keying tone or F1 Revert tone to the station. The station should go back into normal (guarded) PL mode when it changes back to F1.

Program the PL Monitor Control parameters from the Secondary menu:

PL Monitor Tone Timing is shown in sections 7.2 and 7.3.

3.4.1 Momentary PL Monitor Control

When the Monitor input is momentarily activated, the TSAM sends a PL Monitor tone out the selected Secondary site. The station re-enables the PL decoder on the next transmission.

3.4.2 Sustained PL Monitor Control

When the Monitor input is activated, the TSAM sends a PL Monitor tone out the selected Secondary site.

Since the station re-enables the PL decoder after a transmission, the TSAM will re-send the PL Monitor tone after each transmission, as long as the PL Monitor input is active.

When the PL Monitor input goes inactive and a Secondary Site is still selected, the TSAM will generate the appropriate Secondary Frequency tone sequence to that site.

If the PL Monitor input is active when a Secondary Site is first selected, the TSAM unit will do the following:

1. Send the Secondary Frequency tone sequence
2. Wait for the PL Monitor Delay time
3. Send the PL Monitor tone sequence.

After the dispatcher releases the PTT, there will be a slight delay in receiving a mobile without the proper PL, due to the time required to send and decode the PL Monitor tone sequence.

4. Installation

Installation of the TSAM consists of:

- Pre-setting jumper options
- Mounting the unit in a cabinet
- Routing the 25 pair control and audio cable(s) to the cross-connect panel
- Routing the power cable
- Programming the options
- Setting the system transmit and receive audio levels.

4.1 Power Supply Requirements

The TSAM requires either 24V DC or 20V AC at 1 amp maximum for proper operation. A 2-conductor power connector and cord are supplied. Although the TSAM is polarity insensitive, observe proper color coding conventions when connecting the TSAM to a DC supply.

4.2 Expansion TSAMs for more than 8 Transmitters

Multiple TSAMs can be linked together to control more than 8 transmitters or receivers on one channel. As many as 8 TSAMs can be tied together. This allows control of up to 64 transmitters. If you have expansion units, you will have to change some jumpers in the units before you mount them (unless the units are marked as expansion units from the factory).

4.2.1 Expansion Cables

When multiple TSAMs are used together, they are linked through the expansion bus. The expansion bus is made up of the necessary audio and control busses to allow TSAMs to share transmitter control hardware.

The master and slave units are connected via a daisy-chain ribbon cable that connects to P103 on all TSAMs on the channel. Cables are available for systems with 2-8 TSAM units. See Table 1 TSAM Accessories for part numbers.

When installing the expansion cables, install the supplied cable grounding clamps.

4.2.2 Expansion TSAM Addressing & Jumpers

Address switch SW102 on the front of the TSAM is used to set TSAM SPI bus addresses.

A Master TSAM always has address 0. Additionally, the Master TSAM drives the Main and Secondary channel expansion transmit audio busses and receives audio on the Main and Secondary channel receive audio expansion busses.

Slave TSAM units have addresses 1-7. The addresses must be sequential and no addresses may be skipped.

The SW102 master/slave switch must be in the S position on all Slave TSAMs.

The Master TSAM controls the transmitter steering system. The MCU and control logic on the slave TSAM operates only in a standby diagnostic mode. All of the Slaves I/O logic and audio switching are controlled by the master TSAM MCU.

TSAM Address	SW102 4,2,1	SW102 M/S	TX Sites	Jumpers
0	0,0,0	M (Master)	1-8	E109-E112,E125 = In E123,E127,E124,E128 = A E217,E218,E219,E220 = Top
1	0,0,1	S (Slave)	9-16	E109-E112,E125 = See Note E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom
2	0,1,0	S (Slave)	17-24	E109-E112,E125 = See Note E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom
3	0,1,1	S (Slave)	25-32	E109-E112,E125 = See Note E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom
4	1,0,0	S (Slave)	33-40	E109-E112,E125 = See Note E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom
5	1,0,1	S (Slave)	41-48	E109-E112,E125 = See Note E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom
6	1,1,0	S (Slave)	49-56	E109-E112,E125 = See Note E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom
7	1,1,1	S (Slave)	57-64	E109-E112,E125 = In E123,E127,E124,E128 = B E217,E218,E219,E220 = Bottom

Table 2 Expansion TSAM Switch and Jumper Settings

0 = down, 1= up

Note: RS-485 Terminators
Jumpers E109-E112, and E125 install RS-485 terminator resistors on the expansion bus. The terminators are always required on the first and last TSAMs in a system. This means the Master TSAM and the last Slave TSAM always have these jumpers installed. All other Slave TSAMs have these jumpers removed.

4.2.3 Expansion Unit Programming

When a system is programmed for a slave (expansion) TSAM and the slave unit is disconnected, the system must be reprogrammed to insure proper operation. If you must run a system with an expansion unit disconnected, re-program the master TSAM for one less expansion unit. Be sure that the expansion units are addressed sequentially.

4.3 Physical installation of TSAM

A set of rack mount ears are furnished with the TSAM. There are two mounting locations on the TSAM enclosure for the mounting ears. There are two sets of mounting holes in the ears. The ears may be mounted with the mounting flange forward or reversed. These options allow the TSAM to be mounted in any of 8 positions. This allows mounting in a variety of racks or cabinets.

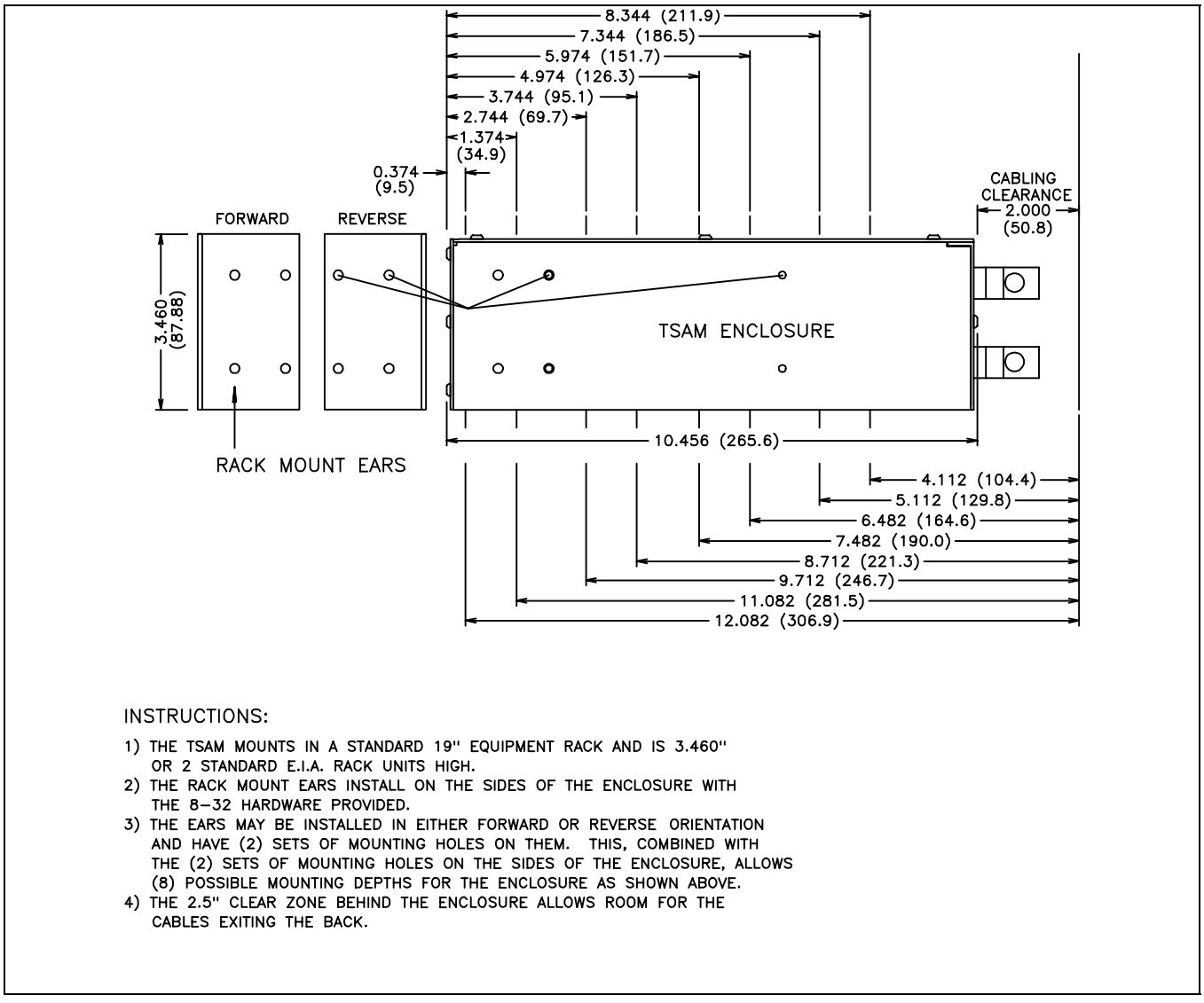


Figure 6 TSAM Mounting Positions

4.4 P101 (TX) Cable Signals

This male connector is present on all units. The TX cable contains all of the transmit audio line outputs and control signals.

Pins	In/Out	Name	Notes
26	In	Console 1 M Keying (/PTT)	LOW=PTT
1	In	Console 1 Coded/Clear	LOW=Coded
27	In	Console 2 M Keying (/PTT)	LOW=PTT
2	In	Console 2 Coded/Clear	LOW=Coded
28	In	FORCESEL	LOW=Force Select Site
3	In	RPT DISABLE	LOW=Repeater TX Disabled
29	In	Instant Mode	LOW=force Instant Update Steering
4	Out	RPT KEY	LOW=Repeater PTT for external transmitter hardware
30		Ground	
5	Out	Console 1 PTT Out COM	Relay Closure=PTT
31	Out	Console 1 PTT Out N.O.	Relay Closure=PTT
6		Ground	
32	In	RX Voted 1	LOW=Voted
7	In	RX Voted 2	LOW=Voted
33	In	RX Voted 3	LOW=Voted
8	In	RX Voted 4	LOW=Voted
34	In	RX Voted 5	LOW=Voted
9	In	RX Voted 6	LOW=Voted
35	In	RX Voted 7	LOW=Voted
10	In	RX Voted 8	LOW=Voted
36		Ground	
11	In/Out	TX Sel 1 /TXS1 Force In/Selected Out	LOW=Steered or Forced
37	In/Out	TX Sel 2 /TXS2	LOW=Steered or Forced
12	In/Out	TX Sel 3 /TXS3	LOW=Steered or Forced
38	In/Out	TX Sel 4 /TXS4	LOW=Steered or Forced
13	In/Out	TX Sel 5 /TXS5	LOW=Steered or Forced
39	In/Out	TX Sel 6 /TXS6	LOW=Steered or Forced
14	In/Out	TX Sel 7 /TXS7	LOW=Steered or Forced
40	In/Out	TX Sel 8 /TXS8	LOW=Steered or Forced
15		Ground	
41	In	Console 1 TX Audio Tip	600 or 10KΩ balanced Input
16	In	Console 1 TX Audio Ring	"
42	In	Console 2 TX Audio Tip	600 or 10KΩ balanced Input
17	In	Console 2 TX Audio Ring	"
43	Out	TX 1 Audio Tip	600 Balanced Output
18	Out	TX 1 Audio Ring	"
44	Out	TX 2 Audio Tip	600 Balanced Output
19	Out	TX 2 Audio Ring	"
45	Out	TX 3 Audio Tip	600 Balanced Output
20	Out	TX 3 Audio Ring	"
46	Out	TX 4 Audio Tip	600 Balanced Output
21	Out	TX 4 Audio Ring	"
47	Out	TX 5 Audio Tip	600 Balanced Output
22	Out	TX 5 Audio Ring	"
48	Out	TX 6 Audio Tip	600 Balanced Output
23	Out	TX 6 Audio Ring	"
49	Out	TX 7 Audio Tip	600 Balanced Output
24	Out	TX 7 Audio Ring	"
50	Out	TX 8 Audio Tip	600 Balanced Output
25	Out	TX 8 Audio Ring	"

Table 3 P101-TX Cable Connector Pinout and I/O Functions

4.4.1 P101 Main Channel Signal Definitions

Console 1 M Keying (/PTT) (C1PTT)	Logic signal from Console Low = PTT on Main Channel
Console 1 Coded/Clear	Logic signal from Console Low = Coded TX Main Channel High = Clear TX Main Channel
Console 1 TX Audio Tip & Ring	600 Ohm (Or Bridging) TX Audio from Console (Main Channel)
RX Voted 1-8	Logic signals from comparator Low = Voted
Instant Mode	Logic signal from Console Low = Instant TX Update Mode
RPT DISABLE	Logic signal from Console Low = Disable Repeater Operation High = Enable Repeater Operation (if programmed)
RPT KEY	Logic Output from TSAM (Not normally used) Low = PTT during Repeat operation
Console 1 PTT Out COM & N.O	Relay contacts active when C1PTT is active.
FORCESEL	Logic signal from Console (used with /TXS1-8) Low to Force Select. This tells the TSAM to use the /TXS1-8 lines as inputs. Holding this line low also disables automatic steering.
TX Sel 1-8 /TXS1-8	Bi-directional logic signals To/from Console (Main Channel) Outputs from TSAM (when FORCESEL is High): Low = Selected TX Inputs to TSAM (Read on low-going FORCESEL): Low = TX to force select
TX 1 - 8 Audio Tip & Ring	600 Ohm TX Audio Outputs to Transmitters (Main Channel)
Gnd	Negative Ground (common for all logic signals)

4.4.2 P101 Secondary Channel Signal Definitions

Console 2 M Keying (/PTT) (C2PTT)	Logic signal from Console Low = PTT on Secondary channel
Console 2 Coded/Clear	Logic signal from Console Low = Coded TX Secondary Channel High = Clear TX Secondary Channel
Console 2 TX Audio Tip & Ring	600 Ohm (Or Bridging) TX Audio from Console (Secondary Channel)
Gnd	Negative Ground (common for all logic signals)

4.5 P201 (RX) Cable signals

This male connector is present only on units with Secondary Mode. It contains all receive audio line inputs, control inputs for secondary operation, and a few other functions.

Pins	In/Out	Function	Notes
26	Out	Disable RX 1	LOW=Disable Site Receiver
1	Out	Disable RX 2	LOW=Disable Site Receiver
27	Out	Disable RX 3	LOW=Disable Site Receiver
2	Out	Disable RX 4	LOW=Disable Site Receiver
28	Out	Disable RX 5	LOW=Disable Site Receiver
3	Out	Disable RX 6	LOW=Disable Site Receiver
29	Out	Disable RX 7	LOW=Disable Site Receiver
4	Out	Disable RX 8	LOW=Disable Site Receiver
30		Ground	
5	Out	Console 2 PTT Out COM	Relay Closure=PTT
31	Out	Console 2 PTT Out N.O.	Relay Closure=PTT
6		Ground	
32	In	Sec Site Sel 1 /SS1	Active Low Binary Site Data
7	In	Sec Site Sel 2 /SS2	"
33	In	Sec Site Sel 4 /SS4	"
8	In	Sec Site Sel 8 /SS8	"
34	In	Sec Site Sel 16 /SS16	"
9	In	Sec Site Sel 32 /SS32	"
35	In	Multicast Enable (Main Channel)	LOW = Enable Multicast (if pgm)
10	In	PL Monitor Secondary Channel	LOW = PL Monitor
36		Ground	
11	In	Sec Freq Sel 1 /SF1	Active Low Binary Freq Data
37	In	Sec Freq Sel 2 /SF2	"
12	In	Sec Freq Sel 4 /SF4	"
38	In	Sec Freq Sel 8 /SF8	"
13	In	Reset All	Low=Reset Main Bases to F1
39	In	Spare R3	
14	In	Spare R4	
40	In	Spare R5	
15		Ground	
41	Out	Console 1 RX Audio Tip	600 Balanced Output
16	Out	Console 1 RX Audio Ring	"
42	Out	Console 2 RX Audio Tip	600 Balanced Output
17	Out	Console 2 RX Audio Ring	"
43	In	RX 1 Audio Tip	600 or 10KΩ balanced Input
18	In	RX 1 Audio Ring	"
44	In	RX 2 Audio Tip	600 or 10KΩ balanced Input
19	In	RX 2 Audio Ring	"
45	In	RX 3 Audio Tip	600 or 10KΩ balanced Input
20	In	RX 3 Audio Ring	"
46	In	RX 4 Audio Tip	600 or 10KΩ balanced Input
21	In	RX 4 Audio Ring	"
47	In	RX 5 Audio Tip	600 or 10KΩ balanced Input
22	In	RX 5 Audio Ring	"
48	In	RX 6 Audio Tip	600 or 10KΩ balanced Input
23	In	RX 6 Audio Ring	"
49	In	RX 7 Audio Tip	600 or 10KΩ balanced Input
24	In	RX 7 Audio Ring	"
50	In	RX 8 Audio Tip	600 or 10KΩ balanced Input
25	In	RX 8 Audio Ring	"

Table 4 P201-RX Cable Connector Pinout and I/O Functions

4.5.1 P201 Secondary Channel Signal Definitions

Console 2 M Keying (/PTT) (C2PTT)	Logic signal from Console Low = PTT on Secondary channel
Disable RX 1 - 8	Logic Output to Comparator Low to disable receiver slot during Secondary operation
Console 2 PTT Out COM & N.O	Relay contacts active when C2PTT is active.
Sec Site Sel 1 - 32 (/SS1 - /SS32)	Logic signals from Console Active Low Binary Secondary Site Select Lines All High = No Secondary Site Selected /SS1 Low = Secondary Site 1 /SS2 Low = Secondary Site 2 /SS1 and /SS2 Low = Secondary Site 3 etc.
Sec Freq Sel 1 -8 (/SF1- /SF8)	Logic signals from Console Active Low Binary Secondary Frequency Select All High = Secondary F1 (Base station F2) /SF1 Low = Secondary F2 (Base Station F3) etc. See Secondary Site Select Table for more details.
Reset All	Logic signal from Console Low sends out a "Revert to F1" tone sequence to all TX sites
Spare R3 - R5	Unused
Console 2 RX Audio Tip & Ring	600 Ohm Audio Output to Console RX Audio for selected Secondary Channel
RX 1 - 8 Audio Tip & Ring	600 Ohm (Or Bridging) Audio from Receivers This is typically in bridging mode and is connected in parallel with the Comparator RX wireline inputs.
PL Monitor	Logic signal from Console Low = PL Monitor. See section 3.4, Secondary Channel PL Monitor Control for operation
Gnd	Negative Ground (common for all logic signals)

4.5.2 P201 Main Channel Signal Definitions

Console 1 RX Audio Tip & Ring	600 Ohm Audio Output Selected RX Audio for Main Channel This is not used in actual operation, since the comparator selects the best signal, but the TSAM routes the RX audio from the selected base station to this pair.
Multicast	Logic signal from Console Low enables Multicast Mode (if programmed)
Gnd	Negative Ground (common for all logic signals)

4.6 TX Select Console Wiring -- Diode Matrix Plug / Schematic

The Diode Matrix Plug is available as an accessory to the TSAM. It can be used to interface consoles with simple Inputs & Outputs with the bi-directionsl TSAM TX Select lines.

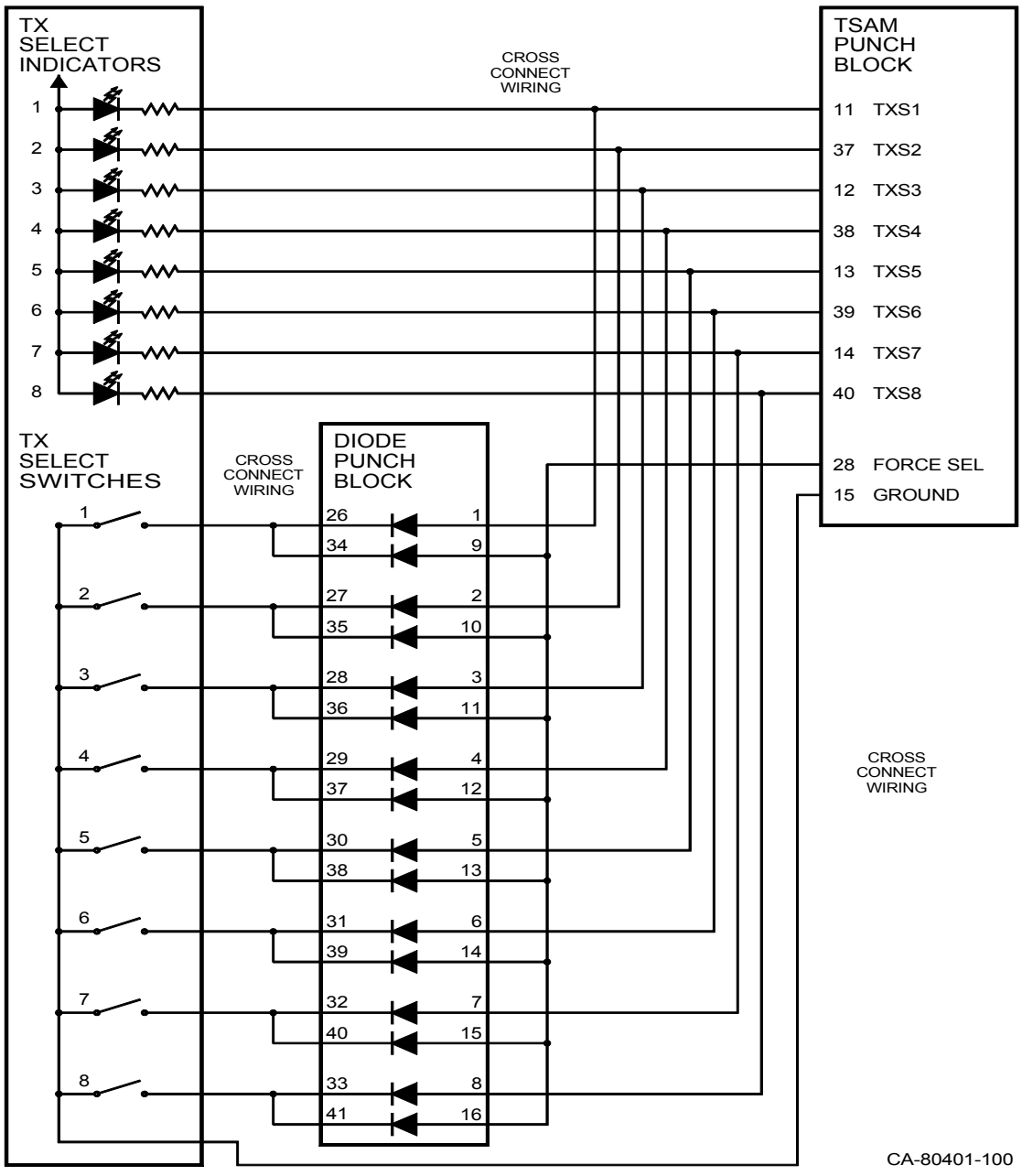


Figure 7 TX Select Console Wiring -- Diode Matrix Plug Schematic

The TXS1-8 lines are bi-directional. Normally they provide an output to indicate the selected transmitter. When the Force Sel line is brought low, the TSAM reads the TXS lines as inputs and force-steers to the site selected by the console.

4.7 TX Select Console Wiring with Diode Matrix Plug / Physical

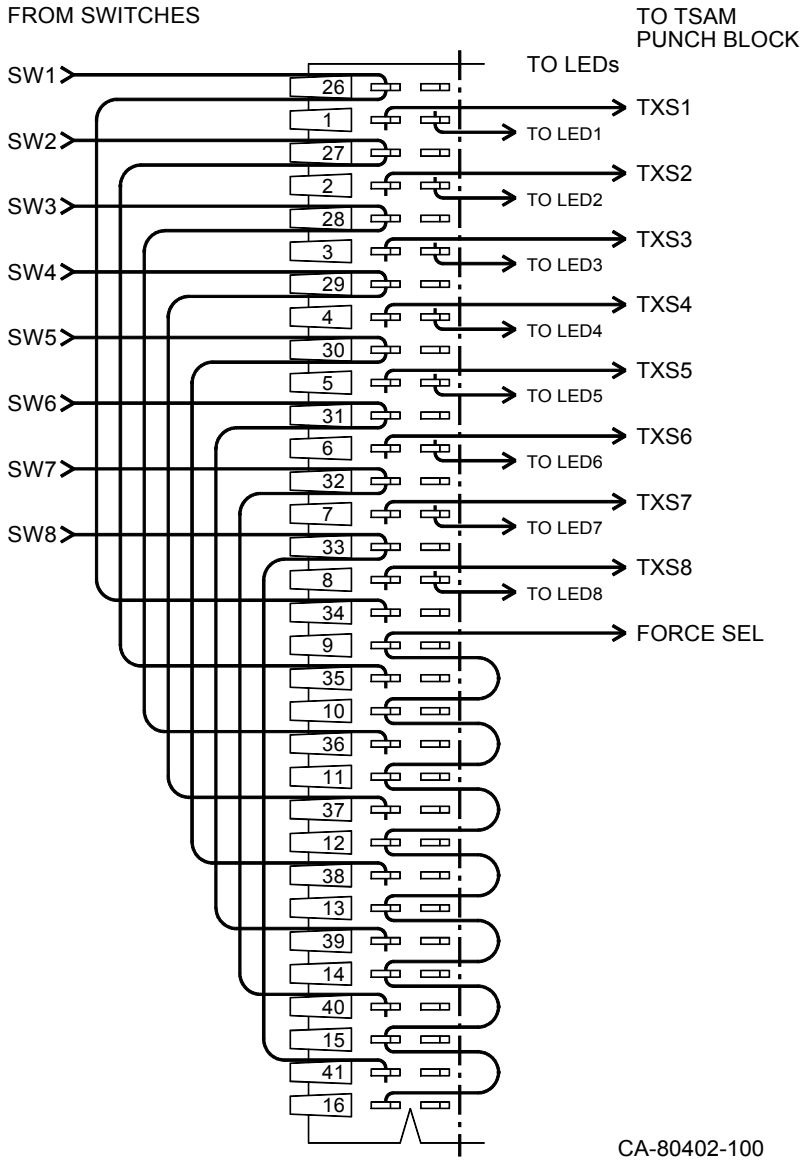


Figure 8 TX Select Console Wiring with Diode Matrix Plug / Physical

The Diode Matrix Plug can be used to implement the TX Select function.
The plug has 25 diodes.

4.8 Receiver to Transmitter Mapping with Diode Matrix

Some systems have more receiver sites than transmitter sites. In these systems you must map each receiver to one transmitter. A diode matrix is used to allow multiple Voted comparator outputs to drive a single RX Voted line on the TSAM unit. An example of system with 8 receivers and 4 transmitters:

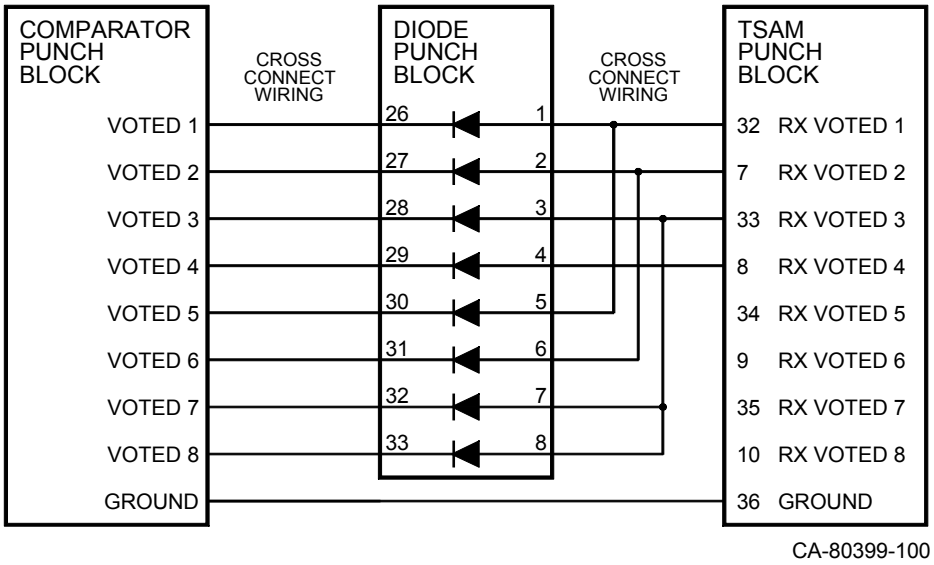


Figure 9 Rx to TX Mapping Schematic

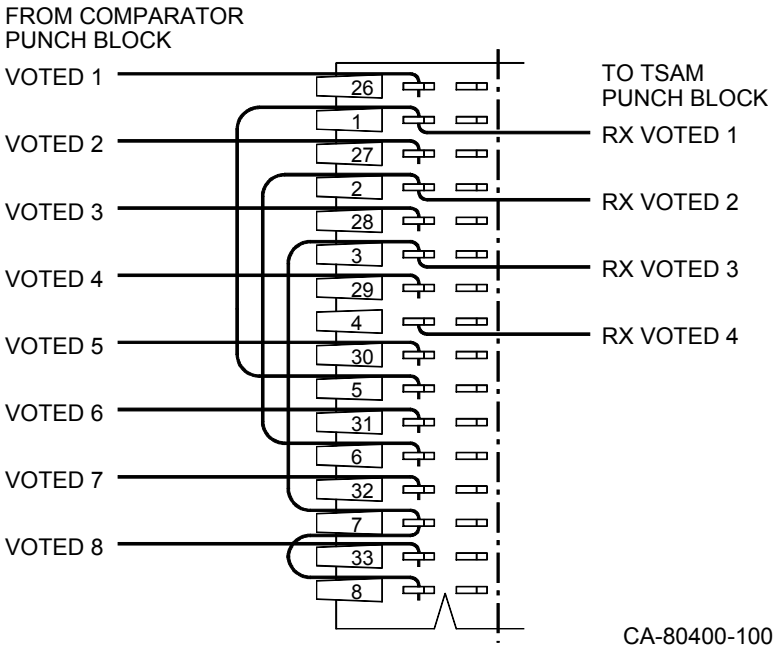


Figure 10 Rx to TX Mapping Diode Matrix Punch Block

4.9 Secondary Site & Frequency Control Wiring

The Secondary Site Select and Frequency Select inputs are binary coded. If your console will not generate binary coded outputs, you will have to generate the binary signals from a "1 of N" output from the console. An 8-site 5-frequency system in the following figure.

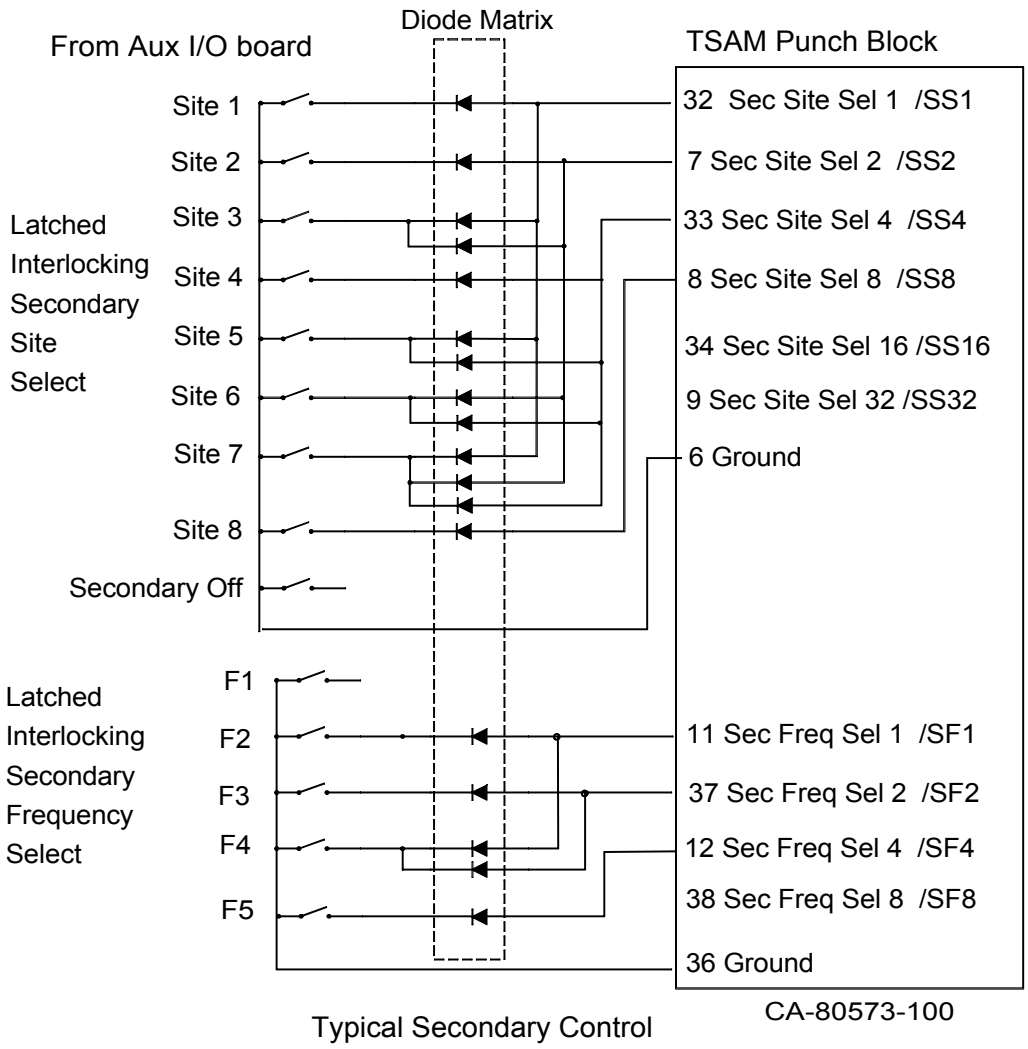


Figure 11 Secondary Site & Frequency Control Wiring

- Console connections are shown on the left as "From Aux I/O Board"
- The Secondary Site Select is straight binary (active low).
- Be sure to have a "Secondary Off" output which resets all the other outputs.
- Secondary Frequency Select is also binary, but offset by 1.
  Secondary F1 is coded as binary 0, F2 is coded as binary 1, etc.
  See section 4.10 Secondary Site Select Table for more details

4.10 Secondary Site Select Table

The Secondary Site Select inputs are binary coded, active low. The following table shows the Secondary Site Select inputs.

TSAM P201 Pin	9	34	8	33	7	32
Secondary Site	**/SS32**	**/SS16**	**/SS8**	**/SS4**	**/SS2**	**/SS1**
None	H	H	H	H	H	H
1	H	H	H	H	H	L
2	H	H	H	H	L	H
3	H	H	H	H	L	L
4	H	H	H	L	H	H
5	H	H	H	L	H	L
6	H	H	H	L	L	H
7	H	H	H	L	L	L
8	H	H	L	H	H	H
9	H	H	L	H	H	L
10	H	H	L	H	L	H
…	…	…	…	…	…	…
15	H	H	L	L	L	L
16	H	L	H	H	H	H
17	H	L	H	H	H	L
…	…	…	…	…	…	…
31	H	L	L	L	L	L
32	L	H	H	H	H	H
33	L	H	H	H	H	L
…	…	…	…	…	…	…
62	L	L	L	L	L	H
63	L	L	L	L	L	L

Table 5 Secondary Site Select Inputs

Note 1: The omitted entries continue in a binary progression (active low).

Note 2: Only Sites 1-63 may be selected for Secondary operation.

Note 3: Inputs are active low. L < 2.0 V, H > 10 V.

4.11 Secondary Frequency Tone Table

The following table shows the relationship between the secondary frequency inputs, the secondary channel frequencies, and the base station frequencies.

TSAM P201 Pin	38	12	37	11	**Base**	**Function**
Secondary Freq	**/SF8**	**/SF4**	**/SF2**	**/SF1**	**Freq**	**Tone (Hz)**
Note 1	X	X	X	X	F1	1950
1	H	H	H	H	F2	1850
2	H	H	H	L	F3	1350
3	H	H	L	H	F4	1250
4	H	H	L	L	F5	1750
5	H	L	H	H	F6	1650
6	H	L	H	L	F7	1550
7	H	L	L	H	F8	1450
8	H	L	L	L	F9	950
9	L	H	H	H	F10	850
10	L	H	H	L	F11	650
11	L	H	L	H	F12	spare
12	L	H	L	L	F13	spare
13	L	L	H	H	F14	spare
14	L	L	H	L	F15	spare
15	L	L	L	H	F16	spare
Not Used	L	L	L	L	None	None

Table 6 Frequency Select Tone Table

Note 1: The Main channel uses F1 in the base station. Secondary Frequency Select signals start at F2 and have no effect on the Main Channel keying tones.

Note 2: The frequencies shown above are the default function tone frequencies. They will vary if the frequencies are changed from the programming port.

Note 3: Default programming supports SF inputs for Secondary Frequencies 1-10.

Note 4: Inputs are active low. L < 2.0 V, H > 10 V.

4.12 Initial System Checkout

A system block diagram for a system with secondary operation is shown in Figure 12. As can be seen from studying the diagram, the TSAM connects to the following system equipment: The steered base stations and receivers, the system comparator, the Centracom Series II console, and Smartswitch II™ controller. Your system connection will vary, depending upon system equipment.

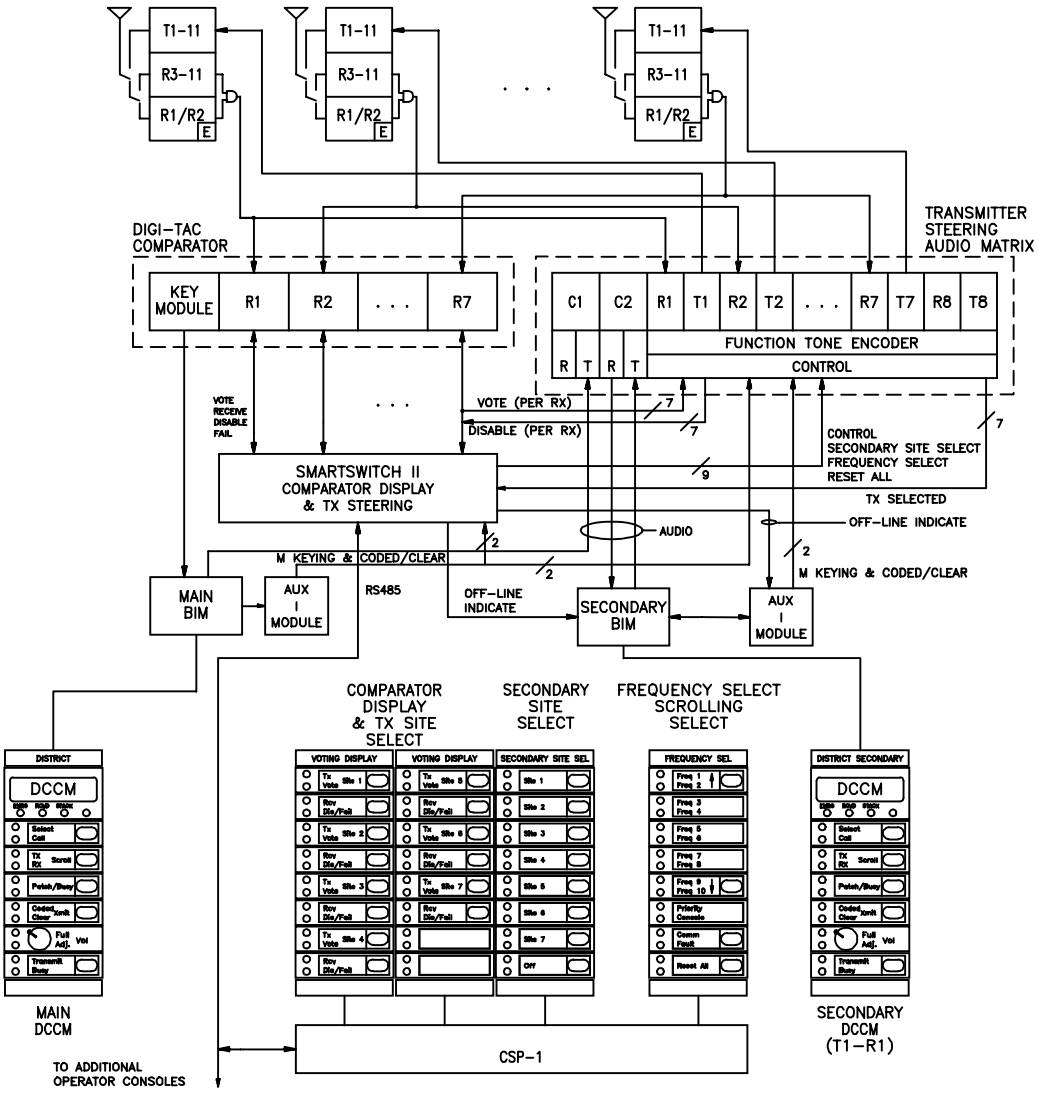


Figure 12 System Block Diagram

Interconnection is accomplished with a TELCO style patch panel consisting of 66 type punch blocks or a prewired patch panel. Use of a prewired patch panel requires metering access to the TSAM transmitter audio outputs and receiver inputs. These points may be accessible from the TELCO line interface equipment, or by connecting a type 66 punch block in series with the 25 pair TX or RX cable.

Many TSAM features may be unused and unconnected on your system. Skip any test procedures for functions that do not apply to your system.

Tip: The factory set levels are adequate for performing initial system check out. Final level setting is performed after successful completion of the system checkout.

4.13 Front Panel Indicators

The TSAM has several front panel LED indictors used to display operational status and diagnostic information.

Reset

This indicator lights when the reset line is held low. This LED should be lit when the front panel reset button is pressed or the TSAM is initially powered.

Vote

The vote led indicates the start of the steering process. This LED is lit when a voted site is detected and the Free Vote Time has expired. the vote has ended The LED remains lit until the Fade Hold time expires.

Active

This indicator is lit when the TSAM successfully powers up and initializes itself. The indicator should always be lit. A problem exists if the indicator is not lit.

Master

This LED indicates when a TSAM is configured as a master unit (SW102-4 is up). Only one TSAM on a steered channel can be a master, all other TSAMs must be slave units.

4.14 Main Channel Checks

Proper connection of the TSAM Main channel controls is verified by performing the system checks that follow.

Note: The following test is intended as a quick verification of basic system functions. A comprehensive system test must be performed after final installation and level setting is complete.

The following procedure tests these connections:

- TX Audio line outputs to base station wirelines
- Console 1 PTT
- Console 1 TX audio input
- TX Select I/O connections to console
- RX Voted inputs from system comparator

TX 1-8 Audio Line Outputs

Connect a line monitor amplifier on the TX 1 transmitter audio line, apply power to the TSAM. Verify that the MSTR LED lights on the master TSAM. You should hear the RESET ALL tone sequence on the monitor amplifier. This sequence is sent on all TX line outputs to return all base stations to F1.

Console 1 PTT

Check for proper PTT operation by keying the main channel PTT switch from the console. A keying tone sequence will be generated on the TX audio line output to the currently steered transmitter. When the TSAM is reset, the currently steered transmitter is set to the HOME A transmitter. HOME A is set to TX 1 at the factory.

Once PTT operation is verified, check for console transmit audio on the steered TX audio line.

TX Select I/O Wiring

Manually select another TX site by pressing the site FORCE VOTE / TX SELECT button on the console. After the site is selected, the TX LED for the site will light. If this does not function, trace the FORCE VOTE / TX SELECT line from its source on the console, through the diode matrix to the TSAM. . Repeat this process for each site, and correct any wiring problems as they are discovered

While any site select button is pressed, the FORCESEL line and the associated TX SEL line should be low. Be sure the FORCESEL line is not stuck low when no Site Select button is pressed. The TSAM starts a force select action when the FORCESEL line goes from High to Low.

RX Voted Input Wiring

Eight RX Vote indicate lines from the comparator connect to the TSAM TX connector P101. These lines indicate to the TSAM when a signal is received and which site is receiving the best signal. Based on this information, the TSAM determines the steered transmitter.

To test this wiring, force vote a receiver on the system comparator. LED1 will light indicating that vote activity has been detected. On consoles equipped with comparator display, a vote indication for the forced receiver will activate.

4.15 Secondary Channel Checks

To verify proper secondary channel operation, complete the following test on the secondary control wiring:

TX cable connections
- Console 2 PTT
- Console 2 TX audio input

RX cable connections
- 1 of N Secondary Site Outputs from the console and
  6 Binary Secondary Site Select inputs from the diode matrix (SS1-SS32)
- 8 Disable outputs to system comparator
- X Secondary Frequency Select outputs from the console and
  4 Binary Secondary Frequency Select lines from the diode matrix into the TSAM
- 1 Reset All input from console
- 1 Console 2 RX Audio output pair to console
- 8 RX audio input pair connections to TELCO lines and bridged across system comparator.

This series of tests verifies wiring and operation of secondary dispatch functions. Systems that do not use secondary dispatch can skip these tests.

Secondary Site Select and Site Disable Wiring

Activate a secondary site from the console. Upon activation the following sequence of steps is set into motion.

The receiver for the selected site is disabled. The RX disable LED for that site should be visible on the system comparator and at the console.

A tone control sequence is sent to the base at the selected site. This is monitored by connecting a line monitor amp on the TX wireline of the selected site.

If you need to check a Function Tone frequency, you can lengthen the Function Tone Time to about 5 seconds. You can then use a use a frequency counter to measure the tone. Alternately, you can use a stable audio generator and an oscilloscope in X-Y mode to give a stable 1:1 Lissajous pattern to check the tones in real-time.

Repeating this step for all sites in the system will complete the secondary site select wiring tests.

Secondary Frequency Select

After completing the previous test, leave the line monitor amp connected to the last site selected. While the secondary site is still selected, switch the site to another frequency using the console frequency select control. A frequency change tone control sequence should be heard on the line monitor amplifier. Select another frequency until all have been tested. Each frequency should have its own unique tone sequence.

Reset All

To test this input, turn off secondary operation. Next, connect the line monitor amp to any base station wireline. Activate the reset all function at the console. The F1 frequency change tone control sequence should be heard. This is the same tone control sequence sent to all system base stations, when the TSAM is reset.

RX Audio Input Wiring

Audio from the remote receiver sites connects to the TSAM RX line inputs. A high impedance audio input allows audio to be bridged directly across the RX audio inputs of the comparator. The audio inputs are used for secondary channel mode. In this mode, the comparator receiver input is disabled. The receiver site is switched to a secondary channel and the audio from this receiver is routed to the console secondary channel.

To verify proper RX Audio wiring, check for the receiver idle status tone from each receiver. This tone is present at the RX1-RX8 input adjustment test points. Use a line amp or some other audio signal tracer to verify the presence of the receiver idle status tone.

Console 2 RX Audio Output

Select a secondary site and generate a signal into the selected base. Audio from the base should be audible at the console. As an alternative, connect an audio generator to the selected site RX audio pair. Set the generator to match the expected RX level from the remote base.

If no audio is heard at the console, verify that the selected site receiver is active by monitoring the RX wireline from the selected site. If audio is detected here, check for audio on the Console 2 RX audio output pair (pair 42,17 in TSAM RX cable).

5. Setting Programmable Options

Many TSAM operational parameters are set in software. To edit these programmable options, connect a dumb terminal (or a PC with a terminal emulator) to the TSAM programming port.

5.1 Terminal Connections & Settings

TSAM Programming Port	DE-9S DCE 9-Pin Female to match PC-AT port
Cable Requirements:	Straight-through 9-Pin RS-232 9-Pin Male to Female for PC-AT Port 25 to 9 Pin adapter required for 25-pin port
Data Format:	9600 baud, no parity, and 1 stop bit (9600,N,8,1)
Terminal Emulation:	None

5.2 Main Menu

After connecting to the TSAM programming port, reset the TSAM. The following reset message will appear:

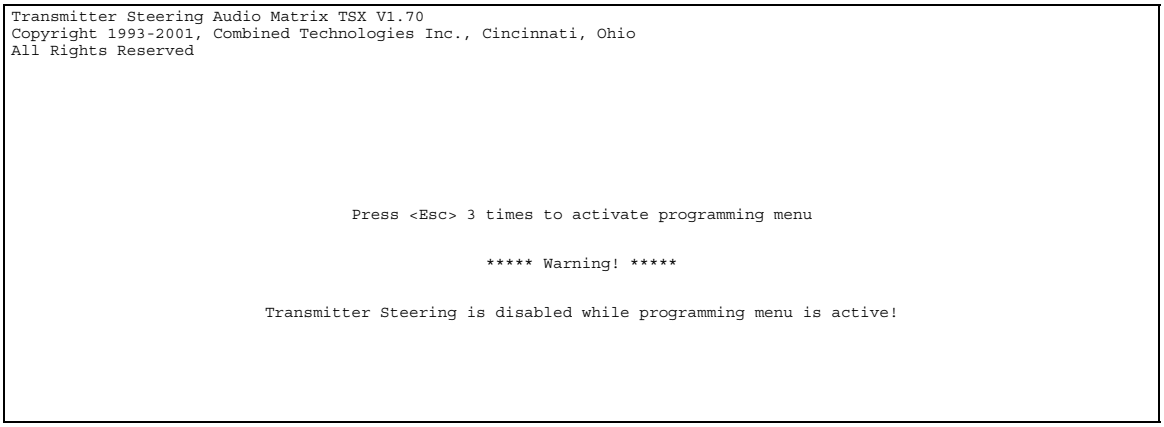


Figure 13 Programming Screen

After the reset sequence is complete (typically 1 second), press the Escape key 3 times to activate the programming menu. While in the programming menu, the TSAM stops transmitter steering and terminates any transmissions in progress on the Main or secondary channels.

When you enter the programming menu, the TSAM displays a list of parameter menus available for viewing and editing.

Main Menu

```
Main Menu Commands:
A      Edit High Level Guard Tone Parameters
F      Fetch Defaults
M      Edit Multicast Parameters
N      Edit Function Tone Parameters
R      Edit Repeater Parameters
S      Edit Secondary Operation Options
T      Edit Transmitter Steering Options
X      Edit Expansion & Home Transmitter Parameters
H or ? Help
Q      Quit

:
```

Enter the menu command to gain access to the desired option menu.

5.3 Saving Changes

When you make changes in the settings, they are not stored in EEPROM until you exit that menu item. You will then be asked whether you want to **Write** the changes to EEPROM or **Abort**. The settings will be saved if you choose Write.

5.4 High Level Guard Tone (HLGT) Options

```
:A

HIGH LEVEL GUARD TONE:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To change type desired value then <return>.
Guard Tone Frequency (2175) 2175 :  2175
Level 0 or -10 db0 = (0) 0 :  0
Duration (msec) = (60) 60 :  60
Finished.
```

Guard Tone Frequency

The TSAM supports a wide range of tone frequencies. Valid frequencies range from 0 Hz to 5000 Hz. 0 Hz results in no Guard Tone being sent. Normal tones range from 300 Hz to 2500 Hz. The default Guard Tone is 2175 Hz.

Guard Tone Level

HLGT is normally set to 0 dB referenced to maximum line level. A tone setting of -10 db0 is also selectable. This setting is useful for solving phone line cross talk or compatibility issues.

Guard Tone Duration

The duration of the High Level Guard Tone (HLGT) is typically between 60 and 120 msec. The range of allowable values is 0 to 32,767 msec. By selecting a longer time, immunity to false detection is increased at the expense of increased system access time. A value of 0 results in no HLGT being sent, but Low Level Guard Tone (LLGT) is still sent. See your base station specifications for minimum HLGT length.

5.5 Function Tone Options

This menu section lets you set the following:

- Function Tone Level & Timing
- Encrypted Transmit Mode Tones
- F1-F16 tone frequencies
- PL enable/disable method and frequencies

The first example shows programming without Encrypted TX mode or PL Enable/Disable:

```
 : N
FUNCTION TONE PARAMTERS:
To accept (DEFAULT) value: type <d> or <D>
To accept CURRENT value: type <return>
To change, type desired value then <return>
Level 0 or -10 db0 = (-10) -10 : -10
Duration (msec) = (40) 40 : 40

Select Coded (Encrypted) TX operation:
P    Positive Mode Control (PMC - Dual function tone)
     Supports Main & Secondary
S    Single Function Tone Coded Control
     Supports Main Only
     F1=Clear Keying;  FCoded=Coded Keying
N    No Coded Support
(P/S/N)? --> (N) N : N
Edit Key-up function tones (Y/N)? -->  : Y
   F1  Key (Hz) = (1950) 1950 : 1950
   F2  Key (Hz) = (1850) 1850 : 1850
   F3  Key (Hz) = (1350) 1350 : 1350
   F4  Key (Hz) = (1250) 1250 : 1250
   F5  Key (Hz) = (1750) 1750 : 1750
   F6  Key (Hz) = (1650) 1650 : 1650
   F7  Key (Hz) = (1550) 1550 : 1550
   F8  Key (Hz) = (1450) 1450 : 1450
   F9  Key (Hz) = (950) 950 : 950
   F10 Key (Hz) = (850) 850 : 850
   F11 Key (Hz) = (650) 650 : 650
   F12 Key (Hz) = (0) 0 : 0
   F13 Key (Hz) = (0) 0 : 0
   F14 Key (Hz) = (0) 0 : 0
   F15 Key (Hz) = (0) 0 : 0
   F16 Key (Hz) = (0) 0 : 0
Enable PL Monitor Function (Y/N)? --> : N

Finished.
Write changes to nonvolatile or Abort (W/A)? (W) W : W
```

5.5.1 Function Tone Level

Function Tone (FT) is normally set to -10 dB referenced to the maximum line level. A tone setting of 0 dB0 is also selectable. This setting is useful for solving phone line cross talk or compatibility issues.

Function Tone Duration

The duration of the Function Tone is typically 40 msec. The range of allowable values is 0 to 32,767 msec. By selecting a longer time, immunity to false detection is increased at the expense of increased system access time. A value of 0 results in no FT being sent. This time must match the FT timing specification for the base station.

5.5.2 Coded (Encrypted) TX operation

The TSAM unit supports Coded (encrypted) operation under the following conditions:

- The encryption and decryption must be done at the base stations.
- The base station automatically passes clear or decrypted audio as appropriate.
- The base station audio control lines must always pass clear audio.
- The base station TX mode is selected by either a specific control tone or is controlled by Motorola's Positive Mode Control (PMC) dual function-tone method.
- The comparator that the customer purchases must vote properly on encrypted and decrypted audio.
- The console provides a Coded/Clear output to the TSAM for desired TX mode.

The TSAM only controls the control tones for the TX mode (coded/clear). It does not provide any digitizing, encryption, or decryption of the transmit or receive signals.

> **Encrypted Systems Warning:**
> The reconstructed audio of a digital system may have different audio noise characteristics than a standard analog receiver system. This may cause an analog voter to mis-vote, or at least vote the reconstructed digital signals differently than it does normal analog signals.
>
> The customer must be sure that the comparator system will vote the proper site when it is receiving a coded (and decrypted) signal.

There are 3 choices for Coded TX operation:

- Positive Mode Control
- Single Function Tone Coded Control
- No Coded Support

Most users will choose **No Coded Support**

```
Select Coded (Encrypted) TX operation:
P    Positive Mode Control (PMC - Dual function tone)
     Supports Main & Secondary
S    Single Function Tone Coded Control
     Supports Main Only
     F1=Clear Keying;  FCoded=Coded Keying
N    No Coded Support
(P/S/N)? --> (N) N : N
```

5.5.2.1 Coded / Clear using Positive Mode Control Keying

This option works with Main (Steered) system and the Secondary system (if used).

The TSAM can be programmed to generate two function tones in a tone control sequence. This is called positive mode control (PMC). PMC is used in some Motorola radio systems for controlling encrypted and clear mode keying. The additional function tone is typically set for:

- Clear TX 1050 Hz
- Coded TX 1150 Hz

Special PMC Frequency Change Tone:
The PMC tone is also used in specially configured base stations for secondary channel frequency change operation. This control tone is the Frequency Change Tone, (2050 Hz). Using the Frequency Change Tone, the TSAM switches remote base stations from frequency to frequency without keying the base station. This prevents a base station being switched back to the Main channel from momentarily keying during an ongoing transmission, which can happen with conventional tone control schemes. This is a very special function found only on specially modified radios used in Denmark.

The PMC tone sequence sent to the base station is:

- HLGT
- PMC Tone
- Standard Function Tone
- LLGT + Voice Audio

```
Select Coded (Encrypted) TX operation:
P    Positive Mode Control (PMC - Dual function tone)
     Supports Main & Secondary
S    Single Function Tone Coded Control
     Supports Main Only
     F1=Clear Keying;  FCoded=Coded Keying
N    No Coded Support
(P/S/N)? --> (N) N : P
   Clear Key FT (Hz) = (1050) 1050 : 1050
   Coded Key FT (Hz) = (1150) 1150 : 1150
   Frequency Change FT (Hz) = (2050) 2050 : 2050
```

To edit the PMC options, press **P** at the menu prompt and enter the desired control tones.

If you do not have specially modified base stations that use the Frequency Change tone, program it the same as the HLGT (typically 2175 Hz).

The PMC tone is controlled by the Console 1 & 2 Coded/Clear signals.

5.5.2.2 Coded / Clear using Single Function Tone Keying

Works with Main (Steered) system only.

The TSAM can be programmed to control the Coded or Clear TX in a base station on the Main (steered) system with a single function tone (versus the dual function tone PMC).

This control tone is controlled by the Console 1 Coded/Clear signal as shown below:

TX State	Console 1 Coded/Clear	Function Tone Sent
Clear	High	F1 as programmed in Function Tones
Coded	Low	Coded Key FT as programmed below

To program the Single Tone Coded Keying tone, answer S and enter the tone desired for Coded mode as shown:

```
Select Coded (Encrypted) TX operation:
P    Positive Mode Control (PMC - Dual function tone)
     Supports Main & Secondary
S    Single Function Tone Coded Control
     Supports Main Only
     F1=Clear Keying;  FCoded=Coded Keying
N    No Coded Support
 (P/S/N)? --> (N) N : S
   Clear Keying is Standard F1
   Coded Key FT (Hz) = (1150) 1150 : 1150
```

5.5.3 Keyup Function Tones

The TSAM supports up to 16 channel base stations. F1 is always the Main steered channel. Whenever the Main channel is keyed, the F1 Function tone is used to key the base on F1 (unless Coded Single Tone Keying is used). In secondary operation, Function tones 2-16 are used. This allows 15 different secondary channels to be supported by the TSAM. The function values are programmable from 0 Hz to 5000 Hz, with 0 Hz being a muted tone.

See Section 4.11, Secondary Frequency Tone Table, for more details on how F1-F16 are controlled.

5.6 Repeater Options

Repeater options are programmed from the Repeater menu.

```
:R

Repeater Keying Options:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To change: type desired value then <return>.
Enable repeater operation (Y/N) = (N) Y : Y
Enable TSAM internal tone keying (Y/N) = (Y) Y : Y
Repeater Hang Time (msec) = (3000) 3000 : 3000
Resteer Key-up Delay Time (msec) = (0) 0 : 0

Finished.
```

5.6.1 Multicast Menu

The Multicast menu is entered with the M command from the main menu:

```
Main Menu Commands:

A         Edit High Level Guard Tone Parameters
F         Fetch Defaults
M         Edit Multicast Parameters
N         Edit Function Tone Parameters
R         Edit Repeater Keying Options
S         Edit Secondary Operation
T         Edit Transmitter Steering Options
X         Edit Expansion and Home Transmitter Parameters
H or ?    Help
Q         Quit


 : M
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
```

The individual commands shown in the Multicast Menu will be covered below.

Changes made while in this menu or its sub-menus will not be saved in EEPROM until you Quit this menu and perform a Write command.

5.6.2 L: Listing Enabled Multicast Transmitters

You can list the enabled multicast transmitters with the L command as shown below. There is a matrix of 8 transmitters and 8 TSAM units.

```
(EA/EI/DA/DI/L/Q)? -->
 : EA
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : L
TSAM(1) Y TX:  1  2  3  4  5  6  7  8
TSAM(2) N TX: __ __ __ __ __ __ __ __
TSAM(3) N TX: __ __ __ __ __ __ __ __
TSAM(4) N TX: __ __ __ __ __ __ __ __
TSAM(5) N TX: __ __ __ __ __ __ __ __
TSAM(6) N TX: __ __ __ __ __ __ __ __
TSAM(7) N TX: __ __ __ __ __ __ __ __
TSAM(8) N TX: __ __ __ __ __ __ __ __
```

Enabled transmitters are shown with their number. (Transmitters 1-8 here)

Disabled transmitters are shown with a blank (__). (Transmitters 9-64 here)

Active TSAM units have a "Y" following their number.

Inactive TSAM units have an "N" following their number.

Only transmitters with active TSAM units will transmit on Multicast. To activate additional TSAM units, use the "X" command from the main menu.

Use the L (List) command to verify your selection before quitting the Multicast menu.

5.6.3 EA Enabling All transmitters for multicast

If you want to enable all transmitters for multicast, use the EA (Enable All) command as shown.

```
(EA/EI/DA/DI/L/Q)? -->
 : EA
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : L
TSAM(1) Y TX:  1  2  3  4  5  6  7  8
TSAM(2) N TX:  9 10 11 12 13 14 15 16
TSAM(3) N TX: 17 18 19 20 21 22 23 24
TSAM(4) N TX: 25 26 27 28 29 30 31 32
TSAM(5) N TX: 33 34 35 36 37 38 39 40
TSAM(6) N TX: 41 42 43 44 45 46 47 48
TSAM(7) N TX: 49 50 51 52 53 54 55 56
TSAM(8) N TX: 57 58 59 60 61 62 63 64
```

As you see in the listing, all transmitters are enabled. Since there is only 1 TSAM unit active, only transmitters 1-8 will be actually used.

5.6.4 EI: Enabling Individual transmitters for multicast

Use the EI command to enable individual transmitters for multicast. The EI command lets you enter a number of transmitters if you wish. End each entry with a <CR> (<Enter>). When you are finished adding transmitters, enter a 0 <CR> for the transmitter number. You can see the results with the L (List) command.

```
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : EI
Enter Transmitter Number (1-64) to Enable
(1-64, or 0 to Quit)? --> : 1
(1-64, or 0 to Quit)? --> : 2
(1-64, or 0 to Quit)? --> : 3
(1-64, or 0 to Quit)? --> : 6
(1-64, or 0 to Quit)? --> : 7
(1-64, or 0 to Quit)? --> : 8
(1-64, or 0 to Quit)? --> : 0
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
: L
TSAM(1) Y TX:  1  2  3 __ __  6  7  8
TSAM(2) N TX: __ __ __ __ __ __ __ __
TSAM(3) N TX: __ __ __ __ __ __ __ __
TSAM(4) N TX: __ __ __ __ __ __ __ __
TSAM(5) N TX: __ __ __ __ __ __ __ __
TSAM(6) N TX: __ __ __ __ __ __ __ __
TSAM(7) N TX: __ __ __ __ __ __ __ __
TSAM(8) N TX: __ __ __ __ __ __ __ __
```

Note that the EI command works with the currently enabled transmitters. In this case we happened to start with no transmitters enabled.

5.6.5 DA: Disabling All transmitters for multicast

Use the DA (Disable All command to disable all Multicast transmitters.

```
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : DA
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : L
TSAM(1) Y TX: __ __ __ __ __ __ __ __
TSAM(2) N TX: __ __ __ __ __ __ __ __
TSAM(3) N TX: __ __ __ __ __ __ __ __
TSAM(4) N TX: __ __ __ __ __ __ __ __
TSAM(5) N TX: __ __ __ __ __ __ __ __
TSAM(6) N TX: __ __ __ __ __ __ __ __
TSAM(7) N TX: __ __ __ __ __ __ __ __
TSAM(8) N TX: __ __ __ __ __ __ __ __
```

5.6.6 DI: Disabling individual transmitters for multicast

Use the DI command to disable individual transmitters for multicast. The DI command lets you enter a number of transmitters if you wish. End each entry with a <CR> (<Enter>). When you are finished deleting transmitters, enter a 0 <CR> for the transmitter number. You can see the results with the L (List) command.

```
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : EA
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
: DI
Enter Transmitter Number (1-64) to Disable
(1-64, or 0 to Quit)? --> : 1
(1-64, or 0 to Quit)? --> : 3
(1-64, or 0 to Quit)? --> : 5
(1-64, or 0 to Quit)? --> : 7
(1-64, or 0 to Quit)? --> : 9
(1-64, or 0 to Quit)? --> : 11
 (1-64, or 0 to Quit)? --> : 0
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
: L
TSAM(1) Y TX: __  2 __  4 __  6 __  8
TSAM(2) Y TX: __ 10 __ 12 13 14 15 16
TSAM(3) N TX: 17 18 19 20 21 22 23 24
TSAM(4) N TX: 25 26 27 28 29 30 31 32
TSAM(5) N TX: 33 34 35 36 37 38 39 40
TSAM(6) N TX: 41 42 43 44 45 46 47 48
TSAM(7) N TX: 49 50 51 52 53 54 55 56
TSAM(8) N TX: 57 58 59 60 61 62 63 64
```

Note that the DI command works with the currently enabled transmitters. In this case we first used the EA command to enable all transmitters and then used the DI command to disable the transmitters we didn't want.

5.6.7 Q: Quitting the Multicast Menu

Use the Q (Quit) command to exit from the Multicast programming menu. You will be asked if you want to write the changes to EEPROM or if you want to Abort.

```
Edit Multicast Transmitter Selection
EA    Enable All Transmitters
EI    Enable Individual Transmitters by TX number
DA    Disable All Transmitters
DI    Disable Individual Transmitters by TX number
L     List Enabled Transmitters
Q     Quit Multicast Selection
(EA/EI/DA/DI/L/Q)? -->
 : Q

Finished.
Write changes to nonvolatile or Abort (W/A)? (W) W : W
```

5.7 Secondary Channel Options

Enter the Secondary Options menu with an "S" from the main menu.

5.7.1 Debounce Time

Selecting the secondary site and frequency may cause the TSAM control inputs to change several times before the desired site and frequency are set, especially if the console uses a scrolling control. To avoid extra tone control sequences being sent for each affected site and frequency, the TSAM waits for the debounce time after seeing a site or frequency change. This give the operator and console equipment time to settle on the final secondary site and frequency value selected.

The length of the debounce time is programmable from 0 to 32,767 msec. Times shorter than the control tone sequence will not result in any faster operation, so setting the debounce time to less than the typical tone sequence is of no value. The default value is 250 msec and is suitable for most applications. If the frequency change function of the PMC tone sequence is not supported by the systems base stations, then setting a longer debounce time is recommended. This reduces the chance of an unwanted base keyup as the secondary site and frequency are selected.

```
:S

Secondary Options:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To change: type desired value then <return>.
Site/Freq change debounce time (msec) = (250) 250 :  250
```

For consoles with non-scrolled controls, this parameter can be set down to 100 or possibly 50 milliseconds.

5.7.2 PL Monitor Menu

Unit Versions 1.70 and up / Secondary System Only

```
Enable PL Monitor Function (Y/N)? --> : Y
   Select PL Monitor Mode
      M - Momentary (Monitor until next transmission)
      S - Sustained (Remonitor after each transmission)
   (M/S)? -->(M) M : M
   PL Monitor Tone (Hz) = (2050) 2050 : 2050
   PL Monitor delay (msec) = (100) 100 : 100
```

Select Momentary or Sustained PL Monitor Mode from the menu. See section 3.4, Secondary Channel PL Monitor Control for more details on this option.

Program the PL Monitor Tone.

Program the PL Monitor Delay Time.

5.8 Transmitter Steering Options

The Transmitter Steering menu is shown below.

```
: T
Steering Options:
To accept (DEFAULT) value: type <d> or <D>
To accept CURRENT value: type <return>
To change, type desired value then <return>
Free Vote Time (msec) = (50) 50 : 50
Fade Hold Time (msec) = (50) 50 : 50
Forced Site Select Hold Time (msec) = (2000) 2000 : 2000
Sense RX activity during Console 1 PTT (Y/N) = (N) N : N
First RX / Integrated Vote steering rules (F/I) = (I) I : I
Integration Time (1/10 second increments) = (50) 50 : 50
Fast Steer option (steer on Console 1 PTT during RX activity) (Y/N) =
(Y) Y : Y
Transmitter Revert Time (sec) = (15) 15 : 15
Dynamic Update Mode  (Y/N) = (N) Y : Y
   Update Time (sec) = 10 : 10
   First RX / Multicast mode (F/M) = M : F
Simplex PTT Release Mask Time (msec) = (0) 0 : 0

Finished.
Write changes to nonvolatile or Abort (W/A)? W : A
```

The Transmitter Steering Parameters are discussed below.

5.8.1 Free Vote & Fade Hold Times

Free Vote is a vote settling period. During this time, voting activity has no effect on the transmitter steering decision.

The Free Vote time is the interval between the detection of initial receiver activity and the triggering of a TSAM action. This time determines how long the TSAM will wait after detecting receiver activity before it recognizes this activity as an input requiring action.

Free Vote allows the comparator to settle before the TSAM makes any transmitter steering decisions. Once the Free Vote time has expired, the TSAM will start the steering process using one of the steering criteria outlined in section 2.1.

Free Vote time is programmable from 0 to 32.767 seconds in 1 ms increments. It can normally be set at the default of 50 ms. Some systems, particularly those using hybrid analog/digital voting may require a larger time, up to approximately 250 ms.

Fade Hold

The Fade Hold time is the interval between the end of receiver activity and the triggering of an End of Reception event. Fade Hold prevents the TSAM from executing End of Reception events on short signal dropouts. If receiver activity resumes before the Fade Hold time expires, no End of Reception event occurs. This keeps the TSAM from resteering on short signal dropouts.

Forced Site Select Hold Time

When a transmitter is manually forced, the TSAM keeps that site as the steered site for the Forced Site Select Hold Time, regardless of system receiver activity.

Hold Time values can be programmed from 0 to 32,767 msec and to *Next Vote*. When set to Next Vote, the current site is held until current vote activity ceases and new activity is detected. To program the time to *Next Vote,* enter any value between 32,768 and 65,535.

5.8.2 Simplex and Duplex System Issues

The proper setting of the Free Vote and Fade Hold times will depend on many system issues. One key determining factor is whether a system is a simplex system or a repeater system.

The TSAM does not resteer on a signal fade or two transmissions from field radios spaced shorter than the Fade Hold time. If the Fade Hold time is set too long, it will interfere with resteering when two sequential transmissions are received from the field and the inter-transmission time is less than the Fade Hold Time.

Simplex systems will perform best with short Fade Hold times since, at worst, a short fade would cause the TSAM to resteer to the transmitter near the currently transmitting portable. This is of no consequence since the transmitter will be inactive until the dispatcher replies. When the dispatcher replies, the TSAM will have steered to the proper transmitter.

Fade Hold can be set as short as required to eliminate unintentional steering caused by quick keys or noise bursts.

On repeater systems, a longer Fade Hold time will provide better performance for the following reasons:

1. On a repeater, a fade of longer duration than the Fade Hold time causes the TSAM to resteer to the transmitter near the currently transmitting portable. This is undesirable, since the steered transmitter should be near the portable unit that last transmitted, not the one currently transmitting.

2. On a repeater system, a portable is less likely to key at the same time or within the Fade Hold time of another portable, since many of the portable units can hear the calling unit.

5.8.3 Resteering During Console 1 PTT

If the steered site should change while a console transmission is in progress, the TSAM offers two modes of operation. If resteering is allowed during Console 1 PTT, the steered transmitter is updated after the current console transmission is complete. The TSAM never resteers in the middle of a transmission regardless of the resteering setting.

With resteering disabled during Console 1 PTT, the transmission is ignored and the steered transmitter remains on the current site.

Resteering during Console 1 PTT allows the console operator to respond to a unit that calls in during console transmissions. This can disrupt ongoing communications, and would require the console operator to manually select the site to continue prior communications.

With resteering disabled, the console operator can carry on existing communications without having to manually select the best transmitter site. However, if the console operator wishes to respond to the newest call, the operator must manually select the best site.

Support for both modes of operation provides maximum flexibility for system operators.

5.8.4 Instant Update / End of Receive Update

If the Smart-Steer Integrated vote mode is selected, the TSAM automatically forces the End of Receive (EOR) Update mode.

If the First Receive steering is selected, you have the option of using Instant Update or End of Receive Update modes:

```
First RX / Integrated Vote steering rules (F/I) = (I) I : F
Instant Update or End of RX Update (I/E) = (I) I : I
```

5.8.5 Fast Steer on C1PTT

This option is described in section 2.2.4. It is recommended that this is option is always turned ON.

5.8.6 Smart-Steer™ Steering Mode

The First RX steering method works well in many applications, but is limited by the fact that it uses the site which a portable/mobile first votes. If the portable/mobile later votes a better site, the First RX steering method will not take this into account.

To address this limitation, some steering systems make a steering decision based strictly upon the last receiver voted. This method does not always choose the best receiver, since the last receiver voted could just have the longest squelch tail or slowest PL decoder. This may not be the best receiver. In the case of dual-level squelch systems, a receiver with a poor signal will have a longer squelch tail than a receiver with a strong signal. In this case, the last receiver to quiet could be the one with the worst signal. The TSAM overcomes this problem by using the Smart-Steer™ method. This picks the receiver voted longest within the past *x* seconds, where x is a programmable time period called the *integration time*.

The TSAM determines the last voted receiver as follows: The TSAM continuously integrates the vote signals over the programmable integration time. At the end of a portable/mobile transmission, the TSAM steers to the site that was voted the most for the last *x* seconds.

5.8.6.1 Integration Time

Integration time is the amount of time (in tenth second increments) over which the RX VOTED Inputs are integrated. The last *Integration Period* seconds of the RX VOTED inputs are integrated. The integration period ranges from 0 to 255 tenth second increments (0 to 25.5 seconds).

5.8.7 Simplex PTT Release Mask Timer Programming

The Simplex PTT Release Mask Timer can be programmed from 0 to 2500 milliseconds, in 1 millisecond increments. Numbers outside the range of 0 to 2500 will produce an out of range error, and you will be prompted again to enter a value in the correct range.

To determine the proper settings for your system, measure the time from release of C1PTT until all receiver voted inputs go inactive. Set the timer for 50 to 100 milliseconds greater than this value.

5.9 Expansion and Home Transmitter Parameters

```
:X

Expansion & Home Transmitter Parameters:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To change: type desired value then <return>.
Number of Expansion TSAM boards present (max = 7) = (0) 0 :  1
HOME A Transmitter = (1) 1 :  1
HOME B Transmitter = (2) 2 :  2
Finished.
```

5.9.1 Expansion Units

Enter the number of expansion units connected to the Master TSAM. A maximum of 7 expansion units can be connected, for a total of 64 transmitters.

5.9.2 Home Transmitter Selection

The TSAM allows the designation of two home transmitter sites. The home transmitter site are used when the current steered site is disabled by selecting it for secondary operation. When this occurs, the TSAM steers to site A if it is available. If site A was the site selected for secondary operation, the TSAM then steers to home site B.

6. Level Setting

After the physical TSAM installation and initial cabling checkout have been completed, all system levels should be measured and adjusted as necessary.

When setting up the TSAM, make all level measurement either directly on the audio input or output lines, or from the metering test points that are accessible from the front panel of the TSAM. The metering test points are designed to accept standard multimeter test probes. Refer to Figure 14 for the location of required test points.

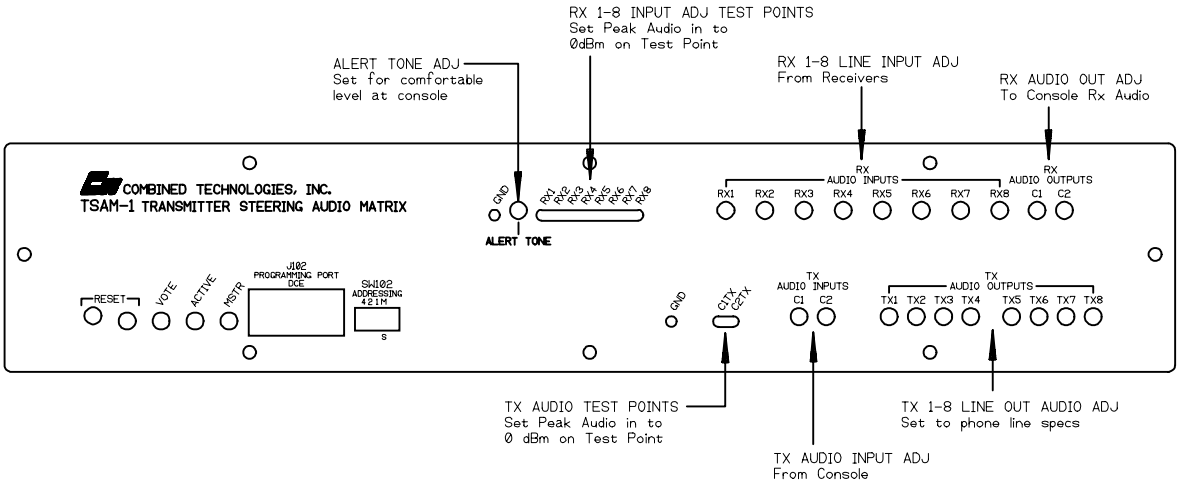


Figure 14 Level Adjustment and Test Point Locations

6.1 Tone Keying Generator Level setting

The tone keying generator is adjusted at the factory and does not normally need to be reset in the field.

To Adjust the Keying Tone Generator Level

1. Remove front panel of the TSAM.
2. Attach an AC voltmeter to the TONE 1 (TP104) test point and ground.
3. Key the Main channel base and hold.
4. While PTT is depressed set the TONE 1 output to 0 dBm (775mV RMS).
5. Verify the 0dBm level at TONE 2 test point (TP105) while keying the secondary channel.

6.2 Console 1 & 2 TX Audio Input Adjustment

Console transmit audio is routed from the console to the TSAM TX audio inputs. The TSAM has two TX inputs. Input C1 is the Main channel audio and input C2 is the secondary audio. To set the audio inputs, follow the procedure below for your console.

6.2.1 Motorola Centracom Series II Consoles

Set the average transmit audio level of the Centracom console to -10 dBm as outlined below. This level provides proper operation with the TSAM when the TSAM is adjusted according to the procedure below. No additional adjustment to the Centracom console are necessary.

Select the high TX audio input range (-8 to +6 dBm) for both Console 1 & 2 TX audio inputs (see jumper Table 7 on page 70).

The Motorola Centracom Series II BIM (Base Interface Module) will generate the series of test tones when the card is manually reset. A 1000Hz tone is generated for 5 seconds followed by 3 seconds of 300Hz and 3000Hz respectively. These tones are generated at 6 dB below HLGT (High Level Guard Tone). Set the 1000Hz test tone level to -10 dBm as measured at the output of the BIM. This level approximates the average voice level.

Connect an AC voltmeter to the TSAM C1 test point. Reset the Main Channel BIM, while the 5 second 1000Hz test tone is being set adjust the C1 TX control for a reading of -6 dBm on the voltmeter. This sets the average voice level for 6 dB below HLGT.

Repeat this procedure for the console 2 audio input using the C2 test point, and secondary channel BIM.

6.2.2 Level setting for other consoles

The TSAM will accept audio levels from -32 to +6dbm referenced to the nominal high level keying tone. Three jumper selectable ranges are available to allow adjustments over this range.

When setting the TSAM TX inputs, use either the high level keying tone or a 1000 Hz test tone from the console mic input set to the maximum voice level. While generating the proper reference tone, meter the C1 and C2 test point and adjust the C1 and C2 level pots until 0 dBm is obtained.

If 0 dBm cannot be obtained, measure the TX audio output from the console and reset the TX input level jumper for the proper range.

6.2.3 Bridging Inputs

To select bridged input mode, jumper the C1 and C2 TX audio inputs according to Table 7 on page 70. In this mode, the audio input impedance is raised to 10K allowing the TSAM to be added to a line with other equipment.

6.3 Transmitter 1-8 Line Output Adjustments

Transmit audio from the console is routed to one of the system base stations. The procedure below outlines how to set the Transmitter Line Out Level for each Transmitter output.

6.3.1 TX Output Level Settings

Output level adjustment is based on your Telephone Company's maximum line level specifications.

6.3.2 Metering of TX outputs

Connect an AC voltmeter across the TX 1 output line. This will be located either on the TX connector punch block or at TELCO line connection.

Manually force select TX 1 from the console by pressing the force site select button, or manually select TX 1 by force voting the system comparator long enough for the TSAM to steer to that site. The time will vary depending on system settings; 2 seconds is normally sufficient.

6.3.3 Centracom Series II

Generate a console test tone by resetting the Main channel BIM. During the 5 second 1000 Hz tone, set the TX 1 output to 6dB below the TELCO maximum allowable line level. HLGT will be generated at 6dB above the console test tone and will be at the maximum allowable line level.

When adjusting base station deviation, the console test tone is set for approximately 3 KHz of deviation.

6.3.4 Other Consoles

Key the Main channel from the console and hold the PTT switch. A tone keying sequence is sent to the TX 1 line and Low Level Guard Tone (LLGT) remains while PTT is held. While generating LLGT, set the TX 1 output to 30 dB below the TELCO maximum allowable line level. With Low Level Guard Tone set to 30 dB below maximum line level, the average voice level is 6 dB below maximum line level. High Level Guard Tone is at maximum line level (or -10 dB if that option is programmed).

6.4 Receive 1-8 Line Input Adjustment

6.4.1 Generating a RX Peak Reference Tone

Attach an AC voltmeter to the base station line output terminals.

Inject a 1000 uV carrier frequency signal at the antenna input to the receiver, modulated with a 1000 Hz tone at ±5 KHz deviation.

Set the line level adjustment on the base for the maximum allowed on the telephone line

6.4.2 Input range jumper selection

The TSAM inputs have two jumper selectable impedance values and three level ranges. To make these selections, refer to Table 7 and Table 8 on page 70.

Factory settings are -8 to +6 dBm input range adjusted for -4 dBm peak input (-10 dBm average voice), and 10K input impedance. The high impedance input range allows the TSAM RX inputs to be bridged across the line with other equipment. Typically the TSAM RX inputs are connected across the system comparator inputs which should have a 600Ω terminating impedance.

At the TSAM location make the following adjustments:

Set the RX input range jumper for the RX level expected on the telephone line. If this is not known, -16 dBm peak is a good starting point. The TSAM inputs are jumpered for the -8 to +6 dBm range and set for a maximum -4 dBm peak input level at the factory.

Connect an AC voltmeter to the RX 1 Test point

While the 1000 Hz RX Peak Reference Tone generated in the previous adjustment (see section 6.4.1) is still present on the phone line, set the RX 1 input pot for an indication of 0 dBm.

Repeat this adjustment for any receivers connected to RX2 - RX8

6.5 Console 1 RX Audio Output Adjustment

The Console 1 RX Audio line has receive audio for the currently steered site. The currently steered site is not always the same as the currently voted site. Main channel RX audio is the audio from the system comparator, which is the audio from the currently voted site. In most systems there is no need for Console 1 RX Audio from the TSAM, and it is left unconnected. Some systems may use the Console 1 RX Audio line for special monitoring functions or for a site intercom. In this case set the Console 1 RX audio outputs to the level required by the application. The outputs are factory adjusted to -4dBm peak (-10 dBm average) voice levels.

To Set Console 1 RX Audio Line Output

1. Force select a site on the Main channel.
2. Generate the 1000 Hz reference tone from the base station as in section 6.4.1.
3. Connect an AC voltmeter to the Console 1 RX Audio line output.
4. Set the line level to the maximum level required by the console.
5. Make any necessary level adjustments on the console (Centracom Series II has no input level adjustment).

6.6 Console 2 RX Audio Output Adjustment

The console 2 RX Audio line has the receive audio from the currently selected secondary site. This audio connects to the console's RX audio line for the secondary channel. If your system does not provide secondary operation, this line is not connected.

To Set Console 2 RX Audio Line Output

1. Enable the secondary channel by selecting a secondary site and frequency.
2. Generate the 1000 Hz reference tone from the base station as in section 6.4.1. Make sure your signal generator is set to the selected secondary frequency.
3. Connect an AC voltmeter to the Console 2 RX Audio line output.
4. Set the line level to the maximum level required by the console.
5. Make any necessary level adjustments on the console (Centracom Series II has no input level adjustment).

7. Tone Timing Diagrams

7.1 Transmit Tone Control Sequence

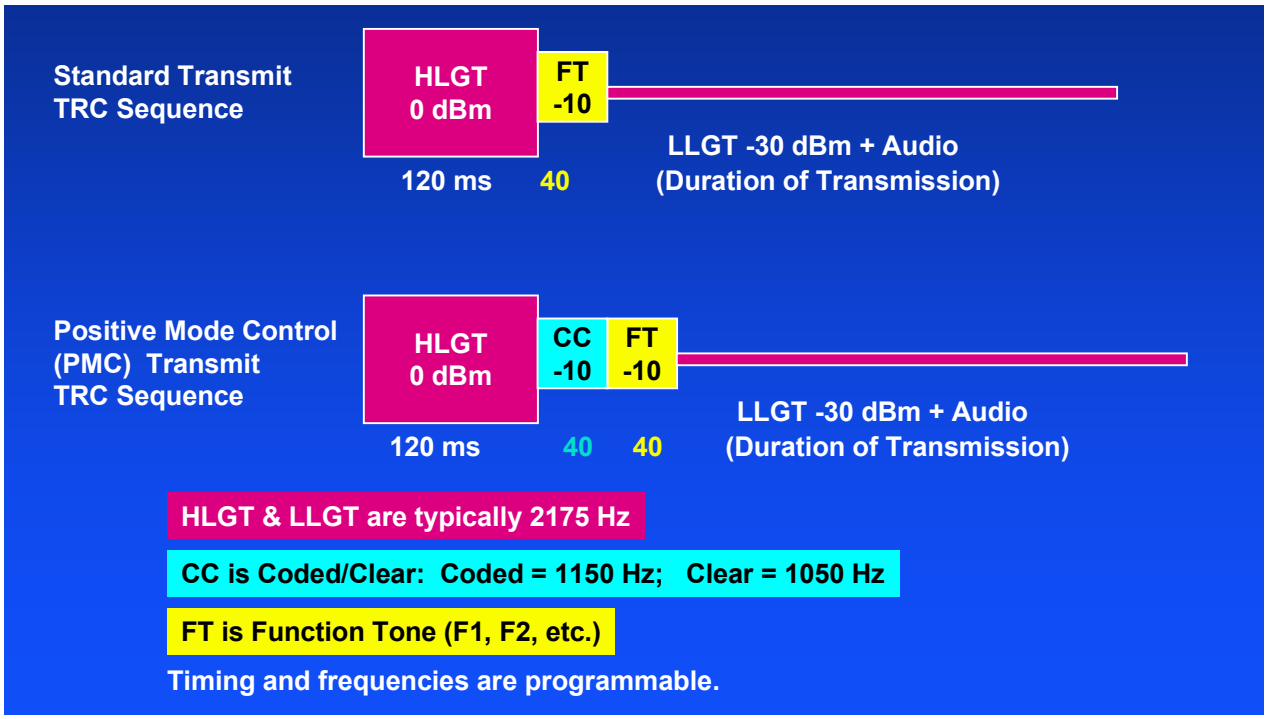


Figure 15 Transmit tone Control Sequence

7.2 PL Monitor / Enable Tones (No TX)

The following figure shows the PL Monitor tone sequence in **Sustained Mode**.

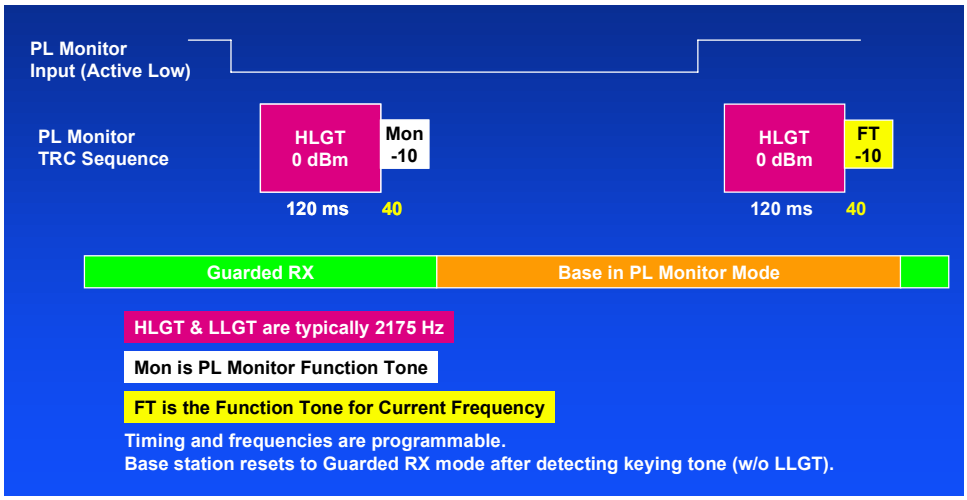


Figure 16 PL Monitor Tone Sequence -- Sustained Mode -- No TX

In **Momentary Mode** the second set of tones would not be generated.
The receiver would go into guarded mode on the next transmission.

7.3 PL Monitor / Enable Tones (With TX)

The following figure shows the PL Monitor tone sequence in **Sustained Mode**.

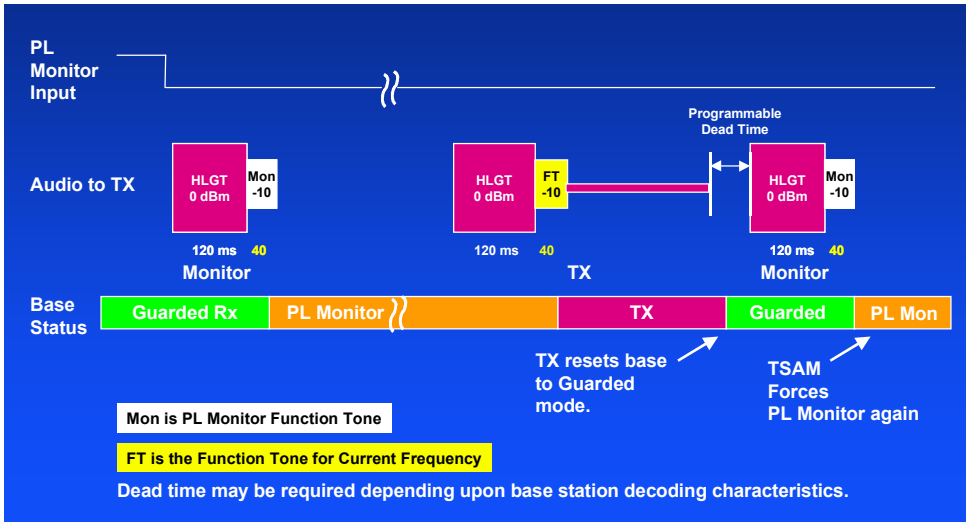


Figure 17 PL Monitor Tone Sequence -- Sustained Mode -- With TX

After transmission, the TSAM waits a programmable dead time and then re-generates the PL Monitor tone sequence.

In **Momentary Mode** the tones after the transmission would not be generated.
The receiver would remain in guarded mode.

8. Maintenance Theory

The TSAM is just one component in a sophisticated radio control system. The maintenance information is intended to allow field service personnel to quickly isolate faults to the TSAM subsystem. Further information is provided to allow a problem to be isolated to a particular TSAM board. The board may then be changed in the field. After any board change, verification of the system levels should be performed.

A troubleshooting flow chart is located at the end of this section. This flow chart allows quick isolation to a particular TSAM board or subsystem. Boards are serviced at the factory on a module exchange basis. For factory service write or call the number below:

CTI Products, Inc.
ATTN: Engineering Department
1211 West Sharon Road
Cincinnati, Ohio 45240
USA
+1 513 595-5900
8:30AM - 5:00PM Eastern time

In addition to board level maintenance information, more detailed technical information is covered. Using this information with diagnostic and trouble shooting techniques presented here, technical personnel can quickly isolate the trouble to a particular TSAM subsystem.

Detailed theory of operation and schematic diagrams provide the additional information required to service individual TSAM subsections to the component level. Some circuit subsystems may be more cost effectively serviced at the factory service center.

All TSAM circuitry is contained on two printed circuit boards (PCBs). The TSAM-T1 board (transmitter audio board), and the TSAM-R1 board (receiver audio) board. The receiver audio board is used for secondary operation only.

8.1 Re-Initializing the TSAM-T1 Transmitter Board

If troubleshooting procedures indicates a MCU subsystem failure, then re-initialization of the MCU should be attempted before replacing the board. If system critical MCU parameters have been corrupted, the MCU subsystem can fail. The MCU initialization restores all EEPROM parameters to the default values.

To re-initialize the MCU subsystem, connect a terminal to the programming port. Install jumper E113 on the TSAM-T1 board. Reset the MCU. If the MCU is functional, a message indicating MCU status will appear on the terminal. Follow the on screen instructions to complete initialization and return the MCU to normal operation.

8.2 Transmitter Board Electronics

The TSAM-T1 board contains the following subsystems:

TSAM-T1 Transmitter Board

- Power Supply
- Microcontroller Unit
- Programming Port Interface
- Serial I/O Bus (SPI)
- Logic I/O circuitry
- Console TX audio line receivers
- TX audio switching
- TX line drivers

8.2.1 Power Supply

The TSAM requires a nominal 20-24V AC or 24V DC power source. Power is fed from J101. Fuse F101 and varistor VR101 provide input over-voltage protection. Diode bridge D111 provides polarity protection when the TSAM is operated from DC. The diode bridge, C235 and L101 provide AC rectification and filtering for AC operation.

All other system voltages are derived from the filtered DC power source. Two switching converters generate 5V DC and 12.7V DC. In addition to these voltages, several low current and reference voltage regulators are used to supply board power. These include:

- -5V volt DC-DC converter
- 5V regulated reference
- 6.3V buffered audio ground references

- 5 V References and 6 V Analog Ground

The -5V supply and 5V reference supply, feed tone generators IC106 and IC107 and mutiplexers IC108 and IC109. The 6.3V audio ground references are supplied by virtual ground buffers IC137 on the TSAM-T1 board and IC210 on the TSAM-R1 board.

+ 5 V and +12 DC-DC Converters

The 5V and 12.7V regulators are simple "Buck" type regulators. They both operate in a similar manner. Only the 5V regulator is discussed in detail.

Filtered DC is fed to the 5V regulator (IC138). The IC and catch diode D112 convert the DC into a pulse width modulated square wave. The square wave is then filtered by L102 and C238. The output is a lower DC voltage that is proportional to the duty cycle of PWM square wave. This DC voltage is then fed back to the regulator FB pin (IC138-4). If the feedback signal is lower than 5 volts, the regulator increases the PWM square wave duty cycle till the voltage reaches 5 volts. If the voltage is above 5 Volts, the regulator decreases the PWM square wave duty cycle till the output drops to 5 Volts. This change in duty cycle in proportion to the feed back voltage provides the power supplies regulating action.

Operation of the 12.7V supply is similar. The 12.7 volt supply has additional filtering components L105 and C264. This further reduces switching noise in the output, as required by the TSAM analog audio circuitry. It also has feedback resistors R162 and R163 that set the output voltage.

8.2.2 Audio circuitry power supply

All audio circuitry uses a mid supply audio reference. This audio reference supply is 6.3 Volts with respect to chassis ground. This reference is the audio ground. Care should be taken not to tie audio ground and chassis ground together. This will short the audio 6.3V supply and severely distort all audio signals. Do not clip the ground lead of a scope or other grounded test equipment to the audio ground. Audio ground is denoted on the schematic by the triangular ground signal.

12.7 volts DC from the system supply feeds the IC137 rail splitter IC (IC210 on receive board). The output of IC137 is a buffered low impedance 6.3V reference supply. This is the audio circuitry ground reference. Op amp IC114 (IC209 on receiver board) provides an alternate 6.3V reference with degraded performance. This circuit is not normally used.

8.2.3 Microcontroller Unit (MCU)

All operations of the TSAM are performed under control of the MCU (IC126). The TSAM uses a Motorola 68HC11 MCU with external RAM (IC129) and ROM (IC128) for data and program storage. The MCU has internal EEPROM memory for the storage of all programmable parameters. This reliable form of non-volatile memory safely stores the configurable parameters when power is removed, without requiring any backup power.

The address and data bus control logic consist of latch IC127 that is used to separate the multiplexed address and data information from the MCU. Address decoding is accomplished by IC125 and IC124. ROM is mapped from Hex address $8000 to $FFFF. RAM is mapped from $0000 to $7FFF.

The MCU integrates the following control functions:

- Serial Peripheral Interface (SPI) for control I/O
- RS-232 SCI interface for communications with programming terminal
- A/D converter used for factory test and diagnostics.

Serial Peripheral Interface BUS (SPI)

Most control inputs and outputs used by the MCU to control board level functions are accessed through the SPI interface. This interface is roughly equivalent to a serial to parallel converter. Parallel I/O data is converted to serial data then shifted into or out of the MCU. The MCU converts that data back to a parallel form were it can be read or written to by the MCU's control program. In addition to parallel I/O, other data is sent on the SPI bus. The MCU sends the frequency control data, for the keying tone generators, over the SPI bus.

The following control logic and peripherals are connected to the SPI bus:

- Command shift register IC130, and SPI command decoder IC131
- Output register IC132, TX crosspoint, and RX crosspoint
- Tone generators 1&2, IC108 and IC109
- Input shift registers IC115-117, IC206-207 (provides 40 logic inputs)

The SPI system allows access to a large number of peripheral components without adding all the hardware required to access peripherals through the traditional memory mapped processor bus.

The SPI command decode logic consists of a command shift register and a 22V10 PAL type device. This device is programmed to perform SPI address and function decoding. The use of this device as an address decoder allows the Master TSAM to control all of the TSAM peripherals on any TSAM attached to the SPI bus. Expansion TSAMs do not require an MCU. The MCU only performs a low level diagnostics when it is addressed as an expansion TSAM.

Each SPI transfer or command ends with the SPI command data. The last 8 bits of data shifted out on MOSI MCU line are loaded in the command shift register. These 8 bits contain the TSAM board address and command data.

Bit Number	Signal Name	Function
8	BC	Reserved
7	A2	Board Addr MSB
6	A1	Board Addr Bit1
5	A0	Board Addr LSB
4	C3	Command word MSB
3	C2	Command word Bit2
2	C1	Command word Bit1
1	C0	Command word LSB

When the proper command value and address value are shifted out the SPI bus, the command decoder on each TSAM determines if the address bits match the board address switch. When a match is detected, the control function is enabled thereby setting or clearing the control line outputs of the command decoder.

The Output Shift Register (IC132) has 32 to outputs that can be set or cleared by the MCU. Many of these outputs are used to control the TX and RX crosspoint switches. Even though the crosspoint switch arrays (IC111 and IC205) are not directly connected to the SPI bus, the MCU programs them through the SPI via the Output Shift Register.

RS-232 Serial Interface

The TSAM is a flexible unit that can be tailored to the needs of a particular installation. Parameters such as the steering algorithm, and timing parameters are easily altered through the programming port. The programming port uses an industry standard RS-232 interface.

The MCU's internal SCI communications port uses standard TTL voltage levels. IC123 converts these to RS-232 levels. IC123 has two on chip charge pump voltage generators. They generate approximately ± 10V unloaded. This voltage drops to ±3V at full load. The charge pump voltages can be measured at IC123 pins 2 and 6. Pin 7 of IC123 provides a DCD indication to satisfy handshaking requirements for the programming terminal. This line should measure +3 to +10 Volts after the MCU is reset, it is always asserted while the MCU is running.

The programming port connector J102 is wired as a 9 Pin PC AT DCE connector. This allows use of a standard straight-through 9 Pin male to female cable. This is the most common portable/ laptop PC connector.

A/D Converter

The MCU integrates an internal A/D converter. The converter is used for factory analog loop back tests. Under MCU control the analog signal to be measured is routed through the crosspoint switch (IC111, IC205). The signal appears on IC111 port X8. The signal is conditioned by IC114 and IC135. Three conditioned signal are then connected to the MCU on the PE0, PE1, and PA0 lines. A peak detector circuit conditions the signal on PE1. This provides a means for measuring the peak signal level of an audio signal. A buffer conditions the PE0 signal that allows more complex measurements to be made of the analog signal. A hard limiter (zero crossing detector) squares the analog signal applied to PA0.

8.2.4 Transmitter Audio Circuitry

Transmit audio from the console's Main and secondary channels connects to the Master TSAM. The TX audio line receivers match the line impedance, and adjust the input audio to the proper level. The line receiver circuit is adjusted so peak input audio is at 0 dBm before the keying tones are inserted. This level is necessary so that keying tones inserted into the transmit audio path have the proper levels.

Line receiver circuits consist of a jumper selectable input attenuator and an adjustable gain input amplifier. The input amplifier has a selectable 600 Ohm or 10K Ohm input impedances.

The keying tone circuit consists of tone generator IC106, 10 dB and 30 dB resistive pads, and an analog multiplexer IC108. When sending HLGT or Function Tones, the mux passes audio direct from the tone generator or through the 10 dB pad, but console transmit audio is muted. When sending LLGT, the mux passes audio from the 30 dB pad as well as console transmit audio, allowing LLGT mixed with console audio to reach the transmitter.

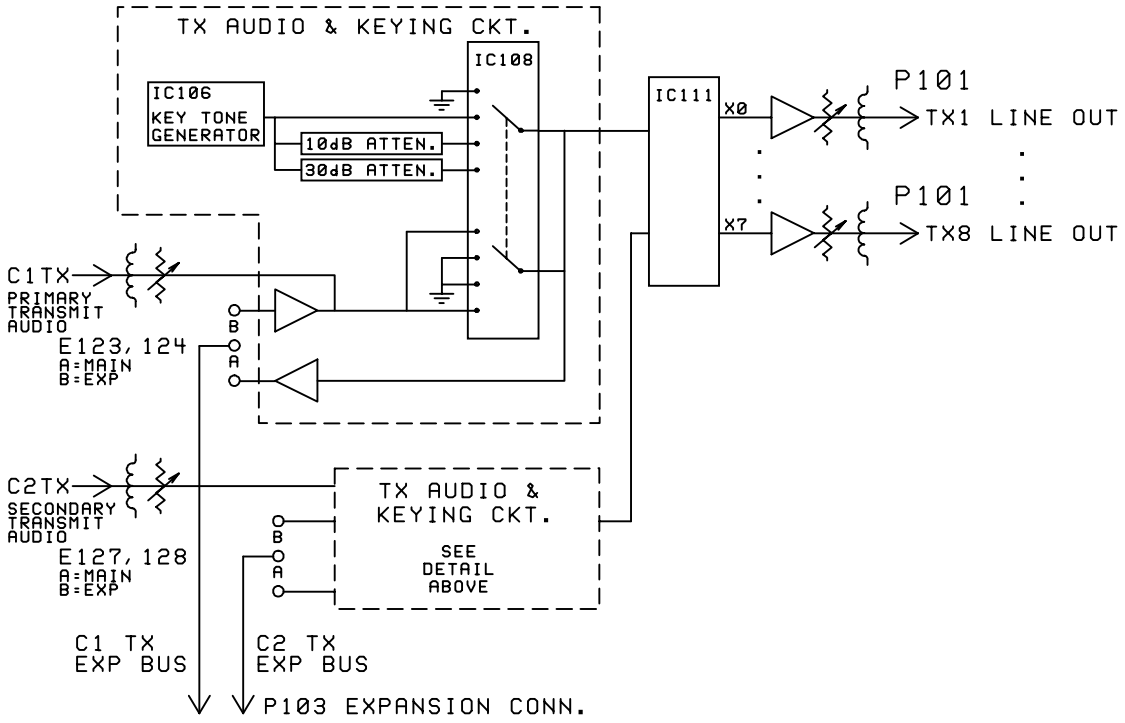


Figure 18 TX Board Audio Block Diagram

Crosspoint Audio Switch

Audio and keying tones from analog mux IC108 are routed to the transmit line drivers through the crosspoint switch IC111. Peak voice and HLGT levels are adjusted to 0 dBm at the switch. This level optimizes signal to noise and minimizes crosstalk.

Transmit Audio Line Drivers

Referring to the transmit board schematic and examining the TX 1 output in detail, we see IC101A and IC101B make up a differential driver. This differential drive is applied to the line transformer T101 through a pair of impedance matching resistors. Op amp IC101 is optimized for driving the low impedance wireline loads. R117 controls the gain of the first inverting amplifier in the differential driver. The second amplifier inverts the output of the first amp and has a gain of 1. Zener diodes DZ101-102 and gas tube GT101 provide transient over-voltage protection for the drive circuit.

8.2.5 TSAM Expansion Bus

The TSAM expansion bus allows up to 8 TSAMs to be connected together to control up to 64 transmitter sites. Expansion connector P103 on the transmitter board allows multiple TSAM to connect together. There are five separate busses on the 26 pin expansion connector. These are the SPI expansion bus, console 1 TX audio, console 1 RX audio, console 2 TX audio, and console 2 TX audio buses.

Transmit Audio Expansion Bus

Transmit audio from the console connects to the Master TSAM (ADDRESS = 0). The master TSAM inserts control and keying tones and then this audio is the distributed to all connected TSAMs. On the Master TSAM, jumpers E123, 124, 127, and E128 are in the A position. This routes audio from Master TSAM TX Audio and Keying Circuit out to the expansion audio bus. All Slave (Expansion) TSAMs have jumper E123, 124, 127, and E128 in the B position. This picks transmit audio and keying tones off the expansion bus and routes them through the TX board analog mux to the crosspoint switch. TX expansion audio is always applied to the crosspoint switch of each slave board. This allows the master to route TX audio to any transmitter in the system by programming the crosspoint switch on each expansion board. The slave boards crosspoint switches are programmed through the SPI expansion bus.

The master TSAM is jumpered to send audio out the console 1 and 2 TX audio buses, and receive audio on the console 1 and 2 RX audio buses. The expansion TSAMs are jumpered in the opposite fashion.

8.3 Receiver Board Electronics

Two circuit boards make up the TSAM, the TSAM-R1 (receiver audio board) board contains all of the RX audio switching circuitry, RX line receivers, Console receive audio line drivers, and all logic I/O required for secondary operation. When secondary operation is not used the receiver audio board is not required.

The receiver audio board connects to the transmitter control board via a 50 pin header located on the TSAM transmitter board. Power, Serial I/O, Audio, and Logic I/O, feed through this connector.

Receiver board circuitry is divided into the following functional blocks:

TSAM-R1 Board

- Receive Audio Line Inputs
- Receive Crosspoint Switch
- Console Audio Line Outputs
- Secondary Mode Logic Inputs

8.3.1 Receive Audio Line Inputs

The receive audio line inputs provide a balanced 600 Ω termination for remote base receive audio lines. Each circuit contains input transient protection, impedance matching, and audio level setting circuitry. The wireline receivers have a jumper selectable 10K high impedance input mode. This allows the TSAM to be connected in parallel with other equipment. Normally the TSAM receive inputs are paralleled with the system comparator.

Refer to the TSAM-R1 (receiver board) schematic diagram. The first of 8 identical receiver input circuits is described. The gas discharge tube GT201 provides input transient protection for large transients. R201 provides a 600 ohm termination for impedance matching. R209, R217 R225, R223 make up a jumper selectable attenuator network. The resistor can be jumpered to provide 3 separate level ranges.

Audio from the attenuator network is coupled via DC blocking cap C209. This cap blocks small dc offsets present on the input of the line receive amplifier.

The line receiver amplifier, consisting of IC201D and associated components, amplifies the input signal to the optimum level for the crosspoint switch. Audio into the crosspoint switch is adjusted to a peak level of 0 dBm. This level optimizes signal to noise levels and minimizes cross-talk levels from adjacent wireline inputs.

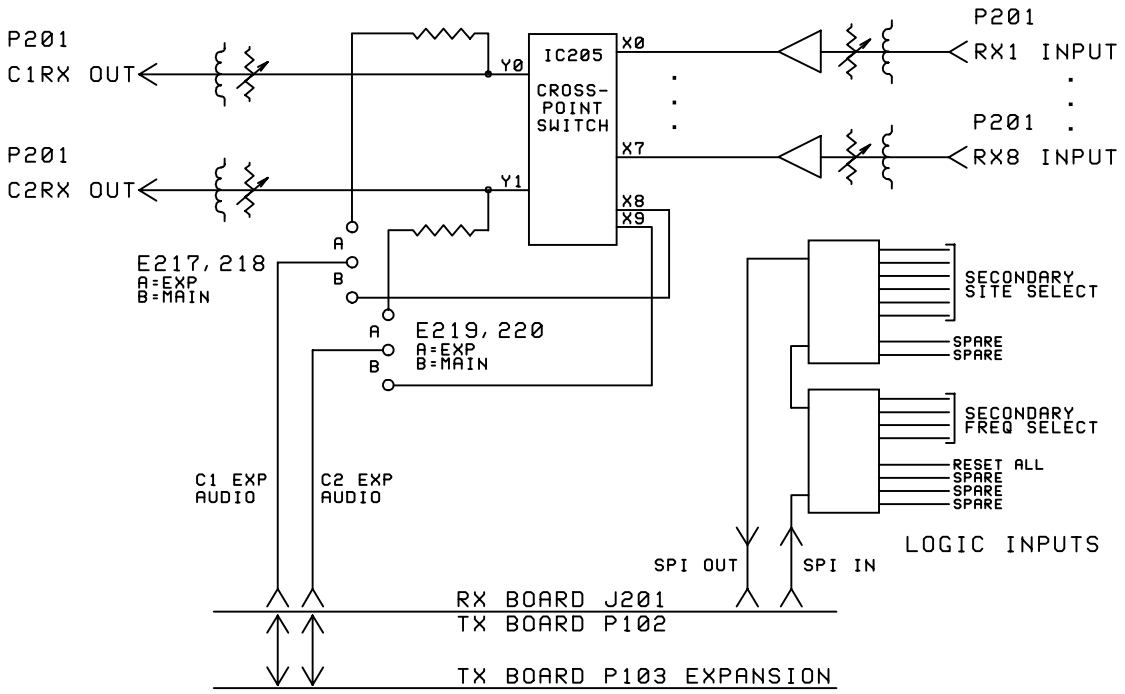


Figure 19 RX Board Audio and I/O Block Diagram

8.3.2 Receive Crosspoint Switch

The crosspoint switch device allows any receiver input to be connected to any receive audio output.

The receive crosspoint switch has two receive audio outputs and 10 receive audio inputs (8 receiver + 2 expansion). In normal operation, the TSAM routes audio from the steered site receive input to the Console 1 RX Audio output (C1 RX). Console 1 RX audio is not typically used. This audio path acts as an intercom from the remote site. The Main channel receive audio comes directly from the system comparator, and is not routed through the TSAM.

When a site is selected for secondary operation, the audio path from the selected site receive input is routed to the secondary channel audio output. This output drives the secondary channel receive audio line to the console.

The crosspoint switch also has inputs from the expansion audio bus and a test tone audio input. On the master TSAM, receive audio from other TSAMs is picked off the expansion audio bus and routed to the C1 or C2 RX output. The test tone input is used for factory testing and to generate the warning tone heard when an attempt is made to key the secondary channel without a secondary site selected.

When the warning tone is generated, the MCU programs the C2 tone generator to alternately generate 480 Hz / 620Hz warning tone. This audio is routed from the receive crosspoint test tone input to the top of R302 the Alert Tone Level adjustment pot. The wiper of R302 is brought back to the crosspoint switch,

routed to R300, and finally routed to the C2 RX audio output. This audio is then heard on the console secondary channel speaker.

Console Audio Line Outputs

Audio that is routed from a receive audio input to the console is amplified by one of the console RX audio line output amplifiers. These amplifiers are functionally equivalent to the TX audio line drivers discussed previously.

8.3.3 Receive Audio Expansion Bus

Master and Slave TSAM board are jumpered to either route audio to or from the receive audio expansion busses. Receive audio from an expansion site is routed to the expansion audio bus. Audio on the expansion bus is selected by the master TSAM, and routed to the console's receive audio port. Expansion busses are used, for both the Main and secondary channels.

Each expansion (slave) TSAM is jumpered to route receive audio from a selected site to the receive audio expansion bus. The master TSAM receive crosspoint switch has 8 site receive inputs and two additional inputs for the receive audio expansion bus. On the master TSAM, the expansion buses are jumpered to crosspoint switch inputs. When the active receive site is on board, the master TSAM routes audio from that site through the crosspoint switch to the console. If the site in an expansion site, then the master TSAM programs the crosspoint switch on the expansion TSAM to route selected site audio onto one of the expansion busses. The master TSAM then programs its crosspoint to route audio off the expansion bus to the console.

8.4 Option Jumpers

In most instances the TSAM is shipped from the factory with all of the necessary jumper options preset. You should refer to the factory jumper table and verify that the proper options for you system have been selected. Most jumpers can either be accessed by removing the front panels or rear cover plate. This allows changes to be made without removing the TSAM from its rack mounted position. Some jumpers can only be accessed with the TSAM top cover removed. In particular, the 10K or 600Ω impedance jumper on each audio input require removal of the top cover. Set these jumpers before mounting the TSAM.

The table below explains factory jumper settings:

Jumper	Setting	Function	Access
E101	IN* OUT	600Ω C1 TX INP 10K C1 TX INP	Inside
E102	IN* OUT	600Ω C2 TX INP 10K C2 TX INP	Inside
E103	OUT A B*	-32 to -18 dBm C1 TX INP -20 to -6 dBm C1 TX INP -8 to +6 dBm C1 TX INP	Front
E104	OUT A B*	-32 to -18 dBm C2 TX INP -20 to -6 dBm C2 TX INP -8 to +6 dBm C2 TX INP	Front
E105	A (FOIL)	TX AUDIO ONLY	Factory use only
E106	A (FOIL)	TX AUDIO ONLY	Factory use only
E107	A (FOIL)	IC TYPE = MT8815AE	Factory use only
E108	IN (FOIL)	IC TYPE = MT8815AE	Factory use only
E109- E112, E125	IN* OUT	RS-422 TERMINATED RS-422 OPEN	Back
E113	OUT*	HC11 MODB	Front
E114	OUT*	HC11 MODA	Front
E115	A (FOIL)	EPROM = 27256	Factory use only
E116	A* B	RAM = 6264 RAM = 62256	Factory use only
E117		Factory Test Points	Factory use only
E119	A B*	Tone Generator High Gain Tone Generator Low Gain	Factory use only
E120	A B*	Tone Generator High Gain Tone Generator Low Gain	Factory use only
E122	IN* (FOIL)	Static to Ckt GND	Factory use only
E123, E127	A* B	C1 TX Audio EXP+ Output C1 TX Audio EXP+ Input	Front
E124, E128	A* B	C2 TX Audio EXP- Output C2 TX Audio EXP- Input	Front
E126	A* B	Transient GND = Ckt GND Transient GND = Static GND	Factory use only

Table 7 Main Board (TSAM-T1) Jumpers
*** Indicates factory default**

Jumper	Setting	Function	Front or Back Panel Access
E201- E208	OUT* IN	10K Input RX1-8 600Ω Input RX1-8	Inside
E209- E216	OUT A B*	-32 to -18 dBm RX1-8 INP -20 to -6 dBm RX1-8 INP -8 to +6 dBm RX1-8 INP	Front
E217	TOP* BOTTOM	MASTER TSAM SLAVE TSAM	Front
E218	TOP* BOTTOM	MASTER TSAM SLAVE TSAM	Front
E219	TOP* BOTTOM	MASTER TSAM SLAVE TSAM	Front
E220	TOP* BOTTOM	MASTER TSAM SLAVE TSAM	Front
E221	B* (FOIL)	IC TYPE = MT8815AE	Factory use only
E222	IN* (FOIL)	IC TYPE = MT8815AE	Factory use only

Table 8 Secondary Board (TSAM-R1) Jumpers
*** Indicates factory default**

9. Hardware Specification

9.1 Audio Input/Output Electrical Specifications

9.1.1 Power Requirements

Parameter	Min	Max	Units
Input Voltage	20 18	30 24	Volts DC Volts AC
Input Current		1.2	Amp
Input Power		24	Watts

9.1.2 Audio Inputs

Input level (600Ω ref.) (Balanced) (jumper selectable)	-32 to -18 dBm -20 to -6 dBm -8 to +6 dBm	(low range) (middle range) (high range)
Impedance	600Ω nominal 10KΩ nominal	(terminated) (bridging)

All input levels are individually adjustable with pots.

9.1.3 Audio Outputs

Output level (600Ω ref.) (Balanced)	-20 to +3 dBm, adjustable
Impedance	600Ω nominal

All output levels are individually adjustable with pots.

9.1.4 Audio Quality

Frequency Response	300 - 3200 Hz +/- 2 dB
Hum and Noise	50 dB below rated output
Distortion	less than 2 percent
Crosstalk	55 dB below rated output

9.2 Control Signal Input/Output Electrical Specifications

9.2.1 All Control Signals EXCEPT "Console 1,2 PTT Out"

Parameter	Min	Max	Units
Input Hi level voltage	9	30	Volts
Input Low level voltage	0	2.5	Volts
Input High level current		0.50	mA
Input Low level current		2.0	mA
Output High level voltage (open collector)		30	volts
Output Low level voltage		0.55	Volts
Output Low level current		100	mA

9.2.2 Console 1,2 PTT Out Control Signals

Parameter	Min	Max	Units
Open circuit voltage		50 40	Volts DC Volts AC
Switched current		100	mA

9.3 Physical and Environmental

Physical Dimensions	19" Rack mount 3.5" high x 15.25" deep
Ambient Temperature	0 to +60 °C

10. Parts List Main Board (TSAM-T1)

Reference Symbol	Part Number	Description
Capacitors:		
C203, 204	140CD50S2-020J	20 pf 50v ceramic disc (20)
C117-124, 133-140, 155, 156, 163, 164, 167, 168, 270, 271, 272, 273, 274, 275	140CD50S2-030J	30 pf 50v ceramic disc (30)
C157, 158	140CD50S2-047J	47 pf 50v ceramic disc (47)
C165, 166, 211	C315C221K2G5CA	220 pf 200v mono (221)
C191, 192, 193, 194	140CD50P2-331K	330 pf 50v mono (331)
C109-116, 151, 152	1C10C0G102J050B	.001 uf 50v mono cap (102)
C125-132 **	19-10029	390 pF 50v mono (391)
C199, 200	C315C103M1U5CA	.01uf 100v mono (103)
C170, 173, 174, 178, 179, 181-187, 189, 190, 201, 205, 206, 207, 210, 212, 214, 215, 217, 218-225, 229, 230, 240-263, 265-269, 303	1C10Z5U104M050B	.1 uf 50v mono (104)
C231-234	C322C104M1U5CA	.1uf 100v mono
C159, 160, 161, 162, 169, 209	1C20Z5U334M050B	.33uf 50 v mono
C202, 208	140-XRL50V1.0	1 uf 50v electrolytic
C153, 154	140-BPR50V3.3	3.3uf 50v non polarized
C101-108, 149, 150	23-82028P07	4.7 uf 200V
C171, 172, 180, 188, 228	140-XRL35V10	10 uf 35v electrolytic
C195, 196, 197, 198, 226, 227	140-XRL35V33	33 uf 35v electrolytic
C213	140-XRL25V47	47 uf 25v electrolytic
C175, 176, 177, 264	ECE-A1EFS101	100uf 25v
C236, 237	ECE-A1JFS101	100uf 63v
C238, 239	ECE-A1EFS471	470uf 25v
C235	ECES1JU222G	2200uf 63v
CP101, 102, 103	CS09Z5U103Z050	.01uf 50v 9-pin 8-pack
Diodes:		
D101, 107, 108, 109, 110, 114-137	1N914B	Switching diode
D102, 103, 104, 105	1N4001	General purpose diode
D111	RS404L	Bridge rectifier
D112, 113	MBR360	Schotky diode
DP101-106	DS05CA-SA30	5 pin SIP diode pack
DP110-111	SAC7.0	5 Pin SIP diode pack
DZ121	SA7.5	Transorb diode
DZ101-120, 125-130	SA12	Transorb diode
DZ122	ICTE-36	Transorb diode
DZ123	5KP5.0A	Transorb diode
DZ124	5KP14	Transorb diode
SAC101-106	SA12C	Transorb diode
LED101, 102, 104	HLMP4700-010	Rt. angle red LED
LED103	HLMP4719-010	Rt. angle yellow LED
CP104	DN5A10CA4148	9 pin SIP diode pack

Reference Symbol	Part Number	Description
Jumper Blocks:		
E101, 102, 113, 114	TSW-1-02-07-S-S	1x2 wrap post
E103, 104, 119, 120, 123, 124, 127, 128	TSW-1-03-07-S-S	1x3 wrap post
E115, 116	TSW-1-04-07-S-S	1x4 wrap post
E117	TSW-1-08-07-T-S	1x8 wrap post
E109-112, 125	TSW-1-05-08-S-D-RA	2x5 Right angle wrap post
TP106	TSW-1-01-07-S-S	1pin wrap post
Integrated Circuits:		
IC101-104	TLE2064IN	Op Amp
IC105, 110, 114, 144	TL084IN	Op Amp
IC106, 107	ML2036IJ	Tone Generator
IC108, 109	MC14052BCP	MC14052BCP
IC111	MT8815-AE	Crosspoint Switch
IC112	MC78L05ACP	7805 Voltage Reg
IC113	MAX660EPA	-5V low power regulator
IC115, 116, 117	TC4021BP	TC4021BP
IC118	MC14504BCP	Hex level shifter
IC119-122	SN75176AP	TTL to RS-485 interface
IC123	MAX-232EPE	TTL to RS-232 Interface
IC124, 133	74HC14AP	Hex Inverter, Schmidt trigger
IC125	74HC10AP	Triple 3 Input NAND gate
IC126	MC68HC711E9CFN2	68HC11 Microcontroller
IC127	74HC573N	Octal tri-state latch
IC128	27C256-15ODI	32K x 8 PROM
IC129	TC5563APL-10	8K STATIC RAM
IC130	MC14094BCP	MC14094BCP
IC131	AT22V10L-20DC	Low Power PAL
IC132	UCN5832A	32 bit open collector shift reg
IC134	UDN2595A	High voltage interface
IC135	LM2903N	Dual Comparator
IC136	MC33064P-5	Low voltage indicator
IC137	TLE2426CP	Mid Supply Voltage Buffer
IC138	LM2575HVT-5.0	5v Switching Reg
IC139	LM2575HVT-ADJ	Adj. Switching Reg
Connectors:		
J101	1-350942	2 Pin Mate-N-Lock, Male Pins
J101 Hardware		6x32 Nut With Lockwasher
J101 Hardware		6x32x3/16 Bolt
J102	K22-E9S-N	DE9-S Rt Angle PC Mount
P101	552726-3	50 Pin Right Angle Centronics (Male)
P101 Hardware		4x40x3/16 Bolts
P102	609-5024ES	50 Pin Vertical Header
P103	609-2604ES	26 Pin Right Angle Header

Reference Symbol	Part Number	Description
Inductors:		
L106, 107, 108	PE52628	Toroidal Coil 470uh
L105	PE53112	Toroidal Coil 47uh
T101-T110	671-8205	TELCO coupling transformer
Resistors:		
R157, 158, 187, 201, 202	29SJ250-0	0 Ohm .25w 5% carbon film
R101-116	29SJ250-330	330 Ohm .25w 5% carbon film
R176	29SJ250-470	470 Ohm .25w 5% carbon film
R133, 134	29SJ250-680	680 Ohm .25w 5% carbon film
R125-132 **	29SJ250-10K	10K Ohm .25w 5% carbon film
R161, 186, 191	29SJ250-1k	1k Ohm .25w 5% carbon film
R199, 200	29SJ250-1.2k	1.2k Ohm .25w 5% carbon film
R182	29SJ250-3.3k	3.3k Ohm .25w 5% carbon film
R135, 136	29SJ250-4.7k	4.7k Ohm .25w 5% carbon film
R166, 167, 175, 177, 178, 180, 181, 188, 189, 194	29SJ250-10k	10k Ohm .25w 5% carbon film
R164, 165, 184, 192, 193	29SJ250-47k	47k Ohm .25w 5% carbon film
R183	29SJ250-82k	82k Ohm .25w 5% carbon film
R195, 196	29SJ250-470k	470k Ohm .25w 5% carbon film
R185	29SJ250-10M	10M Ohm .25w 5% carbon film
R151, 152, 155, 156	29MF250-1.0k	1.00k Ohm .25w 1% metal film
R163	29MF250-2.00k	2.00k 1% .25w metal film
R153, 154	271-2.15K	2.15k 1% .25w metal film
R162	29MF250-17.4k	17.4k 1% .25w metal film
R149, 150	29MF271-30.9k	30.9k .25w 1% metal film
R141, 142	299-100	100 Ohm .125w 5% carbon film
R197, 198	299-470	470 Ohm .125w 5% carbon film
R137-140	299-2.2K	2.2K .125w 5% carbon film
R145, 146	299-47K	47K .125w 5% carbon film
R143, 144	299-220K	220K .125w 5% carbon film
R117-124 **	3386X-1-253	25k Pot
R173	3386X-1-103	10k Pot
R147, 148	3386X-1-504	500k Pot
RP115, 129	4608X-102-101	100 8 Pin ISO Rpack
RP126, 128	4606X-102-103	10k 6 Pin ISO Rpack
RP117, 118, 119, 120, 130	4608X-102-103	10k 8 Pin ISO Rpack
RP123, 124	4610X-102-103	10k 10 Pin ISO Rpack
RP125, 127	4606X-102-473	47k 6 Pin ISO Rpack
RP102, 103, 104, 105, 106, 107	4608X-102-473	47k 8 Pin ISO Rpack
RP131	4606X-101-152	1.5k 6 Pin BUSS Rpack

Reference Symbol	Part Number	Description
RP114	4606X-101-472	4.7k 6 Pin BUSS Rpack
RP113	4610X-101-472	4.7k 10 Pin BUSS Rpack
RP112, 116, 121, 122, 132	4606X-101-103	10k 6 Pin BUSS Rpack
RP111	4608X-101-103	10k 8 Pin BUSS Rpack
RP108, 109, 110	4610X-101-103	10k 10 Pin BUSS Rpack
RP133	4608X-102-472	4.7k 8 Pin ISO Rpack
Miscellaneous:		
F101 Fuse Holder	HBH-M	PCB Mount Fuse Holder
F101 Fuse	217002	2 Amp Fuse (LittleFuse)
GT101-110	3J-1J1	Gas Tube
HS101, 102	6021B	Heatsink
HS101, 102 Hardware		6x32 Nut With Lockwasher
HS101, 102 Hardware		6x32x3/16 Bolt
K101, 102	T82N11D114-12	Relay 12v DPDT PC Mount
Q101	VN0104N3	N channel FET
SW101	39-251 Red	Push PCB mount switch
SW102	1-435802-6	5 Pos DIP switch
TP101, 102, 104, 105	325-102	Test Point Red
TP103	325-103	Test Point Black
VR101	V36ZA80	Varistor
Y101	332-1080	Crystal 8mhz

** These parts were changed for Multicast in Version 170.
Must be changed as a group

Resistors R125-132	were 820 Ohm	New 10K
Pots R117-R124	were 2K	New 25K
Caps C125-132	were .0047 uF	New 390 pF

11. Parts List Secondary Board (TSAM-R1)

Reference Symbol	Part Number	Description
Capacitors:		
C217-224, 229, 230, 233, 234, 240, 243, 244, 245	140CD50S2-030J	30pF 50V ceramic disc (30)
C241, 242, 276-283	140CD50S2-047J	47pf 50V ceramic disc (47)
C235, 236, 268-275, 284, 285	1C10C0G102J050B	.001uF 50V monolithic (102)
C231, 232	C315C472K1R5CA	.0047uF 100V monolithic (472)
C225, 249-257, 263-267, 286, 288	1C10Z5U104M050B	.1uF 50V monolithic (104)
C246, 247, 289, 290	1C20Z5U334M050B	.33uF 50V monolithic (334)
C209-216	140-BPR50V3.3	3.3uF 50V non-polarized
C201-208, 237, 238	23-82028P07	4.7uF 200V electrolytic
C226, 258, 259, 262, 287	140-XRL35V10	10uF 35V electrolytic
CP201, 202, 203	CS09Z5U103Z050	.01uF 50V 9-pin 8-pack
Diodes:		
D101-116	1N914B	GP switching diode
DP201-206	DS05CA-SA30	5 Pin SIP 30V Transorb
DP209, 210	DS05CA-SA12	5 Pin SIP 12V Transorb
DZ208, 209	SA5.0	5V Transorb
DZ207	SA7.5	7.5V Transorb
DZ201-206	SA12	12V Transorb
SAC201-208	SA12C	12V bi-directional Transorb
Jumper Blocks:		
E201-208	TSW-1-02-07-S-S	1x2 wrap post
E217-220	TSW-1-04-08-S-T-RA	3x4 right angle wrap post
E209, 210, 211, 212, 213, 214, 215, 216	TSW-1-01-08-S-T-RA	3x1 right angle wrap post
Integrated Circuits:		
IC203	TLE2064IN	Op Amp
IC201, 202, 204	TL084IN	Op Amp
IC205	MT8815-AE	crosspoint switch
IC206, 207	TC4021BP	Input shift register
IC208	MC14504BCP	Hex level shifter
IC210	TLE2426CP	Mid supply voltage buffer
Connectors:		
J201	C3DPT-5006G-ND	50 pin ribbon cable
P201	552726-3	50 pin right angle Centronics (Male)
P201 Hardware		4x40x3/16 Bolts
Resistors:		
R306-315	29SJ250-0	0 Ohm .25w 5% carbon film
R286, 288, 289, 304	29SJ250-100	100 Ohm .25w 5% carbon film
R271, 272, 277, 278	29SJ250-330	330 Ohm .25w 5% carbon film
R201-208	29SJ250-680	680 Ohm .25w 5% carbon film

Reference Symbol	Part Number	Description
R265, 266	29SJ250-820	820 Ohm .25w 5% carbon film
R287, 273, 274, 295, 305	29SJ250-1k	1k .25w 5% carbon film
R217-224	29SJ250-2.2k	2.2k .25w 5% carbon film
R209-216	29SJ250-4.7k	4.7k .25w 5% carbon film
R269, 270, 275, 276, 290, 291, 293, 294	29SJ250-10k	10k .25w 5% carbon film
R292, 300, 301	29SJ250-47k	47k .25w 5% carbon film
R283, 284, 285, 303	29MF250-10k	10k .25w 1% metal film
R280, 281, 282, 296	29MF250-200k	200k .25w 1% metal film
R225-232	299-100	100 Ohm 1/8W 5% carbon film
R233-240	299-470	470 Ohm 1/8W 5% carbon film
R241-248	299-2.2K	2.2K 1/8W 5% carbon film
R249-256	299-47K	47K 1/8W 5% carbon film
R302	3386X-1-102	1k pot
R267, 268	3386X-1-202	2k pot
R257-264	3386X-1-504	500k pot
RP201-206	4608X-102-103	10k 8 Pin isolated Rpack
RP208, 209	4610X-101-472	4.7k 10 Pin buss Rpack
RP207	4610X-101-473	47k 10 Pin buss Rpack
Miscellaneous:		
GT201-210	3J-1J1	Gas Tube
T201-T210	671-8205	Midcom transformer
TP201-208, 210, 211	325-102	325-102 test point (red)
TP209	325-103	325-103 test point (black)

12. Schematics and Board Layout Diagrams

12.1 TSAM-T1 Transmitter Board Schematic Diagram

TSAM-T1 Schematic page 1

TSAM-T1 Schematic page 2

12.2 TSAM-T1 Board Layout Diagram

TSAM-T1 PCB Layout Diagram page 1

12.3 TSAM-R1 Receiver Board Schematic Diagram

TSAM-R1 Schematic page 1

12.4 TSAM-R1 Board Layout Diagram

TSAM=R1 PCB Layout diagram page 1

13. TSAM Troubleshooting Charts

TSAM Trouble shooting Chart Page 1 Here

TSAM Trouble Shooting Chart Page 2 Here

TSAM Trouble Shooting Chart Page 3 Here

TSAM Trouble Shooting Chart Page 4 Here