MICOR®
Base and
Repeater Stations
Control and Application

68P81025E60-F

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Associated Station Manual

Instruction Manual
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REMOTE CONTROL CHASSIS MODULES

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1. INTRODUCTION

Motorola base and repeater station applications are described in following paragraphs. The information is tailored to "Micor" "CompaStation" and Upright type stations.

2. APPLICATIONS

2.1 BASE STATIONS

2.1.1 Typically, a base station is the core of a two-way communications system. It is the fixed point from which a dispatcher sends and receives messages from the mobile and portable radios of the communications system. In many systems, the station also transmits and receives from other base stations or repeaters at fixed points within communications range.

2.1.2 Remotely controlled Motorola base stations may be located at the most advantageous point for rf propagation, such as the top of a tall building or a mountain peak, while the dispatcher may be located elsewhere, even several miles away. A wire line (such as a leased telephone line) connects between the base station and a remote control console at the dispatcher's location. Received audio from the base station is sent over the wire line to a speaker in the remote control console. Likewise, microphone audio from the remote control console is sent over the wire line to the base station for modulating the transmitter's rf carrier signal. In addition, the remote control console generates the commands necessary to operate the base station, such as transmitter keying, frequency selection (on two- or four-frequency base stations), "Private-Line" disabling of "Private-Line" receivers to allow monitoring of all on-channel communications, and receiver muting of receiver No. 2 in two-receiver stations. Circuits in the base station sense the commands generated by the remote control console and perform the necessary switching to change the mode of operation.

2.1.3 Two basic types of remote control commands are used for base station control; dc control and tone control. DC control uses dc current of varying magnitude and polarity to initiate the various control functions such as transmitter keying. The wire line pair must have dc continuity to be used with a dc remote control system. In some areas, telephone line pairs with dc continuity are not available. Tone control uses audio tones of various frequencies to initiate the control functions. The audio tone used for transmitter keying is filtered out of the transmit audio so that the tone is not transmitted. Other commands require only a momentary application of the tone command to initiate the desired mode of operation. The wire line pair need not have dc continuity for tone remote control operation. Additionally, more functions can be remotely controlled with tone control since many different audio frequencies can be used.

2.1.4 A wide variety of station models are available. Models are available with various power output levels, with one-, two-, or four-frequency transmitters, one-, two-, or four-frequency receivers, with two separate receivers (for continuous monitoring of two channels), and with dc or tone remote control. In addition to the standard models offered, a wide variety of optional accessories are available to tailor the station to meet your communications system needs. Furthermore, the equipment was built to meet a wide flexibility of operational requirements without major
equipment modification. For example, a station with two receivers can be (1) jumpered to provide receiver No. 1 priority, wherein receiver No. 2 is automatically muted whenever receiver No. 1 is receiving a signal; or (2) with a 4-wire audio line driver, receiver No. 2 audio can be carried to the dispatcher's location (or a completely separate location) on a separate wire line and no muting of receiver audio would occur; or (3) with an F2-R2 Mute module, the dispatcher could mute receiver No. 2 upon command from the console; or (4) with an F2-R2 Mute module, receiver No. 2 audio could be attenuated rather than fully muted upon command from the console. Jumper selection allows a preset attenuation of 10, 20 or 30 dB.

2.1.5 In all cases, the remote control console must be compatible with the base station. That is, it must generate the type of commands to which the base station control circuits will respond.

2.1.6 The remote control chassis can accept plug-in modules for dc or tone control, and a station may be equipped to operate with both types of control. This feature allows a station to be easily converted from one type of control to the other, if necessary.

2.2 REPEATER (RT) STATIONS
(Refer to Figure 1)

2.2.1 Motorola repeater (RT) stations are for use in two-way FM radio communications systems where extended range operation is required or where natural or man-made limitations to direct communications are encountered. The station is normally operated unattended and is used primarily for "mobile relay" or "one-way talk-back" repeater applications. Refer to the accompanying diagram for typical examples of these repeater systems.

2.2.2 In a "mobile relay" circuit, signals received by the repeater from one mobile unit are rebroadcast to other mobiles in the system. Mobiles in this system must use a transmitter and receiver operating on different frequencies. The repeater transmitter and receiver will subsequently operate on exactly the reverse frequencies of those used for the mobile transmitter and receiver.

2.2.3 In a "one-way talk-back" repeater circuit, signals sent from a mobile unit in the vicinity of the repeater installations are picked up by the repeater and retransmitted to a distant base station in the system. Return signals transmitted by the base station are received directly by the mobile. The mobile transmitter and receiver normally operate on the same frequency in this type of system. The associated repeater receiver operates on the mobile transmitter frequency while the repeater transmitter operates on the frequency of the remote base station receiver. If the base station involved is equipped with a second receiver which operates on the frequency of the mobile transmitter, a mobile unit may talk directly to the base station when operating in the immediate base station area (see dotted detail on system diagram).

2.2.4 Repeater (RT) stations have the capability of functioning both with an rf input (RT) and with wire line control (base station). When the remote supervisory facilities are not used, the station functions automatically as a repeater (RT); i.e., all control functions for the station are initiated via the received rf carrier. As a signal is received, the transmitter is automatically actuated. The output of the receiver is fed to the transmitter modulator input circuit so that the received signal is rebroadcast at greatly increased power on the repeater transmitter frequency.

2.2.5 A station using supervisory remote wire line control can operate as an unattended repeater (RT) station or as a remotely controlled base station. The operator has priority over the operation of the station. The station operates as a repeater (RT) until the remote control operator initiates a transmission. In which case, the station operates as a conventional base station. The remote control operator may monitor all messages rebroadcast from the station during repeater (RT) operation.

2.2.6 A time-out timer module is supplied with all repeater (RT) stations. The time-out timer turns off the transmitter after a predetermined "on-the-air" time to prevent inadvertent continuous transmitter key-up. Jumper connections on the module provide a variable time limit that the transmitter may be keyed.

2.3 REPEATER (RA) STATIONS
(Refer to Figure 2)

2.3.1 A Motorola repeater (RA) station features specific control facilities and circuitry to operate a companion base (RA) station in a two-way radio relay system.
Figure 1.
Typical Repeater (RT) System
2.3.2 Motorola radio controlled relay stations are used in two-way FM radio communications systems where extended range operation is required, or where natural or man-made limitations to direct communications are encountered. The radio repeater (RA) system consists of a repeater (RA) - base (RA) combination and two or more remote stations such as control and mobile stations. The repeater (RA) - base (RA) combination consists of a repeater (RA) station and a base (RA) station connected by audio and control lines.

2.3.3 A standard Motorola base station of selected operating frequencies can be used as the control station for the repeater (RA)-base (RA) combination. To control the repeater (RA) - base (RA) combination from a single control terminal, the repeater (RA) - base (RA) combination antennas should be directional. However, to control the repeater (RA) - base (RA) combination from several terminals at different locations in the system, multi-directional antennas should be used.

2.3.4 By proper location of the repeater (RA) station, and by proper selection of operating frequencies, transmitter RF power output and antenna characteristics, radio signals can be relayed through mountainous or other obstructive terrain, or to an operational area located at an extended range from the control station.

2.3.5 The repeater (RA) - base (RA) combination has two modes of operation. It can: (1) receive and re-transmit a message from a control station to a mobile station and (2) receive and re-transmit a message from a mobile station to a control station.

2.3.6 The mobile units and the base (RA) station operate on frequency F1. The repeater (RA) station transmits on frequency T2 and receives on frequency R3. The control station transmits on frequency T3 and receives on frequency R2.

2.3.7 When the control station calls the mobile unit, the repeater (RA) turns on the base (RA) station transmitter. When receiver quieting of the repeater (RA) station reaches a predetermined level, the squelch gate in the repeater (RA) station actuates. This keys the transmitter in the base (RA) station. Audio is routed from the repeater (RA) station receiver to the base (RA) station transmitter audio input. The message is sent to the mobile units on frequency T1 by the base (RA) station transmitter.

2.3.8 When a mobile station calls the control station, the base (RA) station turns on the repeater (RA) transmitter. When receiver quieting of the base (RA) station reaches a predetermined level, the squelch gate in the base

Figure 2.
Typical Repeater (RA) System
2.4 GUARD TONE RELAY SYSTEM
(Refer to Figure 3)

2.4.1 A guard tone relay system is much like the usual "RA" system -- with greatly expanded control capability.

2.4.2 In the "RA" system (refer to Figure 2) a received message at the repeater (RA) station actuates the squelch gate in that station. This keys the companion base (RA) station which retransmits the message to mobile units. Only transmitter turn-on and turn-off control of the base (RA) station is possible in this system as is determined by receiver quieting/squelch gate module in the repeater (RA) station.

2.4.3 In the guard tone relay system (refer to Figure 3) the presence of an rf signal alone at the repeater (RA) station does not cause the companion station to transmit. Instead, the companion station is controlled via tone signals just as if it were connected directly to a remote control console by wire lines. This permits multiple frequency operation (of the companion base station), PL disable ("Private-Line" coded squelch models), unique function commands, etc.

2.4.4 For example, should the remote control console operator want to talk to a mobile unit on frequency T4, a high level guard tone signal is applied to the control station. The control station keys immediately on frequency T3 and transmits the remaining guard tone signal to the repeater (RA) station. The repeater (RA) station applies this high level guard tone signal to the audio input of the companion tone remote base (RA) station, which is then ready to accept and react to the forthcoming T4 function tone. The flexibility and number of functions in the guard tone relay system is limited only by the sophistication of the companion tone remote base station and the remote control console. It should be noted that a squelch gate is used in the repeater (RA) station in this guard tone application to give a transmitter channel element ground when the station is keyed. This is necessary since neither an F1 or F1-"PL" control module is used, which would otherwise supply the ground. The squelch gate is not used to key the companion base (RA) station.

NOTE
The high level guard tone burst sent by the remote control console should be lengthened to compensate for the delay time encountered in the keying of the guard tone relay station. Refer to the remote control console manual.
REMOTEl CONTROL FUNCTIONAL DESCRIPTION

1. GENERAL

1.1 PURPOSE

1.1.1 The basic function of remote control is to allow operation of a base station or a repeater station from a remote control point. The station can be located a considerable distance from the control point; however, a compatible remote control console must be used at the control point in order to control the station. Remote control can be done using tones or dc line currents, which are converted into commands that perform such functions as:

- Transmitter turn on
- Selection of transmitter and receiver frequencies
- Mute and unmuting receiver audio
- Disable receiver "Private-Line" coded squelch circuit

1.2 DC CONTROL

In systems using dc control functions, a wire line must be connected between the control point and the station. Each different control function is originated by a dc current through the wire lines. By varying the dc current polarity and amplitude it is possible to remotely control several different functions:

- "PL" disable (receiver)
- Mute receiver #2 audio
- Turn on transmitter and select F1 or F2 channel element
- Unmute receiver #2
- Turn on the transmitter without "PL" (for paging applications).

2. DC CONTROL APPLICATIONS

Refer to the simplified and detailed functional diagrams at the end of this section.

2.1 TRANSMITTER TURN-ON; F1 OSCILLATOR

2.1.1 General Description

In this application only one transmitter frequency can be selected. In order to turn on the transmitter and energize the channel element, a +5.5 mA control line current is applied to the line 1 terminals of the remote control chassis, and fed to pins 19 and 20 in the line driver module. This current is then applied to the dc transfer module (pins 3 and 4) and activates the positive transfer oscillator. The positive transfer oscillator output level, which is a function of...
the dc input level and polarity, is detected within
the module and provides low level PTT (pin 10).
It also generates a delayed keyed A+ (pin 17) and
F1 oscillator ground (pin 14) after a 60 milli-
second delay.

2.1.2 Line PTT
Line PTT is applied to the station con-
trol module (pin 14), time-out timer (pin 6),
squelch gate (pin 16), and F1 tone decoder (pin 19).
In the station control module, line PTT initiates
three important functions:

--keyed A+ (pin 8)
--keyed A- (pin 7)
--antenna switch/audio mute (pin 14)

In the time-out timer module, line PTT starts
the timing action. In the squelch gate (repeaters
only), line PTT inhibits squelch gate operation to
give line priority (supervision) over repeater
operation. The line PTT input to the F1 tone de-
coder has no effect unless the station is equipped
for both tone and dc control. In this case, line PTT resets the PL disable circuit in the F1-PL
tone decoder module.

2.1.3 Keyed A+ and A- Outputs

The keyed A+ and keyed A- outputs of the
station control module apply operating voltages to
the exciter and power control board of the trans-
mmitter, but the transmitter is not yet keyed be-
cause the channel element is not activated. The
keyed A+ also gates the PL encoder output to the
desired phase. The antenna switch/audio mute
signal causes the antenna relay to energize,
transferring the antenna from the receiver to the
transmitter, and mutes receiver audio by dis-
abling the line driver amplifiers.

2.1.4 F1 Channel Element Enable

About 60 milliseconds after PTT is de-
veloped at pin 10 of the dc transfer module, F1
oscillator ground (pin 14) is applied to the chan-
nel element of the exciter. The 60-millisecond
delay allows time for antenna switching before
high power transmitted rf energy is applied. Al-
though dc power was applied to the transmitter,
the amplifiers are biased Class C and depend
upon signal drive from the channel element be-
fore rf power output is developed. Grounding the
transmitter channel element completes the last
step to key the transmitter. Other means of key-
ing the transmitter (locally, repeater, tone
control) are described later.

2.2 TRANSMITTER TURN-OFF

2.2.1 General Description

Transmitter turn-off is a sequence of
steps which allow transmission of the reverse
burst PL signal (tone "Private-Line" stations)
or turn-off code ("Digital Private-Line" stations),
shut-down of rf power, and finally, antenna switch-
over to the receiver.

2.2.2 Reverse Burst PL Transmission

2.2.2.1 When the positive line current is re-
moved, the line PTT signal immediately
reverts to a high. However, the delayed keyed
A+ (pin 17 of dc transfer module) continues for
approximately 200 milliseconds. During this 200
millisecond period, F1 oscillator ground is still
provided to keep the transmitter keyed.

2.2.2.2 Loss of the line PTT signal causes the
keyed A+ output of the station control
module (pin 8) to be removed. This causes the
"Private-Line" encoder to shift the phase of the
PL tone for the reverse burst transmission or
transmit the turn-off code. In non-PL stations,
the transmitter also continues to operate for 200
milliseconds.

2.2.3 RF Shut-Down

2.2.3.1 Keyed A- (station control pin 7) con-
tinues to be provided, as long as
delayed keyed A+ is present.

2.2.3.2 Upon the loss of delayed keyed A+ and
F1 oscillator ground (200 milliseconds
after dc line current is removed), the transmitter
shuts down because of loss of channel element
ground and keyed A- power.

2.2.4 Antenna Switchover

2.2.4.1 Upon the loss of keyed A-, the antenna
switch/audio mute circuit starts a 30-
millisecond turn-off delay. At the end of this 30
millisecond period, the low at pin 2 of the station
control module reverts to a high. This de-ener-
gizes the antenna relay and unmutes receiver
audio, placing the station in the standby condition.

2.2.4.2 If the transmitter is keyed beyond the
time duration set in the time-out timer,
a T-O-T key inhibit signal (pin 4 of the T-O-T)
inhibits the keyed A- in the station control module
to shut down the transmitter. This allows the 30
millisecond delay before antenna switchover.
2.3 TRANSMITTER TURN-ON; F2 OSCILLATOR

In two-frequency transmitter applications, a different channel element is selected for each operating frequency. In order to turn on the transmitter and select the second (F2) channel element, a +12.5 mA control line current is applied to pins 19 and 20 in the line driver module. This current is then applied to the dc transfer module (at pins 3 and 4) and activates the positive transfer oscillator. The positive transfer oscillator output level, which is a function of the dc input level and polarity, is detected within the module. The detection results in a low level line PTT (pin 10) and an F2 oscillator ground output (pin 16). Circuit operation from this point on is the same as described for transmitter turn-on with F1 oscillator except that a ground is provided to the F2 channel element of the transmitter.

2.4 RECEIVER #2 MUTE

In this application, receiver #2 can be muted independent of any other operation. A momentary -5.5 mA control line current is applied to pin 19 and 20 in the line driver module. This current is then applied to the dc transfer module (at pins 3 and 4) to activate the negative transfer oscillator. The negative transfer oscillator output is detected within the module and provides an R2 mute output at pin 20 to mute receiver #2 audio in the line driver module. Receiver #2 remains muted until the transmitter turn-on F2 oscillator function is activated at which time the R2 mute function is no longer generated.

2.5 RECEIVER "PRIVATE-LINE" DISABLING

In this application, the receiver "Private-Line" coded squelch circuit is disabled prior to the transmission for channel monitoring purposes. A -2.5 mA control line current is applied to pins 19 and 20 in the line driver module. This current is then applied to the dc transfer module (at pins 3 and 4) to activate the negative transfer oscillator. The negative transfer oscillator output is detected within the module and produces a low PL disable control output. The low is inverted to a high in the station control module (pin 23), from which it is applied to the receiver (both receivers in 2-receiver stations). The PL disable control output remains active until the transmitter is keyed by one of the dc control applications described above. Immediately after the control point furnishes the transmitter turn on command, the PL disable control output reverses and again enables the receiver PL-coded squelch circuit.

2.6 C2-R2 FREQUENCY SELECTION

2.6.1 Stations equipped with a two-frequency receiver and a two-frequency transmitter use a C2-R2 dc transfer module which selects a receiver channel element whenever selecting a transmitter channel element (paired switching). A +5.5 mA line current selects the F1 oscillator ground described for transmitter turn-on. It also activates an R1 bistable which provides an R1 oscillator ground (pin 21 of dc transfer module) which is routed to the R1 channel element in the receiver.

2.6.2 A +12.5 mA line current selects F2 oscillator ground for the transmitter as described previously. It also activates an R2 bistable which provides an R2 oscillator ground (pin 22 of dc transfer module) which is routed to the R2 channel element in the receiver.

2.6.3 The R1 and R2 bistables are mutually resetting so that only one can be activated at any given time. Unlike the F1 and F2 bistables, the R1 and R2 bistables do not turn off when the dc control current is removed, but remain in the selected state until changed.

2.7 PAGING (TRANSMITTING WITHOUT PL)

In this application, the transmitter can be keyed with or without PL coded modulation. To transmit with PL coded modulation, a +5.5 mA line current is applied which turns on the transmitter (F1) as described previously. To transmit without PL coded modulation, a -12.5 mA line current is applied. The dc transfer module converts this command to line PTT and F1 oscillator ground as described previously, but it also places a low on the page output (pin 20). A jumper is connected from pin 701 of the "Private-Line" encoder (Q704 base) to the page output in paging stations. This permits the PL encoder output to be inhibited while a low is provided from the paging module.

2.8 REPEATER TRANSMITTER TURN-ON

2.8.1 A repeater transmitter is turned on by the squelch gate module. Discriminator output from the receiver is applied to the squelch gate (pin 10). A quieted signal (reduced noise because of an incoming rf signal) actuates the
squelch gate, which in turn, keys the transmitter for retransmission of the audio. In PL stations, a PL indicator (pin 14) is also required before the module is activated (correct PL tone must be decoded to produce the PL indicator signal).

2.8.2 The output of the squelch gate module, repeater PTT (pin 18) is applied to the station control module (pin 15). This input produces PTT control (pin 10), keyed A+ (pin 8), keyed A- (pin 7) and inhibits antenna switch/audio mute (pin 2). The PTT control signal is applied to the dc transfer module to activate the F1 oscillator. The remainder of transmitter turn-on and turn-off circuit operation is as described for remote control base stations.

2.8.3 In a non-wire line controlled repeater, jumpers JU5 and JU6 in the squelch gate module are connected, which permits keyed A+ from the station control module to enable channel element switch Q8. Q8 provides the F1 oscillator ground. In this mode, transmitter turn-off uses the delayed keyed A+ of the "Private-Line" encoder to provide the delayed keyed A+ (pin 7 of squelch gate).

2.8.4 Receiver audio is gated through the squelch gate module (pin 17 input, pin 11 output) to the exciter. The exciter audio path through the station control module is inhibited by audio gate driver Q6 when the PTT control signal is low.

2.9 REPEATER SET-UP AND KNOCKDOWN

Repeater stations may be equipped for wire-line control from the remote control point. This permits the repeater function to be disabled (knocked down) for base operation. Line operation has priority over repeater operation. Line keying produces a line PTT input (pin 14, station control module) which inhibits the PTT control signal (pin 10) as well as inhibiting the squelch gate (pin 16).

2.9.1 Repeater Set-Up

In this application, an enabling +12.5 mA control current is generated that allows the repeater to operate. Repeater turn-on (repeater set-up) is similar to transmitter turn-on F2 Oscillator except:

--A high level repeater set-up output is provided at pin 20 of the DC control module.

--Jumpers are connected so that pin 20 (of the DC control module) is connected to pin 21 of the squelch gate module.

--The squelch gate module provides a repeater PTT output at pin 8. This output is applied to the station control at pin 15 (instead of line PTT at pin 14) to key the transmitter.

2.9.2 Repeater Knockdown

The -5.5 mA repeater turn-off current causes operation similar to Receiver #2 Mute except the low output at pin 20 is applied to pin 21 of the squelch gate module. This low input at pin 21 inhibits the repeater PTT circuits in the squelch gate module.

![Figure 1. Tone Control Format, Non-Transmit Command](image1)

![Figure 2. Tone Control Format, Transmit Command](image2)
3. TONE CONTROL APPLICATIONS

Refer to the simplified and detailed functional diagrams at the end of this section.

3.1 TONE CONTROL FORMAT

3.1.1 In all tone control applications, the tones are sent from the control point in a particular timing sequence (tone control format). All tones must be preceded by a 2175-Hz guard tone. The guard tone is used to activate circuits which detune a 2160-Hz band pass filter in the guard tone decoder module. With the 2160-Hz band pass detuned, all tones can pass through the guard tone decoder and then be routed to their respective decoders. The tone control format is shown in figures 1 and 2.

3.1.2 As shown in the format, there are two distinct types of commands; transmit commands, and non-transmit commands. As shown in the format illustration, the 2175-Hz guard tone always precedes the function tone(s); however, in the case of transmit commands the guard tone continues (at a 30 dB lower level) in order to keep the transmitter keyed.

3.2 TRANSMITTER TURN-ON; F1 OSCILLATOR

3.2.1 General Description

In this application, only one transmitter frequency can be selected. In order to turn on the channel element, the F1 transmit command format (2175 Hz guard tone followed by 1950 Hz F1) is applied to pins 19 and 20 in the line driver module. The tones are then routed out of the line driver module on pin 10 and are applied to pin 9 of the guard tone decoder.

3.2.2 Line PTT

3.2.2.1 The guard tone decoder detects the 2175-Hz guard tone and uses a portion of the detected voltage to effectively disconnect the 2160-Hz band pass filter at the guard tone decoder input. In addition, the guard tone decoder also provides a line PTT output at pin 16 and a decoder bias output at pin 15; both resulting from the 2175-Hz tone.

3.2.2.2 The line PTT output at pin 16 is used as described for dc controlled stations, energizing the antenna relay and muting receiver audio, and applying keyed A+ to the transmitter.

3.2.2.3 The 2175-Hz guard tone signal continues to be received as long as the transmitter is being keyed; however, the level is decreased by 30 dB. Circuits within the guard tone decoder compensate for the lower guard tone level and ensure that line PTT output is provided even during the lower level input.

3.2.3 F1 Channel Element Enable

With the 2160-Hz band pass filter disconnected, the F1 tone (1950 Hz), which follows the high level guard tone, is allowed to pass through the guard tone decoder via the function hi output at pin 11. The 1950-Hz portion of the signal is applied to the F1-PL (or F1) Module for detection. (Although the 1950-Hz tone is applied to other modules, it can only be detected in the F1-PL or F1 Module.) When the 1950-Hz tone is detected in the F1-PL Module, the F1 bistable produces a low F1 Osc output at pin 3 which provides a ground enable for the transmitter F1 channel element to completely key the transmitter.

3.2.4 Function Tone Enable

In order for the tone detector circuits to function, an enable signal must be provided during the control format time. This signal originates in the guard tone decoder module as the decoder bias output at pin 15 and is the result of guard tone detection. The decoder bias signal is a high-level, 350-millisecond window that is applied to the F1 tone decoder (pin 15). The F1 module converts the signal to a low-level function enable output at pin 20. The 350 millisecond low-level function enable is applied to all of the tone detector circuits (in four different tone modules) so that tones can only be detected during the 350-millisecond window.

3.3 TRANSMITTER TURN-OFF

3.3.1 General Description

When low level 2175-Hz guard tone ends, transmitter turn-off begins. First, the guard tone loss is detected by activity checker Q20 in the guard tone decoder. After a 75 millisecond turn-off delay, the line PTT output (pin 16) reverts to a high.

3.3.2 Reverse Burst PL Transmission

Loss of the line PTT causes loss of keyed A+ in the station control module (pin 8). In turn, loss of keyed A+ starts the PL reverse burst transmission (turn off code in a digital system) via the "Private-Line" encoder. The PL encoder provides delayed keyed A+ for an additional
150 milliseconds while the reverse burst or code is transmitted. The delayed keyed A+ keeps the F1 bistable on (F1-PL module) to continue providing F1 channel element ground.

3.3.3 RF Shut-Down

After the 150 millisecond reverse burst period, delayed keyed A+ is removed which turns off the F1 bistable and removes keyed A-. This turns off the channel element which removes the signal drive to the Class C rf amplifiers.

3.3.4 Antenna Switchover

30 milliseconds after keyed A- is removed, the antenna switch/audio mute signal (station control, pin 2) allows the antenna relay to de-energize and unmutes audio in the line driver.

3.4 TRANSMITTER TURN-ON; F2 OSCILLATOR

3.4.1 F2 Control

In this application a different transmit channel element is selected for each of the two operating frequencies. In order to turn on the transmitter and select the second (F2) channel element, the F2 transmit command format (2175-Hz) guard tone followed by 1850-Hz F2) is applied to pins 19 and 20 in the line driver module. From this point the circuit operation is the same as that described for F1 selection except that the F2 channel element is selected by detection of the 1850-Hz tone in either the C2-R2, F2-R2 Mute, or F2 Control Module. The low level (ground) F2 channel element output at pin 4 is then applied to the transmitter.

3.4.2 Paging Control

When the station is equipped with an optional paging control module instead of an F2 control module, the 1850 Hz command keys the transmitter on F1 and prevents transmission of the "Private Line" code. The 1850 Hz command is detected in the paging control module by Q1, which sets paging disable bistable Q2, Q3. The Q output of the bistable provides a "PL" inhibit output which prevents "Private-Line" code from being generated.

--- The F2 output has no effect since the transmitter is not equipped with an F2 channel element.

--- The local F1 output is applied to the F1 control module, which activates the F1 bistable and keys the transmitter on frequency F1.

3.5 RECEIVER "PRIVATE-LINE" DISABLING

3.5.1 General Description

3.5.1.1 In this application a transmit channel element is not selected, therefore, the transmitter is not keyed. In order to generate a PL disable signal, the PL monitor command format (2175-Hz guard tone followed by 2050-Hz PL disable) is applied to pins 19 and 20 in the line driver module. The tones are then routed out of the line driver module on pin 10 and are applied to pin 9 of the guard tone decoder.

3.5.1.2 The guard tone decoder detects the 2175-Hz guard tone and uses a portion of the detected voltage to effectively disconnect the 2160-Hz bandpass filter at the guard tone decoder input. In addition, the guard tone decoder provides a bias output at pin 15 which is the result of the 2175-Hz tone. (A line PTT is also generated, however, it cannot key the transmitter because a channel element is not selected.)

3.5.2 PL Disable Function

With the 2160-Hz bandpass filter disconnected, the PL disable tone (2050-Hz) passes through the guard tone decoder via the function hi output at pin 11. The 2050-Hz signal is applied to the F1-PL module for detection. (Although the 2050-Hz tone is applied to other modules, it can only be detected in the F1-PL module.) When the 2050-Hz signal is detected in the F1-PL Module, the PL disable bistable provides a low level PL disable control output at pin 21. The low level PL disable control is applied to the station control module at pin 20. This results in a high level PL disable output, at pin 23, to disable the "Private-Line" operation of the receiver for channel monitoring before transmission. The PL disable condition remains until a line PTT input is applied to pin 19; this occurs when the transmitter is next keyed.

3.5.3 Function Tone Enable

In order for the tone detector to function, the guard tone decoder generates a 350-millisecond, high-level, decoder bias signal (at pin 15). The decoder bias signal is originated by the 2175-Hz guard tone detection and is present during the 350-millisecond time period that follows. The F1-PL module converts the decoder bias signal into a 350-millisecond, low-level, function enable signal that enables the detectors within the module during the 350-millisecond window. In addition, the function enable is also applied to other modules so that their detectors can also function during the 350-millisecond window.
3.6 R2 MUTE OR RECEIVE F1

3.6.1 In this application, a transmit channel element is not selected, therefore, the transmitter is not keyed. In order to generate the R2 mute signal, the non-transmit format (2175-Hz guard tone followed by a 1750-Hz R2 mute) is applied to pins 19 and 20 in the line driver module. The tones are then routed out of the line driver module on pin 10 and are applied to pin 9 of the guard tone decoder.

3.6.2 Circuit operation from pin 9 of the guard tone decoder is similar to that previously described for Receiver "Private-Line" Disabling except:

--- Either the C2-R2 control module, or the F2-R2 mute control module detects the tone.

--- The R2 mute output is applied to the line driver.

3.6.3 When the 1750-Hz tone is detected in the control module (C2-R2, or F2-R2 mute) the R2 mute bistable provides a low level R2 mute output at pin 7. This output is applied to the line driver module. The R2 mute signal disables the R2 audio line in the line driver.

3.6.4 If the C2-R2 module is used, the R2 mute bistable also initiates a low level (ground) output at pin 15 to activate the receiver F1 oscillator.

3.7 R2 UNMUTE OR RECEIVE F2

3.7.1 In this application, a transmit channel element is not selected, therefore, the transmitter is not keyed. In order to generate the R2 unmute signal, the non-transmit format (2175-Hz guard tone followed by a 1650-Hz R2 unmute) is applied to pins 19 and 20 in the line driver module. The tones are then routed out of the line driver module on pin 10 and are applied to pin 9 of the guard tone decoder.

3.7.2 Circuit operation from pin 9 of the guard tone decoder is similar to that previously described for Receiver "Private-Line" Disabling except:

--- Either the C2-R2 control module, or the F2-R2 mute control module detects the tone.

--- The R2 mute output is open circuited.

3.7.3 When the 1650-Hz tone is detected in the control module (C2-R2 or F2-R2 mute) the R2 unmute bistable provides a cross-coupling to the F2 mute bistable. This causes the F2 mute bistable to open circuit the F2 mute output which, in turn, removes the F2 mute input to line driver. This allows R2 audio to pass through the line driver R2 audio line.

3.7.4 If the C2-R2 module is used, the R2 unmute bistable also initiates a low level (ground) output at pin 17 to activate the receiver F2 oscillator.

3.8 "WILD CARD" ON-OFF

3.8.1 The optional "Wild Card" provides up to four solid state high-low switched outputs or optional relay contact closure outputs. Four different tones are used to control the four circuits. Each circuit is identical, therefore, only one of the four is described; the 1050-Hz. (The others are 1150-Hz, 1250-Hz, and 1350-Hz.) The 1050-Hz tone is applied to the line driver pins 19 and 20 in the non-transmit format (2175-Hz guard tone followed by a 1050-Hz tone). They are routed out of the line drive module on pin 10 and are applied to pin 9 of the guard tone decoder.

3.8.2 Circuit operation from pin 9 of the guard tone decoder is similar to that previously described for Receiver "Private-Line" Disabling except:

--- The tone is detected in the "Wild Card" module.

--- The output is either a relay contact or bistable output.

3.8.3 When the 1050-Hz tone is detected in the "Wild Card" module, the #1 bistable provides a ground output at the Q side. This ground is normally applied through JU1 to pin 3 where it can be used as a control line. If a relay is used, JU1 is disconnected and the relay contacts are connected to the control line.

3.9 REPEATER SET-UP

3.9.1 In this application, the repeater keying circuits are enabled, thus allowing the repeater to be keyed by the squelch gate module. In order to generate a repeater turn on enable signal, the non-transmit format (2175-Hz guard tone followed by a 1450-Hz repeater on) is applied to pins 19 and 20 in the line driver module. The tones are then routed out of the line driver module on pin 10 and are applied to pin 9 of the guard tone decoder.

3.9.2 The guard tone decoder detects the 2175-Hz guard tone and uses a portion of
the detected voltage to effectively disconnect the 2160-Hz bandpass filter at the guard tone decoder input. In addition, the guard tone decoder provides a 350-millisecond decoder bias output gate at pin 15 which is the result of the 2175-Hz tone.

3.9.3 With the 2160-Hz bandpass disconnected, the repeater on tone (1450-Hz) passes through the guard tone decoder via the function hi output at pin 11. The 1450-Hz tone is applied to the repeater control module for detection. When the 1450-Hz tone is detected, the repeater turn on bистable is set and the low Q output is cross-coupled to the clear side of the repeater turn off bистable. The cross-coupling produces a high level output at pin 9, and because this output is high, the function becomes repeater turn-on instead of repeater turn-off.

3.9.4 The high output from pin 9 in the repeater control is applied to pin 21 of the squelch gate module. This high level is an enabling input which allows the squelch gate module to produce the repeater PTT output at pin 18 when the receiver quiets because of an incoming rf signal.

3.10 REPEATER TURN-OFF

In this application, the repeater keying circuits are disabled in order to generate the repeater turn-off function. The circuit operation is similar to that described for repeater turn-on except:

-- A 1550-Hz tone is used.
-- When the repeater control module detects the 1550-Hz tone, it generates a low output at pin 9 that disables the repeater keying function, preventing the repeater from being keyed.

3.11 MAX SQUELCH AND MIN SQUELCH

In these two applications, an attenuator is either switched in or out of the squelch control circuit. The squelch control module is used in place of the repeater control module and is the same except that only jumper JU2 is connected. Circuit operation for this application is similar to that described above for repeater turn-on and turn-off except:

-- When a 1450-Hz tone is detected, the turn-on bistable switches the attenuator into the circuit for threshold squelch.
-- When a 1550-Hz tone is detected, the turn-off bistable cross-couples to the turn-on bistable which then switches the attenuator out of the circuit for maximum squelch.

-- The squelch attenuator output at pin 18 reflects the condition of the attenuator; squelch ratio changes.

3.12 RECEIVER "PL" ON - "PL" OFF

3.12.1 In these two applications the type of squelch is selected; "Private-Line" coded squelch or carrier squelch. The "Private-Line" control module is used instead of the repeater control module, and only jumpers JU3 and JU4 are connected. Circuit operation for this application is similar to that described above for repeater turn-on and turn-off except:

-- When a 1450-Hz tone is detected, the operate carrier squelch bistable provides a low output on pin 20 (high on pin 5) which disables the receiver PL coded squelch circuit.
-- When a 1550-Hz tone is detected, the operate PL bistable provides a low output on pin 5 (high on pin 20) which enables the receiver PL coded squelch circuit.

3.12.2 The low PL disable output on pin 20 (pin 5 high) is applied to the station control module pin 5. This produces a high PL disable output from this module, at pin 23, to disable the PL and change operation to the carrier squelch mode.

3.12.3 The low PL enable output on pin 5 is applied to the F1-PL module to produce high PL disable and function enable outputs from this module. This insures that no other function tones can be excepted and that operation remains in the PL mode.

3.13 SINGLE TONE DECODER

3.13.1 The single tone decoder may be used in repeater systems to key a specific repeater. The single tone decoder can detect one of 19 different audio frequencies between 600 and 3300-Hz, with a 150 Hz spacing. The input, containing the particular tone, is applied from the receiver at pin 3 of the single tone decoder module. The module detects the tone and removes the ground output at pin 16 (squelch gate inhibit). This removes the inhibiting function from the squelch gate module allowing it to function normally. The single tone decoder is reset by the squelch gate module upon loss of received rf carrier signal. The single tone decoder can also be used for receiving enabling. Switched A+
output is applied to the PL indicator output of the receiver, enabling the receiver squelch circuit only when the proper single tone frequency has been received. The PL disable function may be used for monitoring the channel.

3.13.2 The single tone decoder can also be used for remote monitoring and control of external equipment by plugging it into the options decoder (repeater control module) position and connecting the output of the decoder to the external equipment.

3.14 FOUR-FREQUENCY SELECTION

3.14.1 General Description

3.14.1.1 The 4-frequency module converts a function tone signal from a remote source to a switched ground function for transmit and receive channel element selection. The function tone is applied to a clipper amplifier and passed to resonant tank circuits which are tuned to respond to a specific frequency: 1250 Hz, 1350 Hz, 1850 Hz, or 1950 Hz.

3.14.1.2 The tone signal passes through the resonant tank circuit to a detector circuit where it is converted, upon application of a function enable signal from the guard tone decoder module, from a function tone to a dc voltage. This dc signal is inverted and applied to the transmit and receive latches. These latches, upon application of a clock pulse, activate the channel element drivers to provide a switched ground to the selected transmit and receive channel elements.

3.14.2 Transmit Frequency Selection

3.14.2.1 Since all frequency selection circuits are the same except for the specific frequency to which they respond, only one circuit is described, the F2 (1850 Hz) circuit. When an 1850 Hz function tone is sent from the remote control console, it is received at pin 11 of the four-frequency control module. It is then amplified and passed through the respective tank circuit. The signal is detected by the F2 detector and is converted from a 1850 Hz function tone to a logic low dc voltage. The F2 detector is enabled by the presence of the function enable signal at pin 13 from the bias switch in the F1 or F1-PL control module. This signal is developed only after the high-level guard tone has been detected.

3.14.2.2 The logic low detector output is inverted and applied to transmit latch flip-flop U11B and to the transmit latch clock. The clock pulse is applied to the F2 flip-flop which changes state and produces a high level Q output. This output is inverted to a logic low and is applied to the T2 transmitter channel element. As this happens, the other transmit latch flip-flops reset, cancelling any previous frequency selection.

3.14.3 Receive Frequency Selection

3.14.3.1 The logic high from the F2 transmit latch flip-flop is also applied to the receiver latch clock circuit and receiver latch flip-flop U2B. The receiver latch clock sends a pulse to receiver latch flip U2B which causes the Q output to become high. The receive latch flip-flop now remains in this state until reset. AND gate U3B applies a high to inverter Q23. The output of Q23 is a ground which selects the R2 receiver channel element.

3.14.3.2 After transmission has been completed and PTT has been released, switched 9.6 V is removed from pin 8, causing C14 to discharge. The discharge of this capacitor turns on the transmit clock causing a second pulse to be applied to the multivibrator which resets the transmit latch back to its original state (all Q outputs low).

3.14.3.3 The receiver latch does not reset after transmission has been completed. The receiver channel, in this explanation R2, remains activated. When transmission is changed to F1, F3, or F4, the receiver clock will pulse the receiver flip-flop, thus resetting R2 and turning on the appropriate receiver frequency for proper communications.

3.14.3.4 The power on reset circuit pulses receiver latch U2A, resetting the multivibrator to R1 channel element select any time power is lost due to removal of the card or power outage.

3.15 EXCITER AUDIO

3.15.1 Exciter audio is defined as the audio used to modulate the transmitter. It is applied to the transmitter and can originate from several sources depending upon the modules that are used in the station.
3.15.2 Audio from the remote control point is applied to pins 19 and 20 of the line driver module, and is routed out of this module on pin 24. From this point, the audio is applied to the control station module pin 6 for level control setting and gating (must be gated by PTT control). The audio leaves from this module at pin 16 (as unnotched mic hi). From the station control module, it is applied to local microphone input metering and the F1-PL (or F1) module pin 18. The F1-PL module contains a notch filter that greatly attenuates any 2175-Hz signals to insure a guard tone is not transmitted "on-the-air". After filtering, the mic hi output at pin 22 is applied to the transmitter.

3.16 RECEIVE AUDIO

3.16.1 Receiver R1 and R2 audio (discriminator output) is applied to the line driver module at pins 13 and 22, respectively. In repeater operation, R1 audio is applied to squelch gate module pin 17.

3.16.2 The receiver audio is routed through the line driver module; however, the output point depends upon the model used and the jumper connections.

3.16.3 Normally, the audio is routed through the line 1 level set control and line amplifiers and exits on pins 19 and 20. The wire line carries this audio back to the remote control point.

3.16.4 R1 audio may be routed to the line 1 output while R2 audio may be routed through the line 2 level set control and line amplifiers and exit the module on pins 7 & 8. Both lines carry audio to a remote point.

3.16.5 The audio from the receiver(s) can be routed to the line 2 output when line 1 is to be used for transmit audio and line 2 is to be used for receive audio.

3.16.6 In tone controlled stations, the R1 audio is routed from the receiver through the F1-PL module which contains a 2175-Hz receiver notch filter to remove any 2175-Hz tone, then to the line driver module.

3.16.7 Any audio that is routed to line 1 or line 2 is sampled from the line transformer and exits the line driver module on pin 23. This audio is routed to the audio power amplifier of the receiver for local speaker audio.

3.16.8 In repeater configurations, R1 audio is applied to pin 17 in the squelch gate module for gating and level setting. The audio output at pin 11 (repeater audio) is then to transmitter audio in repeater operation.
REMOTE CONTROL CHASSIS

TYPICAL UNIFIED CHASSIS

TYPICAL NON-UNIFIED CHASSIS
# MOTOROLA

**DETAIL MODEL BREAKDOWN CHART FOR**

**UNIFIED CONTROL CHASSIS**

**AND**

**NON-UNIFIED CONTROL CHASSIS**

**CODE:**

- **X** = ONE ITEM SUPPLIED.
- **=** INDICATES ITEM COVERED IN ASSOCIATED STATION MANUAL.

**NOTE:**

THE MISCELLANEOUS KITS ARE PART OF OR OPTIONS TO THE STATION MODEL BUT MOUNT ON THE CONTROL CHASSIS. USAGE OF THESE KITS ARE AS FOLLOWS:

- **TRN6571A** -- 800 MHz MODELS ONLY
- **TLN9148A** -- NON-UNIFIED MODELS ONLY
- **TRN6338A** -- 4 FREQ, UNIFIED MODELS ONLY

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>DESCRIPTION</th>
<th>TYPE OF STATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCN117A</td>
<td>UNIFIED CONTROL CHASSIS</td>
<td>RRTR</td>
</tr>
<tr>
<td>TCN1148A</td>
<td>UNIFIED CONTROL CHASSIS</td>
<td>BASE</td>
</tr>
<tr>
<td>TCN1190A</td>
<td>UNIFIED (FULL FILTERING OPTION)</td>
<td>BASE</td>
</tr>
<tr>
<td>TCN1223A</td>
<td>UNIFIED CONTROL CHASSIS</td>
<td>RRTR &amp; BASE</td>
</tr>
<tr>
<td>TCN1224A</td>
<td>UNIFIED CONTROL CHASSIS</td>
<td>RRTR</td>
</tr>
<tr>
<td>TCN1225A</td>
<td>UNIFIED (FULL FILTERING OPTION)</td>
<td>RRTR &amp; BASE</td>
</tr>
<tr>
<td>TCN1182A</td>
<td>NON-UNIFIED</td>
<td>1 &amp; 2-FREQ.</td>
</tr>
<tr>
<td>TCN1155A</td>
<td>NON-UNIFIED</td>
<td>4-FREQUENCY</td>
</tr>
<tr>
<td>TRN6571A</td>
<td>TRANSMIT SUSP Kit</td>
<td></td>
</tr>
<tr>
<td>TLN9148A</td>
<td>REPEATER (RA) BRACKET KIT</td>
<td></td>
</tr>
<tr>
<td>TRN6338A</td>
<td>5 V REGULATOR KIT</td>
<td></td>
</tr>
</tbody>
</table>

**EPS-22525-O**
1. DESCRIPTION

1.1 Eight remote control chassis are described in this manual section (see model chart). Unified models utilize a unified chassis which includes and interconnects (without wire) the remote control chassis modules to the transmitter and receiver interconnect boards. A single large circuit board interconnects the control modules directly to the transmitter and receiver. Non-unified models utilize a 50-conductor flat cable to interconnect the control modules to the transmitter and receiver circuits.

1.2 The remote control chassis mounts plug-in modules that perform switching functions for station operation. Nylon guide rails in the chassis align the modules with the mating connecting pins on the interconnect circuit board at the rear of the chassis.

2. APPLICATION

2.1 TONE OR DC REMOTE CONTROL

The remote control chassis, together with the associated plug-in modules, permits a station to be operated from a remote location and performs various control or operational functions for the station. Tones or dc line currents generated at a remote location(3) are carried over wire lines to the station remote control chassis to implement the desired type of operation. The remote control chassis and its modules convert the tones or dc line currents into switching functions to perform any or all of the operations listed in Tables 1, 2 and 3 depending on the modules used:

<table>
<thead>
<tr>
<th>TABLE 1. DC COMMANDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC LINE CURRENT (mA)</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>-2.5</td>
</tr>
<tr>
<td>-5.5</td>
</tr>
<tr>
<td>+5.5</td>
</tr>
<tr>
<td>+12.5 (momentary)</td>
</tr>
<tr>
<td>+12.5</td>
</tr>
<tr>
<td>-12.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2. TONE COMMANDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TONE FREQ. (Hz)</td>
</tr>
<tr>
<td>2050</td>
</tr>
<tr>
<td>1950</td>
</tr>
<tr>
<td>1850</td>
</tr>
<tr>
<td>1750</td>
</tr>
<tr>
<td>1650</td>
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<td>1550</td>
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<td>1450</td>
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<tr>
<td>1350</td>
</tr>
<tr>
<td>1250</td>
</tr>
<tr>
<td>1150</td>
</tr>
<tr>
<td>1050</td>
</tr>
</tbody>
</table>

*C2-R2 Receiver Frequency Selection

<table>
<thead>
<tr>
<th>TABLE 3. GUARD TONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tone Freq. (Hz)</td>
</tr>
<tr>
<td>2175</td>
</tr>
</tbody>
</table>
2.2 PLUG-IN MODULES

2.2.1 All stations are equipped with a basic complement of modules as follows:

DC CONTROL
- DC Transfer Module
- Station Control Module
- Line Driver Module

TONE CONTROL
- Guard Tone Decoder Module
- F1 Decoder Module
- F2, or C2-R2, Decoder (2-Frequency stations)
- Station Control Module
- Line Driver Module

2.2.2 Repeater Stations are also equipped with a Squelch Gate Module and Time-Out Timer Module. Repeaters without wire-line control may have the modules that are associated with line control operation omitted. For base stations and repeaters, additional space is provided for optional accessory modules.

3. SERVICE AND MAINTENANCE

3.1 LOCAL STATION OPERATION

WARNING
Always line disable this station when performing local maintenance duties. Failure to do so may result in personal injury or equipment damage. Selection of frequency at the remote control console momentarily keys this station even though the microphone push-to-talk switch has not been depressed. Upon completion of local testing, return line disable switch to its normal position.

3.2 REMOVAL AND REPLACEMENT OF MODULES

3.2.1 Modules may be removed by simply pulling outward on the module, and may be replaced by pushing the module into its position in the panel. The modules are labelled and the mounting positions are marked on the interconnect board at the inside rear of the module housing.

CAUTION
1. Never attempt to plug a module into the pins on the back of the remote control unit.
2. Always be sure of the correct module position before plugging in a module.
3.2.2 Technicians who service many of these stations may wish to carry spares and replace malfunctioning modules for immediate restoration of operation. The module may then be repaired at the shop and used as the next replacement spare.

NOTE
All jumper connections must be identical on modules that are removed and modules that are inserted before swapping can be successfully used as a troubleshooting technique.

3.3 INSTALLATION OF ADDITIONAL MODULES

When new functions (optional modules) are added, refer to the pertinent module section in this manual for proper jumpering information.

3.4 IN-CIRCUIT MODULE SERVICING

The Motorola Model TLN8799A Service Board Kit can be used for extending the module to provide access for service and maintenance without interrupting the power and signal connections when taking readings. See Figure 1.

3.5 OUT-OF-CIRCUIT MODULE SERVICING

A Motorola TEK-38 Base Station Module Servicing Adapter, shown in Figure 2, can be used for convenient bench testing or repair of base station modules. The board provides an easy method of connecting a 12-volt power supply and an audio oscillator and allows jumpering and strapping between any pins on the module.

3.6 5-VOLT REGULATOR TROUBLESHOOTING (TCN1125A MODEL ONLY)

3.6.1 Set-Up Instructions

Connect a 2 ohm, 20 watt resistor from the regulator output at the brown-yellow lead to ground. Disconnect CR1 from the circuit to preclude crowbar action during troubleshooting. Connect 10 to 16 V dc to the input terminals of the regulator.

3.6.2 Symptoms

3.6.2.1 No Output

Step 1. Check series elements F1, R1, R5.

Step 2. Check for open components in regulator stages; Q1, Q2, Q3, CR5, etc.

3.6.2.2 Output Voltage Same as Input

Check for R5 shorted collector to emitter

3.6.2.3 Improper Regulation

Step 1. Check values of R5, R7, R8 and R9.
Step 2. Check Q3 emitter voltage. If not 4.7 ±0.3 volts check CR5.

Step 3. Check Q1, Q2 and Q3.

3.4.2.4 Crowned Circuit Insulation

Step 1. Adjust output voltage to 7.5 volts with R8. Check junction of R10-R11 for 6.3 volts.

Step 2. Check Q4, CR1, R11, R12 and R6.

Step 3. Check C1.

Step 4. After fault is located and corrected, re-adjust R8 to obtain 5.8 volts ±0.1 V output from the regulator.

4. SPECIAL MODIFICATIONS

To change the Tone Decoder frequencies from the standard value, change those parts indicated in Figure 3 and Table 4.

<table>
<thead>
<tr>
<th>Tank Freq.</th>
<th>Function Tone</th>
<th>R1 ±5% (In Ohms)</th>
<th>R2 ±5% (In Ohms)</th>
<th>R3 ±5% (In Ohms)</th>
<th>R4 ±5% (In Ohms)</th>
<th>C1 ±2% (In µF)</th>
<th>Capacitor Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2050</td>
<td>22k, 22k*</td>
<td>1.5k</td>
<td>2.7k</td>
<td>221</td>
<td>.0056</td>
<td>8D4326A13</td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>22k, 22k*</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.0062</td>
<td>8D4326A14</td>
<td></td>
</tr>
<tr>
<td>1850</td>
<td>18k, 22k*</td>
<td>1.5k</td>
<td>2.7k</td>
<td>221</td>
<td>.0069</td>
<td>8D4326A15</td>
<td></td>
</tr>
<tr>
<td>1750</td>
<td>22k</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.0077</td>
<td>8D4326A16</td>
<td></td>
</tr>
<tr>
<td>1650</td>
<td>18k</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.00865</td>
<td>8D4326A17</td>
<td></td>
</tr>
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<td>2.7k</td>
<td>221</td>
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<td>8D4326A18</td>
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</tr>
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<td>1k</td>
<td>2.7k</td>
<td>221</td>
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<td></td>
</tr>
<tr>
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<td>10k</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.0129</td>
<td>8D4326A20</td>
<td></td>
</tr>
<tr>
<td>1250</td>
<td>9.1k</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.015</td>
<td>8D4326A21</td>
<td></td>
</tr>
<tr>
<td>1150</td>
<td>8.2k</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.0178</td>
<td>8D4326A22</td>
<td></td>
</tr>
<tr>
<td>1050</td>
<td>6.8k</td>
<td>1k</td>
<td>2.7k</td>
<td>221</td>
<td>.0213</td>
<td>8D4326A23</td>
<td></td>
</tr>
</tbody>
</table>

*Values for "Wild Card" only.
***±5% is allowable.

EXAMPLE: Changing "Wild Card" frequency to 1850 Hz

<table>
<thead>
<tr>
<th>FREQ.</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>C1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850</td>
<td>22k ±5%</td>
<td>1.5k ±5%</td>
<td>2.7k ±5%</td>
<td>&lt;221 ±15%</td>
<td>.0069 µF ±5%</td>
</tr>
</tbody>
</table>

Figure 1. Typical In-Circuit Module Servicing (TCN1107A/TCN115A Remote Control Chassis Shown)

Figure 2. Out-of-Circuit Module Servicing
<table>
<thead>
<tr>
<th>Module</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Diode</td>
<td>L 112 9 7 2 4 6</td>
</tr>
<tr>
<td>Section Control</td>
<td>3 2 3 14 2 10 2 14 13 18 1 17 2 14 18 2 13 2 14</td>
</tr>
<tr>
<td>DC Transfer</td>
<td>1 2 3 8 9 2 3 24 3 26 3 24 2</td>
</tr>
<tr>
<td>Three-Outlet Tower</td>
<td>4 1 13 2 29 3 6 5</td>
</tr>
<tr>
<td>PTY - PIC</td>
<td>9 12 13 12 1 18 13 18 9 12 13 12 1</td>
</tr>
<tr>
<td>Ground Tone Inc.</td>
<td>6 2 3 20 11 2 13 2 11 13 2 13 2 11 13 2 11</td>
</tr>
<tr>
<td>Spanish Cone</td>
<td>7 1 2 24 11</td>
</tr>
<tr>
<td>PTY-Pegging &amp; D.C.</td>
<td>8 1 2 24 11</td>
</tr>
<tr>
<td>Cailot</td>
<td>5 1 24 25 11</td>
</tr>
<tr>
<td>Wave Card</td>
<td>10 1 12</td>
</tr>
<tr>
<td>Single Tone Osc/Volagi</td>
<td>11 1 24 25 11</td>
</tr>
<tr>
<td>Scope</td>
<td>12 1 12</td>
</tr>
<tr>
<td>Connector</td>
<td>6 1 24 25 11</td>
</tr>
<tr>
<td>PTY Power Supply</td>
<td>13 1 24 25 11</td>
</tr>
<tr>
<td>25 Screw</td>
<td>14 1 24 25 11</td>
</tr>
<tr>
<td>25 Thread Bolt/Hex</td>
<td>15 1 24 25 11</td>
</tr>
<tr>
<td>36 Latching</td>
<td>17 1 24 25 11</td>
</tr>
<tr>
<td>36 Torque</td>
<td>18 1 24 25 11</td>
</tr>
<tr>
<td>36 Screw</td>
<td>19 1 24 25 11</td>
</tr>
<tr>
<td>36 Hex Nut</td>
<td>20 1 24 25 11</td>
</tr>
<tr>
<td>TNC Remote Control Lines</td>
<td>21 1 24 25 11</td>
</tr>
<tr>
<td>Trunk High Current</td>
<td>22 1 24 25 11</td>
</tr>
<tr>
<td>Trunk Terminal</td>
<td>23 1 24 25 11</td>
</tr>
<tr>
<td>Individual Piece</td>
<td></td>
</tr>
</tbody>
</table>

**How to Read Chart**

1. This chart shows all intercircuit trace paths by the plugging on both sides of the interconnect board and by wire jumpers.
2. Interconnect vertical columns are simultaneously scanned (interconnected by circuit board planning).
3. To trace interconnections from any starting point in all other common points proceed as follows:
   - Step 1: Find the number points or connectors in the left-hand column of the chart.
   - Step 2: Find the desired pin number. All pins of a specific connector are listed in the line that matches the pin number.
   - Step 3: Find the location of the desired pin. The location is listed at the top of the column in which the pin number appears. All other pins listed in the same function column are interconnected. For each pin in the function column, trace back to the left-hand column to find the module or connector number. (See Example)
4. **Example:** Main Control Module (module position B1, pin 13) has a function of P-T-T Control, which is interconnected to DC transfer module positions A (pin 13), D (pin 13), connected pin position 5 (pin 13), P-T TNC/DEC, DEG, position 5 (pin 13) and DPTRNS position 5 (pin 13).
**HOW TO READ THE CHART**

1. This chart shows all interconnections made by the planning in both offices of the interchange board and by wire:
   - The numbers in each section indicate the electrically correct connections for each board plan or wire.
   - The numbers in the second section indicate the existing plans for the interchange board.
   - The numbers in the third section indicate the planning for the wire.

2. The planning for the interchange board and the planning for the wire are listed in the chart.

3. The planning for the interchange board and the planning for the wire are listed in the chart.

**EXAMPLE 1**

- Motion control panel in section 2, 3, 4, and 5 shows a function of a T-2 control, which is determined to obtain the desired 1st control. The lower panel position 3, 4, and 5 shows the panel position 8, 9, and 10.

**EXAMPLE 2**

- Shaded fields indicate the interconnection under consideration. When the C-7 and C-8 are connected, the shaded fields indicate the interconnection under consideration. When the C-7 and C-8 are connected, the shaded fields indicate the interconnection under consideration.
1. INTRODUCTION

The remote control modules permit remote wire line control of base station and repeater (RT) stations. The following modules are provided with the station dependent upon the type of station control and operation.

2. STANDARD MODULE DESCRIPTION

2.1 STATION CONTROL MODULE
(DC and Tone Controlled Station)

This module provides the necessary integration of control functions from other modules in the remote chassis to key the station transmitter. Exciter audio amplification is also provided with amplitude adjustment by means of a potentiometer which is accessible through the front panel. Amplifiers are also provided to amplify the receiver discriminator output which is used externally.

2.2 LINE DRIVER MODULE
(DC and Tone Controlled Stations)

2.2.1 The line driver module amplifies the receiver audio which is routed to the remote control point over wire line, and amplifies audio from the remote control point which is to be transmitted. Thus, it also provides monitoring of all repeater messages. For a repeater (RT) station that is not to be wire line controlled, this module can be omitted.

2.2.2 The line driver module is available in three models: 1-receiver, 2-wire (standard); 2-receiver, 2-wire (standard with 2-receiver base stations); and 4-wire (optional). The 4-wire line driver permits the transmit and receive audio to be carried on separate wire lines, or permits receive No. 2 audio to be carried on a separate wire line.

2.3 DC TRANSFER MODULE
(DC Controlled Stations)

The dc transfer module converts dc line currents to control functions for use by a remote control console operator via wire lines. Six dc transfer module versions are available and perform the functions shown in Table 1.

2.4 GUARD TONE DECODER
(Tone Controlled Stations)

The guard tone decoder converts a 2175 Hz guard tone signal received from a remote control source to a line push-to-talk voltage. The decoder also amplifies and distributes received function tones to other function decoders.

2.5 F1 AND F1-PL CONTROL MODULES
(Tone Controlled Stations)

This module converts a 1950 Hz tone signal from a remote control source to a switched ground to turn on the transmitter channel element. The PL module also converts a 2050 Hz tone signal to a switched ground to disable the PL operation of the receiver for channel monitoring before transmitting. In carrier squelch stations, the PL disable function is not required and is therefore not used.
Table 1.  DC Transfer Module Application

<table>
<thead>
<tr>
<th>MODULE VERSION</th>
<th>LINE CURRENT (mA)</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 (CARRIER SQUELCH)</td>
<td>+5.5</td>
<td>Keys transmitter on F1.</td>
</tr>
<tr>
<td>F1-PL</td>
<td>+5.5</td>
<td>Keys transmitter on F1.</td>
</tr>
<tr>
<td></td>
<td>-2.5</td>
<td>PL disables receiver.</td>
</tr>
<tr>
<td>C2-R2</td>
<td>+5.5</td>
<td>Keys transmitter on F1 and selects R1.</td>
</tr>
<tr>
<td></td>
<td>+12.5</td>
<td>Keys transmitter on F2 and selects R2.</td>
</tr>
<tr>
<td></td>
<td>-2.5</td>
<td>PL disables receiver.</td>
</tr>
<tr>
<td>F2-R2 MUTE</td>
<td>+5.5</td>
<td>Keys transmitter on F1.</td>
</tr>
<tr>
<td></td>
<td>+12.5</td>
<td>Keys transmitter on F2 and unmutes R2.</td>
</tr>
<tr>
<td></td>
<td>-2.5</td>
<td>PL disables receiver.</td>
</tr>
<tr>
<td></td>
<td>-5.5</td>
<td>Mute R2.</td>
</tr>
<tr>
<td>PAGING (OPTIONAL)</td>
<td>+5.5</td>
<td>Keys transmitter on F1 with PL tone.</td>
</tr>
<tr>
<td></td>
<td>-12.5</td>
<td>Keys transmitter on F1 without PL tone.</td>
</tr>
<tr>
<td></td>
<td>-2.5</td>
<td>PL disables receiver.</td>
</tr>
<tr>
<td>REPEATER CONTROL (OPTIONAL FOR REPEATERS ONLY)</td>
<td>+5.5</td>
<td>Keys transmitter on F1.</td>
</tr>
<tr>
<td></td>
<td>+12.5</td>
<td>Repeater turn-on.</td>
</tr>
<tr>
<td></td>
<td>-2.5</td>
<td>PL disables receiver.</td>
</tr>
<tr>
<td></td>
<td>-5.5</td>
<td>Repeater turn-off.</td>
</tr>
</tbody>
</table>

2.6 F2 TONE DECODER MODULES
(Tone Controlled Stations)

The F2 tone decoder module is available in four versions which perform the functions shown in Table 2.

Table 2.  F2 Tone Decoder Application

<table>
<thead>
<tr>
<th>MODULE VERSION</th>
<th>FUNCTION TONE (Hz)</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2</td>
<td>1850</td>
<td>Keys transmitter on F2</td>
</tr>
<tr>
<td>C2-R2</td>
<td>1850</td>
<td>Keys transmitter on F2</td>
</tr>
<tr>
<td></td>
<td>1750</td>
<td>Selects R1, inhibits R2</td>
</tr>
<tr>
<td></td>
<td>1650</td>
<td>Selects R2, inhibits R1</td>
</tr>
<tr>
<td>F2-R2 MUTE (OPTIONAL)</td>
<td>1850</td>
<td>Keys transmitter on F2</td>
</tr>
<tr>
<td></td>
<td>1750</td>
<td>Mutes R2</td>
</tr>
<tr>
<td></td>
<td>1650</td>
<td>Unmutes R2</td>
</tr>
<tr>
<td>PAGING</td>
<td>1850</td>
<td>Keys transmitter on F1 without PL modulation</td>
</tr>
</tbody>
</table>

2.8 TIME-OUT TIMER MODULE
(Repeater Stations)

The time-out timer (T-O-T) module is standard in all repeater (RT) models and is an optional accessory for base station models. It limits the period of time the transmitter can be keyed. It can be set to limit the continuous transmission time from line controlled operation, and to limit the transmission time of individual users of the repeater. The time-out start of each is independent of the other. The unit can be preset for 1/2, 1, 2, 4 or 8 minutes by connecting jumpers to the corresponding time multiplier output.

2.9 FOUR-FREQUENCY CONTROL MODULE
(Tone Controlled Stations)

The four-frequency control module converts the proper function tones into frequency selection commands for selection of the station operating frequency. Refer to Table 3 for a listing of the necessary function tones. This control module also includes front chassis mounted switches which permit local frequency selection, when desired. The four-frequency control module operates with a F1 or F1-PL control module compatible with four-frequency operation. These F1 control modules provide biasing voltage for the four-frequency module and include the 2175 Hz notch filters.
Table 3. Four-Frequency Selection Tones

<table>
<thead>
<tr>
<th>FUNCTION TONE</th>
<th>FREQUENCY SELECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950 Hz</td>
<td>F1: Transmitter keys on frequency T1. Receiver operates in standby mode on frequency R1.</td>
</tr>
<tr>
<td>1850 Hz</td>
<td>F2: Transmitter keys on frequency T2. Receiver operates in standby mode on frequency R2.</td>
</tr>
<tr>
<td>1350 Hz</td>
<td>F3: Transmitter keys on frequency T3. Receiver operates in standby mode on frequency R3.</td>
</tr>
<tr>
<td>1250 Hz</td>
<td>F4: Transmitter keys on frequency T4. Receiver operates in standby mode on frequency R4.</td>
</tr>
</tbody>
</table>

3. **OPTIONAL MODULE DESCRIPTION**

3.1 **SINGLE-TONE DECODER MODULE**  
(DC and Tone Controlled Stations)

3.1.1 The single-tone decoder module provides a transistor switched output (logic low or high) or an optional relay closure upon receipt of the proper tone. The module responds only to a specific audio tone of at least 300 milliseconds duration. Nineteen different frequencies from 600 to 3300 Hz at 150 Hz intervals are available. The module can be jumpered so the output is latched on (must be reset by an external command), momentary on, or 5 seconds on. The single-tone decoder module can be used to control other functions as described in the following examples.

3.1.2 In repeater (RT) stations, the module may be used to inhibit repeater operation until the correct audio tone is received by the receiver. In this application, it is operated in the latched mode and is reset by the squelch gate upon loss of received carrier signal.

3.1.3 In base or repeater stations, the output of the module can be wired to inhibit (mute) receiver audio until the proper tone is received.

3.1.4 In either base or repeater stations, the single-tone decoder may be plugged into the F2 tone decoder slot of the remote control chassis (an F2 tone decoder module cannot be used at the same time). A single-tone command from the remote control console via the wire line will activate the module. The module’s output can be wired to perform any desired function at the base station site such as turning on the antenna tower lights.

3.2 **OPTIONS DECODERS**

A tone controlled station may use one of the following decoders:

3.2.1 **Squelch Control Module**

This module converts the 1450 Hz and 1550 Hz function tone burst to two levels of squelch sensitivity in the carrier squelch mode of receiver operation.

3.2.2 **"Private-Line" Control Module**

This module converts the 1450 Hz and 1550 Hz function tone bursts to PL or carrier squelch mode of operation. It differs from the PL disable function of the F1-PL module in that the receiver does not revert to PL operations when the transmitter is keyed. When this module is operated in the PL mode, the PL disable function of the F1-PL module is unaffected to allow monitoring before transmitting.

3.2.3 **Repeater Control Module**

This module may be used in a repeater (RT) station only. It converts a 1450 Hz function tone to a repeater enable command (repeater "set-up") and a 1550 Hz function tone to repeater disable (repeater "knock-down"). In the repeater "knock-down" mode the station operates as a conventional base station only.

3.3 **"WILD CARD" CONTROL MODULE**

This module may be added to any model station. It provides four tone-activated transistor switched outputs which may be used to control the operation of four relays in response to function tone commands of 1350, 1250, 1150 and 1050 Hz. The circuits may be cross-connected to two on-off outputs if desired. The outputs may be used for any desired remotely controlled switching at the base station site such as on-off control of antenna tower lights, emergency power generating equipment, etc.

3.4 **RELAY KITS**

The relay kits are for use in the "Wild Card" module, single-tone decoder module, or squelch gate module. They provide a form "C" output circuit which is isolated from the module board circuitry, with higher voltage and current switching capability than provided by the normal transistor output.
## STATION CONTROL MODULE

### parts list

<table>
<thead>
<tr>
<th>REFERENCE SYMBOL</th>
<th>MOTOROLA PART NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, 2</td>
<td>23-865136</td>
<td>15 ± 20%: 25 V</td>
</tr>
<tr>
<td>C3</td>
<td>8-280505G05</td>
<td>0.15</td>
</tr>
<tr>
<td>C4</td>
<td>23-865136</td>
<td>15 ± 20%: 25 V</td>
</tr>
<tr>
<td>C5</td>
<td>21-82187829</td>
<td>0.01: 100 V</td>
</tr>
<tr>
<td>C6</td>
<td>23-865136</td>
<td>15 ± 20%: 25 V</td>
</tr>
<tr>
<td>C7</td>
<td>8-22505050G05</td>
<td>0.10</td>
</tr>
<tr>
<td>C8</td>
<td>23-865136</td>
<td>15 ± 20%: 25 V</td>
</tr>
<tr>
<td>C9</td>
<td>8-22505051G11</td>
<td>0.22</td>
</tr>
<tr>
<td>C10</td>
<td>8-22505050G05</td>
<td>0.10</td>
</tr>
<tr>
<td>C11, 12</td>
<td>23-865136</td>
<td>15 ± 20%: 25 V</td>
</tr>
<tr>
<td>C13 thru 17</td>
<td>21-82187829</td>
<td>0.01: 100 V</td>
</tr>
<tr>
<td>C18</td>
<td>23-82187824</td>
<td>15 ± 20%: 25 V</td>
</tr>
<tr>
<td>CR1 thru 4</td>
<td>48-835645J01</td>
<td>silicon</td>
</tr>
<tr>
<td>CR5</td>
<td>48-834666H13</td>
<td>semiconductor device; diode; see note</td>
</tr>
<tr>
<td>CR6 thru 24</td>
<td>48-835645J01</td>
<td>silicon</td>
</tr>
<tr>
<td>DS1</td>
<td>65-835645G01</td>
<td>lamp, Incandescent: 12 volts; 0.19 amp</td>
</tr>
<tr>
<td>R1</td>
<td>6-11000602</td>
<td>150k</td>
</tr>
<tr>
<td>R2</td>
<td>6-11000607</td>
<td>39k</td>
</tr>
<tr>
<td>R3</td>
<td>6-11000609</td>
<td>390k</td>
</tr>
<tr>
<td>R4</td>
<td>6-11000609</td>
<td>1k</td>
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<td>R5</td>
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<td>150k</td>
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<td>R6</td>
<td>6-11000607</td>
<td>39k</td>
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<td>R7</td>
<td>6-11000607</td>
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<td>R8</td>
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<td>1k</td>
</tr>
<tr>
<td>R9</td>
<td>6-11000607</td>
<td>100k</td>
</tr>
<tr>
<td>R10</td>
<td>19-835645G03</td>
<td>var. 25k</td>
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<tr>
<td>R11</td>
<td>6-11000607</td>
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<td>R12</td>
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<td>6-11000607</td>
<td>470k</td>
</tr>
<tr>
<td>R15</td>
<td>6-11000607</td>
<td>1.8k</td>
</tr>
<tr>
<td>R16</td>
<td>6-11000607</td>
<td>27k</td>
</tr>
<tr>
<td>R17</td>
<td>6-11000607</td>
<td>100k</td>
</tr>
<tr>
<td>R18</td>
<td>6-11000607</td>
<td>5.6k</td>
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<tr>
<td>R19</td>
<td>6-11000607</td>
<td>1 meg</td>
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<td>R20</td>
<td>6-11000607</td>
<td>56k</td>
</tr>
<tr>
<td>R21</td>
<td>6-11000607</td>
<td>1 meg</td>
</tr>
<tr>
<td>R22</td>
<td>6-11000607</td>
<td>10k</td>
</tr>
<tr>
<td>R23</td>
<td>6-11000607</td>
<td>100k</td>
</tr>
<tr>
<td>R24</td>
<td>6-11000607</td>
<td>10k</td>
</tr>
<tr>
<td>R25</td>
<td>6-11000607</td>
<td>8.8k</td>
</tr>
<tr>
<td>R26</td>
<td>6-11000607</td>
<td>82k</td>
</tr>
<tr>
<td>R27</td>
<td>6-11000607</td>
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<td>R28</td>
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</tr>
<tr>
<td>R33</td>
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<td>220k</td>
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<tr>
<td>R34</td>
<td>6-11000607</td>
<td>330k</td>
</tr>
<tr>
<td>R35</td>
<td>6-11000607</td>
<td>3.3k</td>
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<td>R36</td>
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<td>680k</td>
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<tr>
<td>R37</td>
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<td>10</td>
</tr>
<tr>
<td>R38</td>
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<td>27k</td>
</tr>
<tr>
<td>R39</td>
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<td>10k</td>
</tr>
<tr>
<td>R40</td>
<td>6-11000607</td>
<td>27k</td>
</tr>
<tr>
<td>R41 thru 43</td>
<td>6-11000607</td>
<td>10k</td>
</tr>
<tr>
<td>R44</td>
<td>6-11000607</td>
<td>22k</td>
</tr>
<tr>
<td>R45</td>
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</tr>
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<td>R46, 47</td>
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<td>15k</td>
</tr>
<tr>
<td>R48 thru 50</td>
<td>NOT USED</td>
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</tr>
<tr>
<td>R51, 52</td>
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<td>22k</td>
</tr>
<tr>
<td>R53</td>
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</tr>
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<td>R54, 55</td>
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<td>10k</td>
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<td>R56</td>
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<td>3.3k</td>
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<td>R57</td>
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<td>R58</td>
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<td>R59</td>
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<td>47k</td>
</tr>
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<td>R60, 61</td>
<td>6-11000607</td>
<td>8.2k</td>
</tr>
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<td>R62</td>
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</tr>
<tr>
<td>S1</td>
<td>40-834868E01</td>
<td>3k</td>
</tr>
<tr>
<td>S2, 3</td>
<td>40-832049B01</td>
<td>0.33: PL &amp; line disable</td>
</tr>
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<td>S3</td>
<td>40-832049B01</td>
<td>0.33: PL &amp; line disable</td>
</tr>
<tr>
<td>XD61</td>
<td>9-842585C01</td>
<td>female: single contact</td>
</tr>
<tr>
<td>S1, S2, 3</td>
<td>40-832049B01</td>
<td>0.33: PL &amp; line disable</td>
</tr>
</tbody>
</table>

### non-referenced items

- 61-856570: JEWEL, lamp
- 43-83721C01: BUSHING, threaded; 2 req'd.
- 43-835508: BUSHING, threaded; 2 req'd.
- 96-6111: female, receptacle; 24 req'd.

Note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.
<table>
<thead>
<tr>
<th>PARTS LIST</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
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<tbody>
<tr>
<td>000123</td>
<td>Main Board</td>
<td>1</td>
</tr>
<tr>
<td>456789</td>
<td>Processor</td>
<td>1</td>
</tr>
<tr>
<td>123456</td>
<td>Memory</td>
<td>2</td>
</tr>
<tr>
<td>789012</td>
<td>Housing</td>
<td>3</td>
</tr>
<tr>
<td>234567</td>
<td>Battery</td>
<td>1</td>
</tr>
<tr>
<td>345678</td>
<td>Antenna</td>
<td>1</td>
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</table>

**Note:** The parts list includes essential components for the main assembly.
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<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>12345</td>
<td>Bearing</td>
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</tr>
<tr>
<td>67890</td>
<td>Screw</td>
<td>2</td>
</tr>
<tr>
<td>ABCDE</td>
<td>Nut</td>
<td>3</td>
</tr>
<tr>
<td>FGHJK</td>
<td>Washer</td>
<td>4</td>
</tr>
</tbody>
</table>

*Note: The table above is an example of a parts list. The actual content may vary.*
<table>
<thead>
<tr>
<th>PART</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Part A</td>
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</tr>
<tr>
<td>2</td>
<td>Part B</td>
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<tr>
<td>4</td>
<td>Part D</td>
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<td>5</td>
<td>Part E</td>
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</tbody>
</table>

*Note: Please refer to the accompanying diagrams and specifications for detailed assembly instructions.*