Selectone

Operating Instructions

MODEL ST-050, 051, 052 Time Domain Voice Encryption Module

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GENERAL

The ST-050, ST-051, and ST-052 are voice encryption devices used to secure two way radio communication systems. Unlike most other low cost secure speech devices that are frequency domain, these products cipher process uses Digital Signal Processing (DSP) techniques to produce a time domain analog scrambling algorithm. All three products digitally record microphone audio for a small time segment. The segment is then sub-divided into smaller blocks within the segment. The blocks within each segment are rearranged in time based on a 72 bit pseudo random encryption algorithm. The rearranged blocks are then played back for transmission, with playback being in a backward condition. The ST-050 and ST-051 require an export license if removed from the USA. The ST-050 produces a security level very near digital encryption. The ST-051 algorithm produces a security level significantly superior to commonly available rolling code frequency domain devices similar to the Selectone ST-025A. Though exportable without a license the ST-052 offers a security level significantly greater than simple frequency inversion and "slow" rolling code. Each unit can be programmed with four easily assessable User Code Keys, each being one of well over 1 trillion available code keys. DSP audio filters provide high quality low distortion recovered audio. The small size and low average power requirements make it ideal for portable, mobile, and base station use.

Field programming is accomplished with "Selectone Product Manager" software, a Windows based RS-232 or Over the Air Programming (OtAP) package. Selectone supports this product with application assistance Via phone at (800) 227-0376, (510) 781-0376, FAX at (510) 781-5454, E-Mail at techsupport@selectone.com, or on the World Wide Web at www.selectone.com

SPECIFICATIONS

Specification	Detail
Encryption:	72 bit algorithm
Operating Voltage:	5.2 Vdc to 16.3 Vdc
Operating Current:	
Clear Rx & Standby	<10 mAdc
Ciphered Rx or Tx	<60 mAdc
Available User Code Keys:	1.15 X 10^{18} (10^{12} = 1 Trillion)
Cipher Algorithm:	Time Domain
Synchronization:	Initial and Maintenance (supports late join)
Usable Audio Level Rx and Tx:	25 mV p-p to 2.5 V p-p
Input to Output Gain:	< ± 1 dB
Frequency Response:	300 Hz to 3000 Hz
Temp: Range:	0^0 C to 70^0 C
Interface:	18" flying leads terminated in a 13 pin low profile connector
Size:	0.85" W X 1.5" L X 0.25" H (21.59mm X 38.10mm X 6.34mm)

☞ **Note:** Operation of radio equipment with encrypted speech capability may fall under local government regulations. Purchasers are responsible for compliance with applicable radio regulations regarding operation of this equipment.

OPERATION

Operation is almost transparent to the user. The user may select any one of four User Code Keys. The user then enables or disables the transmit cipher mode. Once enabled all subsequent transmissions will be ciphered using the selected Code Key. Ciphered reception is automatic; other units transmitting with the selected code key will be automatically deciphered. Clear transmissions will also be received automatically.

Each radio model provides different operational and application challenges. A major application consideration is availability of unassigned switches or blank panel space capable of supporting accessory switches. These Selectone modules have been designed to minimize accessory switch requirements on the radio. The Clear/Ciphered line may be connected to any switch (except PTT) capable of providing momentary closures to or away from (-) Supply (GND). The switch retains its normal functions; however the user can toggle between Clear/Ciphered by operating the switch two times in rapid succession (Double Clicking). The ST-050 will then provide a tone output to the radio speaker. A series of beeps indicate subsequent transmissions will be ciphered using the User Code Key corresponding to the number of beeps. A single long beep (.5 Sec.) indicates subsequent transmissions will be in the Clear (NOT Ciphered).

User Code Keys are selected by operating the same switch four times in rapid succession (Quad Clicking). Quad Clicking permits switching between User Code Keys when in the transmit Cipher Mode (Double Click selection). Each Quad Click transaction advances the selected User Code Key one step around a loop of possible selections (#1, #2, #3, #4, and back to #1...). Following a Quad Click sequence the ST-050 enables ciphered transmissions and responds with the associated number of speaker beeps to indicate the selection position (1 Beep, 2 Beeps, 3 Beeps, 4 beeps). When returning to cipher mode from clear mode, the last used User Code Key will be selected and indicated with speaker beeps. Following power-up Cipher operation will select the Primary User Code Key. Slow switching of this control permits operation in a normal manner as assigned by the radio manufacturer. Typically this is connected to the monitor switch, but other switches can be used (freq. select).

INITIAL SYNCHRONIZATION DELAY

All radio systems have an operating delay. This is the time between PTT activation at a transmitter and speaker audio being available at the receiving point. This time may vary considerably from system to system, and may be increased for the first transmission in a sequence for a repeater or trunked radio system. For reliable cipher operation the ST-050 must wait for this time period before signaling the beginning of a ciphered transmission. System delays must be evaluated and accommodated for with the INITIAL SYNCHRONIZATION DELAY parameter. The time domain characteristics of these devices reduce the probability of lost speech from an operator that speaks immediately after PTT activation. The encryption device begins to digitally record mic. audio immediately following user activation of the PTT. The recorded audio is then ciphered and played back for the transmission at the appropriate time to accommodate systems delays. The encryption device has voice storage capacity to accommodate up to 1.2 seconds of system delay. The actual time required for system delay is then made up at the end of the transmission by automatically holding the transmitter keyed until the complete voice message is sent.

USER CODE KEYS

The user has easy access to four of the more than 1.15 X 10^{18} available code keys. These may be used to provide different operating codes within a particular radio system (sergeants, lieutenants, and captains).

PROGRAMMING & ADJUSTMENTS

These devices have NO mechanical adjustments. All adjustments, level setting and customization is accomplished with Selectone Product Manager a PC Windows® based program. For setup direct connection is made via the RS232 port of a PC. During installation all units MUST be connected to the Selectone Program Manager at least once to facilitate serial number loging to the database. After the original setup, any of the available models, can be programmed via a host PC and an **O**ver **t**he **A**ir **P**rogramming (OtAP) Modem (ST-955). Additionally, any ST-050, ST-051, ST-052 with Ver 2.1 or highre firmware can be used as an OtAP modem . The PC Windows based program is fully documented with an on line manual, accessed through the help menu. The online manual provides advantages in that corrections and upgrades can be immediately accessed via the Selectone Web page on the Internet.

INSTALLATION

Installation should be done only by a qualified two-way radio technician. Installation consists of programming, then mounting the unit in the radio set, and making the electrical connections.

> ☞ **Note:** Installation of secure speech equipment is often time consuming and costly due to complex application requirements presented by the host radio equipment. Selectone may be able to provide a substantial cost savings for installation. Please contact the Selectone Sales Department for details on factory installation of secure speech equipment.

We encourage use of our application service to determine hookup. Most radios **do not** provide an interface connector for easy installation of voice encryption equipment as is often provided for CTCSS applications. Installation requires a minimum of ten external connections. These connections are Power, Ground, Transmit Audio Input and Output, Receive Audio Input and Output, PTT Input, and output, Carrier Operated Switch (COS) and the Clear/Ciphered Input. The most critical connections are Transmit Audio Input and Output, and Receive Audio Input and Output. Improper installation of these connections can result in distorted audio, and the loss of either high or low frequency voice components. Selectone supports this product with application assistance on our TOLL FREE at (800) 227-0376 or request via E-Mail at techsupport@selectone.com. Completed application notes are also posted on our web page at

The following paragraphs describe each of the external connections Numbers shown in brackets [#] refer to the connector pin number.

[3] POSITIVE (+) SUPPLY (RED)

This wire should be connected directly to a filtered source of continuous positive DC voltage in the range of +5.2Vdc to +16.3Vdc. This connection should be made "downstream" from the power switch and the power supply filter components in the radio set. If a regulated source of DC voltage is available, it should be used. Low level microphone audio is passed through the ST-050 and use of a quiet and stable source of DC voltage inside the radio set will reduce the possibility of picking up power supply noise that may affect these audio signals.

[9] NEGATIVE (-) SUPPLY (BLACK)

This wire should be connected to a location inside the radio that will supply a DC power ground return to the ST-050. To eliminate ground loops and power supply noise, the ground return should be the same power supply ground used in the transmit and receive audio stages.

[2] RS-232A INPUT / PTT INPUT (VIOLET)

This lead is used for programming only. During programming via a PC, it is connected to the TX pin of the PC RS-232 port (DB9 pin #3)(DB25 pin #3). Normal operation while connected to RS-232 port is not possible.

[4] RS-232A OUTPUT (WHT/ORG)

This lead is used for programming only. During programming via a PC, it is connected to the RD pin of the PC RS-232 port (DB9 pin #2)(DB25 pin #2). Normal operation while connected to RS-232 port is not possible.

[7] CLEAR/CIPHERED INPUT (BLK/YEL)

This wire is normally tied to the monitor switch of the radio, however any switch can be used. The connection point in the radio must switch between logic high (>4Vdc) and logic low (< 1Vdc). The encryption device analyzes transition between these levels and is not concerned with the resting state. This lead is intended to operate in parallel with the existing radio function without effecting radio operation.

[5] COS INPUT (BLK/ORG)

The ST-050 detects the presence or absence of carrier to determine ciphered receive requirements. This lead must be connected to **C**arrier **O**perated **S**witch logic of the host radio. The default sense is High = Carrier present, Low = No Carrier. The sense may be changed from the Operating Mode TAB, COS frame, in the Selectone Product Manager.

[12] TRANSMIT AUDIO INPUT (GREEN)
[13] TRANSMIT AUDIO OUTPUT (WHT/GRN)

These two wires should be connected in series with the transmit microphone audio signal path inside the radio set. The optimum location for connection is directly in series with the microphone. If the microphone requires bias, then the audio path MUST be broken "downstream" of the bias source. In order to provide the best transmit audio quality, be sure that the transmit audio path is broken next to a "DC blocking" capacitor, or in such a location as not to upset any internal DC bias voltages in the transmit audio stages.

If not previously done for the model radio receiving this installation, it is necessary to measure microphone levels related to system deviation, before applying the application to the host radio. At the application connection point, Inject a 1KHz signal from an audio signal generator. Measure and record the peak to peak level required to produce 1/2 system deviation (p-p = 2.8 X rms). This measured level should be used with the Selectone Product Manager Software to set the Microphone Input level for this and all similar radio models. The Microphone Output Level should also be set for the level required to produce 1/2 system deviation.

[6] PTT INPUT(YELLOW)
[2] RS-232A INPUT/ PTT INPUT (VIOLET)
[10] PTT OUTPUT(BLK/YEL)

These three leads operate together and require related consideration. Due to the complexities of applications in modern uP controlled two way radios, these leads are very application sensitive. The PTT INPUT detects a user request for transmit on the host radio. The PTT OUTPUT manages the transmit signal to the host radio as required for encryption device operation, which includes disabling PTT when the encryption device has received a radio KILL command. The input should be connected to the host radio at a convenient location where transmit condition can be detected by a low (<.6 Vdc) or a high (> 1.5 Vdc).

PTT Input operation is configured from the PTT operation block on the Operation Tab in the Selectone Product Manager.

PTT Input

- **Active low:** The connection between the low going PTT switch and the PTT $INPUT_{LOW}$ to the host radio must be broken. Connect to the switch or Mic. side of the break. This point is expected to be held high by the host radio, and taken low by the PTT switch during transmit requests. *The PTT $OUTPUT_{LOW}$ lead (BLK/YEL) is active low and will be connected to the radio side of the broken circuit. PTT $OUTPUT_{LOW}$ will simulate the PTT switch and pull the host radio PTT input low.*

- **Common PTT:** This configuration is used for applications where it is not convenient or practical to break the PTT circuit. This configuration must be selected to avoid transmit lockup. PTT $INPUT_{LOW}$ and PTT $OUTPUT_{LOW}$ are usually tied together and connected in parallel with the PTT circuit in the host radio. This point is expected to be taken low by the PTT switch during transmit requests.

- **Common PTT:** With this special application, the PTT and Mic. use the same lead. Activation of PTT does not produce a full logic transition and is therefore unusable by the Selectone board. For most radios this unusable small amplitude high to low transition is converted to a usable low to high transition. [2] RS-232A $INPUT_{HIGH}$ / PTT INPUT (VIOLET) can detect the low to high signal. PTT $OUTPUT_{LOW}$ (BLK/YEL) is then connected to the actual PTT/Mic circuit through a large value (10K – 100K) series resistor.

[11] RECEIVE AUDIO INPUT (BLUE)
[1] RECEIVE AUDIO OUTPUT (WHT/BLU)

These two wires should be connected in series with the receive audio path inside the radio. The optimum location for connection is immediately following the radio CTCSS filter. This connection location will provide high quality audio recovery. Be sure not to break the audio path between the detector and the squelch circuit, or between the detector and the CTCSS decoder if one is used. Also, be sure that the receive audio path is broken next to a "DC blocking" capacitor, or in such a location as not to upset any internal DC bias voltages in the receiver audio stages.

If not previously done for the model radio receiving this installation, and before applying the application to the host radio, use an RF signal generator or service monitor to generate a full quieting signal modulated with 1KHz at 1/2 system deviation. Measure and record the peak to peak level of the 1KHz signal at the application point in the receiver (p-p = 2.8 X rms). Use the measured level multiplied by two (X 2) as the Receiver Input and Output Level setting for this and all similar radio models using the Selectone Product Manager Software.

[7] MONITOR / CLEAR/CIPHERED (BROWN)

Due to the complexities of applications in modern two way radios, this lead is application sensitive. There are two possible functions for this lead, and the required function must be selected from Operating Mode tab in the Selectone Product Manager. This lead is expected to be normally high.

- **DOUBLE CLICK:** Connect to the monitor button of the host radio or any other available accessory button.
    - Press the button twice in rapid succession to switch between Clear/Cipher operation for the transmitter. The radio's speaker will respond with a long BEEP for Clear or 1 to 4 short Beeps's indicating the currently selected User Code Key.
    - Press the host button four times in rapid succession to enable ciphered Tx and switch between user code keys. The radio's speaker will respond with 1 to 4 Beeps indicating the currently selected User Code Key.

  NOTE: During the status beeps, this line is held low to enable the receiver audio circuits. Some applications may require use of the AUDIO AMP. ENABLE line to permit response tones to reach the speaker.

- **TOGGLE**: Operates as the switching sense for Clear/Ciphered transmit, when connected to a toggle switch. Only permits switching between Clear and Ciphered User Code Key #1. **High** (>4.5Vdc & < 12Vdc) = Clear. **Low** (< .9Vdc) = Ciphered User Code Key #1

NOTE: Ciphered reception is automatic.

[8] AUDIO AMP. ENABLE / PTT #2 (BLK/BRN)

Due to the complexities of applications in modern two way radios, this lead is application sensitive. There are two possible functions for this lead, and the required function **MUST** be selected from the Operating Mode TAB, Special Functions frame, in the Selectone Product Manager. This lead is expected to be pulled normally high via external circuitry. This point low when active. Maximum voltage on this lead is 12Vdc.

- **AUDIO AMP. ENABLE:** Open drain of a FET saturates to (-) Supply when this device is responding to changes in the Clear/Ciphered, or User Code Key status.
- **Special PTT In/Out:** Some portable host radio equipment require separate PTT connections for the normal and speaker Mic. operation. Connect to the normal PTT connection in the radio. This lead functions as an input and output. When using this mode the OtAP RADIO KILL feature is not available.

MOUNTING

Use of a double-sided adhesive pad eliminates hardware requirements. Mount on a clean, dry surface. Press firmly after mounting to insure good contact of adhesive. Do not touch the adhesive or attempt to reposition the unit after mounting.

The clear shrink wrap attached to this manual can be used as insulation to from conducting materials that may contact the PCB. These devices use advanced Surface Mount Technologies to acquire their small size. Do not flex or twist the board, in that solder connections may be damaged.

☞**Note:** An Export License from United States Department of Commerce **is** REQUIRED to **remove the ST-050 or ST-051 beyond the boundaries of the United States of America.** The ST-052 may be exported without license consideration. However upgrade software to convert a ST-052 to a ST-051 or ST-050 requires the same licensing consideration as the ST-050 and ST-051. Contact the Selectone Sales Department for assistance in obtaining the necessary export documents.

WARRANTY POLICY

All standard Selectone products are guaranteed to meet or exceed published performance specifications and are warranted against defects in material and workmanship for a period of five years from the date of purchase. Special configurations and non-standard systems are warranted for a period of one year.

If any standard Selectone product fails to operate within the first 90 days from the date of purchase, Selectone will immediately send out a replacement unit and will issue full credit, including freight, upon the return of the defective unit(s). All prepay/C.O.D. customers must return the defective equipment prior to exchange, otherwise the customer will be required to prepay for the new unit(s) with credit issued only on the return of the defective equipment.

After 90 days, this warranty is specifically limited to correction of the defects by factory or replacement of faulty equipment or parts.

All warranty repairs must be performed at the Selectone factory in Hayward, California. No credit will be given for unauthorized repair work attempted by the customer. Any unauthorized alterations or modification of the equipment, damage caused by external sources, or removal or alteration of the serial number label or date code, will void the warranty. Specifically excluded from this warranty are batteries, fuses, lamps, and damage caused by lightning, power surges, or mechanical abuse.

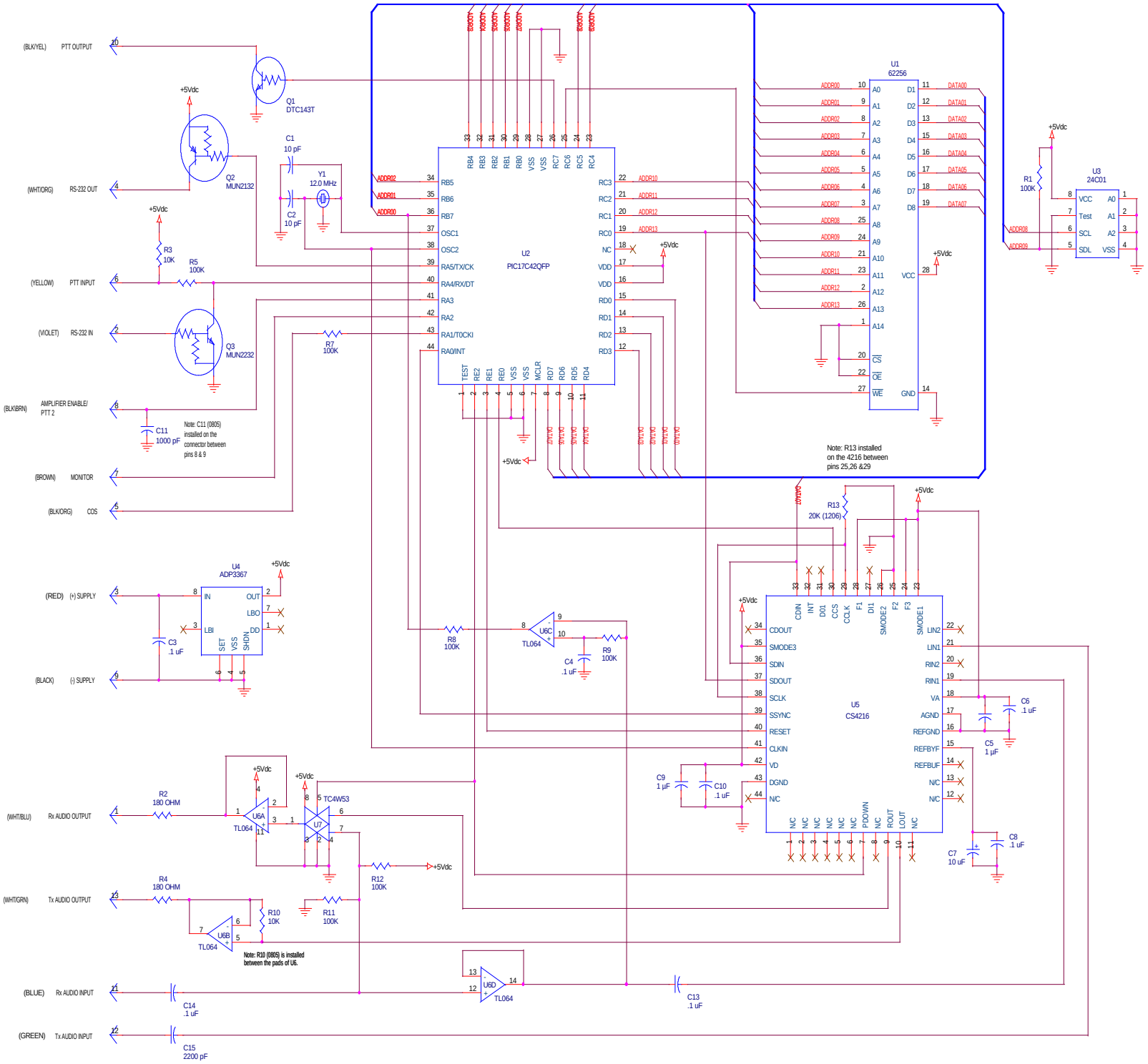
For equipment to be returned to the factory for repair, you must first call and get an RMA# from Customer Service. The RMA# must be written on the outside of the package, otherwise receiving will reject the shipment. In addition, a note must be sent with the packing list briefly describing the nature of the defect.

For special warranty replacement service, of if any other assistance is required, contact Selectone Customer Service Department at (800) 227-0376, FAX (510) 781-5454, E-Mail techsupport@selectone.com, or on the WEB at www.selectone.com.

All repairs and returns are to be sent to:

Selectone

23210 Bernhardt St
Hayward, CA 94545
Attn: Customer Service


(BLK/YEL) PTT OUTPUT
Q1 DTC143T
+5Vdc
Q2 MUN2132
(WHT/ORG) RS-232 OUT
C1 10 pF
C2 10 pF
Y1 12.0 MHz
U2 PIC17C42QFP
U1 62256
U3 24C01
R1 100K
(YELLOW) PTT INPUT
R3 10K
R5 100K
(VIOLET) RS-232 IN
Q3 MUN2232
R7 100K
(BLK/BRN) AMPLIFIER ENABLE/ PTT 2
C11 1000 pF
Note: C11 (0805) installed on the connector between pins 8 & 9
(BROWN) MONITOR
(BLK/ORG) COS
Note: R13 installed on the 4216 between pins 25,26 &29
R13 20K (1206)
U4 ADP3367
(RED) (+) SUPPLY
(BLACK) (-) SUPPLY
C3 .1 uF
R8 100K
U6C TL064
R9 100K
C4 .1 uF
U5 CS4216
C9 1 µF
C10 .1 uF
C5 1 µF
C6 .1 uF
C7 10 uF
C8 .1 uF
(WHT/BLU) Rx AUDIO OUTPUT
R2 180 OHM
U6A TL064
U7 TC4W53
R12 100K
R4 180 OHM
(WHT/GRN) Tx AUDIO OUTPUT
R10 10K
R11 100K
U6B TL064
Note: R10 (0805) is installed between the pads of U6.
(BLUE) Rx AUDIO INPUT
U6D TL064
C13 .1 uF
C14 .1 uF
(GREEN) Tx AUDIO INPUT
C15 2200 pF