

### GENERAL:

The Selectone Model ST-20 is a Miniature Voice Scrambler used in secure two-way radio voice communication systems. The cipher process uses speech inversion and is capable of replicating any 1 of 8 of the most commonly used inversion carrier frequencies. The ST-20 is ideal for commercial, marine, law enforcement, public safety, and government communication systems that require basic protection from casual eavesdroppers. Though the ST-20 is low in cost, the process of speech inversion provides for late entry reception unlike most more expensive units. The microprocessor based product is a very efficient design providing small size and low power consumption ideal for base station, mobile and portable two-way radio installations. Input and output audio processing filters provide for high quality low distortion audio recovery.

### OPERATION

Operation is almost transparent to the user. The Clear/Cipher Input, which is used to enable and disable the cipher mode, is the only user control. Due to the nature of the cipher process, signaling tones, such as DTMF, may not work when passed through the ST-20 in cipher mode.

#### TRANSMIT MODE (Clear/Cipher):

The ST-20 senses a transmit condition by a pull to ground on the PTT Input line. This activates the transmit audio path in the unit. If the Clear/Cipher Input is also pulled to ground, the ST-20 will encrypt the TX audio input (microphone), and transmit in the cipher mode. If the Clear/Cipher Input is floating or pulled high to a voltage greater than 1 volt, the ST-20 will pass the microphone audio unaltered, and will transmit in the clear mode.

#### RECEIVE MODE (Clear/Cipher):

The ST-20 is in the receive mode when the PTT Input line is floating or pulled high to a voltage greater than 1 volt. If the Clear/Cipher Input is pulled to ground, the ST-20 will decipher received audio. If the Clear/Cipher Input is floating or pulled high to a voltage greater than 1 volt, the ST-20 will pass the receive audio unaltered, and will receive in the clear mode.

### NOTE:

Reception of clear audio with the Clear/Cipher Input being held low will produce unintelligible receive audio. Switch the Clear/Cipher input away from low to receive clear audio.

### IMPORTANT:

Operation of radio equipment with encrypted speech capability may be government regulated. You are responsible for compliance with applicable radio regulations regarding operation of this equipment.

### OPERATING SPECIFICATIONS

Operating Voltage:	5.5Vdc to 18Vdc
Operating Current:	Less than 4mA <sub>dc</sub>
Cipher Process:	Frequency Inversion
Synchronisation:	Not Required (Late arrivals accepted)
Audio Input Level:	0 - 2.5 Volts P-P AC coupled, Hi-Z
Audio Output Level:	0 - 2.5 Volts P-P AC coupled, Low-Z
Audio Input / Output Gain:	Less than $\pm 5$ dB
Audio Frequency Response:	300 Hz to 2400 Hz
Carrier Suppression:	Greater than 45 dB
Programming:	3 lines, to select 1 of 8 carrier frequencies
PTT Input:	Pull to (-) Supply to transmit
Clear / Cipher Input:	Pull to (-) Supply for Cipher
Temperature Range:	30°C to +60°C
Interface:	18" flying leads terminated at miniature low profile connector.
Size:	1.50" L X 0.825" W X .25" H 38.2cm X 20.96cm X .64cm

## INSTALLATION:

The interface between the ST-20 board and the radio is by 13 wire leads on a miniature low profile connector. Most applications will not require the use of all leads. Unused leads should be removed from the connector by carefully lifting the small tab near each connection pin and pulling the wire from the connector. We recommend this method (rather than cutting wires) because it allows reusing pins if an error is made.

Installation should be done only by a qualified two-way radio technician. Installation consists of selecting an inversion carrier frequency, mounting the ST-20 in the radio set, and making the electrical connections.

The following paragraphs describe each of the external connections. Numbers shown in brackets [#] refer to the 13 connector pin number.

**[3] Positive (+) Supply (RED):** Connect to (+) Supply (5.5Vdc to 16Vdc). This wire should be connected directly to a filtered source of continuous positive DC voltage in the range of +5.2Vdc to +18.0Vdc. Make this connection “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 audio signals are passed through the ST-20. Use of a quiet and stable source of DC voltage inside the radio will reduce the possibility of picking up power supply noise that may affect these audio signals.

**[9] Negative (-) Supply (BLACK):** Connect to System (-) (Ground). This wire should be connected to a location inside the radio that will supply a DC power ground return to the ST-20. 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] CODE SELECT 3 INPUT (VIOLET)

## [4] CODE SELECT 1 INPUT (WHITE/ORANGE)

## [5] CODE SELECT 2 INPUT (ORANGE/BLACK)

These three inputs are used for selecting up to eight unique inversion carrier reference frequencies on the ST-20. These inputs may be left unconnected for new system applications. Systems using the ST-20 as an addition to an existing inversion scrambling will have to reference the following frequency chart for compatibility.

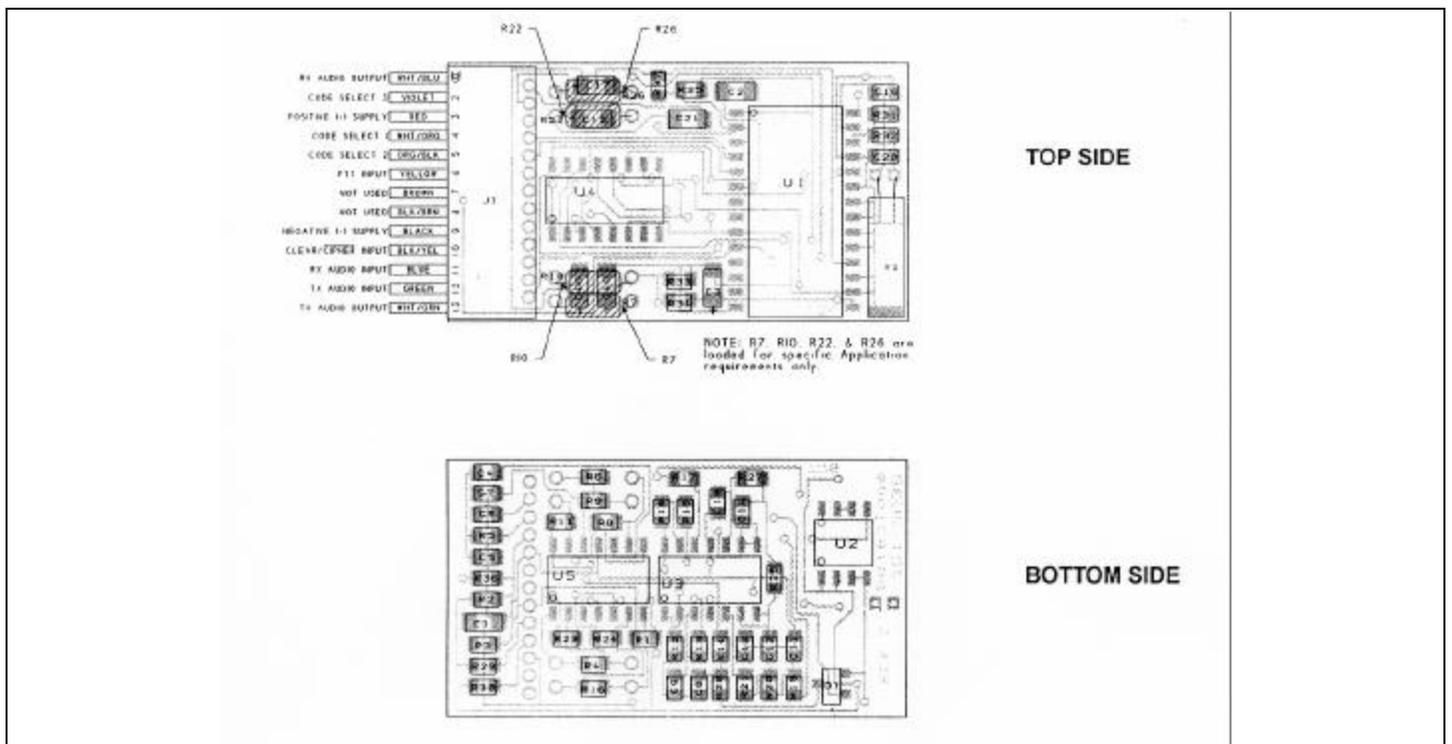
### FREQUENCY CHART

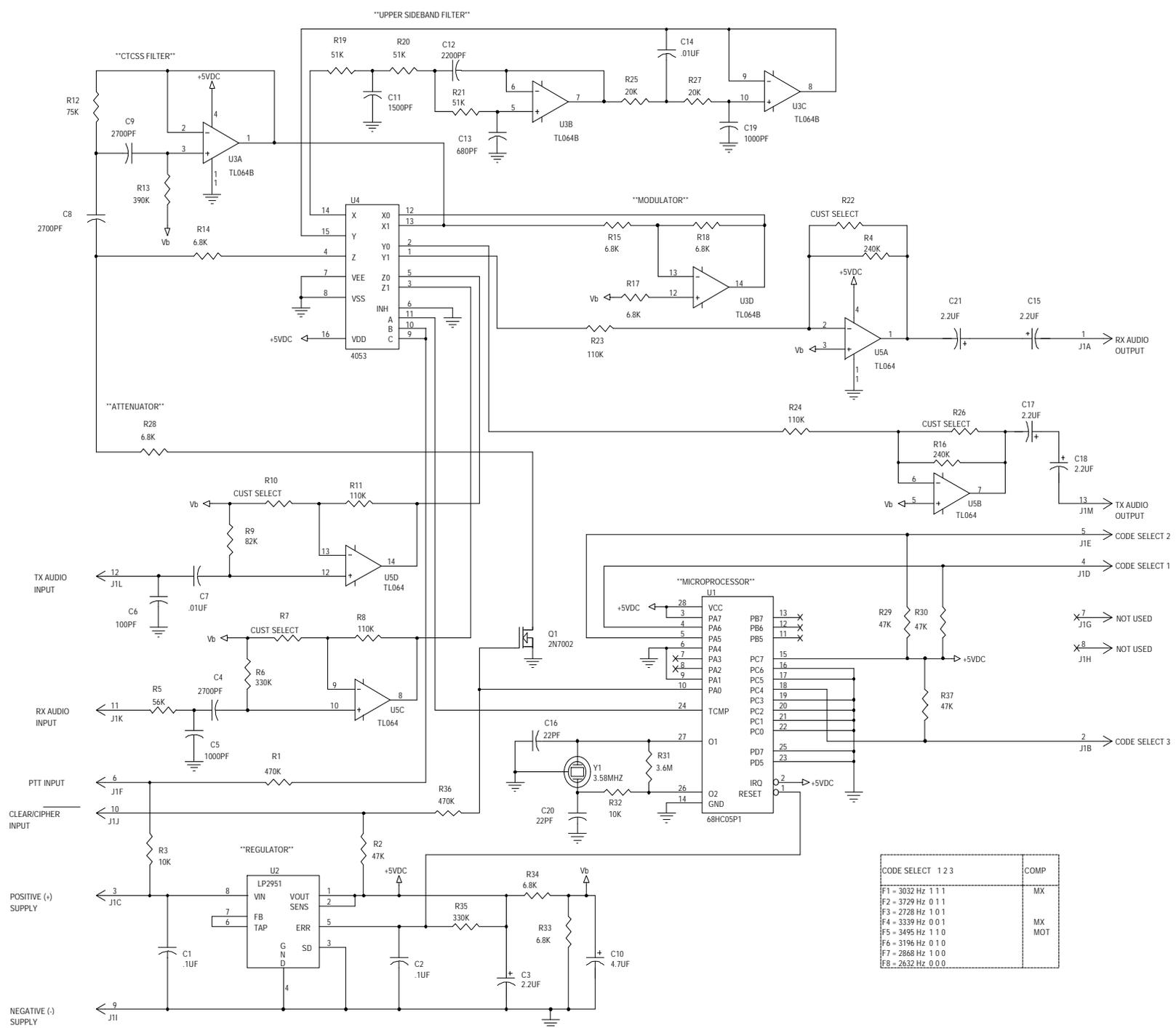
1=Line Floating / Unconnected; 0=Connection to (-) Supply

Freq.	1	2	3	Freq.	1	2	3
3023 Hz	1	1	1	3495 Hz	1	1	0
3729 Hz	0	1	1	3196 Hz	0	1	0
2718 Hz	1	0	1	2868 Hz	1	0	0
3339 Hz	0	0	1	2632 Hz	0	0	0

## [6] PTT INPUT (YELLOW)

The PTT Input detects a pull to ground on the PTT line in the radio to indicate a transmit condition. This information is used by the ST-20 to determine receive or transmit status. To install the PTT Input line on the ST-20, connect this wire to the PTT line in the radio at a convenient location. If this wire is floating or greater than 1 Vdc above (-) Supply, the ST-20 audio path will be set for receive operation. If this wire is connected to ground or is less than 1 Vdc above (-) Supply the ST-20 audio path will be set for transmit operation.





CODE SELECT	1	2	3	COMP	
F1	=	3032 Hz	1	1	MX
F2	=	3729 Hz	0	1	
F3	=	2728 Hz	1	0	
F4	=	3339 Hz	0	0	MX
F5	=	3495 Hz	1	1	MOT
F6	=	3196 Hz	0	1	
F7	=	2868 Hz	1	0	
F8	=	2632 Hz	0	0	

#### [10] CLEAR/CIPHER INPUT (BLACK/YELLOW)

This wire is used to activate the transmit and receive cipher mode when pulled to ground and may be connected to a two position ON/OFF SPST switch that can be used to enable and disable the cipher mode. If this wire is floating or above 1 volt, the ST-20 will remain in the clear mode.

#### [12] TRANSMIT AUDIO INPUT (GREEN)

#### [13] TRANSMIT AUDIO OUTPUT (WHITE/GREEN)

These two wires should be connected in series with the transmit microphone audio signal path inside the radio. 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 signal path is broken BEFORE the transmit modulation limiter circuit. Also, 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. After the installation is complete, it may be necessary to readjust the transmit modulation slightly in order to compensate for the installation of the ST-20.

#### [11] RECEIVE AUDIO INPUT (BLUE)

#### [1] RECEIVE AUDIO OUTPUT (WHITE/BLUE)

These two wires should be connected in series with the receive audio path inside the radio. The optimum location for connection is directly off the receiver discriminator circuit BEFORE any audio processing circuits. This connection location will provide high quality audio recovery. Be sure not to break the audio path between the discriminator and the squelch circuit, or between the discriminator 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 you find it necessary to break the audio path after a CTCSS decoder, be sure to disable or bypass the CTCSS high pass filter if one is used. The ST-20 will filter out any CTCSS tones as it contains a CTCSS high pass filter.

#### 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 a replacement unit post-paid via airmail or UPS Blue Label (air), and will issue full credit, including freight, upon the return of the defective unit(s). For special warranty replacement service, call Selectone Customer Service Department TOLL FREE at 1-800-227-0376. C.O.D. customers must return the defective equipment prior to exchange or will receive the replacement C.O.D. 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 external source, or removal or alteration of the serial number label or date code, will void the warranty. Specifically exclude from this warrant are batteries, LED's, fuses, lamps, and damage caused by lightning, power surges, or mechanical abuse.

Equipment for repair may be returned to the factory without prior written authorisation; however, a note must be sent with the packing list briefly describing the nature of the defect.

## ADJUSTMENTS

The transmit and receive audio levels are passed through the ST-20 at near unity gain in clear and cipher modes. In clear and cipher mode, operation should be near transparent compared to unmodified operation.

### INVERSION CARRIER FREQUENCY SELECTION

The eight available carrier frequencies are inversion carriers ON or NEAR carrier frequencies commonly used by manufacturers of similar equipment. Applications requiring multiple codes for co-channel users, should be considered carefully. The ST-20 will provide speech security for casual listeners (scanners), or non-equipped co-channel users. Co-channel users with different carrier frequencies may be able to decipher each other. Co-channel users capable of switching carrier frequencies cannot be protected against. Experimentation was done using listeners having minimal radio experience. The results were as follows: Most listeners could derive intelligibility when carrier frequency differences were less than 300 Hz, a few listeners could understand communications with differences up to 500 Hz, and experienced radio operators could often discern communications with differences as great as 900 Hz. For MOST applications the 3023 Hz default carrier is the best choice. Carrier frequency switching should NOT be made available to users. For high security applications, we recommend use contacting the Selectone Sales department for information on products offering increased security.

#### \*\*\*\* IMPORTANT \*\*\*\*

Selectone supports this product with application assistance on our Toll Free (800) phone line and with APPNOTES (Application Notes). Most radio equipment DOES NOT make provision for easy application of voice encryption equipment by providing an interface connector, as is often provided for CTCSS applications. We recommend use of our application service to determine hookup. Radios NOT supported in our application library will receive special consideration and may qualify for sample installation of two units at the Selectone factory at no cost. Due to our experience with this product, we may be able to provide complete installation more economically than local installation. Please contact our sales department for a quotation. Installation requires a minimum of eight external connections. These connections consists of Power and Ground, Transmit Audio Input and Output, Receive Audio Input and Output, PTT Input, and the Clear/Cipher Input. The most critical connections are the Transmit Audio Input and Output, and the Receive Audio Input and Output. Improper installation of these connections typically results in distorted audio, and the loss of either high or low frequency voice components.

# Selectone

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