Selectone
PRODUCT GROUP

OPERATING INSTRUCTIONS
Model ST-25B
Rolling Code Voice Encryption Module

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GENERAL

The ST-25B is a frequency domain rolling code voice encryption device used to protect the security of two way radio communication systems. The cipher process uses a proprietary microprocessor controlled analog scrambling algorithm. Each unit can be programmed with four User Code Keys, with over 4 billion code keys to choose from. Special factory set master code key groups are reserved to provide extra security for special services. Each master code key group has over 268 million possible code keys. To maintain security, code keys are never transmitted. Audio processing filters provide high quality low distortion recovered audio. The small size and low power requirements make it ideal for portable, mobile, and base station use.

The ST-25C and ST-25B are code-compatible and may be used in the same system. The only difference between the two units is that the ST-25C provides a path for CTCSS tones while the ST-25B does not. The ST-25B should be used when the unit is installed in the receive audio path after the CTCSS decoder. The ST-25C must be used if the unit is installed before the CTCSS decoder.

Field programming is accomplished using a PC serial connection, and Product Manager Software. Product Manager is available on disk from SmarTrunk at a nominal price, or it is available at no charge on the Selectone web page **www.selectone.com.** Product Manager is supplied as two separate programs for use with Microsoft Windows or DOS.

ST-25PM   Windows & DOS based Product Manager

ST-954B   RS-232 to Selectone connector adaptor.

Application information is available or can be developed for most radio models. Documentation on ALL current products and many of our application notes are available for instant access on our web site **www.selectone.com.** If you would like application details for a specific radio, please call us at (510)887-1950 or request assistance via E-Mail at techsupport@selectone.com.

OPERATING SPECIFICATIONS

SPECIFICATION	DETAIL
Encryption:	32 bit algorithm
Operating Voltage:	5.2 Vdc to 16.3 Vdc
Operating Current:	< 8mAdc
User Code Keys:	Greater Than 4 billion
Cipher Algorithm:	Real Time Frequency Domain
Synchronization:	Initial and Maintenance
Usable Audio Level Rx and Tx:	25 mV p-p to 2.0 V p-p
Input to Output Gain:	< ± 1 dB
Frequency Response:	300 Hz to 2600 Hz
Temperature Range:	-30° C to +60° C
Interface:	18" flying leads terminated in a 13 pin low profile connector
Size:	0.90" W x 1.50" L x 0.18" H (22.8mm x 38.1mm x 4.6mm)

Note: Operation of radio equipment with encrypted speech capability may be government regulated. The purchaser of this equipment is responsible for compliance with applicable radio regulations regarding operation of this equipment.

Note: Export of this product is under the jurisdiction of the U.S. Department of Commerce, Office of Defense Trade Control. **An Export License is Required.**

OPERATION

Operation is almost transparent to the user. The user may select any one of 4 previously programmed User Code Keys. The user then enables or disables the transmit cipher mode. Once enabled all subsequent transmissions will be ciphered using the selected User 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 challenges. This is generally due to availability of unassigned switches or blank panel space capable of supporting accessory switches. To accommodate these varying situations the ST-25B provides two modes of operation for enabling and disabling transmit cipher operation, and making User Code Key selections.

SWITCHED MODE

This is the default mode of operation, as shipped from the factory. Clear/Ciphered switching is achieved by a dedicated switch providing a single closure to (-) Supply. User Code Key selection is also selected by a dedicated switch providing a binary input to the two Code Select lines on the ST-25B.

DOUBLE CLICK MODE

This mode of operation is enabled during programming. Operation with this mode minimizes accessory switch requirements on the radio. The Clear/Ciphered line is connected to any switch (except PTT) capable of providing momentary closures to or away from ground. 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-25B will then provide a tone output to the radio speaker. A high frequency beep or series of beeps indicate subsequent transmissions will be ciphered. A low frequency tone for .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 (Primary, Alt #1, Alt #2, Alt #3, Primary ...). Following a Quad Click sequence the ST-25B responds with speaker beeps to indicate the selection position (Primary: 1 Beep, First Alt: 2 Beeps, Second Alt: 3 Beeps, Third Alt: 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).

In either mode a visual cipher indicator is available.

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 or even from transmission to transmission. For reliable cipher operation, the ST-25B 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.

For many radio operators it is difficult to know reliably how long to wait before speaking in ciphered mode. This can cause loss of the beginning of a message. The ST-25B can be programmed to accommodate this problem. For cipher transmissions the ST-25B will provide all the necessary timing and beep the speaker as a "GO AHEAD" and speak indication.

USER CODE KEYS

Of the more than 268 million available code keys, four may be selected and easily accessed as User Code Keys for each unit. These may be used to provide different levels of security within a particular radio system (officers, sergeants, lieutenants, captains).

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 the application requirements presented by the radio equipment. We may be able to provide a substantial cost savings for installation. Please contact the SmarTrunk Sales Department for details on factory installation of secure speech equipment.

SmarTrunk supports this product with application assistance via phone line and with APPNOTES (Application Notes). 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. Radios that are not in our application library will receive special consideration and may qualify for sample installation of two units at the Selectone factory for no cost.

Installation requires a minimum of eight external connections. These connections are Power, Ground, Transmit Audio Input and Output, Receive Audio Input and Output, PTT Input, 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.

ELECTRICAL INTERFACE

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-25B 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 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-25B. 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.

[7] MONITOR/CLEAR/CIPHERED (BROWN): Double Click Mode: This wire is used as an input line for the Double Click and Quad Click signal. It 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 states, high (>4Vdc) and logic low (< 1Vdc). The ST-25B 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.

Switched Mode: This wire is used to select the transmit in cipher mode when pulled to logic low (< 1Vdc). This may be accomplished with an ON/OFF SPST switch. When this lead is at logic high (> 4Vdc) the ST-25B will operate in clear mode when transmitting.

[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 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 signal path is broken BEFORE the pre-emphasis and 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. If this is not possible, a DC blocking capacitor should be placed in series with this lead.

[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 detector circuit BEFORE any audio processing circuits (de-emphasis). 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 this is not possible, a DC blocking capacitor should be placed in series with this lead.

Note: In some applications it is impossible to avoid breaking the path between the detector and the input to the CTCSS decoder. For these applications it is necessary to use the ST-25C, to permit CTCSS to pass through the board without being eliminated or ciphered.

[6] PTT INPUT (YELLOW): The PTT Input detects a pull to ground on the PTT line in the radio set to indicate a transmit condition. To install the PTT Input line on the ST-25B, connect this wire to the PTT line in the radio set at a convenient location.

Note: Operation of the ST-25B will be erratic if the PTT input is allowed to float. If this point floats when the transmitter is not keyed, a pull-up resistor to Positive (+) Supply must be added.

[10] PTT OUTPUT (BLACK/YELLOW): This lead is not used for this product.

[4] SPK BEEP/CIPHER LED/RS232 OUT (WHITE/ORANGE): Speaker Beep & Double Click Mode: Speaker beep is vital to operation in this mode. This lead is the beep output. It may usually be connected directly to the high side of the speaker. In some applications direct speaker connection may not be usable. In these cases connect to the input of the receiver audio amplifier through a series resistor. The value of the series resistor will have to be determined experimentally.

[8] AMP ENABLE (BLACK/BROWN): Many portables power down the receiver audio amplifier when squelched.

Double Click Mode: When beep tones are not present this lead is high impedance. During beeping it is switched to ground through a series 10K resistor. If the receiver audio amplifier is turned off while the receiver is squelched, this output may be used to enable the amplifier for speaker beeping.

[2] CODE SELECT 1 INPUT/ RS232 INPUT (VIOLET)

[5] CODE SELECT 2 INPUT (BLACK/ORANGE): When not used as an RS232 INPUT, these two inputs are used for selecting up to four unique code keys on the ST-25B. These inputs have pullups to +5Vdc internal to the uP, and may be left unconnected if only the Primary User Code Key is to be used. The three Alternate User Code Keys are selected by connecting these leads to a binary coded switch. The switch must cause switching to ground (logic low) as indicated in Table 1 (Logic High = Open, Logic Low = Grounded).

TABLE 1

CODE KEY	CODE SELECT 1	CODE SELECT 2
Primary	Open	Open
Alt #1	Grounded	Open
Alt #2	Open	Grounded
Alt #3	Grounded	Grounded

MOUNTING

Use of a double-sided adhesive pad or an insulating shrink tube eliminates hardware requirements. When using the adhesive pad, mount the ST-25B on a clean dry surface, oriented to allow easy routing of the wiring to the radio and to allow future adjustments should they be necessary. Press firmly after mounting to ensure good adhesive contact. Do not touch the adhesive surface or attempt to re-position after mounting.

ADJUSTMENTS

GAIN SETTINGS

As shipped from the factory, the ST-25B is fully functional for many applications. However experience indicates the ST-25B functions best when audio signals internal to the ST-25B are at or near pre-determined levels. To optimize operation, receive and transmit levels must be evaluated independently and the proper gain setting resistors must be installed. Use the following procedures to determine the input level for the receive and transmit audio paths. The measured levels are for evaluation with TABLE 2. Use TABLE 2 to select resistors values for optimum operation.

Measurements may be made with an oscilloscope or an AC level meter. For convenience TABLE 2 presents input levels in mV peak to peak and mVrms.

TABLE 2						
Input Level				**Gain Resistor**		
mVpp		**mVrms**		**TX R35**		**TX R28**
From	To	From	To	**RX R21**		**RX R4**
10	65	4	23	1.1K		1.1K
65	125	23	45	2.2K		2.2K
125	250	45	89	4.7K		4.7K
250	500	89	179	11K		11K
500	1000	179	357	33K		33K
1000	2000	357	714	None		None

Receive: Measure the level on the **[11] RECEIVE AUDIO INPUT (BLUE)** lead while receiving a full quieting signal modulated at full system deviation. Use this level to select R21 and R4 from TABLE 2.

Transmit: The RF generated by the transmitter often makes it difficult to make accurate measurements for the microphone circuit. Two methods of measurement are presented, the first does not always produce accurate results. If method 1 does not appear effective use method 2.

METHOD 1

Key the transmitter and while speaking loudly into the microphone, measure the Peak to Peak level on the **[12] TRANSMIT AUDIO INPUT (GREEN)** lead. Use this level to select R35 and R28 from TABLE 2.

METHOD 2

Disconnect the **[12] TRANSMIT AUDIO INPUT (GREEN)** from its connection in the radio. Use an audio signal generator to inject a 1KHz tone into this lead. Key the transmitter and adjust the output level from the signal generator to produce 2/3 system deviation as measured on a service monitor. Un-key the transmitter and measure the output level from the signal generator. Use this reading multiplied times 4 to select R35 and R28 from TABLE 2.

NOTE: In some cases the output level from the signal generator may be too low for accurate readings, or the level may be difficult to adjust. In these cases build a resistive divider with the supplied 11K and 1.1K resistors from the resistor packs. Don't damage the resistors they may be required as gain resistors. Connect the 11K to the output of the signal generator, connect the 1.1K to (-) Supply for the ST-25B, and connect the junction between the resistors to **[12] TRANSMIT AUDIO INPUT (GREEN).** *Key the transmitter and adjust the output level from the signal generator to produce 2/3 system deviation as measured on a service monitor. The output level from the signal generator divided by 10 produces 2/3 system deviation. Use this reading times 2 to select R35 and R28 from TABLE 2.*

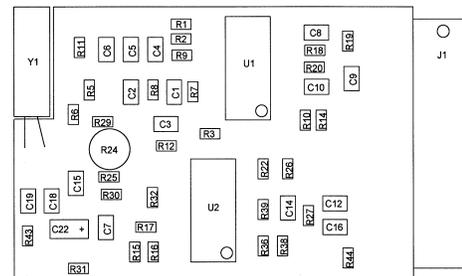Don't forget to reconnect the **[12] TRANSMIT AUDIO INPUT (GREEN)** lead in the radio.

SYNCHRONIZATION LEVEL

During cipher transmissions the ST-25B transmits synchronization information approximately twice per second. This signal carries no coding information but is necessary for proper operation. For optimum performance the synchronization bursts should be adjusted to produce 1/2 system deviation.
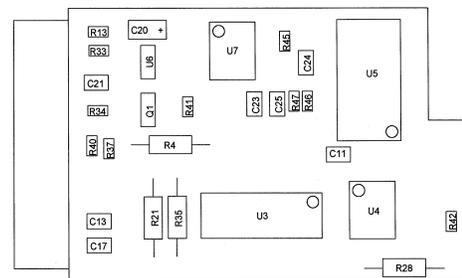
After installation is complete, switch to the cipher mode and key the transmitter. Using a service monitor with an oscilloscope display, adjust R24 for a peak reading of ± 1/2 system deviation. Deviation readings made with a deviation meter may not accurately measure the intermittent synchronization burst signal. If proper adjustment is difficult or not possible, the transmit audio gain may be set incorrectly. Repeat the gain setting procedure for the transmitter using METHOD 2. If difficulties continue, contact the Selectone Applications Department for assistance.

PROGRAMMING

The ST-25 Product Manager is required to configure this product to accommodate the specific application requirement.

The Windows based Product Manager ST25.exe installs using normal Windows installation procedures. This program defaults to use serial port com2. To use com1 add /1 to the launch command (ST25.EXE /1)

The DOS based Product Manager is included on a separate disk. The DOS Product Manage 025DOS.exe may be transferred to the working directory (C:\Select.one), or run directly from the supplied disk.

Many popular Windows programs access serial communications and lock access to COM ports by any other program, Windows or DOS. Before running 025DOS.EXE, shut down the computer and reboot in DOS mode. For DOS operation, press F8 immediately following the report "Starting Windows 95". Select "Command Prompt Only".

Note: The security of your system depends on the secrecy of your code keys. For maximum security, Selectone recommends changing your code keys often.

ST-25B COMPONENT LOCATOR

The ST-25B uses multi-layer printed circuit boards. Field repair is not recommended.

TOP SIDE

BOTTOM SIDE

ST-25B SCHEMATIC

COMMITTED TO QUALITY
ISO 9001
REGISTERED FIRM

Note:
1. Board layout allows loading R21 and R35 as
   surface-mount or through-hole components.