# 5 i50R Programming

## 5.1 Overview

This section contains DIP switch programming information for the i50R Basic Interconnect Controller.

## 5.2 Programming the i50R

### 5.2.1 Dipswitch Settings for SwA and SwB

Down is ON for all switches. SwA is the leftmost switch bank consisting of 8 switches that control the phone patch operations. SwB is the right switch bank consisting of 8 switches that control the repeater interface functions. Switches are numbered left to right.

Table 5-1 and Table 5-2 show the functions of the SwA and SwB switches for the i50R.

*Table 5-1. SwA Dip Switch Settings for i50R*

| SwA Section | Function |
|---|---|
| 1 | **Ring Detect Defeat:**<br>OFF = Land-line to mobile ring signalling allowed<br>ON = Land-line to mobile signalling not allowed |
| 2 | **Phone Line Busy Detect (when mobile tries to access phone patch):**<br>OFF = Mobile access allowed any time<br>ON = Mobile access denied and busy signal returned when line in use (low voltage on line) |
| 3 | **Initiate Ring Signalling to Mobile:**<br>OFF = After 1st ring<br>ON = After 4th ring |
| 4, 5 | **Access Timer:**<br>**SW4** **SW5**<br>No Timer OFF OFF<br>3-Minute Timer ON or OFF ON<br>10-Minute Timer ON OFF |
| 6 | **Long Distance Inhibit (1 or 0 leading digit):**<br>OFF = 1 or 0 leading digit allowed<br>ON = 1 or 0 leading digit not allowed |
| 7 | **Telephone Line Signalling:**<br>OFF = Rotary dial (pulse dialing)<br>ON = DTMF (Touch Code dialing) |
| 8 | **2-Digit Connect and Release Command**<br>OFF = "#*" to access, "##" to release<br>ON = "*" to access, "#" to release |

*Table 5-2. SwB DIP Switch Settings for i50R*

| SwB Section | Function |
|---|---|
| 1 | **Dropout Delay Enable (transmitter only):**<br>OFF = No repeater dropout delay<br>ON = Enable repeater dropout delay |
| 2 | **Dropout Delay Length:**<br>OFF = 3-second dropout time<br>ON = 1.5-second dropout time |
| 3 | **Audio Output Select:**<br>OFF = Audio to mic input of transmit radio (pin 2 of J3)<br>ON = Audio to flat input of transmit radio (pin 5 of J3)<br>Used when signalling features contained in the "RapidCall" package are going to be transmitted through the repeater to the field radios. All signalling will be generated by the field radios and the transmit radio of the repeater must be programmed to transmit "CSQ." JU551 in the receive radio must be in the "A" position. |
| 4 | **Transmit Audio from Receive Radio to Transmit Radio Mute:**<br>OFF = Unmuted at all times<br>Depends on the receive radio squelch functions for muting (JU551 in the GM300 mobile radio in the "B" position)<br>ON = Muted when not receiving "COR"from receive radio<br>Used when audio from the receive radio is flat (not deemphasized and unmuted [discrim] JU551 in the GM300 mobile radio in the "A" position) |
| 5 | **Remote Setup/Knockdown Enable (from J5-4 [RX] or from J4-4 [ACC] external alarm outputs):**<br>OFF = Disable remote setup/knockdown<br>ON = Enable remote setup/knockdown |
| 6 | **Patched Mobile Mute:**<br>OFF = Unmute repeat audio to the transmit radio while receiving a mobile, allowing other mobiles to hear both sides of the conversation<br>ON = Mute repeater audio to the transmit radio while receiving a mobile and the patch is accessed. This prevents other mobiles from hearing the mobile side of the conversation, providing a measure of privacy. |
| 7 | **PTT Source:**<br>OFF = I/O pin 14 of J5 (from receive radio to transmit radio)<br>ON = I/O pin 8 of J5 (from receive radio to transmit radio) |
| 8 | **Power-up Setup/Knockdown Condition:**<br>OFF = Repeater powers up in "knocked down" state<br>ON = Repeater powers up in "setup" state conversation, providing a measure of privacy. |

## 5.2.2 Additional Jumpers

The following jumpers and controls are accessible by removing the i50R module cover. They are preset for normal installations and access is not normally required. Special installation requirements may necessitate adjustment.

**JU1: Off hook voltage threshold (normally out).**
The Threshold circuit output is used by the processor to determine that the telephone is busy (being used by a line sharing telephone). The shunt is normally out, allowing for the worst case.
**IN** (shunt in) = 48 volt idle telephone line voltage
**OUT** (shunt parked) = 24 volt idle telephone line voltage

**JU2: Telephone line load (normally out)**
This jumper is in only for testing levels and **must** be out for normal operation.
**IN** (shunt in) = 620 Ohm telephone line load in
**OUT** (shunt parked) = no load on telephone line

**JU3: Watchdog timer defeat (normally out)**
This jumper is in only during testing to defeat the watchdog timer when halting the processor during emulation. No shunt or header pins are provided.

**JU4/JU5: Alert inhibit source (normally in JU4 position)**
When the telephone line rings, the processor will not key the transmit radio and send ring signalling to the field radios if the alert inhibit source indicates that the channel is in use. This input normally comes from pin 8 of the ACC connector of the transmit radio that has been programmed to receive on the same frequency that it transmits. Certain cases may require that the "COR" signal from the receive radio be used instead. In this case, JU5 should be used. Note that the repeater must be enabled and set up in order for "COR" to be operational.
**JU4 IN** (shunt in JU4 position) = alert inhibit taken from pin 8 the transmit radio.
**JU5 IN** (shunt in JU5 position) = alert inhibit taken from receive radio COR as determined by SwB4.

**JU6: Ring sensitivity (normally out)**
The ring voltage on the telephone line is normally greater than 40 volts RMS (90 volts is generated by the central office). In certain cases of very long lines, or several devices with ringer loads on a telephone line, the ring voltage may be lower than normal. JU6 is normally out, but, if pulse dialing equipment causes ring falsing (possible on a highly inductive line that oscillates when pulsed), the sensitivy can be reduced by installing JU6.
**IN** (shunt in) = low ring sensitivity
**OUT** (shunt parked) = high ring sensitivity

**JU21: ("1" or "2"): Repeater audio phase reversal**
For use with digital signalling where "inverted code" is desired. Position 1 provides normal phase of flat transmit audio path. Position 2 provides phase reversal.

## 5.3 Programming Examples

### 5.3.1 i50R Repeater with 16-Channel GM300 Radios

The following section describes the programming information for the radios used to assemble a repeater with the i50R repeater controller. The configuration uses two 16-channel, UHF Radius GM300 radios to allow using the repeater mode of programming with the Radius RSS. A low power, 1 to 10 Watt, radio is used for the receive radio and a 25 Watt radio for the transmit radio.

A weekend sporting event requires the temporary use of a repeater with basic telephone interconnect capability. You decide that this is an application for a Radius GR300 portable repeater. The frequencies for the repeater are receive on 469.550 MHz and transmit on 464.550 MHz. Tone coded squelch, TPL, of 114.8 (2A) will be used. The Time Out Timer of the transmit radio will be set for 240 seconds (4 minutes). The area to be covered is not great but the RF interference potential is significant; "local" mode will be needed. No signalling systems will be programmed into the radios. Normal receiver and transmitter audios will be used for both radios.

The repeater drop out delay (or hang time) will be set at 3.0 seconds. No remote setup/knockdown is needed but the repeater will have to power-up in the setup condition.

The interconnect system will be setup with a telephone deskset in parallel with the i50R to allow a local dispatcher to answer the telephone. If the dispatcher is not present, the mobiles and portables (field radios) will be signalled after the 4th ring on the telephone line. If the line is busy, the field radios will be denied access to the line. The event does not want the telephone line tied up excessively or long distance calls made by the field radios. The 3 minute (Call Limit) Timer will be used. DTMF dialing is required.

# Section 6
# i50R Basic Interconnect Repeater Controller

## Overview

This section describes the basic operation, system configurations, theory of operation, and jumper configurations for the i50R Basic Interconnect Repeater Controller.

## Basic Operation

The i50R allows telephone service to be extended to mobiles and portables.

### *Controls and Indicators*

The front panel of the i50R phone patch contains switches to manually control the operations of the module and LED indicators to display the status of the various functions.

#### "Rptr Enable" Pushbutton

The "Rptr Enable" button is a latching type switch that enables the various repeater functions within the module when it is in the "in" position and disables those functions when in the "out" position. The LED indicator labeled "Rptr En" reflects the position of the switch at a glance.

In order for the repeater to function, the manual "Rptr Enable" switch must be in the "in" position (enabled as indicated by the LED indicator) and the repeater must be "set up" (either manually by the front panel switch or remotely by signalling to the receive radio). The "COR" LED indicator illuminates when the receive radio is receiving a "system mobile" (with appropriate coding, if applicable). This will cause the repeater to activate, if enabled and setup.

#### "Rptr Set-Up" Pushbutton Switch

The momentary push button labeled "Rptr Set-Up" is the manual control that alternately sets up or knocks down the repeater. Depending on the SWB-5 and SWB-8 programming switch positions, the repeater will power up in the setup or the knockdown mode and may be controlled remotely. The LED indicator labeled "Set-Up" indicates when the repeater is set up.

#### "PTT" LED

The "PTT" LED will be on any time a PTT signal is being sent to the radio from repeat PTT, patch PTT, or PTT from the accessory input.

#### "Patch On/Off" Pushbutton Switch

The "Patch On/Off" momentary switch will manually cause an access of a released patch and cause a release of an accessed patch. The "Access" LED indicates when the telephone line has been accessed by the manual pushbutton or by a mobile command.

### *Additional Controls*

When the front panel cover plate is removed, the two banks of programming switches and the repeater level adjustment potentiometer are accessible. The adjustment should be made only by a qualified technician familiar with the detailed operation of the unit since satisfactory system operation depends on the settings.

## Theory of Operation

### *i50R Interface/Patch Interface Circuitry*

The interface circuitry portion of the i50R is straightforward and does not require a detailed examination of the theory of operation.

### *i50R Phone Patch and Microprocessor Circuitry*

#### Digitally Controlled Audio Gain

The digitally controlled audio gain stage consists of IC's U15, U14, U12A, U12C, U29A and U29B. The microprocessor can select the gain stage input by control lines PC0 and PC1 controlling U15, an integrated double pole, four-throw analog switch. When one input to the gain stage is selected, a source for the DTMF decoder is also selected (pins 1, 5, 2, and 4 of U15). The inputs to the gain stage are:

- Switched network on 0X
- Repeater receiver on 1X
- DTMF encoder and/or microprocessor "beep" tone on 2X and 3X

The microprocessor can control the overall gain of the functional block by changing digital lines P10-P17 to the analog multiplier IC U14, allowing a 1 to 255 gain change (gain numbers are limited by firmware to 10-250). The current output of U14 is converted to a voltage by U29A and amplified by U29B. The output of the gain stage is routed to the phone line through analog switch U12C and/or to the transmit radio through analog switch U12A.

### Peak Reading Voltmeter Circuit

The voltmeter circuit consists of gain switch U12B, U10, U13, and U17. The voltmeter input is always from the variable gain stage. Two levels of gain are controlled by digital line PA5. High gain is used to indicate when a signal is present (VOX) and low gain to measure its present level. The output of the gain stage U10A is fed to the precision rectifier circuit U10D and U10C. The peak of this rectified signal is compared with the voltage generated by counter U17 and the 1R-2R resistance ladder in comparator U10B. If the rectified signal peaks are higher than the voltage from the ladder, oscillator U13C is gated on to increment counter U17, raising the ladder voltage until it is greater than the rectified input or the maximum counter count of 15 is reached. The microprocessor periodically resets the counter and reads its output to determine proper gain numbers for the various path configurations.

### DTMF Encoder/Decoder

The DTMF encode/decode circuitry consists of U16, U9A, and U5A. The microprocessor clock is buffered by U5A and supplied to U16, the DTMF encoder/decoder. The decoder receives its input from switch U15 as described above. When the decoder sees a valid DTMF tone pair, it asserts DV (pin 22). This line is sampled every 5 milliseconds by the microprocessor. When a data valid is seen, the microprocessor takes data enable (DE, pin 5) low causing U16 to output the decoded number on digital lines PB0-PB3. The outputs are then turned off. When a DTMF tone is to be generated, the microprocessor places the digital number on PB0-PB3 and then takes data latch low (LCH pin 17), then back high. To turn the tone off, the microprocessor takes reset (pin 16) high. The generated DTMF tone is buffered by amplifier U9A and sent to the analog switch U15 for routing. When a beep or tick is required, the microprocessor sends a 949Hz square wave from P22 through C38 to switch U15.

### Phone Line Limiters and Filters

Audio from the phone line is fed through high pass filter U8B to filter out low frequency hum and noise. Audio to the phone line is routed through low pass filter U8A which provides the rolloff characteristics required for FCC registration. Limiters Q6 and Q7 limit the instantaneous voltage that can be applied to the phone line. Surge protectors S1 and S2, in conjunction with chokes L6 and L7, provide a very high degree of surge protection to the phone patch, provided that the frame ground connections are made as described in the installation section.

### Off Hook and Ring Detect Circuitry

In normal telephone systems, one of the telephone lines is grounded at the central office or PBX location and a negative voltage is applied to the other line. The off hook circuitry of U11 detects this voltage and informs the microprocessor via PC5. Large voltage excursions on the phone line are detected by opto-isolator U18 and sent to the microprocessor on digital line PC4. The microprocessor times and counts these pulses to differentiate between dial pulses, ring, etc.

### Microprocessor Bus

Microprocessor U1 puts out multiplexed address and data on AD0-AD7. These signals are demultiplexed by address latch U2 which provides the low order address bits to ROM U3. ROM U3 contains the patch firmware. Peripheral interface adaptor U4 provides 24 input/output lines for operating the various functions in the patch.

### Power Supply

Input voltage is fused, filtered, and sent to 5 volt regulator U7 which supplies most of the patch power. Oscillator U5B generates about 100kHz which is buffed by U5C and U5E and fed to VFET's Q1, Q2, and Q3. These FET's provide a push-pull, full B+ swing output. This signal is AC coupled and rectified by high speed diodes D1 and D2. This voltage is filtered and regulated to about -6 volts for the various analog devices.

U305 provides regulated 8 volts for the repeater logic circuits.

### Power Fail/Restart

When the patch is first powered up, microprocessor reset is held low until B+ reaches about 9 volts (D18, R24) which removes the high through D3 to C13. Reset is then allowed to go high after C13 discharges through R23. Once the microprocessor is running, pulses are generated at PA7, keeping C13 discharged through R20 and Q5 and preventing reset. If these pulses are lost due to program malfunction or if power falls below the D18-U5D threshold, reset is again asserted. JU3 is for system emulation use only.

## Internal Diagnostics

The i50R interface/patch has built in test procedures to assist in unusual setup situations and troubleshooting procedures. These tests are invoked through use of the TEST and RESET buttons on the circuit board. Pressing the TEST button once will start test 1 and cause the MODE LED to flash once. Pressing it again will start test 2 and cause the MODE LED to flash twice and so forth through test 5. Each time a new test is selected, a test timer is set to 15 minutes. If this timer reaches zero, the patch resets itself to idle, ready to process telephone calls. The following paragraphs describe each test and its various indications.

### *Test 1*

Keys the transmit radio, accesses the telephone line, and sends a TouchCode (DTMF) star (*) at a level of about 11dBm (into a 600 Ohm load) to the switched network and about 80 mv (into a 600 Ohm load) to the

transmit radio. This test can be used to check transmit radio deviation and telephone line access.

While in this test, the MODE LED indicates the level of the COR signal from the receive radio source selected by programming switch SWB-4. The LED is on when receiving a system mobile signal. In normal operation, this signal is used by the patch to inhibit automatic sending of ring signalling to the field mobiles, to open the patch audio path from the receiver to the phone line, and by the repeater interface to key the repeater.

The STATUS LED indicates the level of the patch disable input. The LED is on when the patch is disabled (repeater in knockdown condition) and off when enabled.

### Test 2

The transmit radio is keyed and the switched network is accessed. The patch generates the 12 TouchCode tones at six different levels. These tones are sent to the switched network and looped back to the DTMF decoder. The STATUS LED illuminates on data valid from the DTMF decoder, indicating that it is receiving its own DTMF codes. The tones are on for 100 milliseconds and may be slowed down to 500 milliseconds by pressing the RESET button. Pressing the RESET button again will freeze the test at the current DTMF tone and level. Pressing the RESET button again will allow the test to continue at the fast rate. The highest level is adequate to overdrive the radio transmitter and exceed the maximum input specification on the DTMF decoder. This procedure may be used to test the patch DTMF encoder/decoder and most of the audio paths in the patch.

During this test, the MODE LED indicates the "Patch On/Off" button position, illuminating when the button is pushed.

### Test 3

The switched network is accessed and landline signalling is enabled. A system mobile can dial a phone number in DTMF or dial pulse, as programmed. When not landline signalling, receive radio audio is routed to the phone line with autoleveling. This test allows exercise of the repeater to switched network path, with autoleveling.

While in this test, the STATUS LED is on while receiving a valid DTMF tone pair. The MODE LED indicates the level of the COR input, illuminating when a system mobile is being received by the receiver.

### Test 4

The transmit radio is keyed and the switched network is accessed. Switched network audio is routed to the transmit radio with autoleveling enabled. This test allows exercise of the phone line to transmit radio audio path, with autoleveling. The MODE LED is on when the audio level on the switched network is adequate to cause autoleveling. The STATUS LED is on when a valid DTMF tone is being sent to the switched network.

### Test 5

This test exercises the nonaccessed functions of the patch. The MODE LED illuminates when off hook (phone line voltage below threshold) and extinguishes when on hook (voltage above threshold). The STATUS LED flashes on when ringing is received on the phone line. The MODE LED also flashes since ringing will cause the off hook thresholds to be exceeded.

## Jumper Configurations

Table 6-1 lists the jumper settings for GM300 16-channel transmit and receive radios when used with the GR300 or GR500 and the i50R. Table 6-1 lists the jumper settings for the GM300 8-channel, M120, and M10 transmit and receive radios when used with the GR300 or GR500 and the i50R.

*Table 6-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | X* |
| JU701 | X* | X* |

* either A or B

*Table 6-2. Radio Jumper Settings (GM300 8-Channel, M120, and M10 Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | X* |
| JU809 | X* | Remove |

* either A or B

**Note:** When using the Basic Repeater Controller, if you encounter cyclical keying of the transmit radio, cut the wire running from the controller to pin 8 of the 16 conductor cable to the transmit radio.