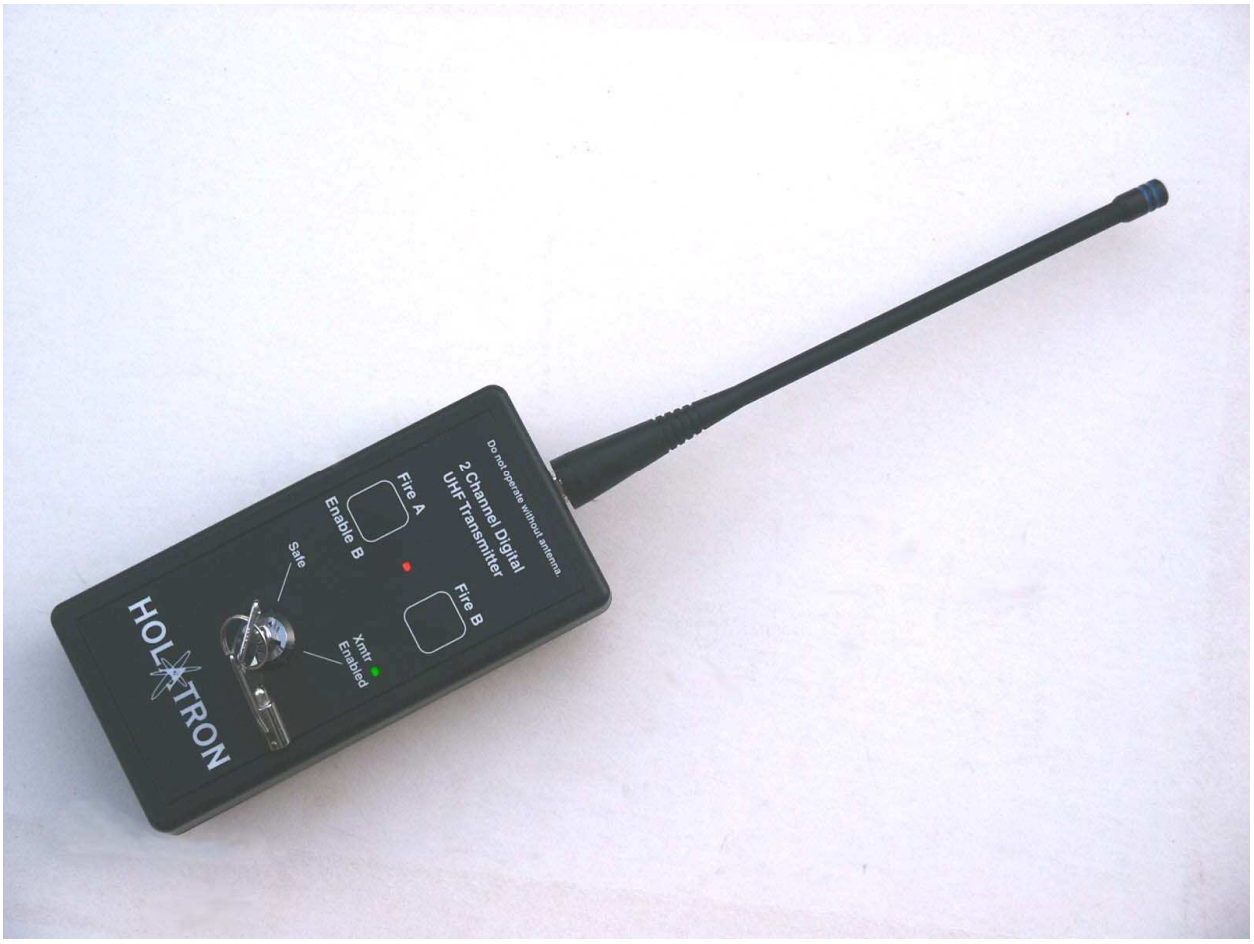
OPERATION & MAINTENANCE GUIDE -
12 Channel Configurable Sequential Controller



HOLATRON SYSTEMS, LLC
2800 Woodlawn Dr, Ste. 138
Honolulu, HI 96822
(808) 372-0956
www.holatron.com

WARNING

Holatron Systems specializes in the design and manufacture of standard and custom electronic control systems where reliability and error free data communication are critical. The transmitter described in this manual is part of a system intended to remotely actuate pyrotechnic or other hazardous devices, and the components of this system have been carefully designed to minimize the possibility of accidental actuation of such devices. Holatron's design goal is to ensure that data communication errors due to radio interference or to insufficient signal strength due to low battery, exceeding specified range, or conductive objects in the signal path will result in failure of intentional actuation rather than unintended actuation. Techniques used to achieve this design goal are described in section 1.9. Though the probability of unintended actuation is extremely small, it cannot be guaranteed to be zero. Therefore, **it is important that the user not enable the receiver until all persons who might be harmed by accidental actuation are in a safe area**.

As a condition of purchase, the user must acknowledge awareness and agreement that utilization of this product and participation in activities utilizing fireworks, rockets, and explosives is an ultra-hazardous activity carrying implied and explicit risks of injuries and damages to the user and to other participants. The user assumes the risk connected with the utilization of this product and all risks of participation in the activities for which this product is sold. User acknowledges that he/she/it has the necessary and required skill, expertise, training and licensing, as may be applicable or necessary by custom, usage, trade or law, to engage and participate in the ultra-hazardous activities connected with the use, purchase, transportation, or employment of the products sold under this agreement. User acknowledges that Holatron Systems, LLC, has not and will not conduct any investigation into the skill, expertise, training and licensing, as may be applicable or necessary by custom, usage, trade or law, of the user or of user's agents, employees and assigns, to engage and participate in the ultra-hazardous activities connected with the use, purchase, transportation, or employment of this product. User specifically agrees that Holatron Systems, LLC, its officers, employees, and agents shall not be liable for any claim, demand, cause of action of any kind whatsoever for, or on account of death, personal injury, property damage or loss of any kind resulting from or related to user's or user's employees', agents' or assigns' use of this product, and user agrees to indemnify, defend in any action at law, and hold harmless Holatron Systems, LLC, from same, whether brought by the user, user's agent, or assigns, or any third party.

Usage of this transmitter is authorized under FCC Rules and Regulations as listed in CFR 47 Ch.1 (10-1-96 Edition), part 15, subpart C, sections 15.209 and 15.231. This equipment has been tested and assigned **FCC ID number: OI4RFLS1XT.**

Any changes or modifications to the hardware not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This manual is divided into two sections. The first is a description of the system hardware. The second covers the recommended operating and maintenance procedure.

1.0 HARDWARE DESCRIPTION.

The model RFLS-12HSXT 12 Channel Configurable Sequential Controller is a low power, hand-held remote control transmitter which can transmit commands over any of 12 different digital channels. The transmitter's channel configuration can be set by the user for single or multi-channel operation as described in section 1.4.2. The channel setting is saved in non-volatile memory even when power is disconnected, and it is flashed on the green and red LEDs at power-on. Transmitters operating on separate digital channel numbers can transmit simultaneously without interfering with each other. This permits up to 12 different receivers or groups of receivers to be controlled by separate transmitters simultaneously. The transmitter will only actuate receivers set to the channel on which the transmitter is operating. Thus, multiple transmitters may be used to actuate different selected receivers even though all operate on the same frequency. Transmitters operating on the same digital channel number will interfere with each other and result in failure-to-fire when actuated simultaneously.

When used with RFLS-96HSRC, RFLS-496HSRC, RFLS-491HSRC, or RFLS-912HSRC receivers, a range of ½ mile can be achieved. A range of ¼ mile is achievable with the RFLS-P91HSRC micro-receiver. All inscriptions on the transmitter panel are luminescent to facilitate use of the transmitter in a dark environment. The panel will continue to glow for two to three hours after being exposed to a bright light source. The transmitter's two commands are digitally encoded and amplitude modulated on a single carrier frequency of 418 MHz (or optionally 315 or 433.96 MHz). This frequency is controlled by a SAW (surface acoustic wave) device for exceptional stability. No alignment or tuning procedures are ever required to maintain optimum performance. The command signal is transmitted by amplitude modulating the carrier to indicate to the receiver which of the transmit buttons is depressed. The modulated RF output occurs continuously while either of the two transmit buttons is depressed. Resulting receiver output is continuous while the "A command" signal (semi-automatic fire) is being transmitted, and the receiver fires outputs in rapid-fire mode at a rate selected by the transmitter's FIRE RATE SELECTION SWITCH (refer to section 1.8) while the "B command" signal is being transmitted.

More than twelve separate cues can be actuated from a single RFLS-12HSXT transmitter in semi-automatic (single-shot) or automatic (machine-gun) mode by using multiple digital channels. To actuate cues in semi-automatic mode, press the "A" button repeatedly, as described in section 1.4.1. To actuate cues in automatic mode, press the "B" button, and firing will continue until it is released.

The user has access to the following components:

1.1 THE ANTENNA.

The RF signal is radiated by a quarter-wave flexible whip antenna which screws onto the top end of the transmitter box. **The transmitter should never be operated without this antenna in place, as damage to the RF components could result.** Such operation will void the warranty.

Antennas with red rings are used on 433 MHz transmitters, and antennas with blue rings are used on 418 MHz transmitters. Be careful not to overtighten the antenna when screwing it on. The recommended way to install the antenna is to grasp it by its small diameter upper part and rotate gently in a clockwise direction until increased resistance is felt. It need not be tight to achieve a good electrical connection.

1.2 THE SAFETY LOCKING SWITCH.

The Safety Locking Switch is a miniature keylock with two positions, “Safe” and “Xmtr Enabled”. In the “Safe” position no RF output occurs even if a button is pressed. In the “Xmtr Enabled” position modulated RF output occurs continuously while a button is pressed. Whether transmitting or not, a green warning indicator near the switch flashes whenever the switch is in its “Enabled” position and the battery voltage is above the low battery detect threshold. Approximately 1 milliamp is drained continuously from the battery while the transmitter is enabled and not transmitting. So this switch should always be turned to the “Safe” position while the transmitter is not being used. Keys are interchangeable, as all Holatron RFLS-12HSXT transmitters are keyed the same.

Firing always commences at cue 1 of the transmitter’s base channel after the transmitter has first been enabled. Thus the system can be reset to cue 1 of the base channel at any time by turning this switch momentarily to “Safe” and then back to “Transmitter Enabled”. The system will be similarly reset if the transmitter’s digital switch setting which selects automatic firing rate is changed during operation.

1.3 THE LED INDICATORS.

The green lamp, located at the “Enabled” position of the lockswitch, warns the user that transmission will occur when a button is pressed and that battery drain is occurring. It also verifies that battery voltage is adequate to transmit a signal over the specified range.

The red lamp lights while the transmitter is generating RF output after completion of power-on channel display. It is located between the two buttons. It will light even if the battery voltage is below the low battery detect threshold.

Additionally, when the transmitter is first turned on (transmitter enabled), the green LED will flash the “Base Ch” number (starting channel), and then the red LED will flash the “Last Ch” number (highest channel number in the transmitter’s configured range). Each digit is indicated by a series of short blinks totaling the digit number or or one longer flash if the digit is zero. Leading zeroes are not shown.

After channel number indication is complete, the red LED will light to indicate automatic transmission of the “RESET” command that sets all receivers in the configured channel range to cue 1. After that, normal battery flash mode will commence on the green LED, indicating that the controller is ready to transmit.

Normal battery flash mode indicates the battery status by the number of flashes in each burst. The intermittent bursts consist of one, two, or three flashes at a time if the battery has enough capacity to power the transmitter. If no flashing occurs, the battery must be replaced before the transmitter can be used reliably. Three flashes per burst indicate that the battery has full capacity, two flashes indicate that its capacity is beginning to diminish, and one flash indicates that it is near the end of its useful lifetime in which case it should be replaced immediately after the current use. Adequate transmitter output to achieve the specified range will occur as long as the battery voltage is above approximately 7.0 volts, but the battery voltage will drop rapidly at this point.

1.4 THE FIRE BUTTONS.

These buttons are snap action dome switches under a sealed overlay, labeled “A” and “B”, respectively. “A” causes cues to be fired in semi-automatic (single-shot) mode, and “B” fires cues in automatic (machine-gun) mode. These buttons have a high spring constant which requires a firm depression for actuation, decreasing the likelihood of accidental depression. The enabled transmitter can be kept in a shirt or jacket pocket without fear of accidental button depression.

The transmitter is idle while no buttons are pressed. Continuous transmission occurs while a button is pressed.

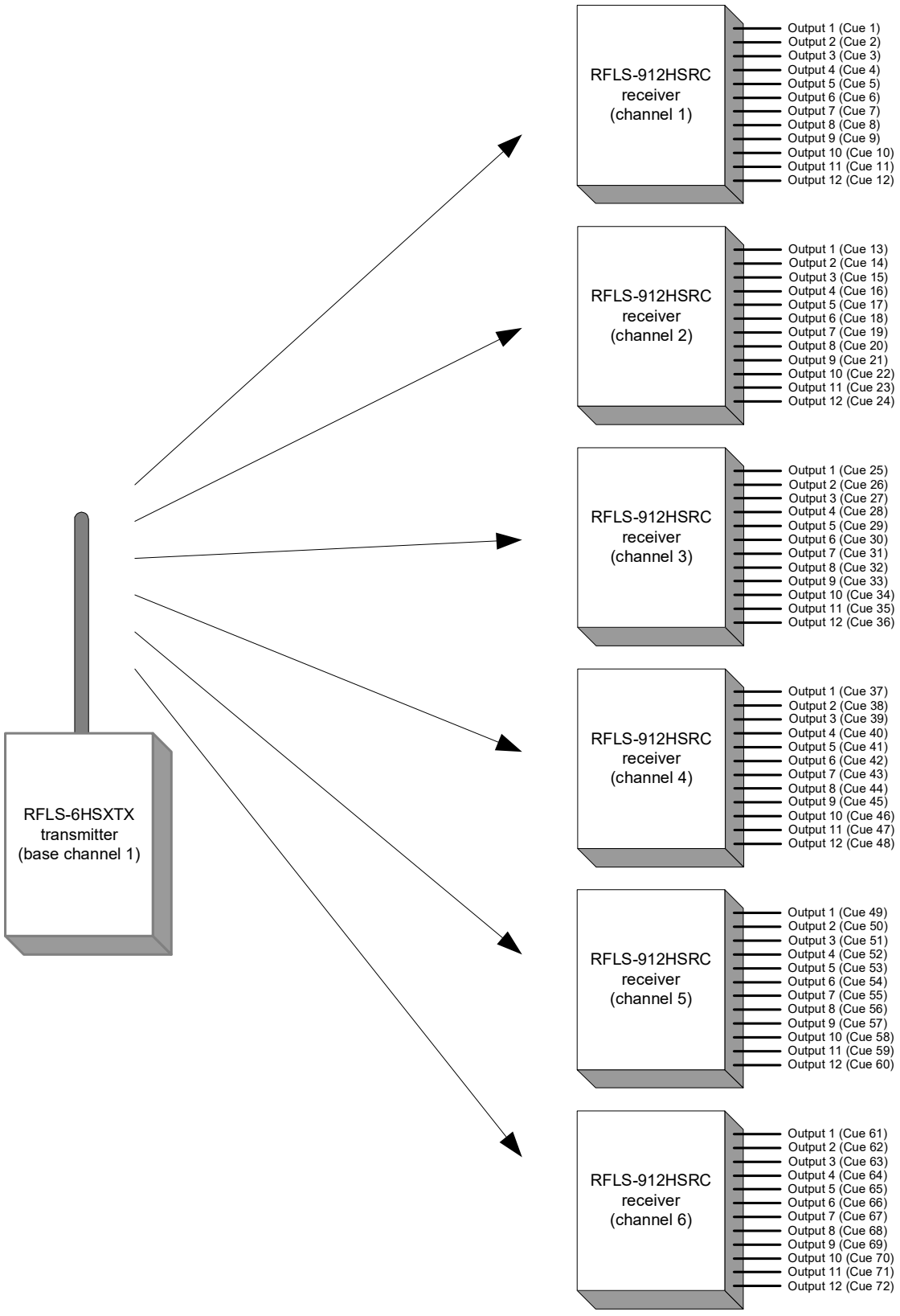
1.4.1 Normal Operational Mode (after power-on)

Depression of either button fires the next receiver output after the one fired last. For example, if output 3 had been fired last, pressing “Fire A” would cause output 4 to fire, etc. Firing output 12 will also switch the transmitter to the next channel after the previously selected one, and output 1 will be fired next on that channel. Thus, this transmitter can fire a series of up to 144 sequential shots spanning 12 channels of 12 cues each. These can be implemented with 12 twelve-output receivers, 24 six-output receivers, 144 single-output receivers, or a combination thereof. (See following diagrams for typical 72 cue examples.) Note that after powering up the transmitter, output 1 will be the first receiver output fired by a depression of either transmitter button, and commands will be directed to receivers set to the transmitter’s “base channel”.

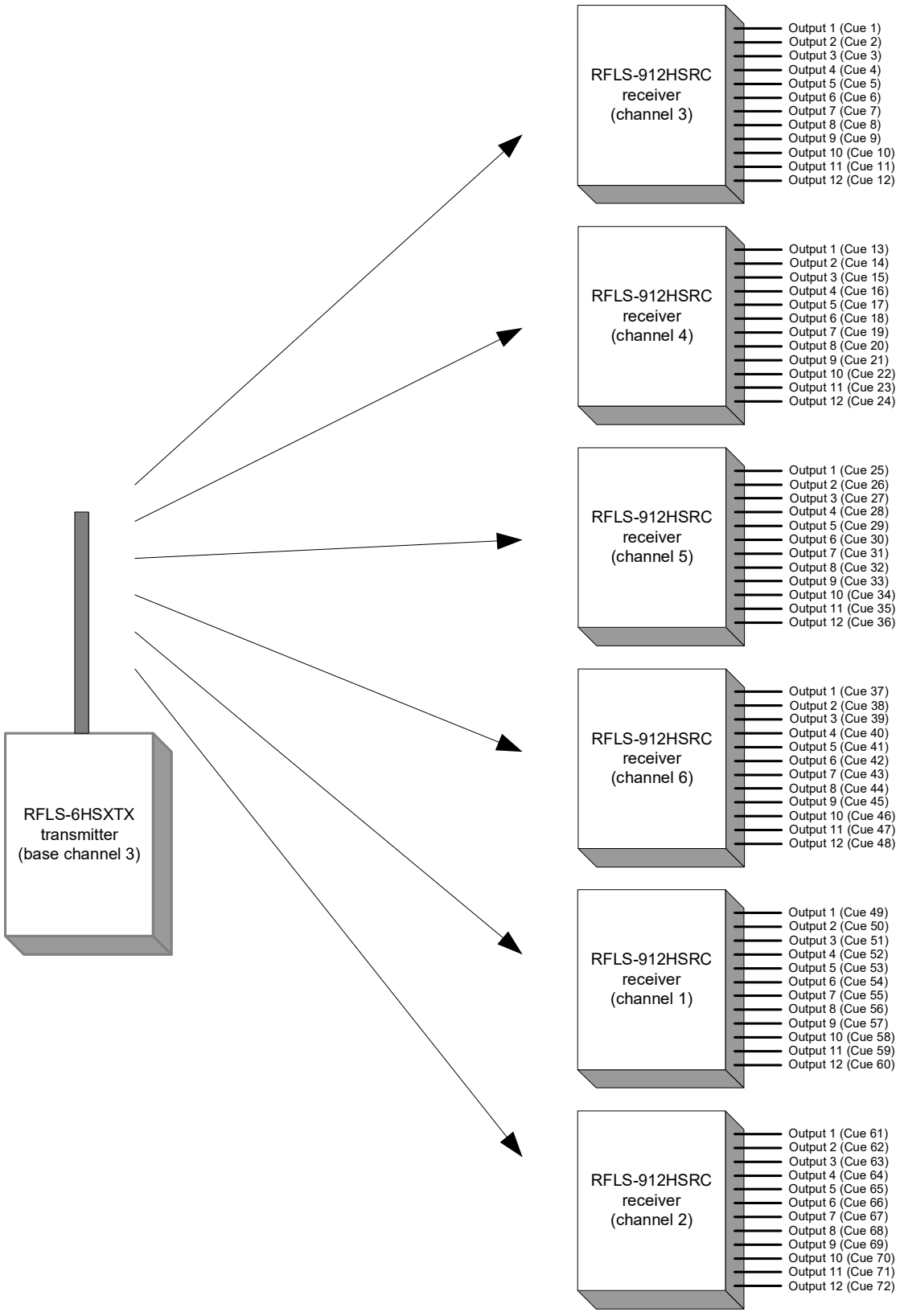
Output firing pulses are stretched to a minimum duration of 0.6 seconds in the receivers to ensure that all cues fire reliably, even when the fire buttons are pressed for a shorter period of time. Note that it is not necessary to wait for the completion of the 0.6 second firing pulse period before firing subsequent cues. They can be fired as fast as the operator can press the button, provided that each button depression lasts at least 0.1 second, followed by at least 0.1 second with the button released. If many transmitters are transmitting simultaneously, it may be necessary to depress a fire button slightly longer than 0.2 second in order to ensure an output from the receiver.

NOTE: When resuming fire, firing commences at the next cue after the last one fired in most cases, but under some circumstances at very high fire rates, a cue may be refired or skipped due to uncertanties in receiver – transmitter synchronization.

Typical 72 Cue System (for Base Channel 1)



Typical 72 Cue System (for Base Channel 3)



1.4.2 Channel Configuration Mode (power-on)

Three parameters determine the channel range of the controller:

Base Channel (1-12),
Last Channel (1-12),
Low Channel (1-12)

There are 12 cues on each channel. So single channel operation controls 12 cues. Additional cues can be controlled by configuring the transmitter to operate on multiple channels. For example 3 channels would control 3x12 = 36 cues, and 12 channels would control 12x12 = 144 cues. The controller switches automatically to cue 1 of the next higher channel in its configured range after firing cue 12. If cue 12 of **Last Channel** is fired, the controller will switch to cue 1 of **Low Channel**. The controller always starts on cue 1 of **Base Channel** after power-on. Some configuration examples are:

Base Ch = **Last Ch** = **Low Ch** => Single channel.
Base Ch = **Low Ch** = 1, and **Last Ch** = 2 => Channels 1 & 2.
Base Ch = **Low Ch** = 1, and **Last Ch** = 12 => Channels 1 thru 12.
Base Ch = **Low Ch** = 3, and **Last Ch** = 5 => Channels 3 thru 5.
Base Ch = 3, **Last Ch** = 5, and **Low Ch** = 2 => Channels 2 thru 5, with operation starting on channel 3 after power-on.

<u>Channel range is configured as follows</u>:

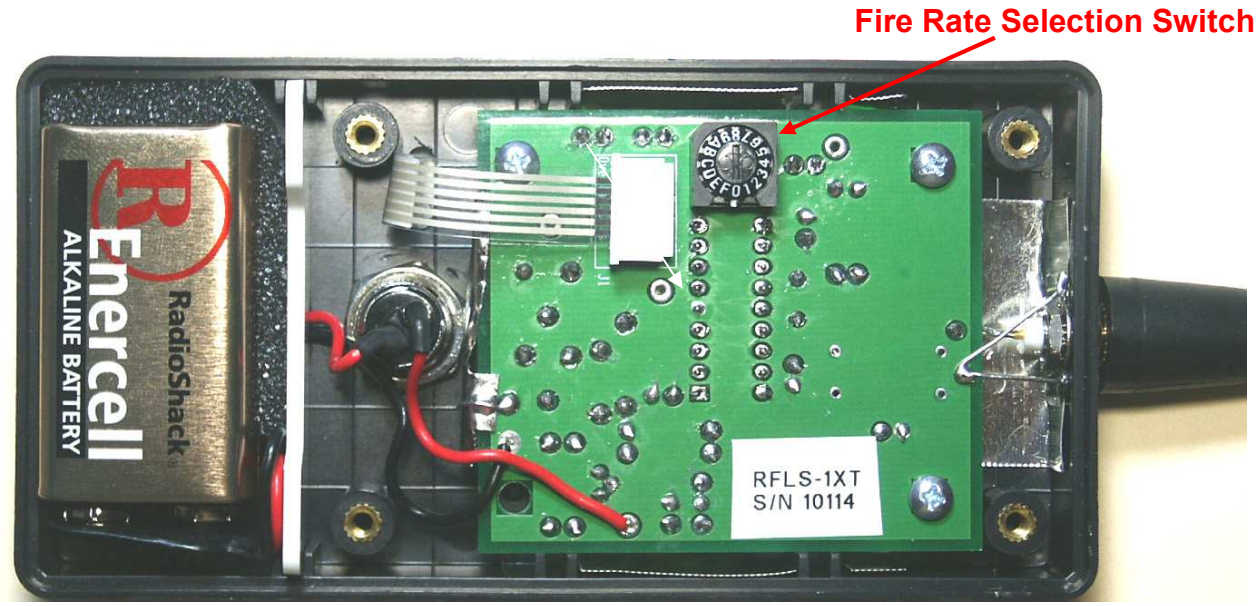
1. While the “A” or “B” button is depressed, turn on the Enable key switch. Then release the button.
2. Enter each channel parameter by setting its number on the controller’s digital switch and then momentarily pressing the “A” and “B” buttons simultaneously.
3. The parameter being entered is indicated by the panel LEDs as:
   green = Base Ch,
   red = Last Ch,
   green and red = Low Ch.
4. All 3 parameters need not be entered. If only Base Ch is entered, the configuration will be for single channel operation. If only Base Ch and Last Ch are entered, the configuration will be for multi-channel operation with Low Ch = Base Channel.
5. Turn off the key switch when done.
6. Set the digital switch back to the desired automatic fire rate setting, and turn on the key switch.
7. At power-on, the green LED will flash the Base Ch number, and then the red LED will flash the Last Ch number, as described in sectin 1.3.
8. Channel configuration is saved in non-volatile memory. So it is not necessary to reconfigure the channel range each time the controller is turned on.

1.5 THE BATTERY.

Power is supplied from an alkaline 9 volt battery, accessible beneath a slide-out door on the back side of the transmitter. This battery should be replaced when required by conditions described in section 1.3 above. In order to prevent the possibility of damage due to battery leakage, the battery should always be removed if the transmitter is to be stored for a prolonged period. Damage due to battery leakage is not covered under the warranty.

1.6 THE FIRE RATE SELECTION SWITCH.

A 16 position miniature rotary switch is accessible from the back of the transmitter. The switch is on the left edge of the internal printed circuit board. It can be set to positions 0 – 9 or A – F by rotation with a small screwdriver. The switch selects automatic fire rate that will be transmitted while the “B” button is pressed.



(Transmitter with rear cover removed)

The available fire rates which can be selected are described in the following table. Holatron Systems can supply custom fire rates if required.

Firing modes with RFLS-P91HSRC, -491HSRC, -496HSRC, -96HSRC, and -912HSRC rcvrs:

Fire Rate Selection Switch Setting	"A" Cmd Action	"B" Cmd Action
0	Semi-automatic firing. (Single shot, sequential)	**0.1** shot per second. (10 seconds per shot)
1	Semi-automatic firing. (Single shot, sequential)	**0.2** shot per second. (5 seconds per shot)
2	Semi-automatic firing. (Single shot, sequential)	**0.3** shot per second. (3.33 seconds per shot)
3	Semi-automatic firing. (Single shot, sequential)	**0.4** shot per second. (2.5 seconds per shot)
4	Semi-automatic firing. (Single shot, sequential)	**0.5** shot per second. (2 seconds per shot)
5	Semi-automatic firing. (Single shot, sequential)	**0.6** shot per second. (1.67 seconds per shot)
6	Semi-automatic firing. (Single shot, sequential)	**1** shot per second. (1 second per shot)
7	Semi-automatic firing. (Single shot, sequential)	**2** shots per second. (0.5 second per shot)
8	Semi-automatic firing. (Single shot, sequential)	**3.03** shots per second. (0.33 second per shot)
9	Semi-automatic firing. (Single shot, sequential)	**4** shots per second. (0.25 second per shot)
A	Semi-automatic firing. (Single shot, sequential)	**5** shots per second. (0.2 second per shot)
B	Semi-automatic firing. (Single shot, sequential)	**5.88** shots per second. (0.17 second per shot)
C	Semi-automatic firing. (Single shot, sequential)	**7.69** shots per second. (0.13 second per shot)
D	Semi-automatic firing. (Single shot, sequential)	**10** shots per second. (0.1 second per shot)
E	Semi-automatic firing. (Single shot, sequential)	**14.3** shots per second. (0.07 second per shot)
F	Semi-automatic firing. (Single shot, sequential)	**20** shots per second. (0.05 second per shot)

Firing modes with RFLS-9HSARC, RFLS-49HSARC, or RFLS-912HSARC receivers:

Fire Rate Selection Switch Setting	Fire "A" Action	Fire "B" Action
0	Semi-automatic firing. (Single shot, sequential)	**1** shot per second. (1 second per shot)
1	Semi-automatic firing. (Single shot, sequential)	**2** shots per second. (0.5 second per shot)
2	Semi-automatic firing. (Single shot, sequential)	**3.03** shots per second. (0.33 second per shot)
3	Semi-automatic firing. (Single shot, sequential)	**4** shots per second. (0.25 second per shot)
4	Semi-automatic firing. (Single shot, sequential)	**5** shots per second. (0.2 second per shot)
5	Semi-automatic firing. (Single shot, sequential)	**5.88** shots per second. (0.17 second per shot)
6	Semi-automatic firing. (Single shot, sequential)	**6.67** shots per second. (0.13 second per shot)
7	Semi-automatic firing. (Single shot, sequential)	**7.69** shots per second. (0.5 second per shot)
8	Semi-automatic firing. (Single shot, sequential)	**8.33** shots per second. (0.1 second per shot)
9	Semi-automatic firing. (Single shot, sequential)	**9.09** shots per second. (0.25 second per shot)
A	Semi-automatic firing. (Single shot, sequential)	**10** shots per second. (0.2 second per shot)
B	Semi-automatic firing. (Single shot, sequential)	**11.1** shots per second. (0.17 second per shot)
C	Semi-automatic firing. (Single shot, sequential)	**12.5** shots per second. (0.13 second per shot)
D	Semi-automatic firing. (Single shot, sequential)	**14.3** shots per second. (0.1 second per shot)
E	Semi-automatic firing. (Single shot, sequential)	**16.7** shots per second. (0.07 second per shot)
F	Semi-automatic firing. (Single shot, sequential)	**20** shots per second. (0.05 second per shot)

1.7 REMOTE FIRE JACK.

Transmitters that include this optional feature can be actuated remotely through a three conductor cable plugged into a receptacle located on the left side of the transmitter box.

The transmitter is actuated remotely by connecting wire “A” to common to duplicate the action of the “A” button, and by connecting wire “B” to common to duplicate the action of the “B” button. The transmitter’s FIRE buttons also remain operational while the cable is plugged in.

NOTE: The transmitter should always be turned off when plugging in or extracting the remote cable to ensure that no fire commands are accidentally transmitted if jack contacts should be momentarily shorted during the insertion or extraction.

1.8 RADIO INTERFERENCE REDUCTION.

For obvious safety reasons, Holatron's design goal is to ensure that data communication errors due to radio interference or to insufficient signal strength due to low battery, exceeding specified range, or conductive objects in the signal path will result in failure of intentional actuation rather than unintended actuation. This goal is achieved by transmitting a 64 bit noise-tolerant code repeatedly while a transmitter button is depressed and with extensive error checking of the received codes. 60 of these bits must match the pattern expected by the receiver. Thus, there is one chance in (2 to the 60th power) of an actuation occurring due to reception of a random signal. Expressed in decimal numbers, this is (1.1529 times 10 to the 18st power, or 11529 followed by 14 zeroes). This is a probability of 8.6736 times 10 to the -19th power (or a decimal point followed by 18 zeroes followed by 86736). Though this probability of unintended actuation is extremely small, it cannot be guaranteed to be zero. Therefore**, it is important that the user not arm the receiver until all persons who might be harmed by accidental actuation are in a safe area**.

Additional protection is offered by use of codes that are unlikely to occur in random radio noise and by the use of UHF operating frequencies. These frequencies are sparsely used only by low power transmitters with a maximum range of approximately 100 yards. They are not commonly used by auto security systems, garage door openers, radio control models, cordless or cellular telephones, wireless microphones, or two way communications equipment. Because this system operates in the UHF region, interference from lamp dimmers, electrical discharges, and other natural sources is also minimal.

No confirmed cases of false triggering with this communications technology have been reported to date.

1.9 SPECIFICATIONS.

Parameter	Minimum	Typical	Maximum
Carrier Frequency, MHz.	417.96	418.02	418.08
Carrier Frequency, MHz. (optional)	432.90	433.96	434.02
Range (line-of-sight with RFLS-491HSRC, -496HSRC, -96HSRC, & -912HSRC receivers)			½ mile
Range (line-of-sight with RFLS-P91HSRC receivers)			¼ mile
Delay from start of button depression to receiver output (fewer than 4 transmitters transmitting simultaneously)		50 msec	75 msec
Delay from start of button depression to receiver output (more than 3 transmitters transmitting simultaneously)		100 msec	400 msec
Button depression time per cue (fewer than 4 transmitters transmitting simultaneously)	100 msec		
Button depression time per cue (more than 3 transmitters transmitting simultaneously)	400 msec		
Battery current, average, (enabled) Battery current, average, (xmting)		1.0 mA 4.0 mA	
Battery life (enabled, not transmitting)		300 hrs	
Low Battery Detect Threshold		7.7 V	
Transmitter Supply Voltage	7.0 V		

2.0 OPERATION AND MAINTENANCE.

This section describes the recommended operating procedure and maintenance for the transmitter-receiver system.

2.1 OPERATION.

2.1.1 With the receiver turned off and its arm switch set to “disarm” or “safe”, connect devices to the receiver outputs.

2.1.2 With the arm switch still in the previous position, turn on the receiver. Verify a flashing green battery indicator on the receiver module. This indicator will flash intermittently in bursts of one, two, or three flashes at a time if the battery has enough capacity to power the receiver. If no flashing occurs, the receiver cannot be used reliably. Three flashes per burst indicate that the battery is fully charged, two flashes indicate that its charge is beginning to diminish, and one flash indicates that it is near the end of its useful charge, in which case it should be replaced immediately after the current use.

2.1.3 Enable the transmitter, and **with the receiver's ARM switch in "safe" or "disarmed" position**, perform a range test by observing the green activity light on the receiver while pressing a transmitter button**.** There should be no intervening conductive objects for most reliable operation. All receivers must be elevated 12" or more above ground level to achieve specified range. When transmitting over water, range will normally exceed the specified value.

Verify that the transmitter battery is not depleted by observing the flashing "Xmtr Enabled" light while not pressing the FIRE buttons. (See section 1.3) Then turn the transmitter lock switch back to "Safe" position.

2.1.4 When the area around the devices to be actuated is clear of persons who might be harmed by an accidental actuation, and after verifying that the receiver's green activity light is off (no radio signal is being detected), turn the receiver's ARM switch to its "Armed" position. Refer to the receiver manual for the corresponding arming procedure.

WARNING - If the receiver's green activity light is erratic or on continuously, a radio signal is being received which may actuate its output immediately upon changing its ARM switch to the "Armed" position.

2.1.5 Verify electrical continuity through the devices connected to the receiver outputs. Continuity is tested on the RFLS-96HSRC and RFLS-496HSRC receivers by pressing the test button. On the RFLS-912HSRC receiver, it is done by pressing the ARM toggle switch down into its "Test" position. Lighted lamps indicate open circuits. It is recommended this be done with the Arm Switch in the "Safe" or "Disarmed" position, but the test circuit will also function in the "Armed" position.

In the RFLS-P91HSRC and RFLS-491HSRC receivers, continuity is tested automatically while the receiver is armed.

2.1.6 Turn the transmitter lock switch to its "Enabled" position. Press the appropriate button to actuate the desired receiver output channel.

The transmitter should be held with the antenna in a vertical orientation, away from the body and other conductive objects to achieve maximum range and communication reliability. Generally, the higher the transmitter is held, the greater the range. Conductive objects such as chain-link fences, aluminum bleachers, automobiles, or dirt embankments in the transmission path will reduce the range.

2.1.7 When finished, turn off the receiver, and turn the transmitter lockswitch back to its "Safe" position to stop further drain of the transmitter battery. You may remove the antenna to make it easier to store the transmitter. Observe the precautions in section 1.1 before removing the antenna. If the transmitter is to be stored for a prolonged period, remove the battery as described in section 1.5 above.

2.2 MAINTENANCE.

Since there are no calibration or tuning adjustments in the transmitter, the only maintanance required is periodic replacement of the 9 volt battery. This should be done at least once per year, or at the next opportunity if the “Xmtr Enabled” light fails to flash when the transmitter is enabled.

The face of the transmitter, which is completely sealed, may be safely cleaned by wiping with a damp cloth if care is taken not to get moisture into the lock switch. The battery compartment door and the junction between the front and back panels are NOT water tight, however. The transmitter must never be immersed in water.

If further information or service is required, contact:

Holatron Systems, LLC.
2800 Woodlawn Dr, Ste. 138
Honolulu, HI 96822
(808) 372-0956
www.holatron.com