

# HOLATRON

## OPERATION & MAINTENANCE GUIDE - *AIR-FIRE 6* Compact Pairable Receiver



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## **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 receiver 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 2.0. Though the 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.**

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.

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This manual is divided into four sections. The first is a description of the system hardware. The second describes radio interference suppression methods. The third lists transmitter specifications. The fourth covers the recommended operating and maintenance procedure.

## **1.0 HARDWARE DESCRIPTION.**

The model RFLS-49HSRC and RFLS-49HSXC "AIR-FIRE 6" compact user pairable six-shot high speed UHF receivers are highly sensitive narrow band superhetrodyne digital radio receivers designed to be used for remote control applications where high reliability is critical. This receivers can be "paired" with the desired cue range, channel #, and proprietary system code of any Holatron transmitter on a matching frequency via a very simple operation. The channel # (1-12) can optionally be selected via an internal digital switch, overriding the paired channel #.

When used with the Holatron model RFLS-12USXT, RFLS-12USXC, RFLS-MK3USXT, RFLS-MK3USXC, XMTR12B, or XMTR12C remote control transmitters, a range of ½ mile (line of sight operation) is typical, provided there are no intervening conductive objects such as automobiles, chainlink fences, etc. Range increases as the receiver is elevated above earth or other conductive objects (such as aluminum bleachers). Range will be even greater when transmitting over water.

Model numbers ending in "XC" provide bidirectional radio links which confirm communication on the transmitter prior to firing. The reception carrier frequency is fixed at 315, 418, or 433 MHz by a SAW (surface acoustic wave) oscillator for exceptional stability. No alignment or tuning procedures are ever required to maintain optimum performance.

The receiver's firing signal is digitally decoded from the transmitted digital code which is amplitude modulated on the fixed carrier frequency. The transmitted digital codes from the RFLS-12 and RFLS-MK3 series transmitters indicate to the receiver which of the two transmit buttons, "A" or "B", is being pressed. The "A" button fires the show cues sequentially. (Each depression of the button fires the next show cue in sequence.), and "B" button commands fire show cues in fully automatic mode as explained in the transmitter manual.

The digital code from the model XMTR12 series transmitters indicate to the receiver which of the 12 random-fire buttons is being pressed and causes that cue to be fired immediately. The "Next Fire" button transmits a digital code that causes the next cue in sequence to be fired. After pressing the Rst button, the next depression of this button will fire cue 1. These transmitters can fire a maximum of 12 cues per channel on 12 channels for a total off 144 cues.

Pressing the Rst button on a model XMTR12 series transmitter causes the transmitter to switch to the channel indicated by the following press of one of the numeric keys (1 – 12). This allows manual selection of the communications channel. See the transmitter manual for a detailed description of channel selection.

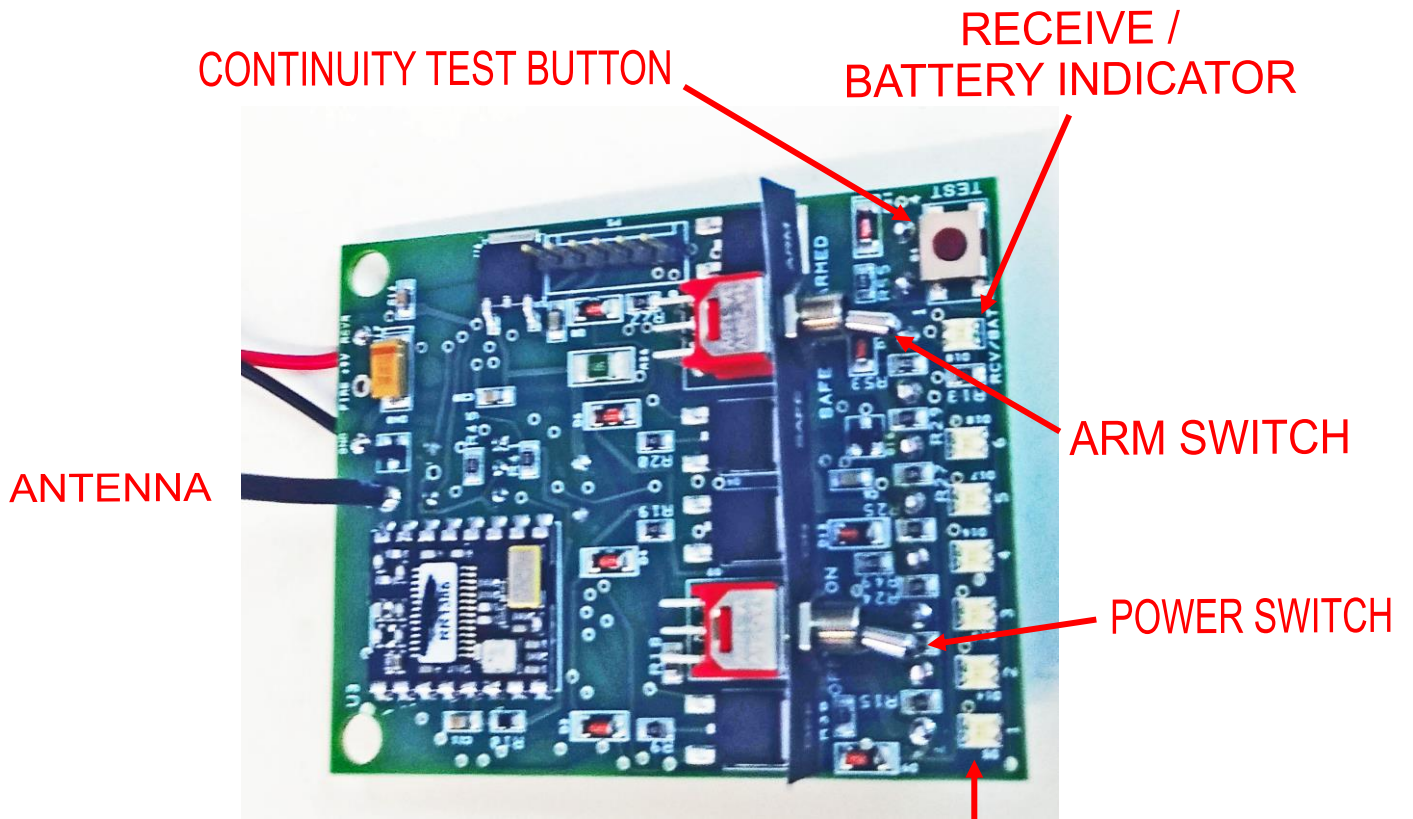
There are 12 different communication channels (1-12) and two different cue ranges (1-6 and 7-12) available. The transmitter will control receivers paired to the channel matching that of the transmitter and its 6 outputs will fire the cue range (1-6 or 7-12) it has been paired with. Receiver paired channel can be overridden by the receiver digital switch setting as shown in the following tables.

<b>Rcvr Digital Switch Setting</b>	<b>Action</b>
0	Pair with xmtd cue range (1-6 or 7-12), channel, & system code
1	Fire paired cue range, channel 1, and paired system code.
2	Fire paired cue range, channel 2, and paired system code.
3	Fire paired cue range, channel 3, and paired system code.
4	Fire paired cue range, channel 4, and paired system code.
5	Fire paired cue range, channel 5, and paired system code.
6	Fire paired cue range, channel 6, and paired system code.
7	Fire paired cue range, channel 7, and paired system code.
8	Fire paired cue range, channel 8, and paired system code.
9	Fire paired cue range, channel 9, and paired system code.
A	Fire paired cue range, channel 10, and paired system code.
B	Fire paired cue range, channel 11, and paired system code.
C	Fire paired cue range, channel 12, and paired system code.
D	
E	Pair with xmtd cue range (1-6 or 7-12), channel, & system code .
F	Fire paired cue range, paired channel, and paired system code.

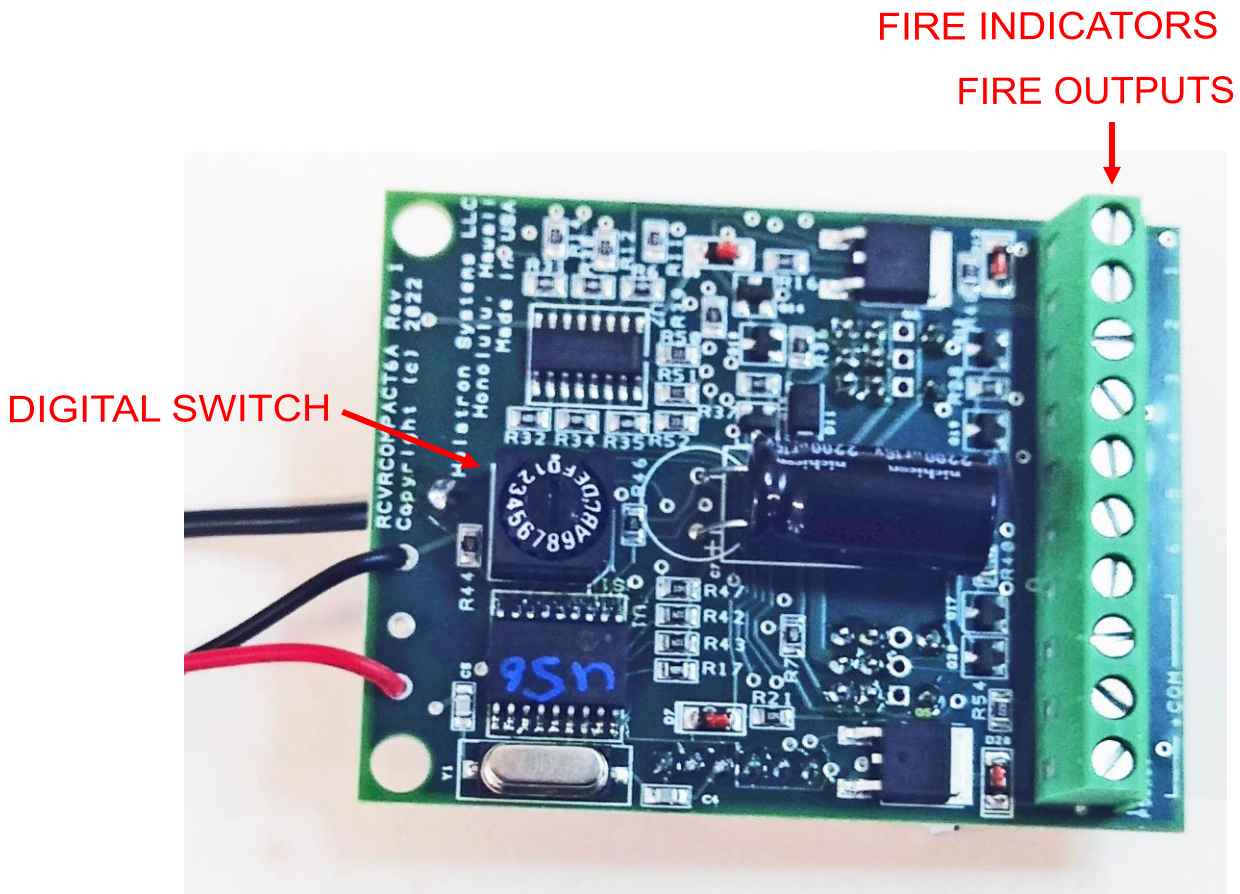
Transmitters that are set to separate channels can transmit simultaneously to separate receivers or groups of receivers without interfering with each other. Transmitters set to the same channel will interfere with each other and possibly result in failure-to-fire if fired simultaneously.

Multiple receivers can be used to fire more than 6 sequential cues from a single transmitter. For example, two receivers set to cue ranges 1-6 and 7-12, respectively, can fire 12 cues (cues 1-6 from the first receiver, and cues 7-12 from the second receiver), and 24 receivers can be used similarly to fire 144 cues using cue range 1-6 and 7-12 on each of 12 channels. Multiple receivers can be configured to fire simultaneously by setting their cue ranges and channels to the same numbers. Combinations of sequential and simultaneous receivers can also be used.

Receiver channels are selected by pairing or by switch position. Cue range and system code are selected only by pairing. Refer to section 4.2 for a detailed description of the pairing procedure.



**FIGURE 1 (top view)**



**FIGURE 2 (bottom view)**

The user has access to the following components (refer to figures 1 & 2):

### 1.1 THE ANTENNA.

The RF signal is received by a quarter-wave bendable antenna consisting of a permanently attached piece of 20 AWG solid insulated wire. If this wire should ever be damaged, it should be replaced with a similar wire of exactly 7 1/8" length (from top of circuit board to tip of wire) for optimum reception and range on 418 MHz. **The exposed tip of the wire must be bent over with needle-nose pliers to avoid the possibility of injury in case of accidental contact with eyes.**

The antenna wire may be attached to either the top or the bottom of the circuit board. Bottom attachment is used if the receiver is to be mounted underneath an aircraft, and top attachment is used when the receiver will be sitting on ground or other objects. Note that reception is better when the receiver is elevated at least 12" above ground level.

### 1.2 THE POWER & ARM SWITCHES.

These miniature sealed toggle switches are located on the top side of the PC board. The "POWER" switch turns on power to the receiver. The "ARM" switch has "Safe" and "Armed" positions. In the "Safe" position, output firing current is limited to 200 microamps so that no outputs can be fired, although the firing position will advance each time the transmitter button is pressed, and the firing indicators will glow faintly. **It is recommended that the receiver always be powered up in "Safe" mode if devices are already connected to the outputs. The operator can then verify that the green "RCV / BAT" light does not indicate that any radio reception is occurring before arming the receiver.**

### 1.3 THE "RCV / BAT" INDICATOR.

While the power switch is on, this indicator, located on the top side of the circuit board, will flash red if armed or green if safe 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 battery must be replaced before the receiver 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 receiver power is available as long as the battery voltage is above approximately 7.0 volts, but the battery voltage will drop rapidly at this point. While this additional time should be adequate to complete the current firing sequence, it is not absolutely predictable, and so the battery(s) should be replaced at the very next opportunity.

This indicator will light while a signal is being received that matches the expected preamble and sync code of the system communication protocol, even if it is from a transmitter set to a different digital channel. This feature is useful for warning of reception of signals before the arm switch is turned on and for indication of activity on other digital channels.

## 1.4 THE OUTPUT CONNECTORS.

Electric matches or other igniters are connected to this miniature terminal block with 10 screw terminals located on the bottom of the circuit board. (We can supply a modular receptacle instead for quick connection of pre-wired terminal blocks.) A miniature screwdriver is required to secure the connections to the terminal block. Insert one wire from each of the 6 devices to be fired into its corresponding numerical hole. The remaining 6 wires are inserted into the "+COM" terminals. Since there are only 4 "+COM" holes, 2 wires will have to be inserted into a couple of these holes. Wire gauge should be #22 or higher. In order to minimize the chance of shorts to other wires or to components on the circuit board, be sure to use solid conductor wire whose insulation is not stripped back too far. Also be sure that the screw terminals are clamped onto the wires' conductors and not onto the insulation. Ensure that no exposed conductors are shorting any terminals to adjacent terminals, as this condition will not be detected during continuity check. A short from a numeric to a "+COM" terminal will result in a failure to fire. A short between numeric terminals will result in simultaneous firing of the outputs shorted together.

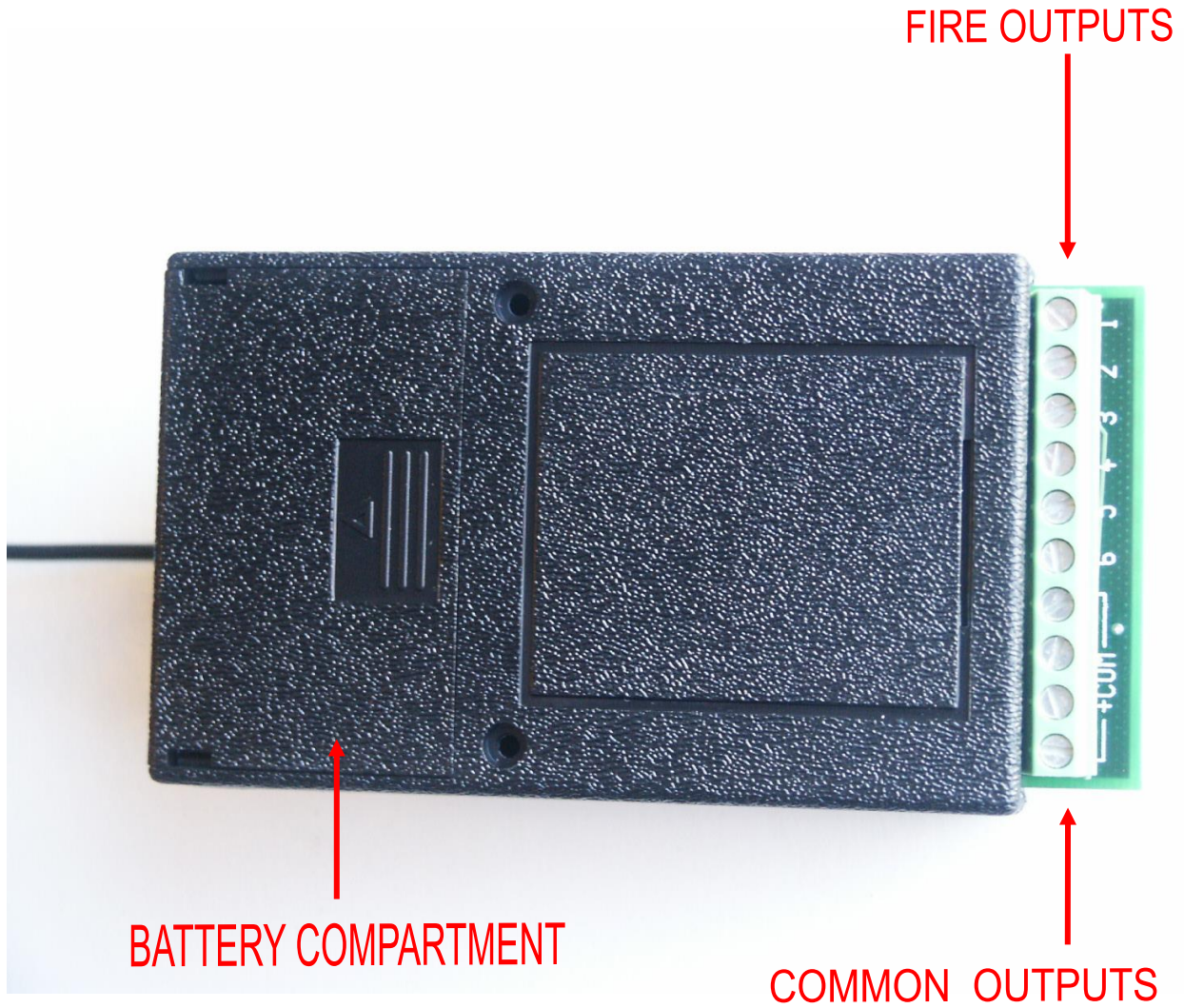
## 1.5 THE TEST BUTTON.

Pressing this button, located at the right corner of the exposed circuit board (refer to figure 1), performs a continuity test on all six outputs simultaneously. While the button is pressed, a maximum test current of 1 milliamp flows through each output and green LED indicators light next to outputs that see loads (resistance < 500 ohms) connected to "+COM". LEDs next to outputs that do not see continuity to "+COM" (> 500 ohms) will remain dark. **Outputs that are dark will not fire when actuated.** These output connections should be examined and the electric match and/or wire should be replaced if necessary. The receiver must be turned on to perform the continuity test, but the "ARM" switch may be in either position. Normally, the continuity test is performed before arming the receiver.

## 1.6 THE BATTERY.

All power is supplied from one alkaline 9 volt battery, contained in a compartment in the bottom of the black plastic box. This compartment is accessed by pushing a sliding door to the left with the thumb. Refer to figure 3 below.

The 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 receiver is to be stored for a prolonged period. Damage due to battery leakage is not covered under the warranty.



**FIGURE 3**  
**(bottom view)**



## 1.7 THE DIGITAL SWITCH.

A 16 position miniature rotary switch is located on the bottom side of the receiver PC board (refer to figure 2). It can be set to positions 0 – 9 or A – F by rotation with a miniature screwdriver. If set to position F, the receiver will only respond to transmitters whose digital channels correspond to the receiver's paired channel. If set to position 1 through C, it will only respond to transmitters on the corresponding channel (1 through 12, respectively, as shown in the table in section 1.0). Multiple transmitters may be used to actuate different receivers even though all operate on the same frequency. Simultaneous multiple transmissions are possible without interference if all transmitters are set to different digital channel numbers. Transmitters set to the same digital channel number will interfere with each other and result in failure-to-fire when actuated simultaneously.

## 2.0 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 pressed. To fire an output, 48 of these bits must exactly match the pattern expected by the receiver. There is one chance in (2 to the 48<sup>th</sup> power) of actuation of an individual output occurring due to reception of a random signal. Expressed in decimal numbers, this is (2.815 times 10 to the 14<sup>th</sup> power, or 2815 followed by 11 zeroes). This is a probability of 3.553 times 10 to the -15<sup>th</sup> power (or a decimal point followed by 14 zeroes followed by 3553). Error checking on an additional 8 bits of code provides further protection with a probability of 0.0625 of acceptance of this as a random code. The product of these probabilities, (3.553 times 10 to the -15<sup>th</sup> power) x (0.0625), = 2.220 times 10 to the -16<sup>th</sup> power, the probability of unintended actuation of single given output. Multiplying by 6 yields the probability of unintended actuation of one of the 6 receiver outputs = 1.332 times 10 to the -15<sup>th</sup> power, or the probability of 6-shot receiver actuation from random radio noise. Expressed numerically, this is a decimal point followed by 14 zeroes followed by 1332. The actual probability is considerably lower than that, however, due to additional noise rejection in the receiver hardware.

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 315, 418, or 433 MHz as the operating frequency. These UHF frequencies experience minimal interference from lamp dimmers, electrical discharges, and other natural sources. Though these frequencies are used only by low power transmitters, it is possible for high power transmitters such as handi-talkies to bleed over from nearby frequencies and cause a failure-to-fire. 315 MHz is the preferred frequency, as it has not experienced any interference from handi-talkies or other digital remote controls.

No instances of unintended actuation with this communications technology have been reported to date.

### 3.0 SPECIFICATIONS.

Parameter	Minimum	Typical	Maximum
Carrier Frequency, MHz. (USA, Canada)	417.96	418.02	418.08
Carrier Frequency, MHz. (Europe)	433.86	433.92	433.98
Carrier Frequency, MHz. (USA, Canada)	314.95	315.00	315.05
Range (line-of-sight with Holatron xmtr)			½ mile
Delay from start of transmission to receiver output		75 msec	150 msec
Receiver battery drain, (Rcvr switch on)		8 mA	9 mA
Receiver battery drain, (Rcvr switch off)			0 mA
Receiver battery drain, (Firing)			1100 mA
Receiver battery life, (Not firing)	40 hours	48 hrs	
Receiver Supply Voltage	6.5 V		
Low Battery Detect Threshold		7.7 V	
Battery Input Voltage	7 V	9 V	10.0 V
Output Fire Pulse Duration			0.56 sec
Output Fire Voltage			9 V
Output Fire Current, (Armed)			1 amp
Output Fire Current, (Safe)			200 uamp
Output Continuity Test Current (while test button pressed, 0 while not pressed)		0.9 mA	1.1 mA
Height of box		1.00 in	
Width of box		2.37 in	
Length of box		3.75 in	
Length of box + terminal extension		4.25 in	
Weight of receiver + box (without battery)		3.04 oz	
Weight of receiver + box (with battery)		4.71 oz	

### 4.0 OPERATION AND MAINTENANCE.

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

#### 4.1 OPERATION.

- 4.1.1** Before connecting electric matches, perform a reception test by observing the receiver firing lights while pressing the transmitter buttons. An assistant may be needed for this test. If the receiver location will be fixed, determine the limits of the range in the current environment, and position the transmitter and receiver so that their separation does not exceed  $\frac{3}{4}$  of this maximum range. Verify that the receiver and transmitter batteries are not depleted by observing the flashing RCV / BAT and XMTR ENABLED lights on the receiver and transmitter, respectively. Operation of these indicators is as described in section 1.3 above. Turn the transmitter off, and turn off the receiver.

- 4.1.2** Connect devices to receiver outputs as described in section 1.4 above. The operator should retain possession of the transmitter or transmitter key while performing the next two tasks. With the ARM switch turned off, turn on the receiver power switch. Verify continuity through the devices by pressing the TEST button. All connected outputs should light green. Check that the RCV / BAT indicator is only flashing in bursts of one, two or three to indicate battery status. **If this indicator exhibits continuous or erratic behavior, there is a signal being received which could cause firing when the “ARM” switch is turned on.** Determine the source of the interference before attempting to use the system.
- 4.1.3** When the area around the devices to be actuated is clear of persons who might be injured by an accidental actuation, and with the ARM switch turned off, turn on the receiver. After verifying that the receiver’s RCV / BAT indicator does not show reception of signals, turn on the receiver’s ARM switch.
- 4.1.4** Turn the transmitter to its ON or Enabled state, arm it if necessary, and press the appropriate button to actuate the desired receiver output. A button must be depressed for at least 100 milliseconds to produce a receiver output. 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.
- 4.1.5** When finished, turn off the receiver POWER and ARM switches, and return the transmitter back to its “Safe” or “Off” state to stop further drain of its batteries. If the receiver and transmitter are to be stored for a prolonged period, remove their batteries as described in section 1.6 above.

You may remove the transmitter antenna to make it easier to store the units. The receiver antenna is permanently attached but bendable for ease of storage.

Be careful not to overtighten the transmitter antenna when screwing it back on, as this could cause its mating connector to rotate and break its internal connection. Rotation could also occur, with the same result, when subsequent removal of an overtightened antenna is attempted. 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. When removing the antenna for storage, observe the base of the mating connector to ensure that it is not rotating. If the antenna is so tight that rotation is occurring, grasp the hex base of the mating connector with long nose pliers, and then unscrew the antenna.

## 4.2 PAIRING.

Three parameters determine the transmitters to which the receiver will respond:  
**Proprietary System Code** (0-255),  
**Digital Channel** (1-12),  
**Cue Range** (1-6 or 7-12)

With the digital switch set to position 0 or E, a single transmission will cause the receiver to grab all three parameters and pair itself with the transmitter that sent them. Cue range will be set so that it contains the transmitted cue number. This pairing will be saved in non-volatile memory even when the receiver power is off. When the switch is subsequently set to position F, the receiver will continue to respond to this saved system code, channel, and cue range. Optionally, the channel number can be selected from the switch by setting it to positions 1-C, as shown in the table in section 1.0. The paired system code and cue range are still used in this case.

Paired or switch selected channel number is displayed as a series of RCV / BAT flashes for each digit at power-on. Paired system code is displayed as a series of flashes for each digit during the pairing operation. Zero digits are represented by a single long flash in this display. Leading zeroes are not displayed.

When the receiver pairs with a transmitter, it will flash the received system code number once and then cease flashing the battery level. Be sure to return the digital switch to position F or to 1-C after pairing with a transmitter to prevent possible change of the saved parameters on subsequent transmissions, and turn receiver power off for a few seconds and then back on to restore normal operation with the new parameters.

## 4.2 MAINTENANCE.

Since there are no calibration or tuning adjustments in the units, the only maintenance required is periodic replacement of the 9 volt batteries. This should be done at least once per year, or at the next opportunity if the RCV / BAT indicator fails to flash at least twice per burst while power is switched on.

The receiver should occasionally be vacuumed to remove any dust or contaminants that may have entered through the opening in the end of the box.

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 and receiver must never be immersed in water.

If further information or service is required, contact:

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