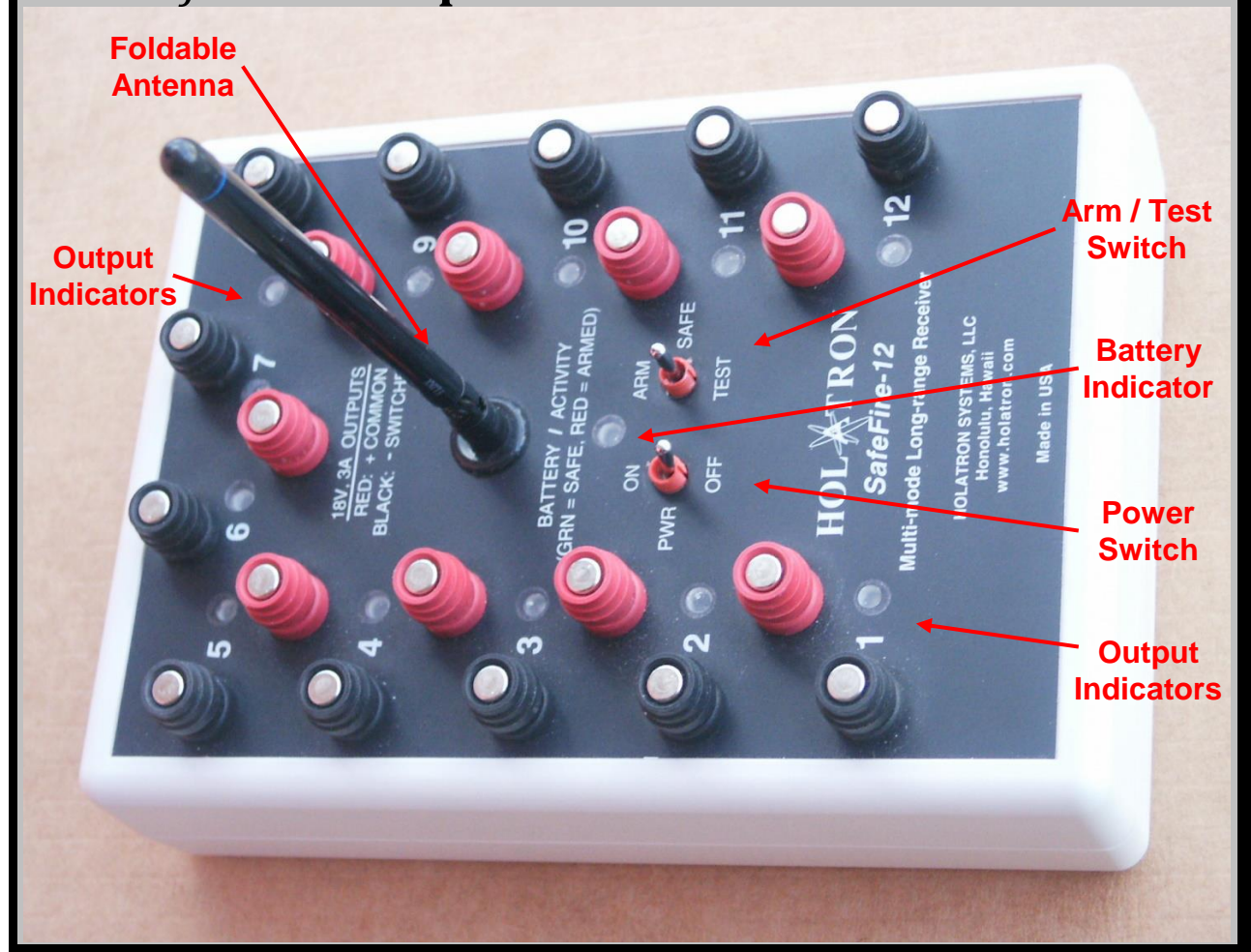


HOLATRON

OPERATION & MAINTENANCE GUIDE - *SafeFire-12* pairable 12 channel 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-912HSRC “SafeFire-12” user pairable 12-shot multi-mode high speed receiver is a highly sensitive narrow band (superhetrodyne) radio receiver designed to be used for remote control applications where high reliability and low latency are critical. This receiver can be “paired” with the 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-1XT, RFLS-6HSXT, RFLS-6HSXTX, RFLS-12XT, RFLS-12XTX, 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.

The reception carrier frequency is fixed at 418 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 a single carrier frequency of 418 MHz. The transmitted digital codes from the RFLS-6HSXT & RFLS-6HSXTX 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 RFLS-12XT or XMTR12 series transmitter indicates to the receiver which of its 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 of 144 cues.

Pressing the Rst button on the model RFLS-12XTX or 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). The receiver will respond only to the transmitter channel and proprietary system code it has been paired with. Receiver pairing and channel selection override can be implemented by the receiver digital switch setting as shown in the following table.

| Rcvr Digital Switch Setting | Action |
|------------------------------------|---|
| 1 | Fire cues 1-12 (of 12) for channel 1 & paired system code. |
| 2 | Fire cues 1-12 (of 12) for channel 2 & paired system code. |
| 3 | Fire cues 1-12 (of 12) for channel 3 & paired system code. |
| 4 | Fire cues 1-12 (of 12) for channel 4 & paired system code. |
| 5 | Fire cues 1-12 (of 12) for channel 5 & paired system code. |
| 6 | Fire cues 1-12 (of 12) for channel 6 & paired system code. |
| 7 | Fire cues 1-12 (of 12) for channel 7 & paired system code. |
| 8 | Fire cues 1-12 (of 12) for channel 8 & paired system code. |
| 9 | Fire cues 1-12 (of 12) for channel 9 & paired system code. |
| A | Fire cues 1-12 (of 12) for channel 10 & paired system code. |
| B | Fire cues 1-12 (of 12) for channel 11 & paired system code. |
| C | Fire cues 1-12 (of 12) for channel 12 & paired system code. |
| D | Fire second 12 cues (of 24), and ignore first 12 cues after power-on, for paired channel & system code. |
| E | Pair with transmitted channel & system code . |
| F | Fire cues 1-12 (of 12) for paired channel and system code. |
| 0 | Fire first 12 cues (of 24), and ignore second 12 cues, for paired channel & system code. |

Transmitters that are set to separate channels can transmit simultaneously to separate receivers or groups of receivers without interfering with each other, permitting up to 12 separate receivers or groups of receivers (144 cues) to be controlled by up to 12 separate transmitters simultaneously. Transmitters set to the same channel, even though they have different system codes, will interfere with each other and possibly result in failure-to-fire if fired simultaneously. Transmitters with different system codes will not cross-fire, however.

Multiple receivers can be used to fire more than 12 sequential cues from a single transmitter. For example, two receivers set to channels 1 & 2, respectively, can fire 24 cues (cues 1-12 from the first receiver, and cues 12-24 from the second receiver), and 12 receivers can be used similarly to fire 144 cues using a total 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. System code is selected only by pairing. Refer to section 4.2 for a detailed description of the pairing procedure.

The user has access to the following components:

1.1 THE ANTENNA.

The RF signal is received by a quarter-wave foldable antenna which is permanently attached to the receiver circuit board. The antenna may be folded for storage.

1.2 THE POWER & ARM SWITCHES.

These switches are located on the top side of the receiver as shown in the photo on the cover page. A waterproof silicone seal around the base of the switch handles permits the receiver to be operated safely in exposed rainy conditions. The "POWER" switch turns on power to the receiver and resets the automatic firing mode to start at output 1. The "ARM" switch has "Safe", "Armed", and "Test" 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 "BAT / ACTIVITY" light does not indicate that any signal reception is occurring before arming the receiver.**

1.3 THE TEST FUNCTION.

This function is activated by pressing the ARM switch into its momentary "Test" position. While in this position, the receiver performs a continuity test on all 12 outputs simultaneously. While the switch is pressed, a maximum test current of 1.2 milliamp flows through each load, and red LED indicators light next to outputs with "open" loads (resistance > 8 Kohms). LEDs next to outputs that see continuity to +COMMON (< 8 Kohms) will remain dark. **Remember that red LEDs during test indicate OPEN outputs, and such outputs 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.

1.4 THE “BATTERY / ACTIVITY” INDICATOR.

This indicator will be green while the receiver is in “Safe” mode and red while in “Arm” mode. While the power switch is on, this indicator, located between the switches and the antenna, will flash intermittently in bursts of one, two, or three flashes at a time if the batteries have enough remaining capacity to power the receiver. If no flashing occurs, the batteries must be replaced before the receiver can be used reliably. Three flashes per burst indicate that the batteries have full capacity, two flashes indicate that their capacity is beginning to diminish, and one flash indicates that they are near the end of their useful lifetime in which case they should be replaced immediately after the current use. Adequate receiver power is available as long as the batteries’ summed voltage is above approximately 14.0 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 batteries 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 or system code. 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.

1.5 THE OUTPUT CONNECTORS.

Electric matches are connected to spring clip terminals (Pyro-clips) on the receiver top panel as shown in the photo on the first page. No tools are required to secure the connections. Each device to be actuated should be connected to one of the 12 black terminals and to one of the nine red terminals, with +common indicated by red and switched negative by black. The black terminals are numbered one through twelve. Since there are only nine red terminals, it will be necessary for three of them to be shared by pairs of devices. To connect a wire to an output terminal, simply push down the plastic top of the connector and insert the wire into the gap between the metal terminal and the plastic. Release the plastic top to lock the wire into the terminal. Wire gauge should be #20 or higher to fit into the gap. Solid copper wire is best. If stranded wire is used, be careful that no frayed strands (whiskers) extend out and accidentally contact any adjacent terminals. Also be careful that the wire is not inserted so far that the metal terminal is contacting the wire’s insulation instead of its internal conductor. This will be detected during continuity check. Ensure that no exposed conductors are shorting any black terminals to adjacent terminals, as this condition will not be detected during continuity check. A short to a red terminal will result in a failure to fire and possible damage to the firing circuitry. A short to a black terminal will result in simultaneous firing of the outputs shorted together.

1.6 THE BATTERIES.

Power is supplied from two 9 volt alkaline batteries, inserted into a compartment in the bottom of the box. A sliding cover can be removed to gain external access to the compartment. The batteries are connected in series to provide 18 volts of firing power.

The batteries should be replaced when required by conditions described in section 1.4 above. In order to prevent the possibility of damage due to battery leakage, the batteries 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.

1.7 THE DIGITAL SWITCH.

A 16 position miniature rotary switch is located near the center of the receiver PC board as shown in Figure 1 below. It is accessed by removing the bottom cover of the receiver enclosure, and it can be set to positions 0 – 9 or A – F by rotation with a small screwdriver to select receiver pairing mode or to override the paired channel selection as shown in the table in section 1.0. Refer to section 4.2 for a detailed description of the pairing procedure performed with this switch.

For backwards compatibility, switch positions 0 and D enable the receiver to fire in “24 cue mode”. When set to position 0, the receiver will fire the first 12 shots and ignore the next 12 shots on the paired or selected channel. Position D will cause the receiver to ignore the first 12 shots and fire the next 12 shots. After the 24th shot, the sequence will repeat, starting with output 1 on the first receiver. This feature is useful for expanding from 12 to 24 sequential shots with a single 12 shot transmitter and two 12 shot receivers set to switch positions 0 and D, respectively. This feature can only be used in single channel systems. For random access or systems with more than 24 cues, receivers must be paired and fired on multiple channels with 12 cues on each channel.

DIGITAL SWITCH

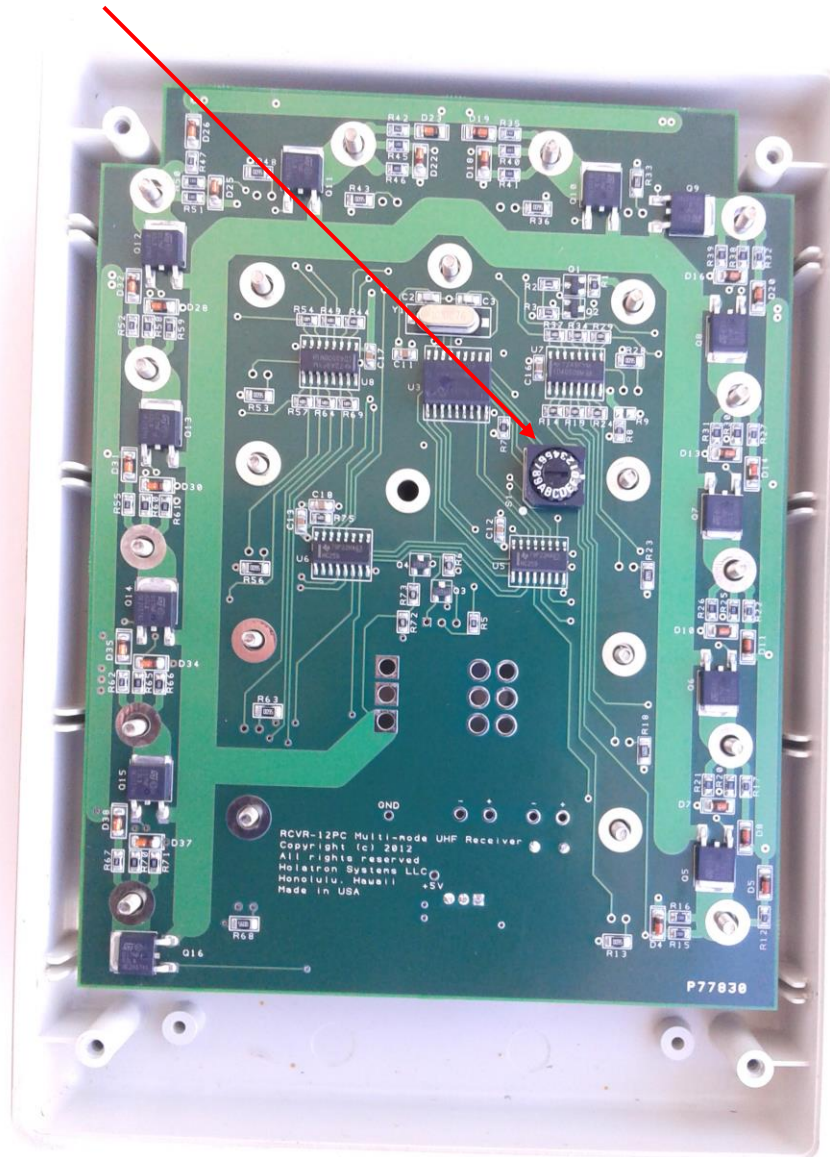


FIGURE 1

(Receiver bottom cover removed)

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 depressed. 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 18th 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 315, 418, or 433 MHz as the operating frequency. These frequencies are sparsely used only by low power transmitters with a maximum range of approximately 100 yards. It is 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.

3.0 SPECIFICATIONS.

| Parameter | Minimum | Typical | Maximum |
|---|---------|----------|----------|
| Carrier Frequency, MHz. | 417.96 | 418.02 | 418.08 |
| Carrier Frequency, MHz. (optional) | 433.86 | 433.92 | 433.98 |
| Range (line-of-sight with RFLS-1XT xmtr) | | | ½ mile |
| Delay from start of transmission to receiver output (fewer than 4 transmitters transmitting simultaneously) | | 50 msec | 75 msec |
| Delay from start of transmission to receiver output (more than 3 transmitters transmitting simultaneously) | | 100 msec | 400 msec |
| Battery drain, (Rcvr switch on) | | 8 mA | 9 mA |
| Battery drain, (Rcvr switch off) | | | 0 mA |
| Battery drain, (Test btn pressed) | | | 75 mA |
| Battery drain, (Firing into short circuit) | | | 3 amp |
| Battery life (not firing) | 40 hrs | 48 hrs | |
| Receiver Supply Voltage (from low-side battery) | 6.5 V | | |
| Low Battery Detect Threshold | | 15.4 V | |
| Output Fire Voltage | | 18 V | |
| Output Fire Current | | 1 amp | 3 amp |
| Output Continuity Test Current (while test button pressed, 0 while not pressed) | | 1.0 mA | 1.2 mA |
| Continuity Detect Threshold | | 8 Kohms | |
| Width of box | | 6.5 in | |
| Length of box | | 7.4 in | |
| Height of box | | 1.9 in | |
| Height of box (including terminals) | | 2.7 in | |

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 range test by observing the receiver firing lights while pressing the transmitter buttons. An assistant may be needed for this test. 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 transmitter and receiver batteries are not depleted by observing the flashing "ACTIVITY / BAT" lights on each. Operation of these indicators is as described in section 1.4 above. Turn the transmitter off, and turn off the receiver.

- 4.1.2** Connect devices to receiver outputs. The operator should retain possession of the transmitter or transmitter key while performing the next two tasks. With the “ARM” switch in “SAFE” position, turn on the receiver power switch. Verify continuity through the devices by momentarily pressing the “ARM” switch to “TEST” position. All indicators should remain off. Check that the “ACTIVITY / BATTERY” 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 after verifying that the receiver’s “ACTIVITY / BATTERY” indicator does not show reception of firing signals, set the receiver’s “ARM” switch to its “ARM” position..
- 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 to its “OFF” or “Safe” 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 storage easier. 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.

The receiver antenna can be folded down, but it is not removable.

4.2 PAIRING.

Two parameters determine the transmitters to which the receiver will respond:
Proprietary System Code (0-255),
Digital Channel (1-12),

With the digital switch set to position E, a single transmission will cause the receiver to grab both parameters and pair itself with the transmitter that sent them. When the switch is subsequently set to position F, the receiver will continue to respond to this paired system code and channel. Optionally, the switch can be set to positions 1-C, as shown in the table in section 1.0, to force operation to the selected channel. The paired system code is still used in this case.

After pairing, the activity indicator will cease flashing the battery level and will flash the received system code number once before going dark. Be sure to switch away from position E after pairing to prevent possible change of the paired parameters on subsequent transmissions. Turn receiver power off for a few seconds and then back on to restore normal operation with the newly paired parameters. The receiver will remember the paired parameters even when power is off. So pairing does not need to be repeated on subsequent uses.

Paired channel number is displayed at power-on, and paired system code is displayed during the pairing operation, as a series of activity flashes for each digit. Zero digits are represented by a single long flash in this display. Leading zeroes are not displayed. No flashes are displayed for the generic system code zero.

4.3 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 battery indicators fail to flash at least twice per burst while power is switched on.

The faces of the transmitter and receiver, which are completely sealed, may be safely cleaned by wiping with a damp cloth if care is taken not to get moisture into the transmitter lock switch. The battery compartment doors are NOT water tight, however, and so the transmitter and receiver must never be immersed in water. The toggle switches on the receiver are sealed, and so it is safe for the receiver to be exposed to rain. Be aware that the receiver's top panel should be protected from sparks or other high temperature fallout from pyro effects, as these can melt the receiver's plastic overlay.

If further information or service is required, contact:

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