OPERATION & MAINTENANCE GUIDE - SPREAD SPECTRUM 12V Firing System

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WARNING

This equipment has been approved for mobile applications where the equipment should be used at distances greater than 20 cm from the human body (with the exception of hands, wrists, feet, and ankles). Operation at distances less than 20 cm is strictly prohibited.

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 3.0. 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 with its keylock switch until all persons who might be harmed by accidental actuation are in a safe area**.

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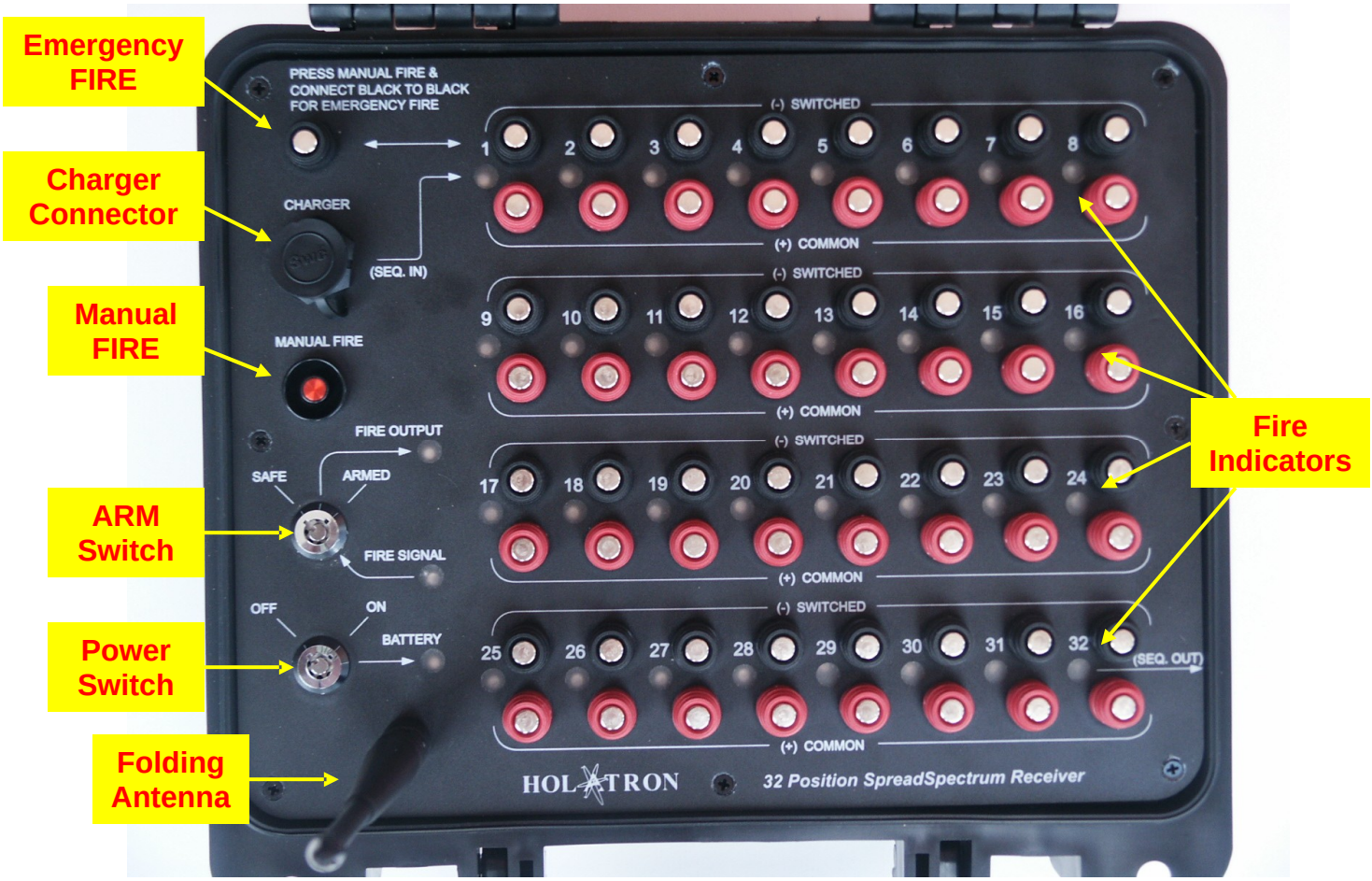
This manual is divided into six sections. The first is a description of the receiver hardware. The second is a description of the transmitter hardware. The third describes possible effects of radio interference and design techniques used to prevent it. The fourth describes operation of the system in rapid-fire (burst) mode. The fifth is a summary of system specifications, and the sixth covers the recommended operating and maintenance procedure.

1.0 RECEIVER HARDWARE DESCRIPTION.



The model 10000RS "Spread Spectrum" Two Way Firing Receiver is a long range frequency-hopping spread spectrum two way radio transceiver designed to be used for remote control applications where high reliability is critical. When used with the Holatron model 10000TS "Spread Spectrum" Two Way Transmitter, a range of two miles (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 usually exceed two miles when transmitting over water. Communication occurs on multiple synthesized carrier frequencies in the 900 MHz band. Since synthesis is digitally controlled from a quartz crystal, no alignment or tuning procedures are ever required to maintain optimum performance.

All received commands are contained in transmitted data packets which are digitally decoded and executed. These packets contain extensive error detection coding and are transmitted reduntantly multiple times on multiple frequencies to enhance successful communication even in the presence of severe narrow band interference. All communication is “two way” for enhanced reliability. After successful command reception and execution, the receiver transmits a confirmation signal back to the transmitter. The receiver also continuously transmits status information, such as armed status and received signal strength, which is displayed on the transmitter panel. This enables the operator to have confidence that receiver outputs will fire successfully when commanded.

When a FIRE command is received, the selected output turns on and remains on (even if the transmitter button is released) until a new FIRE command is received or until a one second timeout, whichever occurs first. The purpose of the one second timeout is to prevent firing transistor damage when accidentally firing into short circuits. Maximum output current is limited to approximately 5 amps. The firing circuitry is also protected from external short circuits and electronic failure resulting in loss of timeout protection by automatically resetting thermal fuses.

One transmitter can communicate with multiple receivers to fire large arrays of devices, up to a limit of 9999 cues, total. Receivers are programmed in advance from the transmitter panel to sequential cue ranges (so that each receiver fires a selected portion of the total cue range), or to identical cue ranges (so that multiple receivers fire identical cues for “fronts” and similar effects), or to any combination thereof.

No more than one transmitter should ever be turned on at the same time, as each powered up transmitter continually sends out a beacon signal for the receivers to lock onto, resulting in interference with each other and possible “failure to fire”.

Randomly selected cues are fired by punching in the cue number and then pressing FIRE on the transmitter panel. Cues can be fired sequentially by simply pressing FIRE repeatedly since the transmitter advances to the next sequential cue after each depression of the FIRE button. Cues can be fired in rapid-fire (automatic) mode after pressing **Prgm Rcvr** while the transmitter is armed, as indicated by a red Rcvr Signal light. Cues will then fire at the most recently selected rate, ranging from 1 to 20 shots / second, while the FIRE button is held down. See section 4.0 for additional details and the fire rate selection procedure.

Numerous other features, described in detail below, are incorporated in this system. Despite the complexity of the system’s hardware and software, operation is simple and straightforward, and reliability is high.

A detailed description of the receiver components follows:

1.1 THE ANTENNA.

The RF signal is received and transmitted through a half-wave dipole antenna. This antenna must be folded down in order to close the receiver box. The receiver may be operated in the folded configuration, but maximum range will be achieved when the antenna is unfolded and vertical. The antenna may be partially folded, and the box lid swung down to rest on top of the antenna tip, to achieve maximum range while still using the lid to provide fallout or rain protection for the receiver panel. The antenna should always be folded, and the lid closed, while the receiver is being stored.

1.2 THE POWER & ARM SWITCHES.

These rotary lock switches are located on the lower left side of the receiver panel. Both switches share a common key which can be removed in either switch position. The “POWER” switch turns on power to the receiver. The “ARM” switch has “Safe” and “Armed” positions. In the “Safe” position no firing outputs can be activated. The receiver TEST function may be performed in either position of the ARM switch, however. For operator safety, the ARM switch should always be kept off when turning on the power switch if devices are connected to the output terminals or rear cable connector. The switch should be rotated from “Safe” to “Armed” only after verifying that the FIRE SIGNAL indicator is not illuminated or flashing, indicating that no FIRE signals are being received on the radio channel. **It is important that the operator not arm the receiver until all persons who might be harmed by accidental firing are in a safe area**.

The color of the flashing “Battery” indicator shows the state of the ARM switch as described in section 1.3 below.

1.3 THE “BATTERY” INDICATOR.

While the power switch is on, this indicator, located immediately above the ARM switch, will flash intermittently in bursts of one, two, or three flashes at a time if the battery has enough capacity to power the receiver. It will flash green if the ARM switch is in “Safe” position, and it will flash red if in “Armed” position. If no flashing occurs, the battery must be recharged 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 charge in which case it should be recharged immediately after the current use. Adequate receiver power is available as long as the battery voltage is above approximately 11.0 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 recharged at the very next opportunity.

This indicator will also light momentarily while a valid FIRE or TEST signal is being received from the radio channel or while the MANUAL FIRE button is depressed.

1.4 THE FIRE SIGNAL INDICATOR.

This red indicator lights whenever a valid FIRE signal is received from the radio channel or from the MANUAL FIRE button.

1.5 THE FIRE OUTPUT INDICATOR.

This indicator lights red whenever firing voltage is present on the output terminals. If lighted and no firing commands are being received, a malfunction is indicated, most likely a defective firing relay. Verify that this indicator is not lighted or flashing before connecting devices to the output terminals or connector, before performing any continuity tests, and before turning on the ARM switch.

If this indicator is lighted red and the test function is activated, full firing voltage will appear on the outputs, and devices may be fired during the test (even if the ARM SWITCH is off).

This indicator will flash green each time a FIRE or TEST signal is received that is outside of the receiver's programmed cue range (even if the ARM switch is off). This feature is useful for detecting reception of signals that are directed to receivers other than the one being observed.

1.6 THE OUTPUT CONNECTORS.

Electric matches or other devices to be actuated are connected to spring terminals (pyro-clips) on the receiver panel or optionally to an external firing strip connector on the rear of the receiver box.

The panel contains 32 red and black terminal pairs for connection to the devices to be actuated by receiver cues 1 – 32 (these cue numbers may be different from the show cue numbers, depending on the receiver's programmed first cue number). Positive is indicated by red and negative by black. To connect a wire to a spring terminal, simply push down the plastic top of the terminal 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. #22 is recommended if a firing current of less than 3 amps will be required and if the source is close (within 20 feet). #20 wire should be used for higher currents or longer wire runs. 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.

The optional firing strip connector on the rear of the box permits receiver cue outputs 1 – 32 to be connected to 32 pairs of terminals on a standard PyroMate, FireOne, or Pyro Magic firing strip. These outputs are connected in parallel with the corresponding receiver spring terminals on the receiver panel. If the rear connector is a 50 pin connector and is configured for PyroMate strips, additional receiver cues 33 – 45 are also available here with pins 46 – 50 used as positive common. If it is a 50 pin connector and is configured for 48 cues, additional receiver cues 33 – 48 are also available here with pins 49 & 50 used as positive common. Detailed firing strip connector pinout is shown in the table in section 1.10.

1.7 THE CHARGER CONNECTOR.

This connector is used to attach the battery charger. The battery charger can charge a fully discharged battery in about 4 hours, after which it switches automatically from high rate mode to trickle charge mode. It can be left connected indefinitely in this mode. A second red indicator on the charger illuminates when the charger is in high-rate mode. In trickle charge mode, only the charger's power indicator is illuminated. When the charger is not plugged in, the attached rubber cap should be placed over the receiver panel connector.

An optional remote firing trigger (pickle) is available which can be plugged into the charger connector to enable the operator to manually fire the receiver in sequential mode where outputs are fired in ascending sequence. Manual firing can be programmed from the transmitter to occur in semi-automatic (single-shot) mode, where each press of the trigger fires the next receiver output in sequence, or in automatic (machine-gun or rapid-fire) mode, where outputs are continually fired in ascending sequence at selected rates from 1 to 20 shots per second while the trigger is activated. See section 2.11 for this programming procedure.

Operation with this remote trigger is identical to that described with the manual fire button in the following section. Radio reception is not required for this mode of operation.

1.8 THE MANUAL FIRE BUTTON.

This button can be used to manually fire the receiver outputs in the event of radio link failure. Each time it is pressed, the receiver fires the next output in sequence, starting with output #1 if the ARM switch is on. If the ARM switch is off, the selected output advances with each button press, but no outputs are generated.

This button can also be programmed to fire the receiver in automatic (rapid-fire or machine-gun) mode at selected rates from 1 to 20 shots per second. See section 2.11 for this programming procedure.

1.9 THE EMERGENCY FIRE TERMINAL.

This provides a second backup method for firing in the event of electronic failure that disables the manual fire button function. Emergency firing can be accomplished by connecting a wire to this terminal and, while holding the MANUAL FIRE button down, touching it to the black terminal of the output that is to be fired. Outputs can thus be fired as if by a pin board and wand. Be careful not to touch the wire to the red terminals as this will place a short circuit across the battery. The shorted output is protected by automatically resetting fuses, but a large spark will still be produced.

1.10 OPTIONAL FIRING CONNECTOR PINOUT.

Connector description: 50 position SCSI-I .085" female panel receptacle.
Digi-key part number: 1050F-ND

Mating connector: 50 position male Centronics cable connector with boot
Digi-key part number: T1504-ND

Pin #	Description	Notes
1	Output 1	(connects to negative side of 12 volt source while firing)
2	Output 2	(connects to negative side of 12 volt source while firing)
3	Output 3	(connects to negative side of 12 volt source while firing)
4	Output 4	(connects to negative side of 12 volt source while firing)
5	Output 5	(connects to negative side of 12 volt source while firing)
6	Output 6	(connects to negative side of 12 volt source while firing)
7	Output 7	(connects to negative side of 12 volt source while firing)
8	Output 8	(connects to negative side of 12 volt source while firing)
9	Output 9	(connects to negative side of 12 volt source while firing)
10	Output 10	(connects to negative side of 12 volt source while firing)
11	Output 11	(connects to negative side of 12 volt source while firing)
12	Output 12	(connects to negative side of 12 volt source while firing)
13	Output 13	(connects to negative side of 12 volt source while firing)
14	Output 14	(connects to negative side of 12 volt source while firing)
15	Output 15	(connects to negative side of 12 volt source while firing)
16	Output 16	(connects to negative side of 12 volt source while firing)
17	Output 17	(connects to negative side of 12 volt source while firing)
18	Output 18	(connects to negative side of 12 volt source while firing)
19	Output 19	(connects to negative side of 12 volt source while firing)
20	Output 20	(connects to negative side of 12 volt source while firing)
21	Output 21	(connects to negative side of 12 volt source while firing)
22	Output 22	(connects to negative side of 12 volt source while firing)
23	Output 23	(connects to negative side of 12 volt source while firing)
24	Output 24	(connects to negative side of 12 volt source while firing)
25	Output 25	(connects to negative side of 12 volt source while firing)
26	Output 26	(connects to negative side of 12 volt source while firing)
27	Output 27	(connects to negative side of 12 volt source while firing)
28	Output 28	(connects to negative side of 12 volt source while firing)
29	Output 29	(connects to negative side of 12 volt source while firing)
30	Output 30	(connects to negative side of 12 volt source while firing)
31	Output 31	(connects to negative side of 12 volt source while firing)
32	Output 32	(connects to negative side of 12 volt source while firing)
33	Output 33	(connects to negative side of 12 volt source while firing)
34	Output 34	(connects to negative side of 12 volt source while firing)
35	Output 35	(connects to negative side of 12 volt source while firing)
36	Output 36	(connects to negative side of 12 volt source while firing)
37	Output 37	(connects to negative side of 12 volt source while firing)
38	Output 38	(connects to negative side of 12 volt source while firing)
39	Output 39	(connects to negative side of 12 volt source while firing)
40	Output 40	(connects to negative side of 12 volt source while firing)
41	Output 41	(connects to negative side of 12 volt source while firing)
42	Output 42	(connects to negative side of 12 volt source while firing)
43	Output 43	(connects to negative side of 12 volt source while firing)
44	Output 44	(connects to negative side of 12 volt source while firing)
45	Output 45	(connects to negative side of 12 volt source while firing)
46	Output 46	(connects to negative side of 12 volt source while firing)
47	Output 47	(connects to negative side of 12 volt source while firing)
48	Output 48	(connects to negative side of 12 volt source while firing)
49	COM +12V	(connects to positive side of 12 volt source while firing)
50	COM +12V	(connects to positive side of 12 volt source while firing)

2.0 TRANSMITTER HARDWARE DESCRIPTION.

The model 10000TS “Spread Spectrum” Two Way Firing Transmitter is a long range frequency-hopping spread spectrum two radio transceiver designed to be used for remote control applications where high reliability is critical. When used with Holatron model 10000RS “Spread Spectrum” two way receivers, a range of two miles (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 usually exceed two miles when transmitting over water. Communications occurs on multiple synthesized carrier frequencies in the 900 MHz band. Since synthesis is digitally controlled from a quartz crystal, no alignment or tuning procedures are ever required to maintain optimum performance.

The transmitter’s user interface is powerful and versatile, yet simple to understand and operate. It is designed to be useable without requiring reference to an instruction manual. Twelve LED indicators continuously display transmitter and receiver status, and fifteen sealed buttons enable the operator to enter a wide variety of commands. Since no toggle, slide, or rotary switches are used, the transmitter panel is completely sealed to prevent damage from moisture. The buttons are covered with embossed overlays for good tactile feedback, and they are luminescent, facilitating operation in a dark environment.

Commands are transmitted to the receivers in digitally encoded data packets. These packets contain extensive error detection coding and are transmitted reduntantly multiple times on multiple frequencies to enhance successful communication even in the presence of severe narrow band interference. All communication is “two way” for enhanced reliability. After successful command transmission and execution, the receiver transmits a confirmation signal back to the transmitter. The receiver also continuously transmits status information, such as armed status and received signal strength, which is displayed on the transmitter panel. This enables the operator to have confidence that receiver outputs will fire successfully when commanded.

One transmitter can communicate with multiple receivers to fire large arrays of devices, up to a limit of 9999 cues, total. **No more than one transmitter should ever be turned on at the same time, as each powered up transmitter continually sends out a beacon signal for the receivers to lock onto, resulting in interference with each other and possible “failure to fire”.**

Receivers are programmed in advance from the transmitter panel to sequential cue ranges (so that each receiver fires a selected portion of the total cue range), or to identical cue ranges (so that multiple receivers fire identical cues for “fronts” and similar effects), or to any combination thereof. Randomly selected cues are fired by punching in the cue number and then pressing FIRE on the transmitter panel. Cues can be fired sequentially by simply pressing FIRE repeatedly since the transmitter advances to the next sequential cue after each depression of the FIRE button.

Numerous other features, described in detail below, are incorporated in this system. Despite the complexity of the system’s hardware and software, operation is simple and straightforward, and reliability is high.

A detailed description of the transmitter components follows:

2.1 THE ANTENNA.

Radio commands are transmitted and responses received through a half-wave dipole antenna. This antenna is permanently attached to the transmitter box. Range will be greatest when the transmitter is oriented so that the antenna is parallel to the receiver antennas, normally a vertical orientation.

2.2 THE BATTERY.

The transmitter is powered by a standard 9 volt alkaline battery accessible by removing a sliding door from the back of the transmitter. When a new battery is installed, the transmitter may power up even though the POWER button has not been pressed. If this occurs, press and hold the POWER button for at least ¾ second to turn the transmitter off. Because this is a 100 milliwatt transmitter and communication is occurring continuously with the receivers, the battery will only last for a few hours of continuous operation. To extend battery life, keep the transmitter turned off until just before it will be used. A few seconds will be required for the receivers to resynchronize to the transmitter's beacon once it is turned on. Acquisition of synchronization is indicated when the transmitter's RECEIVER SIGNAL indicator begins flashing in bursts of two or more. Once flashing occurs in bursts of two or more, the operator may transmit commands to the receiver.

2.3 THE BATTERY / RCVR PROGRAM INDICATOR.

Battery status is indicated by the flashing of this lamp when the transmitter is turned on and a programming mode has not been selected with the **Prgm Rcvr** button. It flashes intermittently in bursts 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 be dropping rapidly at this point.

If a programming mode has been selected, this indicator will light continuously, and its color will indicate which programming mode is currently active. See section 2.11 for additional information about this function.

2.4 THE “RECEIVER SIGNAL” INDICATOR.

The strength of the transmitted beacon at the receiver selected by the “Next Cue” number is indicated by the flashing of this lamp. It flashes intermittently in bursts of two, three, or four flashes at a time if the beacon is being received by the receiver. If fewer than two flashes occur, there is not a reliable radio link, and the receiver will not execute transmitted commands. Four flashes per burst indicate that a very strong signal is being received, three flashes indicate that a moderate to strong signal is being received, and two flashes indicate that a weak to moderate signal is being received. Before actual firing, it is a good idea to perform a walk-around to determine the limits of system range by observing this indicator. To ensure a margin of reliability, operate the transmitter within ¾ of this maximum range while actually firing. Verify before firing that the radio link is reliable with the transmitter and receivers located in the exact spots where they will be used, as there will sometimes be dead-zones within the maximum range perimeter due to multi-path cancellation from signal reflections from nearby objects. When operating near the maximum range, this becomes more critical, and movement of only a few feet can make the difference between a successful or unsuccessful radio link.

Be sure to punch in a “Next Cue” number that falls within the programmed cue limits of the receiver whose radio link is to be monitored. See section 2.5 & 2.6 for a description of the “Next Cue” number display and “Next Cue” entry procedure, respectively. If no receiver with programmed cue limits that include the transmitter’s “Next Cue” number is operating, the RECEIVER STATUS indicator will only give single flashes, indicating that no radio link is currently functioning. A few seconds after a “Next Cue” number within an operating receiver’s limits is punched in, the RECEIVER STATUS indicator will begin flashing if a radio link has been established.

It should be noted that the RECEIVER STATUS indicator will only function when communicating with receivers programmed into MASTER mode. Receivers programmed into SLAVE mode will provide no indication of a radio link since they are listeners only and do not transmit status or confirmation signals back to the transmitter. Only MASTER receivers do that.

This indicator also displays the remote armed state of the selected receiver. It will flash red if the receiver has been armed from the transmitter and green if is unarmed (safe). **To fire, a receiver must be armed from its local lockswitch as well as from the transmitter.** Note that this indicator is not affected by the state of the selected receiver’s ARM switch. It is the operator’s responsibility to ensure that that switch has been turned on before firing.

2.5 THE “NEXT CUE” NUMBER DISPLAY.

The number of the next cue to be fired or tested is displayed on the LED numeric indicators located on the right edge of each numerical button, with 9999 being the highest number that can be displayed. The digit sequence of the number is flashed repeatedly. For example, cue number 122 would be indicated by a sequence of three flashes: LED 1, LED 2, LED 2, followed by a pause. This sequence repeats continuously. The color of these LEDs indicates the results of the last receiver test. See section 2.7 for a detailed description of the TEST function.

2.6 THE “NEXT CUE” ENTRY BUTTONS.

The number of the next cue to be fired or tested is entered on the ten numerical buttons, with 9999 being the highest number that can be entered. Entered dIgits are appended to the right side of the number being displayed (like a calculator). A new number can be entered (erasing the currently displayed number) after one of the five non-numerical function buttons has been pressed. The new cue number will be displayed at the next digit flash cycle.

2.7 THE TEST BUTTON.

If a radio link is established, this button will cause the MASTER receiver whose programmed cue limits include the displayed cue number to perform a continuity test on the output corresponding to the displayed cue number. The flashing numerical display will then turn green if continuity was detected, or red if an open circuit was detected. If no response to the test command is received, the numerical LEDs will flash with a yellow color. Yellow indicates that a reliable continuity test on the displayed cue number has not been performed. If a new cue number is entered, the cue number display will return to yellow. If TEST is pressed a second time without entering a new number or pressing any other function button, automatic testing of all remaining cues in ascending order will commence. This will continue until a cue is tested that does not return a signal indicating continuity of the MASTER receiver output corresponding to that cue number. Testing will then stop, and the transmitter will display the number of the failed cue, either red to indicate an open circuit or yellow to indicate that no receiver response was detected. If all cues test OK, the transmitter will stop with a yellow indication on the first cue past the upper limit of the last receiver. When a failed cue is detected, the operator should make a note of the number and then press TEST again. Automatic testing will then continue until the next failure is detected. In this way, the entire range of cues to be fired can be tested quickly and easily.

It is also easy to retest any individual cue, even while firing, by punching in its number and pressing TEST, with the result being displayed on the next digit flash cycle. If TEST is pressed while the transmitter is armed, it will automatically switch to SAFE.

NOTE: Receivers that have been programmed to fire simultaneously (master and slaves programmed to the same cue range) must be tested individually, as they will otherwise transmit their test results simultaneously and interfere with each other. To test a receiver individually, all other receivers programmed to the same cue range must be turned off. If slaved receivers are not being used in a show, all receivers may be turned on and tested in a single scan.

2.8 THE FIRE BUTTON.

Cues can be fired sequentially by simply pressing the fire button repeatedly (semi-automatic mode) Cues can be randomly selected and fired by punching in the selected cue number and then pressing fire. This selection-fire sequence can be repeated as required. Note that this is a manual firing system, and it is not currently configured to fire programmed sequences. Holatron Systems offers optional transmitter accessory modules with preprogrammed firing modes such as “automatic fire” at preset or selectable rates, and preprogrammed rhythms.

If the RECEIVER STATUS indicator is flashing red, the FIRE button will cause the receiver outputs corresponding to the displayed “NEXT CUE” number to fire (in receivers whose ARM switch is on). The transmitter will then advance its display to the next higher cue number, whether the receiver output is successfully fired or not. The next fire command will be directed to the receiver outputs corresponding to that new cue number

2.9 THE ARM BUTTON.

If the RECEIVER STATUS indicator is flashing green, a press of this button causes all receivers, both MASTER and SLAVE, within radio range of the transmitter to switch to the REMOTE ARMED state. The MASTER receiver selected by the currently displayed “NEXT CUE” number will then radio confirmation of the state change back to the transmitter, causing its RECEIVER STATUS indicator to begin flashing red. If the RECEIVER STATUS indicator is flashing red, a press of this button causes all receivers, both MASTER and SLAVE, within radio range of the transmitter to switch to the REMOTE DISARMED state. The RECEIVER STATUS indicator will then begin flashing green whether or not confirmation is received at the transmitter. The transmitter will not transmit any firing commands unless the RECEIVER STATUS indicator is flashing red.

2.10 THE POWER / CLEAR BUTTON.

This button performs three functions. If the transmitter is off, pressing it turns the power on. If the transmitter is on, a short press (less than ¾ second) will clear the last number entered into the “NEXT CUE” ENTRY buttons, leaving the display flashing cue number 1. Any number entered after that will replace the number 1. If the transmitter is on and this button is pressed continuously for more than ¾ second, the transmitter power will switch off. Simply hold the button down until the lights switch off. While powered down, the transmitter will save in non-volatile memory its ARMED state and the “NEXT CUE” number that was being displayed before power-down, and it will start up with this ARMED state and number when power is turned back on.

The transmitter will also power down automatically, saving its ARMED state and “NEXT CUE” number, after a continuous 43 minute period without button activity.

2.11 THE MODE / PROGRAM BUTTON.

This button, labeled **Prgm Rcvr**, sequentially selects one of three programming modes or the normal operating mode. In the normal operating mode, the Bat / Rcvr Program indicator flashes green to indicate the transmitter battery status, as described in section 2.3 above. The programming modes are used to program individual receiver operating parameters and are indicated by continuous illumination of the Bat / Rcvr Program indicator instead of flashing. Programming should be performed upon one receiver at a time, with all other receivers powered down. The transmitter must be at least 5 feet away from the receiver in order not to overload its RF circuitry. Programming must be the first operation after transmitter power-up. Programming mode will be disabled in the transmitter after any other operation such as ARM, FIRE, TEST, or next cue entry has occurred (to protect against accidental reprogramming by hitting the mode button during a show). Newly programmed values will be retained by the receiver, even while its power is off, until reprogrammed from the transmitter.

The first press of this button switches to MASTER programming mode, as indicated by continuous green light from the Bat / Rcvr Program indicator. If no number is entered into the numerical buttons, the second press of **Prgm Rcvr** switches to SLAVE programming mode (indicated by continuous yellow). If no number is entered, the third press switches to # OF RECEIVER CUES programming mode (labeled as “XMT RCV CH #” on first generation transmitters). This mode is indicated by continuous red. The fourth press always switches back to normal operating mode.

While in MASTER mode, entering a cue number followed by depression of the **Prgm Rcvr** button will cause that number to be programmed as the show cue number corresponding to the first output of the receiver being programmed. All other outputs on this receiver will be mapped in ascending order. This operation also programs the receiver to MASTER mode, meaning it will radio responses back to the transmitter.

While in SLAVE mode, entering a cue number followed by depression of the **Prgm Rcvr** button will cause that number to be programmed as the first show cue of the receiver as above, but the receiver will be programmed to operate in SLAVE mode, meaning it will execute commands but will not radio responses back to the transmitter. SLAVE mode is required if more than one receiver will occupy the same cue range. Only one of these receivers should be programmed as a MASTER, as only one receiver should be transmitting at a time (to avoid data collisions resulting in corruption of responses). Note that continuity testing cannot be performed on slave receivers since they cannot radio results back to the transmitter.

While in # OF RECEIVER CUES mode, entering a cue number followed by depression of the **Prgm Rcvr** button will cause that number to be programmed as the total number of cues to be fired by the receiver being programmed. This number should not normally be set higher than the total number of outputs available in the receiver being programmed (usually 32, 45 or 48). In this case, receiver manual-fire mode will be programmed to semi-automatic (single-shot). If a number with more than two digits is entered and followed by depression of the **Prgm Rcvr** button, the two least significant digits will program the total number of cues to be fired by the receiver as described above, and the receiver manual-fire mode will be set to automatic (machine-gun or rapid-fire), where the more significant digits will set the receiver's manual-fire rate in shots per second. This rate must be in the range of 1 to 20 shots per second. For example, an entry of 2032 would program the receiver for automatic manual-fire at a rate of 20 shots per second and a total of 32 cues. An entry of 906 would program the receiver for automatic manual-fire at a rate of 9 shots per second and a total of 6 cues. An entry of 32 would program it for single-shot manual-fire and a total of 32 cues.

If a cue number is erroneously entered while in program mode, pressing the CLEAR button will enable the operator to reenter the number or to exit program mode (by additional depressions of the **Prgm Rcvr** button) without programming the receiver.

This button can also be used to read the first cue number or total number of cues of the receiver without programming it. After switching to MASTER or SLAVE mode, the receiver's first cue number will be displayed on the transmitter numeric indicators. After switching to # OF RECEIVER CUES mode, the receiver's total # of cues to be fired will be displayed. Without entering a number, continue pressing this button until normal operating mode is restored, and the programmed values will remain unchanged.

3.0 RADIO INTERFERENCE REDUCTION.

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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 using two-way communication (where the receiver confirms successful or unsuccessful command reception back to the transmitter) and by transmitting commands in the form of digital data packets, each containing a 40 bit security code and 24 bit command code plus packet error check code. When a transmitter command button is pressed, the packets are transmitted redundantly on multiple frequencies until two successive identical error free packets are detected by the receiver. Since two successive packets of security code bits must match the pattern expected by the receiver, a continuous 80 bit error free pattern must be recognized before a command (such as FIRE) will be executed by the receiver. Thus, there is one chance in 2 to the 80th power of a random interfering signal matching the security code and possibly resulting in unintended actuation at the receiver. Expressed in decimal numbers, this is 1.1209 times 10 to the 24th power (or 11209 followed by 20 zeroes). This is a probability of 8.2718 times 10 to the -25th power (or a decimal point followed by 24 zeroes followed by 82718). 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 with its keylock switch until all persons who might be harmed by accidental actuation are in a safe area**.

Additional protection is offered by the inclusion of packet error checking code generation in the transmitter and detection in the receiver. The packet error checking reduces the probability of unintended actuation to a value considerably lower than that calculated above. Because this system operates in the UHF region (900 MHz), interference from such sources as lamp dimmers, electrical discharges, and natural sources is minimal.

Since its introduction in 2005, the technology in this system has been tested and used in numerous public fireworks displays and theatrical applications, and no instances of unintended or accidental actuation have been reported to date.

4.0 RAPID-FIRE BURST MODE.

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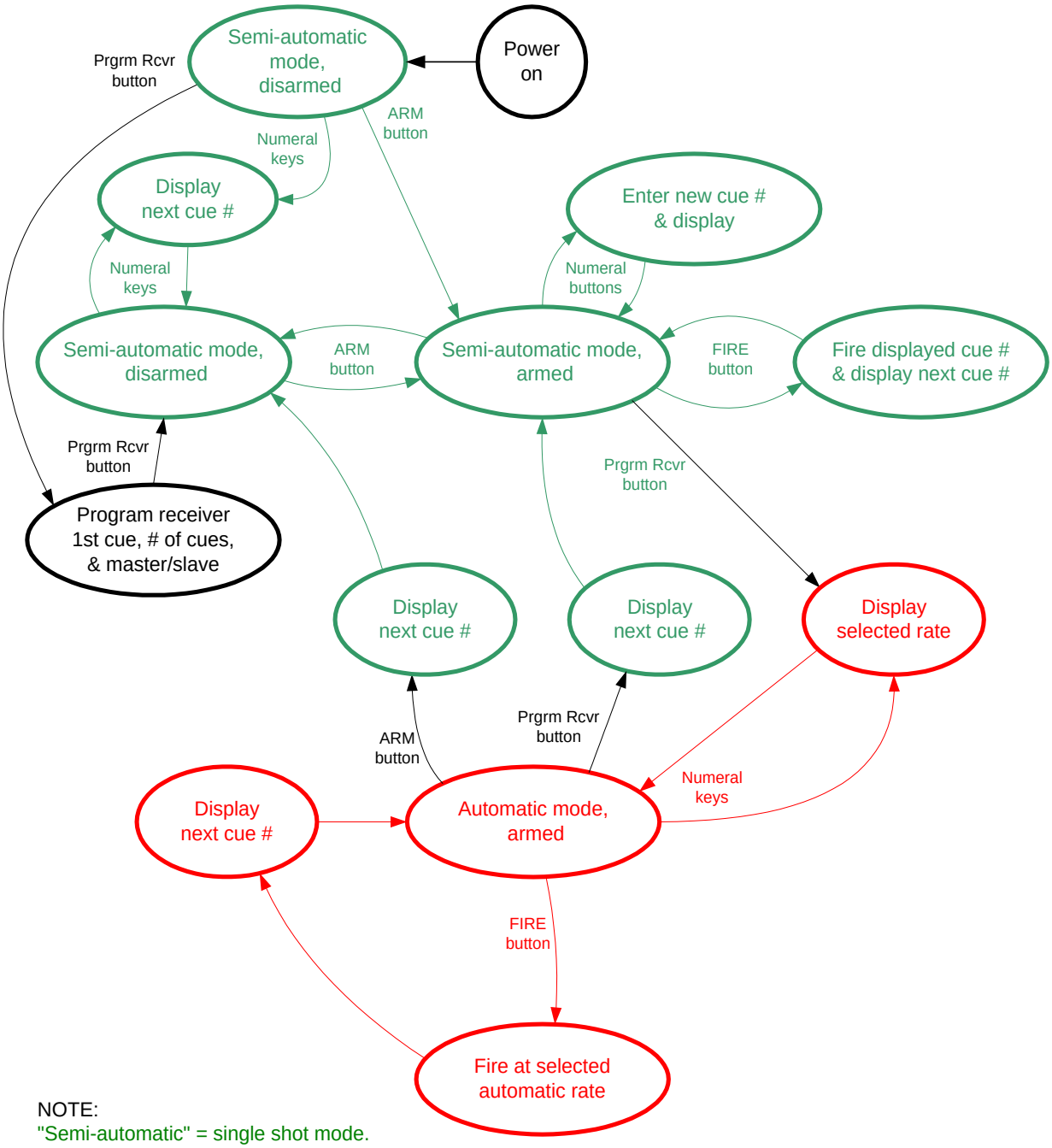
This transmitter incorporates built-in rapid-fire burst capability which is accessed by pressing the mode button while the transmitter is armed. When in rapid-fire mode, the “Bat / Selected Mode” indicator turns red and flashes continually at the selected rapid-fire rate. A rate of 1 to 20 shots / second may be selected by pressing the numeric keys, and the numeric indicators will flash to show the numerals selected. Entering rates greater than 20 will default to 20. The receivers will fire at the selected burst rate while the transmitter’s FIRE button is held down. When released, the numeric indicators will display the number of the next cue to be fired. The firing rate can be changed by entering a new rate on the numeric buttons, and the new rate will then be displayed. If an incorrect rate is accidentally entered and must be changed, press the CLR button before reentering the rate. The operator can freely switch back and forth between rapid-fire and single-shot operation by repeatedly pressing the **Prgm Rcvr** button while the transmitter is armed. See the following firing mode state diagram for a detailed explanation of the behavior of this user interface.

When using a later generation transmitter with a first generation receiver, the selected rapid-fire rate must not exceed 7 shots / second, or some cues may be skipped in the receiver, resulting in some unfired outputs.

Transmitter Firing Mode State Diagram



NOTE:
"Semi-automatic" = single shot mode.
"Automatic" = rapid fire mode.

5.0 SPECIFICATIONS.

Parameter	Minimum	Typical	Maximum
Spread Spectrum Carrier Frequency-hopping Range, MHz. (US & Canada)	902.217		927.492
Spread Spectrum Carrier Frequency-hopping Range, MHz. (Australia)	915		927.492
Range (line-of-sight, no intervening conductive objects)	5 feet		2 miles
Transmit Signal Security Code Length		80 bits	
Transmit Retries per Command Failure			4
Radio Communications Link Data Rate		76.8 KBaud	
Delay from start of transmission to receiver output			100 msec
Transmitter rapid-fire burst rate, shots / second	1		20
Receiver battery capacity, amp-hours		1.4	
Battery charge life, (Rcvr switched off) Battery charge life, (Rcvr switched on, not firing) Battery charge life, (Rcvr switched on, firing)		6 months 48 hours 10 hours	
Receiver 12V battery charge current			300 mA DC
Receiver 12V battery charge time			4 hours
Low Battery Detect Threshold		11.1 V	
Output Fire Voltage		12 VDC	
Output Fire Current			5 amp
Output Continuity Test Current		0.9 mA	1.1 mA
Output Continuity Test Pulse Duration		100 msec	
Enclosure height with lid closed, inches		4 ⅞	
Enclosure length, inches		10 ¾	
Enclosure width, inches		9 ⅞	
Total Weight (no external strip connector)		6 lbs 3 oz	
Total Weight (with external strip connector)		6 lbs 5 oz	

6.0 OPERATION AND MAINTENANCE.

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

6.1 OPERATION.

Note that the transmitter and receiver should be separated by at least 5 feet to establish a radio link. Smaller separations overload the receiver input circuitry, corrupting communication.

6.1.1 Perform a range test by observing the RECEIVER SIGNAL indicator on the transmitter panel. Refer to section 2.4 for a detailed description of the operation of this indicator. No assistant is needed for this test as the range of the radio link is displayed on the transmitter panel. Determine the limits of the range in the current environment, and position the transmitter and receiver so that their separation does not exceed ¾ of this maximum range. Verify that the transmitter battery is not depleted by observing the flashing “Bat / Rcvr Prgm” indicator on the transmitter panel, and verify that the receiver battery has a sufficient charge by observing the flashing “BATTERY” indicator on the receiver panel. Operation of these indicators is as described in sections 1.3 and 2.3 above. Turn the transmitter power switch off, and turn off the receiver.

6.1.2 Connect devices to the receiver outputs. With the “ARM” switch turned off, turn on the receiver power switch. Verify continuity through the devices by pressing the “TEST” button on the transmitter as described in section 2.7. When done, turn off transmitter power to conserve the battery.

6.1.3 Be sure all receiver ARM and POWER switches are turned on. Turn on the transmitter, and make sure the correct first cue is punched in. Arm the system with the transmitter ARM button. Fire the desired cues. When finished, disarm the system with the transmitter ARM button. Turn off the transmitter and then the receivers.

6.2 MAINTENANCE.

Since there are no calibration or tuning adjustments in the units, the only maintanance required is periodic replacement of the 9 volt transmitter battery and recharging of the 12 volt receiver battery. The receiver battery should be replaced every 3 to 5 years under normal useage. It should be replaced immediately if accidentally left on and completely discharged. Such a discharge causes irreversible damage to the cells of the battery. Note that there are 4 small vent holes under the lip of the receiver box. These should not be blocked, as they prevent the buildup of hydrogen gas within the receiver box during battery charging to avoid the danger of an explosion caused by an arcing switch or relay.

The face of the transmitter, which is completely sealed, may be safely cleaned by wiping with a damp cloth, but the battery compartment door and the junction between the front and back panels are NOT water tight. The transmitter and receiver must never be immersed in water.

If further information or service is required, contact:

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