HOLATRON

OPERATION & MAINTENANCE GUIDE - *SureFire-1* High Energy Trigger

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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 module described in this manual is part of a system intended to remotely actuate pyrotechnic or other hazardous devices, and the components of this system have been carefully designed to minimize the possibility of accidental actuation of such devices. Holatron's design goal is to ensure that data communication errors due to radio interference or to insufficient signal strength due to low battery, exceeding specified range, or conductive objects in the signal path will result in failure of intentional actuation rather than unintended actuation. Techniques used to achieve this design goal are described in section 1.8. 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 module 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.

This manual is divided into five sections. The first is a description of the system hardware. The second details techniques to minimize radio interference, the third lists system specifications, the fourth describes operating procedure, and the fifth describes recommended maintenance.

1.0 HARDWARE DESCRIPTION.

The model RFLS-CD1 High Energy Trigger is a single output capacitor discharge firing module which can be triggered by an onboard manual switch, wire command input, or radio command input. The wire command input is applied to the red and black REMOTE INPUT PyroClip terminals. The input accepts 9 VDC pulses (red is +, black is -) or contact closures. The input is optically isolated from the internal high voltage firing circuitry.

NOTE:
Due to safety concerns over the possibility of accidental manual firing, the MANUAL FIRE position of the ARM switch is only enabled for 3 seconds after the switch is moved out of the ARMED position. This ensures that the output cannot be fired manually by accidentally pushing the ARM switch in the wrong direction after it has been in SAFE position for 3 seconds or longer.

Radio commands are received by a highly sensitive narrow band (superhetrodyne) radio receiver designed to be used for remote control applications where high reliability is critical. When used with the Holatron model RFLS-6HSXT, XMTR12B, and similar high speed 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 PLL frequency synthesized oscillator for exceptional stability. No alignment or tuning procedures are ever required to maintain optimum performance.

The radio firing signals are digitally decoded from the transmitted digital code which is amplitude modulated on a single carrier frequency of 418 MHz. The transmitted digital code indicates to the trigger which of the transmit buttons is being pressed as well as the current transmitter cue and channel number.

A 16 position digital switch inside the module is used to select radio pairing mode or one of three firing modes (“radio-fire / fire-by-wire”, “fire-by-wire only”, or “radio only”), and one of five output energy levels. The “fire-by-wire” modes also enable operation of the manual fire switch. Switch position assignments are shown in the table in section 1.8. Other custom switch assignments can be incorporated in software at time of manufacture.

The digital channel switch has been initially set to position “5” at the factory for output of 12.3 joules in both radio and wire-fire modes. Charging to full energy takes approximately 9 seconds and is initiated when the ARM switch is moved from SAFE to ARMED position.

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 antenna which screws onto the top of the module. The antenna should be removed for storage.

The antenna need not be tight to achieve a good electrical connection. It should be hand-tightened only to the point where resistance to further rotation is felt. It should never be tightened with pliers or other tools.

Note that reception is better when the antenna is elevated at least 12” above earth ground or nearest conductive surface. This is necessary to achieve specified range.

1.2 THE POWER, ARM, & TEST SWITCHES.

These miniature toggle switches are located on the top panel.

The POWER switch turns on power to the module but does not initiate charging. After a delay of a couple of seconds, the BATTERY / ACTIVATE light will flash amber to indicate the channel number to which the radio receiver has been paired. The flashing pattern will consist of a series of flashes equaling the channel number for channels 1 through 9, or a short-flash followed by a delay and then a long-flash for channel 10, or short-flash / delay / short-flash for channel 11, or short-flash / delay / 2 short-flashes for channel 12. The light will then begin the normal battery level flash indication described in section 1.3.

The ARM switch has SAFE, ARMED, and MANUAL FIRE positions. In the SAFE position, the output cannot be fired, even if fire commands are received from the radio or wire terminals. **It is recommended that the module always be powered up in SAFE mode if devices are connected to the output. The operator can then verify that the BATTERY / ACTIVITY light does not indicate that any wire or radio signal reception is occurring before switching to ARMED. A prolonged or erratic illumination of this light may indicate the presence of an active fire-by-wire or radio input which could cause the output to fire as soon as the ARM switch is placed in the ARMED position with a charge present on the capacitors.**

If not in “radio-only” mode, full energy level is reached within 0.5 to 9 seconds, after switching to ARMED, depending upon the energy level selected. Capacitor charge is then maintained until the output is fired or the ARM switch is moved to SAFE position. Length of charge time is a function of the energy level. Firing into a load will immediately discharge the capacitors to a lower value, but not to zero. Switching to SAFE will merely stop charging, but the firing energy will remain in the capacitors until the PWR switch is turned off. The capacitor bank is slowly discharged while the power switch is off. This process takes approximately one minute for complete discharge from maximum energy to zero.

The MANUAL FIRE position is a momentary spring return position which, if not in "radio-only" mode, causes the output to fire when actuated within 3 seconds of having been in ARMED position. Switching to SAFE for more than 3 seconds disables the MANUAL FIRE function until the switch is again placed in ARMED position. To conserve battery life, capacitor charging is stopped whenever MANUAL FIRE is activated. It will not resume until this switch is moved from SAFE to ARMED position.

The TEST switch is a spring-return switch which activates the module's output continuity test function. Operation of the "TEST" switch is described in section 1.4.

1.3 THE BATTERY / ACTIVATE INDICATOR.

While power is on, this indicator, located just above the POWER switch, will flash periodically in bursts of one, two, or three flashes at a time if the battery has enough capacity to power the module. If the capacitor bank is discharged, it will flash green, if partially charged, it will flash orange, and if charged fully to the selected energy level, it will flash red.

If no flashing occurs, the batteries will need to be replaced before the module 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 module power is available as long as the battery voltage is above approximately 5 volts, but the battery voltage will drop rapidly after this point. While this additional time should be adequate to complete the current operation, it is not absolutely predictable, and so all batteries should be replaced at the very next opportunity.

This indicator will also light while a wire-fire input signal, or a radio signal that matches the expected preamble and sync code of the system communication protocol, is being received, even if it is from a transmitter set to a different digital channel, different system code, or firing a different cue than the one to which the receiver has been paired. It will light green if the reception does not match the selected cue, channel, and system code, and it will not fire the output. **It will light red if the received command is capable of firing the output.** This includes the wire-fire and manual-fire commands. This feature is useful for warning of the presence of firing signals before the arm switch is turned on and for indication of activity on other digital channels.

At power-on, this indicator will flash amber to indicate the channel number to which the radio receiver has been paired. This flashing pattern is described in section 1.2 above. It will then begin its normal battery flashing cycle.

1.4 THE TEST INDICATOR.

This indicator, located just above the TEST switch, lights green when the switch is momentarily pressed upward if there is a device connected between the yellow output terminals. This test uses a one milliampere current to perform a galvanometer function that verifies continuity through the device connected to the output, ensuring that a successful firing will occur when the module is actuated. The test current is well below the minimum fire current of electrically actuated devices, and it is only applied while the TEST switch is actuated. The test can be performed safely in both the SAFE and ARMED positions of the ARM switch.

1.5 THE REMOTE INPUT CONNECTORS.

When the ARM switch is in the ARMED position, a contact closure or a 9 VDC pulse applied to these terminals will cause the output to fire. If triggering with a DC pulse, the pulse's positive wire should be connected to the red terminal, and the pulse's negative wire should be connected to the black terminal. The input is protected from accidental reverse polarity connection, but the output will not fire in this case.

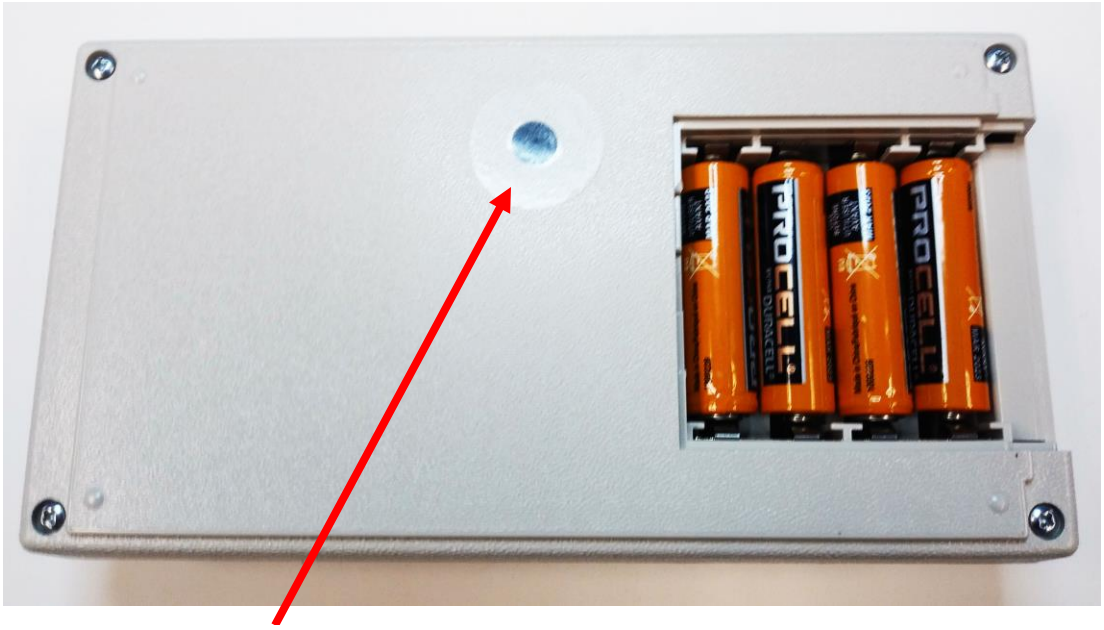
1.6 THE OUTPUT CONNECTORS.

The device to be fired is connected between the yellow "PyroClip" spring terminals located at the end of the top panel.

CAUTION: The pulse applied to these terminals may be as high as 315 volts when the output is fired. This will result in a painful, and possibly lethal, electric shock to a person touching these terminals at the moment they are fired. BE CAREFUL! Do not touch their metal contacts unless the ARM switch is in "SAFE" position and/or the power switch is off. To be sure no charge remains on the capacitors, wait at least one minute after turning off the power switch. This is especially important before opening the module's enclosure, as it is possible to accidentally make direct connection to the stored capacitor voltage, even in SAFE mode, while the enclosure is open.

1.7 THE BATTERIES.

All power is supplied from four AA alkaline batteries, contained in a compartment in the bottom of the plastic box as shown below:



The batteries should be replaced when required by conditions described in section 1.3 above. Be careful to observe the positive and negative polarity markings in the battery compartment when installing batteries. In order to prevent irreversible damage to the module, the batteries should be removed before storing the module for long periods of time. **To prevent battery depletion and resulting leakage, be sure the power switch is turned off when the module is not being used.**

1.8 THE DIGITAL SWITCH.

A 16 position rotary switch inside the module, accessed as shown above, is used to select radio pairing mode or one of three firing modes (“radio-fire / fire-by-wire”, “fire-by-wire only”, or “radio-only”) and one of five output energy levels.

The digital switch has been initially set to position “5” at the factory for operation by radio, wire-fire, and manual-fire, with energy level of 12.3 joules (316 VDC output pulse). Access to this switch is gained by removing the adhesive seal over the hole in the bottom cover shown in section 1.7 above. The digital switch can then be set by turning it with a miniature flat blade screwdriver. The possible selections are shown in the following table:

Switch Position	Output Energy / Max Voltage	Mode
1	1.14 joules / 96 volts	Radio / wire-fire
2	3.16 joules / 160 volts	Radio / wire-fire
3	5,55 joules / 212 volts	Radio / wire-fire
4	8.67 joules / 265 volts	Radio / wire-fire
5	12.3 joules / 316 volts	Radio / wire-fire
6	1.14 joules / 96 volts	Manual / wire-fire only
7	3.16 joules / 160 volts	Manual / wire-fire only
8	5,55 joules / 212 volts	Manual / wire-fire only
9	8.67 joules / 265 volts	Manual / wire-fire only
A	12.3 joules / 316 volts	Manual / wire-fire only
B	1.14 joules / 96 volts	Radio only
C	3.16 joules / 160 volts	Radio only
D	5,55 joules / 212 volts	Radio only
E	8.67 joules / 265 volts	Radio only
F	12.3 joules / 316 volts	Radio only
0		Pair with transmitted cue, channel, and system code.

(Factory setting shown in yellow)

Other combinations of output energy level, cue number, and radio channel can optionally be provided by the factory.

Charging does not start when power is turned on.

If “manual / wire-fire only” (no radio) is selected by setting the switch to positions 6 – A, output capacitor charging will begin upon switching from SAFE to ARMED. It will take approximately 9 seconds to charge from 0 to 12.3 joules. Charge will then be maintained until a wire-fire or manual-fire command input, at which time charging will cease in order to conserve battery life. The ARM switch must be set to SAFE and then back to ARMED to restart charging in this mode.

If “radio-only” mode is selected by setting the switch to positions B – F, output capacitor charging will not begin until the module is armed and a transmitter is turned on. Holatron transmitters output a “Reset” command automatically when they are turned on. So the High Energy Trigger can be left on and armed, but its power will be conserved until the transmitter is turned on and charging commences. Charging ceases upon output firing in order to further conserve battery life. Charging can be restarted by turning the transmitter off and then back on in this mode.

All other switch positions allow firing by wire, manual, and radio command. Charging is initiated by switching from SAFE to ARMED in these modes.

2.0 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 transmitting a 64 bit noise-rejecting 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 18st power, or 11529 followed by 14 zeroes). This is a probability of 8.6736 times 10 to the -19th power (or a decimal point followed by 18 zeroes followed by 86736). Though this probability of unintended actuation is extremely small, it cannot be guaranteed to be zero. Therefore**, it is important that the user not power up and arm the trigger with device(s) connected until all persons who might be harmed by accidental actuation are in a safe area**.

Additional protection is offered by use of 418 MHz as the operating frequency. This frequency is 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. In case of 418 MHz interference problems, we recommend use of our 315 MHz systems, and this little used frequency has never produced any complaints of interference problems.

No instances of unexpected actuation with this communications technology have been reported to date, but the user must consider that radio is a shared medium. It is very important to know what other wireless devices are operating in the vicinity of this equipment. Interference from non-Holatron equipment can result in diminished range or failure-to-fire, and **interference from other Holatron devices operating on the same channel and with the same system code can result in unexpected actuation**. To be protected from this possibility, the user must request a proprietary system code from Holatron when ordering a transmitter.

3.0 SPECIFICATIONS.

Parameter	Minimum	Typical	Maximum
Carrier Frequency, MHz.	417.96	418.02	418.08
Range (line-of-sight with XMTR12B or RFLS-1XT xmtr)			½ mile
Delay from start of transmission to fire output			100 msec
Charge-up time from pwr-on to max energy level			9 sec
Average battery drain, (1.14 joules) Average battery drain, (12.3 joules) Instantaneous battery drain, (charging)		20 mA 45 mA 500 mA	
Continuous battery life, (not charging) Continuous battery life, (1.14 joules, charging) Continuous battery life, (12.3 joules, charging)		4 months 4 days 2.5 days	
Low Battery Detect Threshold		5.0 V	
Battery Input Voltage	4.0 V	6.0 V	6.5 V
Output Fire Voltage	96 V		316 V
Output Fire Energy (standard trigger)	1.14 joules		12.3 joules
Output Test Current			1 mA
Height of box		1.0 in	
Width of box		4.0 in	
Length of box		7.5 in	
Weight of receiver, including batteries		13 oz	

4.0 OPERATION AND PAIRING.

This section describes the recommended operating and pairing procedure for the High Energy Trigger module.

4.1 OPERATION.

4.1.1 If firing by radio signal, turn on and arm the transmitter, and **with the module's ARM switch in SAFE position and no devices connected**, perform a range test by observing the BATTERY / ACTIVITY light on the module while pressing a transmitter fire button**.** An assistant may be needed to observe the module activity light while you operate the transmitter. There should be no intervening conductive objects for most reliable operation. Module antenna must be elevated 12" or more above earth ground level or nearest conductive surface to achieve full specified range. When transmitting over water, range will normally exceed the specified value.

4.1.2 With the transmitter off and in the possession of the operator, the module power off, and its ARM switch in SAFE position, connect the device to be fired to the yellow output terminals.

4.1.3 Turn on the module power switch, and verify that the batteries are not depleted and that no radio or wire-fire signals are being received by observing the “BATTERY / ACTIVITY” indicator as described in section 1.3.

4.1.4 Momentarily press the TEST switch upward and verify continuity through the output device by observing that the TEST indicator lights green.

4.1.5 When the area around the device to be actuated is clear of persons who might be harmed by an accidental actuation, and after verifying that the module’s activity light is not erratic or illuminated continuously (radio or wire-fire signal being detected), move the ARM switch downward into its ARMED position. If the module’s digital switch is not in a “radio-only” position, charging will begin immediately. Otherwise, it will wait for a transmitter turn-on signal. Allow 9 seconds for full 12.3 joule charge to be achieved, as indicated by a red flashing BATTERY / ACTIVATE light.

WARNING:

If the module’s activity light is not green and is erratic or on continuously, its output may be actuated immediately upon switching to ARMED.

Never arm (or power up) the module with a connected device if it has been internally contaminated with water or any other substance, as unexpected actuation could occur due to conductive residues remaining on the circuit board. Contact Holatron Systems first.

4.1.6 If firing by radio, move to a safe distance and wait until you are ready to fire before turning on the transmitter. This causes the transmitter to automatically signal the module to begin charging. In order to conserve module battery life, the module will not charge up until signaled that the transmitter has been turned on.

4.1.7 If possible, verify that the module output capacitors are fully charged by observing that the flashing activity light has changed from green to red. (Orange flashes indicate partial but not full charge.) If unable to view the flashing module charge indicator, wait at least 10 seconds before firing.

4.1.8 The module charge will be maintained until it is fired, disarmed, or powered off. Since battery consumption is relatively high during the charge / maintenance period, you should fire the module soon after charge-up is complete in order to maximize battery life.

4.1.9 Fire the module by transmitting the cue and channel number and system code to which the module has been paired. Reception of these paired parameters when firing by radio, whether the module is armed or not, will immediately stop capacitor charging in order to conserve battery life. Charging can be restarted by turning the transmitter off and back on.

4.1.10 Alternatively, if not in “radio only” mode, you can fire manually or by wire by applying a contact closure or 9 VDC signal to the remote input terminals. Red is positive, and black is negative. The remote input terminals are optically isolated from the high voltage output for safety.

If not in “radio-only” mode, charging can be restarted by setting the module’s ARM switch to SAFE for at least 3 seconds and then back to ARMED. In “radio-only” mode, charging can only be restarted by turning the transmitter off and back on.

4.1.11 When finished firing, power down the transmitter and then the module(s). If a module was flashing green, it is OK to disconnect its output wires immediately. If it was not green, wait at least one minute before disconnecting its output wires.

4.2 PAIRING WITH A TRANSMITTER.

Three parameters determine the transmitters to which the module will respond:

Proprietary System Code (0-255),
Digital Channel (1-12),
Cue Number (1-12)

With the digital switch set to position 0, a single transmission will cause the module to grab all three parameters and pair itself with the transmitter that sent them. This pairing will be saved in non-volatile memory even when the module power is off. After power is cycled and the switch is subsequently set to a non-zero position, the module will respond only to this saved system code, channel, and cue number.

The default factory setting is system code 0, channel 1, cue 1.

5.0 MAINTENANCE.

Since there are no calibration or tuning adjustments in the module, the only maintenance required is periodic replacement of the AA batteries. They should be replaced with a pair of new batteries at least once every two years, at the next opportunity if the battery level indication is flashing 1 flash per burst, or immediately if there are no flashes.

The face of the High Energy Trigger, which is sealed, may be safely cleaned by wiping with a damp cloth. The battery compartment door and the junction between the front and back panels are not water tight, however. The High Energy Trigger must never be immersed in water.

For prolonged storage or shipping, the batteries should be removed. The antenna can also be removed by unscrewing it.

If further information or service is required, contact:

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