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List of Abbreviations used:

A	Amperes
AC	alternating current
°C	degrees Celsius
Hz	Hertz
GUI	Graphical User Interface
IEC	International Electrotechnical Commission
kHz	kilohertz
kW	kilowatts
kΩ	kiloohms
mA	milliamp
mm	millimeter
mV	millivolt
V	volts
VAC	alternating voltage
VDC	direct voltage
PE	Protective Earth
PFN	pulse forming network
W	watts
pk	peak
HV	high voltage
RMS	Root Mean Square
RTN	signal return
Ω	ohms

WARNING

Electric Shock Hazard.
Read this before proceeding further.

The voltages generated by this equipment are potentially hazardous and could result in serious injury or death. Only qualified factory-trained technical personnel should service this equipment.

To avoid possible injury always follow the following safety precautions:

1) To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth.
2) Ensure all metal enclosures are connected to a protective earth ground using the provided PE terminal stud on the rear panel.
3) The protective earth ground PE terminal is for protective grounding connections only and must not have any current carrying conductors attached.
4) Never disable or defeat the safety interlocks which are provided for operator protection.
5) Covers should only be removed by qualified factory-trained technical personnel and only after the AC Mains are disconnected from the rear panel.
6) All storage capacitors must be discharged before any attempt is made to service the unit, to disconnect and re-arrange the output cables, or to replace the flashlamp. Use a high voltage probe with an appropriate voltmeter to check capacitor voltages.

1 Overview

This manual covers a standard Model 8808V flashlamp driver and controller which provides variable pulse width current for pumping solid-state lasers and other similar pulsed loads. Computer control provides the flexibility and convenience of software control with a graphical user interface (GUI). The system status is presented on the various menus of the GUI colored display. The Model 8800V can be configured to include software, simmer supply and a capacitor charging supply to form a complete turn-key laser flashlamp controller in a 19" rack mounted assembly. The 8800V controllers can be synchronized to control two independent flashlamp loads for master oscillator-power amplifier (MOPA) laser applications.

2 Specifications

2.1 Electrical

Input Power	200-240 VAC, 50-60 Hz, single phase 14 – 11.7 Amps RMS
Power Factor	>0.98
Charge Voltage	500, 800 or 1000 VDC maximum
Output Current	500 or 1000 Amps peak
Maximum Pulse Energy	7000 Joules at 10 ms pulse width
Pulse Width Range	0.2 to 10.0 ms
Capacitance Capacity	8808V Controller up to 33.6 mF 8808C External Cap Box up to 112 mF

2.2 Mechanical

8808V Controller	19 inch rack compatible 4U height, 7.0 inch nominal 6.56” high, 16.56” wide, 18.25” deep without the handles
8808C External Cap Box	19 inch rack compatible 4U height, 7.0 inch nominal 6.69” high, 17.0” wide, 21.13” deep,

2.3 Environmental

2.3.1 Operating

Ambient Temperature:	0°C to +40°C
Altitude:	up to 2000 m

2.3.2 Non-operating (transport and storage)

Ambient Temperature:	-40°C to +70°C
Relative Humidity:	10% to 100%, non-condensing
Atmospheric Pressure:	500 hPa to 1060 hPa (7.25 to 15.37 psia)

2.4 Regulatory

Isolation:	1500 VAC, 1MOOP
Safety:	Designed to the following standards Medical use: IEC/EN 60601 3rd edition Industrial use: IEC 61010-1:2010

The lamp drive system, comprised of the 8808V controller and an optional 8808C capacitor bank, is designed for one Means of Operator Protection (1 MOOP) clearance distances for the high voltage operation up to 1 kV output.

2.5 Symbols

Hazard. This equipment produces high voltages which can be fatal. Only Analog Modules, Inc. qualified technicians are allowed to service this equipment.

High Voltage Present. This equipment produces high voltages which can be fatal. Only qualified service personnel are permitted to install the system components. Please see the manual.

Chassis Ground: This symbol indicates where the PROTECTIVE EARTH TERMINAL (PE) ground connection is located. It is provided for protective grounding purposes only and must not have current carrying conductors attached such as any load current return conductor.

3 Installation and Setup

3.1 Location and Mounting

The 8808V is designed to be securely mounted inside a standard 19-inch equipment rack. The unit must have free air flow behind the system and at least one inch above the unit for air to circulate.

Ensure all metal enclosures are connected to a protective earth ground using the provided PE terminal stud on the rear panel.

3.2 Rear Panel Connections

Please note the following before operating the system:

a) Do not use any other interconnection cables to the flashlamp and between the cap box and controller other than those provided by Analog Modules, Inc. The system was designed to keep cable lengths and cable inductance to a minimum and sized appropriately for loads' expected amperage.

CAUTION

Use of cables other than those provided may cause damage to the system.

b) The 8808V system was designed for use with an external flashlamp trigger transformer. The end user's laser head must accommodate this type of triggering with sufficient electrical isolation so that there can be no possibility of arcing between the trigger plane to both the anode of the flashlamp and to a ground plane.

CAUTION

Any arcing of the trigger to the flashlamp anode will permanently damage the output isolation diode of the system and prevent simmering of the flashlamp.

The standard 8808V models have two rear panel setups, one with a Fischer connector for lamp output currents up to 30 A_{RMS}, and another with two Supercon connectors for lamp output currents up to 100 A_{RMS}.

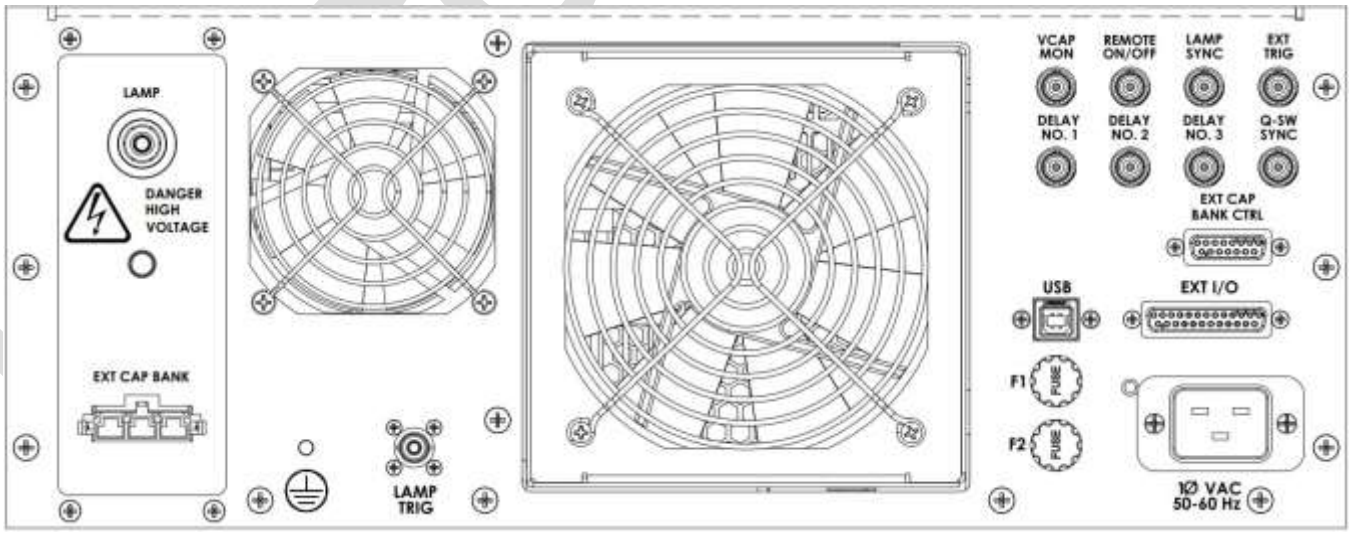

Figure 1, Rear Panel with Fischer 30 Amp Lamp output connector

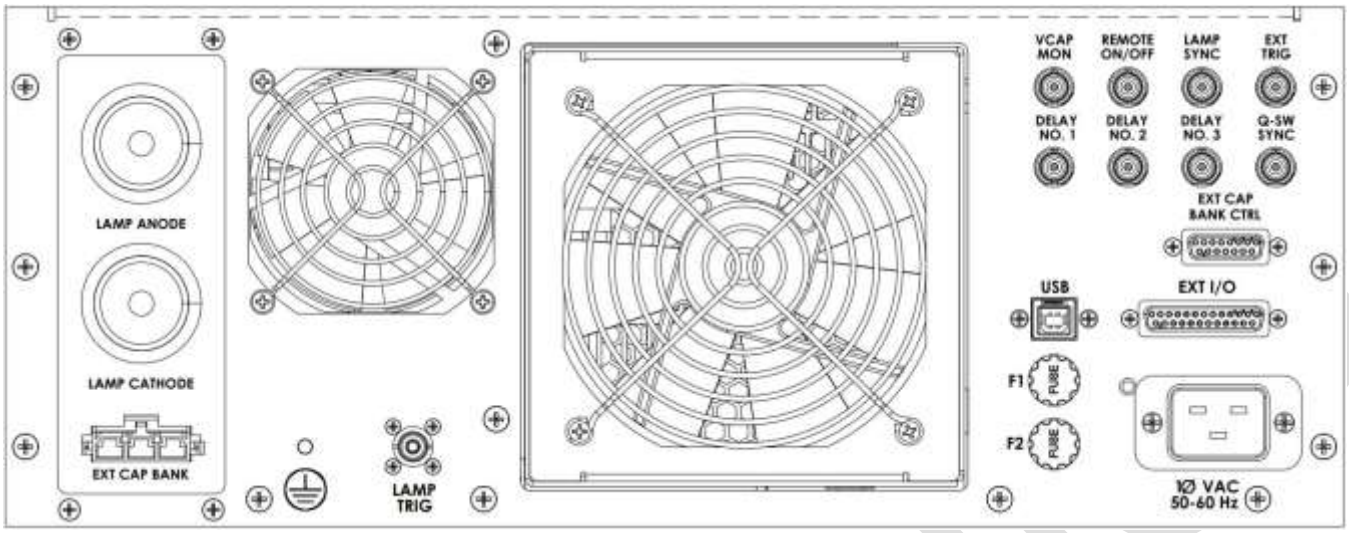

Figure 2, Rear Panel with 100 Amp Supercon Lamp output connectors

Connect the supplied cables in the following order:

1. Plug in the laser head trigger transformer to the “LAMP TRIG” MHV connector.
2. After connecting the lamp cable to the flashlamp, plug in to either the “LAMP” Fischer connector (shown in *Figure 1*), or the red Supercon to the “LAMP ANODE” and the black Supercon to the “LAMP CATHODE” connectors (shown in *Figure 2*).
3. Connect an earth grounding conductor to the PE terminal located by the symbol ⏚. This is the terminal for the chassis safety grounding conductor to prevent electrical shock hazards on the chassis metal enclosure. Current carrying conductors, such as the lamp cable or mains neutral, ***must not*** be connected to the PE terminal.
4. Connect the system interlocks using the EXT I/O 25 pin D connector. See *Table 2, External I/O Interface*, in section *7.1* for the connector pin out and definitions.
5. If an optional external capacitor bank, Model 8808C, is used: first connect the control cable to the EXT CAP BANK CTRL 15 pin D connector, then connect the high voltage cable from the capacitor bank to the EXT CAP BANK connector.

4 Controls and Configuration Setup

4.1 Controls

The front panel layout is shown in *Figure 3* below which includes the key switch, emergency stop (E-STOP) push-button, a USB port, and the color display touch panel.

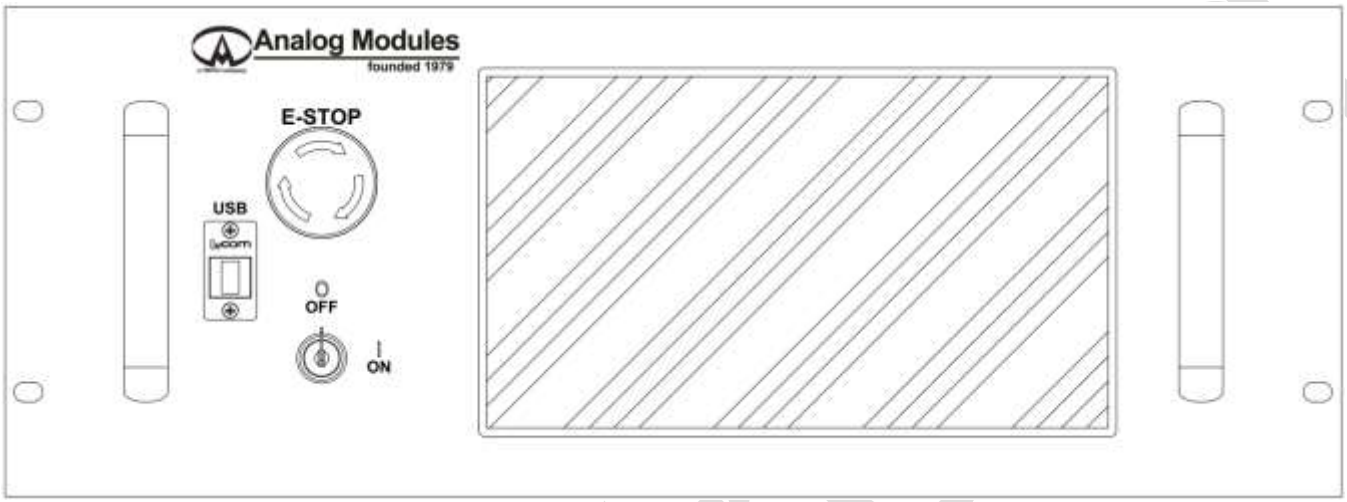

Figure 3, Front Panel

The key switch turns AC power on to the low voltage power supply which powers the computer controls.

The E-STOP red mushroom push button immediately turns off all high voltage and lamp simmer when depressed. The emergency off is also referred to as an emergency LASER-STOP in laser safety standards. Once depressed, the red mushroom cap needs to be rotated clockwise to release the button and restore operation.

The USB port is available for storing system configurations and data on to a USB memory device. It is also used for software updates. Please contact the factory for any available updates.

The 10-inch color display touch panel is easily visible from a wide viewing angles. All the GUI menus, setup configurations, operating parameters, and control modes are displayed and entered through the capacitive touch panel. Please see section *6.1 Display Touch Screen Cleaning* for the display touch screen cleaning process.

4.2 Initial Operating Data Entry

The initial operating configuration is entered through the following menus with the operator entering the data for each menu. The first menu and most often used is the Configuration Menu shown below in *Figure 4, Operating Configuration Menu*.

4.2.1 Operation Configuration Settings

Enter the following operating data: Voltage, Pulse Width, and Repetition Rate. The display will show the total system capacitance according to the 8808V model and external capacitor bank used.

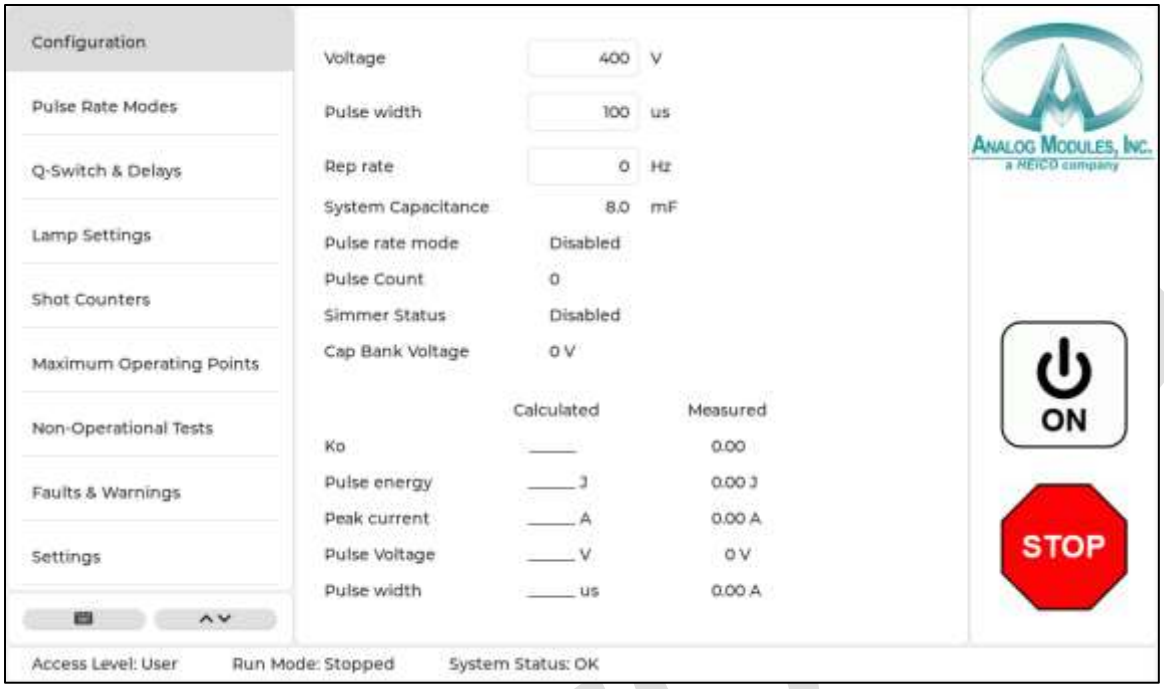

Figure 4, Operating Configuration Menu

4.2.2 Pulse Mode Settings

Enter the desired pulsing mode and rates in the Pulse Rate Modes menu shown below in *Figure 5, Pulse Repetition Rate Settings*. The following pulsing modes are supported: continuous, burst, single, duty cycle, and external trigger and are described below.

Figure 5, Pulse Repetition Rate Settings

Continuous mode operates in a continuous flash according to the entered repetition rate. The flashlamp will start flashing when the "RUN" key is pressed while in the READY state with the HV charged. The high voltage symbol shown to the right, will be displayed as an emission indicator that the lamp can and will be pulsing until the "PAUSE" key is pressed, the “STOP” key is pressed, or the E-STOP button pushed in.

Burst mode sets the controller to run a burst of flashlamp pulses according to the set number of pulses at the set repetition rate and then stops automatically. For a continuous burst mode or for a set of bursts, also set the Duty Cycle mode. After the set of pulses, the system will enter a PAUSE state and will stop pulsing until the "RUN" key is pressed.

Single Shot mode is a single output pulse setting. When a single shot is selected, the flashlamp will pulse only once when the "RUN" key is pressed and will enter a PAUSE state until the "RUN" key is pressed again.

Duty Cycle mode is a feature which allows the operator to flash the flashlamp for a specified “ON” time and stop the flashlamp for a specified “OFF” time and repeat this ON/OFF cycle for a set number of times. The flashlamp will flash at the repetition rate specified in the pulse rate modes window. For a continuous burst mode operation, enter the time between the burst of pulses and the desired number of burst cycles is entered. After the burst set of pulses is complete, the system will enter a PAUSE state and will stop pulsing until the "RUN" key is pressed.

External Trigger mode allows the user to provide an external TTL trigger to flash the flashlamp. This input uses either the rear panel BNC labeled EXT TRIG or via the 25-pin EXT I/O D-connector. Please see section *7.1 Rear Panel External I/O* for connection details. A >4.0 VDC pulse is needed with the BNC connection while the EXT I/O uses a pull-down transistor to generate the trigger pulse. When using this mode, the repetition rate is dependent upon input trigger frequency.

4.2.3 Q-Switch and Delay Settings

This menu allows for the setup of various Q-Switch, lamp firing, and other delays needed for laser operation. The settings and the various delays needed for operation are shown below in *Figure 6, Q-Switch Settings and Delays*.

Lamp trigger signals can be individually delayed from the lamp sync signal by setting values in this menu up to 1000 µs.

If a Q-Switch is used, then check the box next to Q-Switch. The Q-Switch delay, firing mode, and the “ON” time are entered in the boxes. The firing delay is from the flashlamp trigger. The system can be set up to generate a Q-Switch trigger for each lamp firing or to skip the entered number between flashlamp pulses. The “ON” time of the Q-Switch pulse can also be set up to 1000 µs.

Delay times, up to 1000 µs, can also be set from time T_0 (using an external trigger input) to the lamp firing or the three Delay BNC outputs on the rear panel as shown in the menu (see *Figure 1, Rear Panel with Fischer 30 Amp Lamp output connector*).

An identical Q-Switch buffered signal is also available from the external I/O connector (see section *7.1 Rear Panel External I/O*). Either of these signals can be used to trigger a Pockels Cell for Q-Switching a solid-state laser.

Figure 6, Q-Switch Settings and Delays

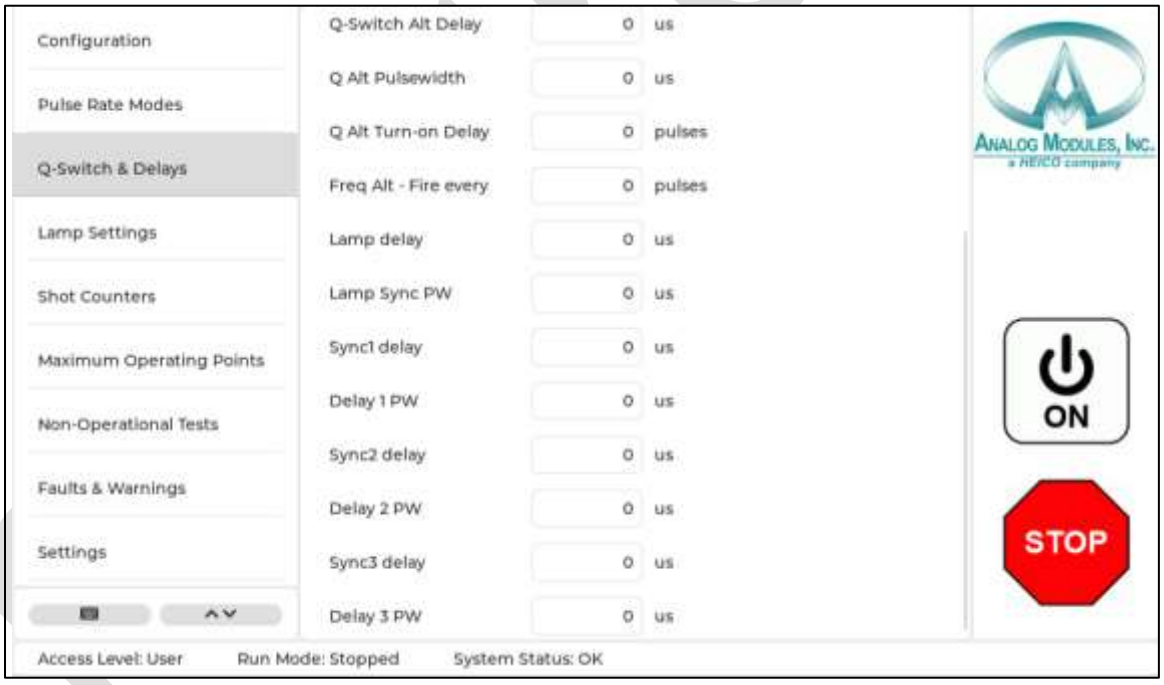

Figure 7, Additional BNC Signal Delays

Using a finger, this menu can be scrolled down (scroll bar to the right of the window) to show the additional delays for the rear panel BNC signals as shown in *Figure 7, Additional BNC Signal Delays*. Each signal's output pulse width and delay from T_0 can be entered for synchronizing other laser system equipment, such as a pulse picker.

4.2.4 Flashlamp Settings

Enter the flashlamp data in the Lamp Settings menu shown below in *Figure 8, Lamp Data Menu*: lamp bore diameter in mm, arc length in inches, gas fill pressure and select the gas type. The system will calculate the lamps characteristic impedance K_0 from the data entered.

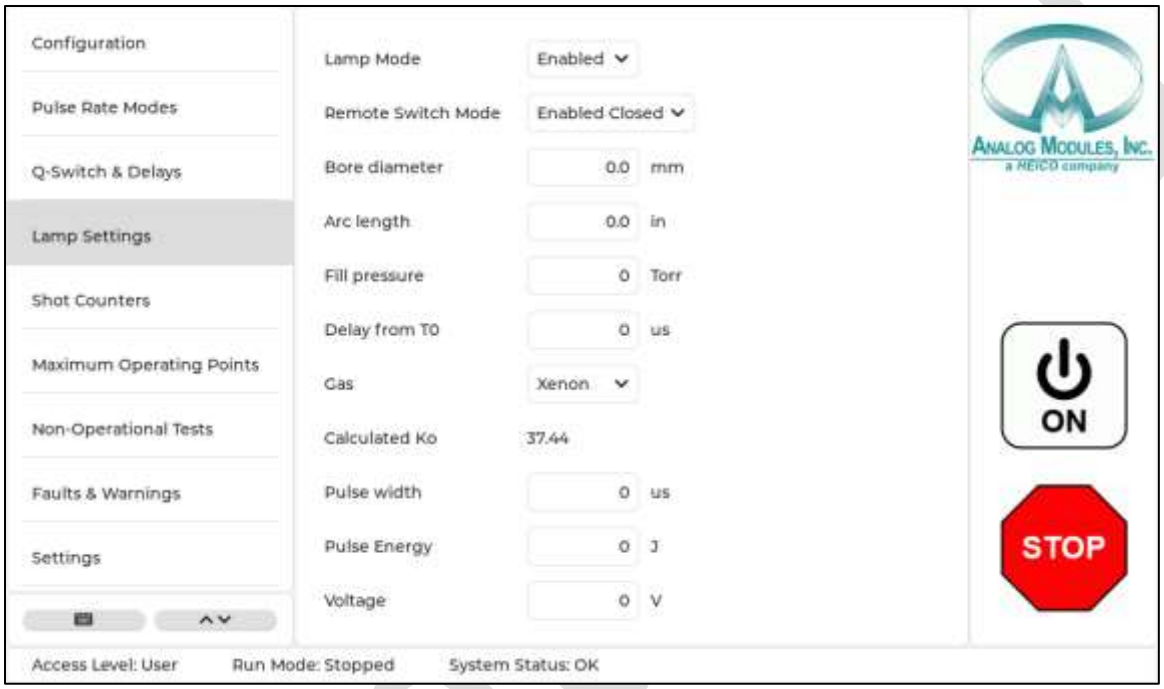

Figure 8, Lamp Data Menu

4.3 Maximum Operating Parameters

The system's range of operating parameters are set on this menu. The parameters are set according to the capacitor configuration and the expected flashlamp load range. The window can be scrolled up and down with one finder. The values that appear when the menu is first selected are displayed at the top of the window as shown in *Figure 9, Maximum Operating Settings, Window Top*. The values shown correspond to a typical 800 Volt system with an external capacitor box as listed in *Table 1, Typical Maximum Settings Values for Capacitor Configuration*.

The system's maximum range of operating parameters are set at the factory for each model in the SUPER user column and should not be changed without contacting AMI.

The user range of parameters listed in the ADMIN column can be changed by the customer by setting the user level to Admin in the Settings menu, entering the access password (see section *4.5 Admin/Super User Settings*), and then unlocking the user level column on the menu. Once unlocked, the parameters can be narrowed for a particular load or experiment. This allows the operator to adjust the lamp data or operating parameters in the previous menus for a given experiment or laser system.

Table 1, Typical Maximum Settings Values for Capacitor Configuration

System Voltage	500 Volt	800 Volt	1000 Volt
Capacitor Config.	4300 µF, 550 VDC All in parallel	5600 µF, 450 VDC Series-Parallel	4300 µF, 550 VDC Series-Parallel
Voltage min	100 V	200 V	200 V
Voltage max	500 V	800 V	1000 V
Pulse Width min	100 µs	100 µs	100 µs
Pulse Width max	5000 µs	2000 µs	2000 µs
Pulse delay min	0 µs	0 µs	0 µs
Pulse delay max	25 s	25 s	25 s
Pulse energy min	10 J	10 J	10 J
Pulse energy max	6000J	5000 J	6000J
Rep period min	0.01 s	0.01 s	0.01 s
Rep period max	60 s	60 s	60 s
Lamp Bore dia min	1.0 mm	2.0 mm	3.0 mm
Lamp Bore dia max	6.0 mm	10.0 mm	10.0 mm
Arc length min	20 mm	50 mm	75 mm
Arc length max	100 mm	250 mm	300 mm
Fill pressure min	300 Torr	300 Torr	300 Torr
Fill pressure max	1000 Torr	1000 Torr	1000 Torr
Internal Capacitance	25.8 mF	8.4 mF	6.45 mF
External Capacitance	86 mF	28 mF	21.5 mF

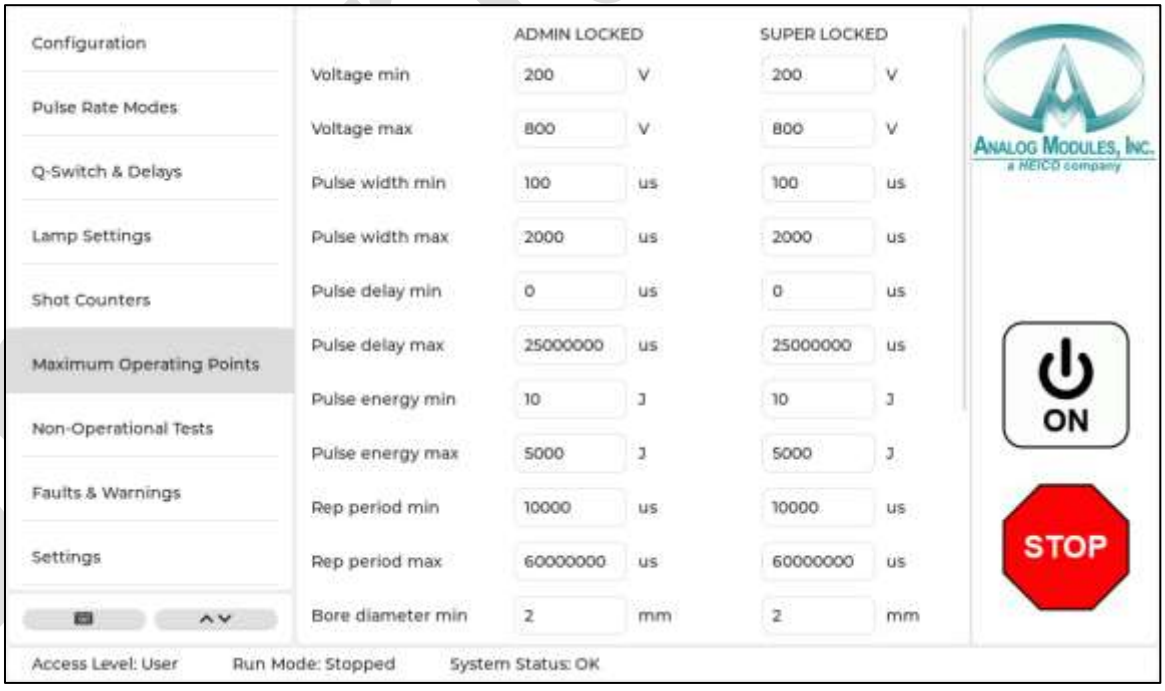

Figure 9, Maximum Operating Settings, Window Top

Scrolling to the bottom of the window will display the rest of the maximum operating parameters shown below in *Figure 10, Maximum Operating Settings, Window Bottom*.

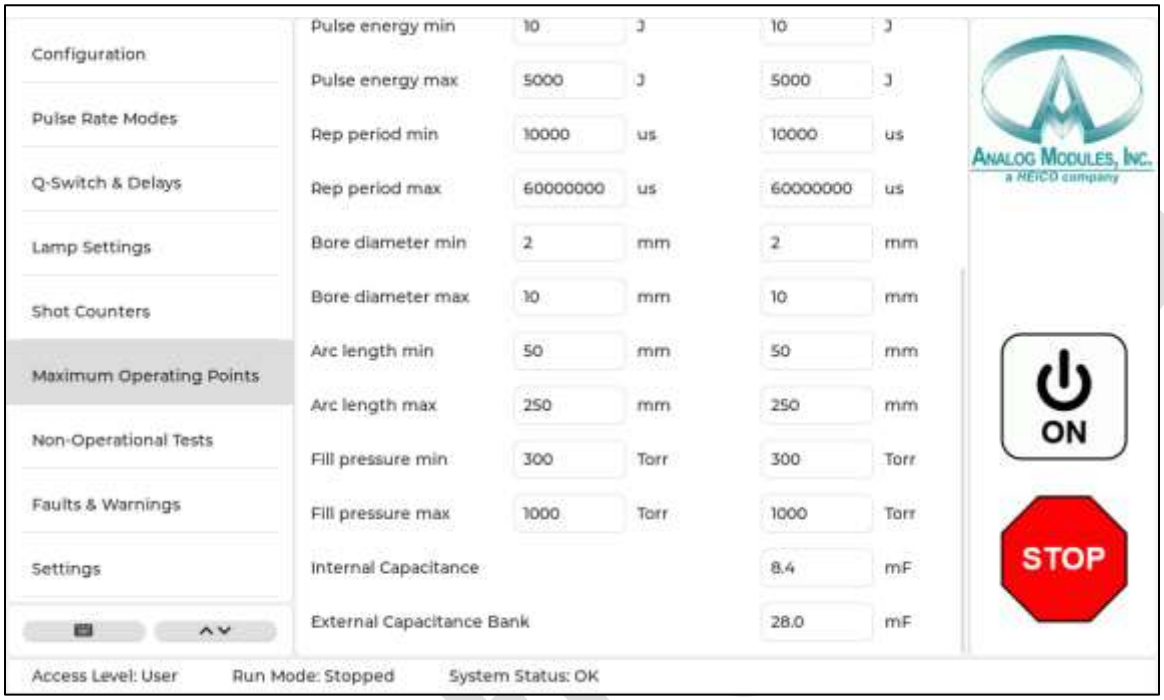

Figure 10, Maximum Operating Settings, Window Bottom

4.4 Saving and Recalling Configurations

The Settings menu shown in *Figure 11* below is where the operating setup can be saved or recalled. This menu also sets operator access level control, passwords, and for system software/firmware updates. Please contact AMI, for available software updates.

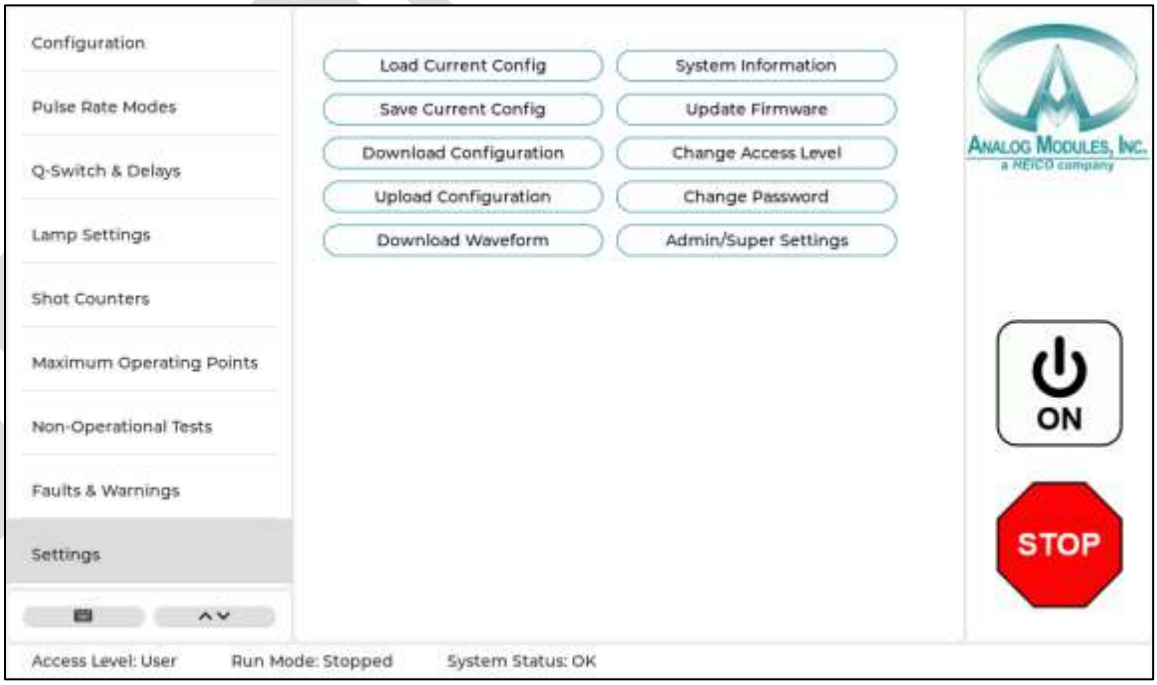

Figure 11, System Settings Controls

Configurations can be loaded and saved using the four configuration selections. The first two selections of “Load Current Config” and “Save Current Config” open a sub menu to load and save the operating configurations to internal memory locations or to a USB memory stick. The “Download Configuration” and “Upload Configuration” open a sub menu to save complete system configuration and calibration to a USB memory stick.

An added feature is the “Download Waveform” which allows saving operating load current and voltage measurements and waveforms to a USB memory stick.

4.5 Admin/Super User Settings

Additional settings are accessible through the Settings menu shown above in *Figure 11, System Settings Controls* by selecting the Change Access Level button to enter the Admin/Super Settings. A box will pop-up to enter the access level password. At these levels the Admin/Super Settings and Change Password buttons appear.

4.5.1 Simmer and Rear Panel Signal Setup

Selecting the Admin/Super Settings opens the menu shown below in *Figure 12, Admin/Super Settings menu* . This menu allows additional operational settings described below.

To change the simmer mode, press the **Simmer Mode** drop-down arrow to select one of the following simmer modes.

Disabled, will turn off the simmer supply
Continuous (default mode) will simmer the flashlamp continuously while in RUN.
Spare IN1 to enable and disable the lamp simmer via the EXT I/O Spare 1 Input.
Spare IN2 to enable and disable the lamp simmer via the EXT I/O Spare 2 Input.

See section *7.1 Rear Panel External I/O* for the spare input signal details and EXT I/O connector pin-out.

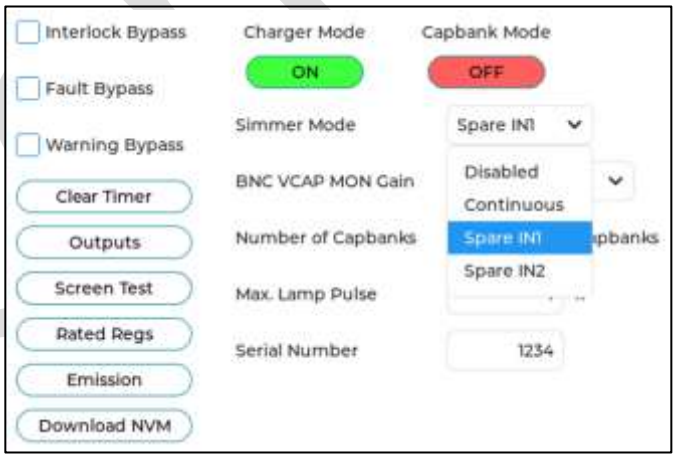

Figure 12, Admin/Super Settings menu

4.5.2 Charger and Cap Bank Enable

Charger Mode, this button manually enables and disables the capacitor charging power supply. This must be ON for normal operation.

Capbank Mode, this button manually enables and disables the optional external capacitor bank. When OFF the capacitor bank dump circuit is activated. This must be ON for normal operation when an optional external capacitor bank is connected. This must be OFF when there is no external capacitor bank connected.

BNC VCAP MON Gain, this selects the rear panel VCAP MON voltage level such that 10V indicate either 500 Volt max cap charge or 1000 Volt max cap charge level.

4.5.3 Fault Bypass Settings

The following control settings are also available on this menu. Please see *Section 5.2 Interlocks, Faults, and Warnings* for more information and how to disable individual interlocks, faults, or warnings.

Interlock Bypass, disables all the interlocks. This should only be used when troubleshooting the system operation. Do not operate the system will the interlock's bypassed since this disables these protection signals.

Fault Bypass, disables the fault notifications. This should only be used when troubleshooting the system operation. Do not operate the system will the interlock's bypassed since this disables these protection signals.

CAUTION

Use of the system with the interlocks or faults disabled could cause damage to the controller and the flashlamp load.

Warning Bypass, disables the warning notifications. This should only be used when troubleshooting the system operation.

Clear Timer clears the capacitor discharge resistor cool down time when the unit is set to STOP mode after running. When the STOP button is pressed there is am allowed time to discharge the capacitor energy and cool down the capacitor dump resistors before recharging the capacitor banks. This timer can be cleared by pressing the Clear Timer button.

CAUTION

Use of the Clear Timer must be used with care as over-heating and possible damage to the energy discharge resistors could result during multiple use.

4.5.4 Rear Panel Signal Settings

Selecting the **Outputs** button opens the menu shown below in *Figure 13, Rear Panel Signals Setup*. The rear panel BNC and EXT I/O output signals can be set to various control signals.

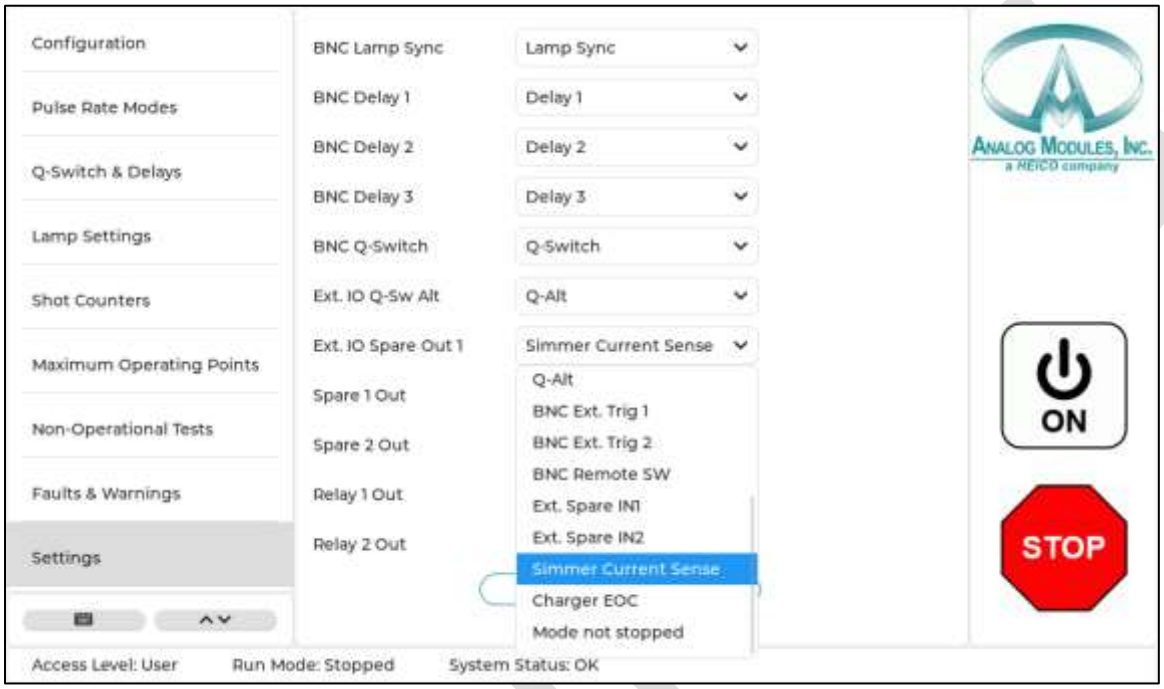

Figure 13, Rear Panel Signals Setup

Each of the five BNC outputs on the rear panel can be set to indicate the Lamp Sync, Q-Switch trigger, or any of the three settable delay outputs. Other settings include the simmer current sense indication, power supply End of Charge (EOC) indicator, Q-Switch alternate trigger, constant logic level high or low. Please see section *4.2.3 Q-Switch and Delay Settings* for setting the signals' pulse width and time delays.

The EXT I/O connector's two output signals can also be individually set to various control signals. For example, the Spare 1 Out signal on pins 9 and 22 can be set to indicate the lamp simmer condition by setting it to the Simmer Current Sense for the output. See section *7.1 Rear Panel External I/O* for the spare output signal details on the EXT I/O connector pin-out.

4.5.5 Other Admin System Settings

The last four buttons shown above in *Figure 12, Admin/Super Settings menu* are factory settings that are not used for normal setup and operation. These are usually set in the factory and do not need to be adjusted. Below is a brief description of each selection. Please contact Analog Modules factory for any changes that are needed.

Screen Test, this is used to verify complete functionality of each section of the GUI touch screen.

Rated Regs, this is only used at the factory to calibrate the controller's internal measurements.

Emission, this option is used to adjust the optional audible emission indicator and when it sounds. The audible beep rate can get changed to indicate startup, stopped, paused, or running modes.

Download NVM, this button accesses the various Non-Volatile-Memory sections to download to a USB memory stick. This is usually used during the factory system setup.

4.6 Numeric Data Entry

Any menu that requires data entry, a numeric entry keypad can be accessed to enter the setting's numerical values. When the keypad icon in the bottom left corner of the display is pressed, the keypad will open on screen as shown in *Figure 14, Numeric Keypad Data Entry*. The units of measure for the given data entry will be selectable from the right side of the keypad. Once the unit of measure is selected or pressing Enter will enter the new value and close the keypad.

Figure 14, Numeric Keypad Data Entry

5 Operation

5.1 Turn-on auxiliary equipment

Prior to starting the 8808 system, make sure the laser auxiliary support equipment is turned on. Select the *Non-Operational Tests* menu as shown below in *Figure 15*.

If the cooling system uses the Pump relay signals (see *Table 2, External I/O Interface*) provided in the external I/O on the rear panel, then check the box next to the pump to start the cooling system.

Check the box next to the Shutter Enable to open the shutter for resonator function.

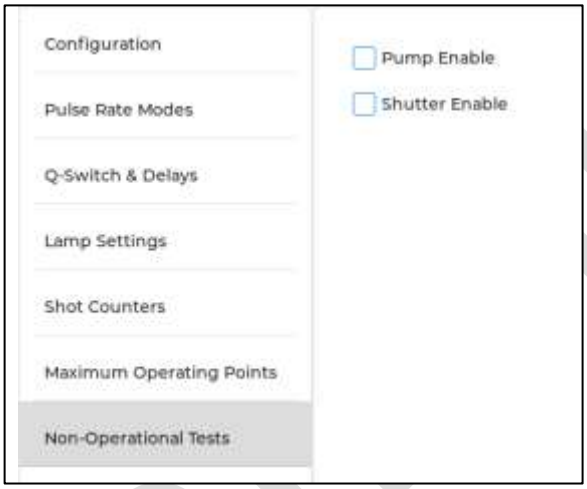

Figure 15, Non-Operational Tests

5.2 Interlocks, Faults, and Warnings

Prior to starting the 8808 system, make sure all the interlocks' status is set OK for system operation to begin. The interlocks' status is shown below in *Figure 16, Faults & Warnings Conditions Menu.* To bypass any individual interlock requires Admin or Super user access. Please see section *4.5* Admin/Super User Settings on how to change the user access level.

Figure 16, Faults & Warnings Conditions Menu

5.3 System Turn-on

Start the system by turning the key-switch to the ON position, see *Figure 3, Front Panel*. Note that the key-switch should not be toggled quickly from ON to OFF back to ON, this can interfere with the computer memory store and recalls. When turning the key-switch to the OFF position always wait at least 5 seconds before switching the key-switch of ON again.

The display will come up with the previously entered operational settings. If new settings are desired, either load the settings per section *4.4 Saving and Recalling Configurations* or follow setup in *4.2 Initial Operating Data Entry.*

Once all interlocks are met, the lamp simmer and high voltage are enabled by pressing the ON button on the display touch screen shown on the right.

Allow time for lamps to ignite and simmer followed by the charging power supply to charge the capacitors bank(s). After the high voltage present symbol appears, as shown on the right, and the optional capacitor bank READY LED is on, then the lamp pulsing can start.

To start pulsing the flashlamps, press the RUN button on the display touch screen as shown on the right.

To pause the system from pulsing the flashlamps, press the PAUSE button on the display touch screen as shown on the right.

5.4 System Shutdown

Follow the following steps for a proper shut-down sequence:

a. Stop the system from pulsing the flashlamps by pressing the PAUSE button on the display touch screen as shown above.

b. Press the display STOP button on the display touch screen to turn off the flashlamp simmer and stop the capacitors' high voltage charging supply. This also starts the capacitor bank(s) discharge circuits.

c. Allow the system to complete the cool-down time as displayed on the bottom of the display.

d. Turn the key switch to the OFF position.

e. To safeguard against unauthorized usage, remove the key and store it in a secure location.

5.5 System Shot Counters Menu

The following menu in *Figure 17, Lamp Shot Counters*, will show the operator the system shot counters. These include the number of shots for a given user, number of shots on the lamps, number of shots for the current operating session, and the total number of shots by the system.

When a new user operates the system or the flashlamps are changed, those counters can be reset to zero by pressing the on screen Reset button.

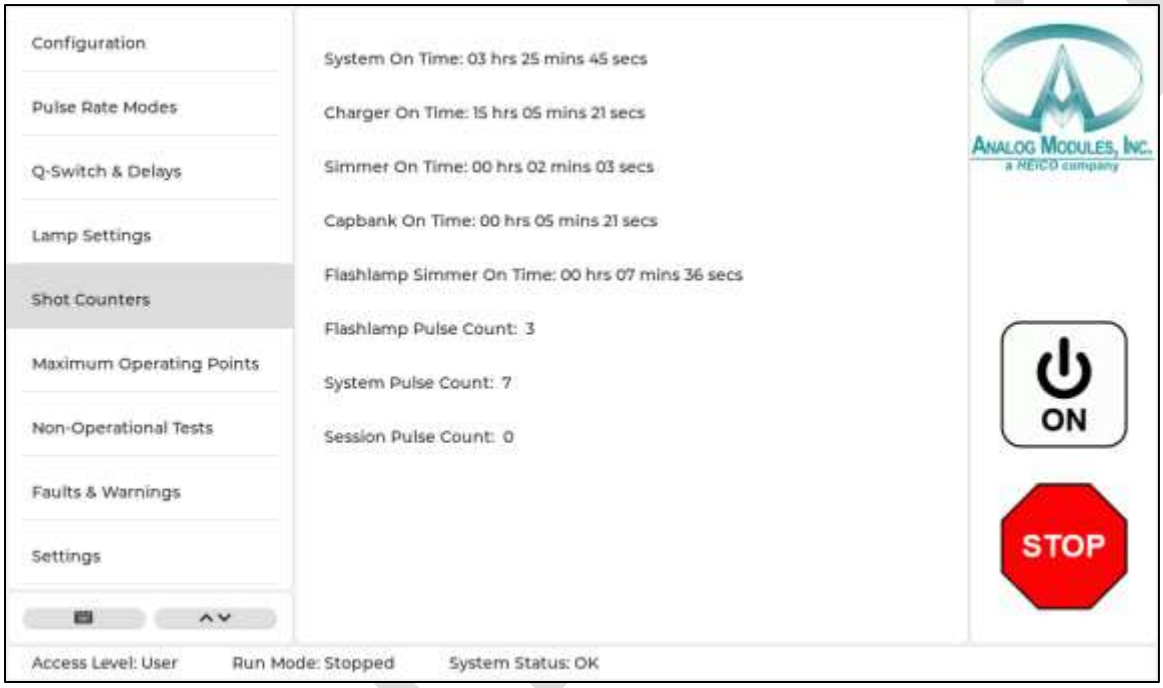

Figure 17, Lamp Shot Counters

5.6 Setting Changes during Operation

If during operation a setting needs to be adjusted, for example the voltage or pulse width needs to be increased or decreased, this can be done using the arrow keypad. To make a change, select the setting to adjust, then press the arrow up/down icon in the bottom left corner of the display. See *Figure 18, Arrow Keypad Data Entry* below. As the up or down arrows are pressed, the numerical value will increase or decrease immediately while the system is in operation. Pressing the right or left arrow will highlight the next digit to be adjusted.

Figure 18, Arrow Keypad Data Entry

6 Maintenance

6.1 Display Touch Screen Cleaning

A microfiber cloth and distilled water is recommended for cleaning the display glass. Although distilled water is recommended for wiping the display glass, you can use a cleanser developed explicitly for cleaning displays. However, do not spray it directly onto the display. Spray a tiny amount of the cleaner onto a microfiber cloth first to avoid getting any cleaning solution inside the display.

The touchscreen is made of plastic and is more prone to scratches. Only use a microfiber cloth and don't use chemicals to clean a resistive touchscreen.

Remove any tags on the cleaning cloth to prevent scratching the screen with the labels.

Lightly dampen the microfiber with distilled water and gently wipe the display. Avoid glass cleaners and harmful chemicals that can damage the display, please see Cautions below. Do not use paper towels or tissues to clean the display as these can cause tiny scratches. Also avoid aggressive wiping to prevent damaging the display.

CAUTION

Never spray any liquids directly onto the display.

A spray is too hard to control and confine. The fluids can seep into the other display layers or surrounding components and cause irreversible liquid damage.

CAUTION

The following are unsafe cleaning agents that can damage the electronic display:

- Ammonia
- Acetone
- Ethyl alcohol
- Methyl chloride
- Ethyl acid

6.2 Software and Firmware Updates

To update the controller processor software and the FPGA firmware go to the Settings Menu shown in *Figure 19, Settings Menu* and select Update Firmware. Plug in a USB memory stick that contains the new controller software files. A menu will appear to select the updating of either the front panel GUI or the controller FPGA.

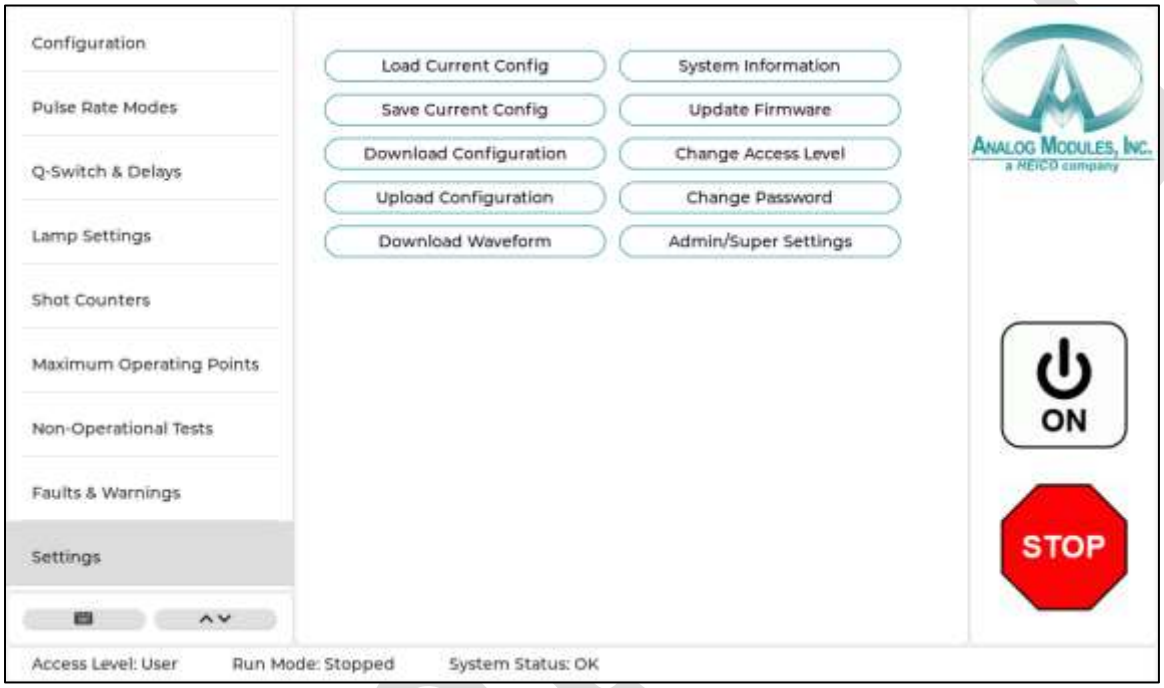

Figure 19, Settings Menu

Select GUI to update the display touch screen program. The available Newfile.BIN files will appear. Select the most recent .BIN file, press OK, and the front panel software will be updated.

Select the FPGA to update the controller programming, the available Newfile.SPI files will appear. Select the most recent .SPI file to upload. Press OK and the upload will start. There are three steps to the FPGA controller update which will take a few minutes. First the file transfers from the USB memory stick with the display indicating "XXXX of YYYYY bytes written." Second step, the message "Transferring memory Please wait" appears when the processor is putting the new firmware into its memory. Third step will display "Programming … This may take a few minutes."

When done the message "Programming Complete!" will appear with "Please restart". Turn the key switch off, wait about 10 seconds, and then turn the key switch back on to restart the controller with the updated FPGA firmware.

Note: Toggling the key-switch off then on too quickly will cause a DDR warning. This indicates the power supply did not fully reset by going to zero voltage output. To reset this message, turn the key switch off and wait 10 seconds before turning the system back on.

6.3 Service

WARNING

Electric Shock Hazard.
Read this before proceeding further.

The voltages generated by this equipment are potentially hazardous and could result in serious injury or death. Only qualified factory-trained technical personnel should service this equipment.

To avoid possible injury always follow the following safety precautions:

1) Never disable or defeat the safety interlocks which are provided for operator protection.
2) Covers should only be removed by qualified factory-trained technical personnel and only after the AC Mains are disconnected from the rear panel.
3) All storage capacitors must be discharged before any attempt is made to service the unit, to disconnect and re-arrange the output cables, or to replace the flashlamp. Use a HV probe with an appropriate voltmeter to check capacitor voltages.

6.3.1 Packaging and Shipping

The Model 8808V should be shipped flat. Shipping the system while on an edge will likely damage the front panel and internal components.

When shipping the controller make sure the unit is appropriately supported to avoid damage due to mechanical shock. Inspect all cables for looseness at connectors and visual damage. Do not lift or support units by the front panel handles only, support the unit by the bottom panel or slides on the side panels. Protect exposed power and lamp connections from human touch.

7 External Interfaces

7.1 Rear Panel External I/O

There are twelve control signals available via the rear panel 25-pin D-type, DB-25S, connector. The signal names and descriptions are listed below in *Table 2, External I/O Interface* with the equivalent circuits shown in *Figure 20, External I/O Circuits*.

Table 2, External I/O Interface

PIN	SIGNAL NAME	DESCRIPTION
1	Remote Interlock	Door Interlock input, must be connected to pin 14 (Remote Interlock-), or pulled low <2.0 Volts to allow system operation. When open the HV output stops immediately. Internal 3.3 kΩ pull-up resistor to +24 V.
2	Flow Interlock	Coolant Flow Interlock input, must be connected to pin 15 (Flow Interlock-), or pulled low, <2.0 Volts to allow system operation. When open the HV output stops immediately. Internal 3.3 kΩ pull-up resistor to +24 V.
3	Temperature Interlock	Coolant Temperature Interlock input, must be connected to pin 16 (Temp Interlock-), or pulled low, <2.0 Volts to allow system operation. When open the HV output stops immediately. Internal 3.3 kΩ pull-up resistor to +24 V.
4	PUMP+	+24 VDC supplied for pump relay coil when used with pin 17, PUMP-. control output.
5	SHUTTER+	+24 VDC supplied for shutter solenoid when used with pin 18, SHUTTER-. control output.
6	+24 VDC Output	+24 VDC, 500 mA, auxiliary power output for customer controls.
7	+15 VDC Output	+15 VDC, 250 mA, auxiliary power output for customer analog controls.
8	+24 V Switched	+24 VDC, 500 mA, switched interlock voltage output. When all interlocks are satisfied the controller outputs +24 VDC for customer controls.
9	Spare 1 Digital Output	Switched high, +5 VDC, 15 mA, output, customer programmable.
10	Q-Switch Trigger	Switched high, +5 VDC, 15 mA, output for triggering or synchronizing the Q-switch operation.
11	Spare 1 Digital Input	Opto-coupler input, anode connection for +5 V, signal, 475 Ω resistance
24	Spare 1 Digital Return	Opto-coupler input, cathode connection for Spare 1 input on pin 11.
12	Spare 2 Digital Input	Opto-coupler input, anode connection for +5 V, signal, 475 Ω resistance
25	Spare 2 Digital Return	Opto-coupler input, cathode connection for Spare 2 input on pin 12.
13,14,15, 16,19,20, 21,22,23	SIGNAL and POWER Return	Signal, +24 VDC, and +15 VDC ground return for any external control circuitry.
17	PUMP-	Open-drain output, capable of sinking 500 mA to activate a pump relay coil, goes low when all interlocks are satisfied, Used with pin 4, PUMP+.
18	SHUTTER-	Open-drain output, capable of sinking 500 mA to activate a shutter solenoid, goes low when all interlocks are satisfied and the system is in RUN (lamps flashing) mode, Used with pin 5, SHUTTER+.

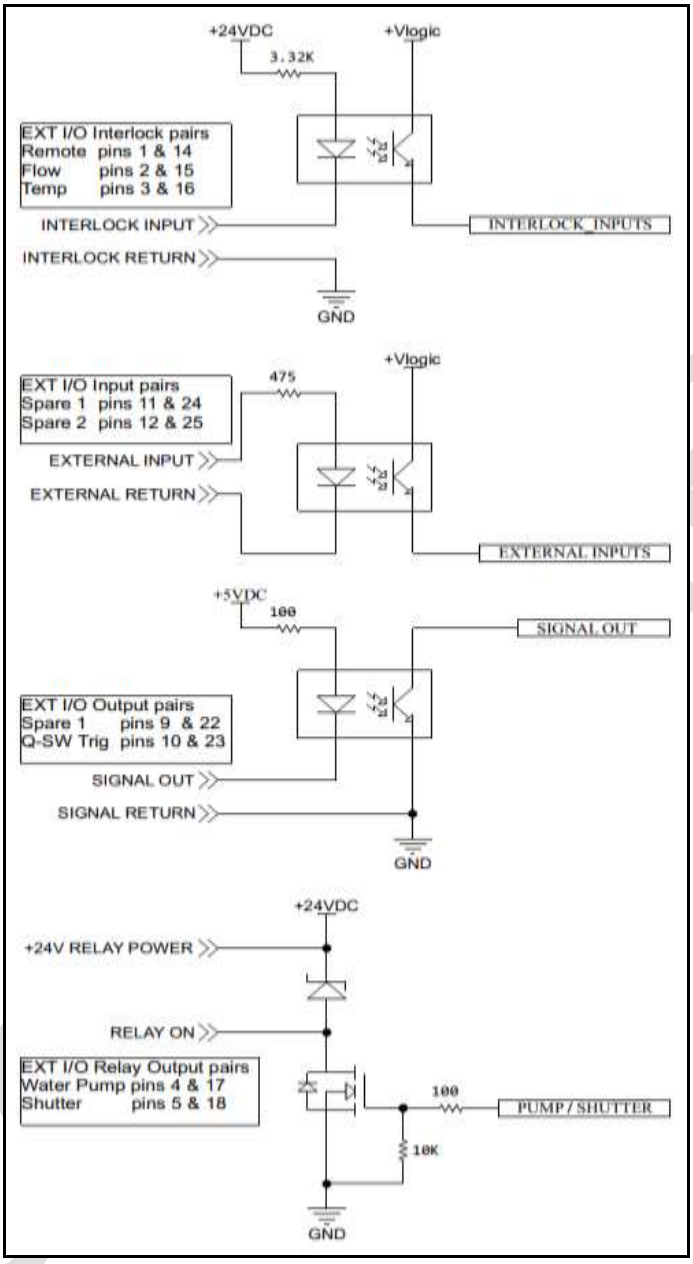

Figure 20, External I/O Circuits

7.2 Capacitor Bank Control Interface

For reference, the optional external capacitor bank control signals via the rear panel 15-pin D-type, DB-15S, connector are listed below in *Table 3, Capacitor Bank Interface*. These signals are not for user interface usage.

Table 3, Capacitor Bank Interface

PIN	SIGNAL NAME	DESCRIPTION
1	ENABLE/DUMP	4.0 to 15 V output to enable cap bank operation and turn-off dump circuit. <2.0 V turns on the cap bank discharge (dump) circuit. 100 Ω output impedance.
2	+24V_SW	+24 VDC switched interlock voltage output. When all interlocks are satisfied the controller outputs +24 VDC to the cap bank interlock loop.
3	OVER TEMP	Discharge resistor over temperature input, a high signal >3 V indicates the resistors need a cool-down period. 10 kΩ input resistance to ground.
4	PROGRAM RTN	Input return for program voltage, internally connected to signal ground.
5	PROGRAM VOLTAGE	0 to 10 V capacitor charge voltage signal. 0 to 10 Volts output indicates: 0 to 1 kV for 800 to 1000 Volt systems, 0 to 500 V for 500 Volt systems. 100 Ω output impedance.
6	FAULT 1	Cap Bank #1 fault input signal, a high signal >3 V indicates a cap bank fault, either an over-voltage charge condition or the discharge resistors need a cool-down period. 10 kΩ input resistance to ground.
7	Vmonitor 2	Cap Bank #2 charge voltage monitor input signal, 0 to 10 Volts indicates: 0 to 1 kV for 800 to 1000 Volt systems, 0 to 500 V for 500 Volt systems. 10 kΩ input impedance.
8	Vmonitor 1	Cap Bank #1 charge voltage monitor input signal, 0 to 10 Volts indicates: 0 to 1 kV for 800 to 1000 Volt systems, 0 to 500 V for 500 Volt systems. 10 kΩ input impedance.
9	+15VDC	15 VDC output to power the capacitor banks circuitry.
10	+24V Loop	+24 Volt interlock loop input. The cap banks' interlock loop pulls this input to ground to allow controller operation. If any cap bank has a fault or cover is removed this input goes to +24 V to stop controller operation. Internally pulled up to +24 VDC.
11	Vmonitor 3	Cap Bank #3 charge voltage monitor input signal, 0 to 10 Volts indicates: 0 to 1 kV for 800 to 1000 Volt systems, 0 to 500 V for 500 Volt systems. 10 kΩ input impedance.
12	FAULT 3	Cap Bank #3 fault input signal, a high signal >3 V indicates a cap bank fault, either an over-voltage charge condition or the discharge resistors need a cool-down period. 10 kΩ input resistance to ground.
13	FAULT 2	Cap Bank #2 fault input signal, a high signal >3 V indicates a cap bank fault, either an over-voltage charge condition or the discharge resistors need a cool-down period. 10 kΩ input resistance to ground.
14	SIGNAL RTN	Signal ground return for any external control circuitry. Common to pin 4.
15	INTERLOCK	Interlock output pulled low, <2.0 Volts allows cap bank fault circuitry operation. When open the output has a 1 kΩ pull-up resistor to +15 V that resets the fault latch.

7.3 BNC Signals

There are eight control signals available via BNC connectors on the rear panel shown below in *Figure 21, Rear Panel BNC Connections*. The signal names and descriptions are listed in *Table 4, BNC Signal Descriptions* with the equivalent circuits shown in *Figure 22, BNC Signal Circuits*.

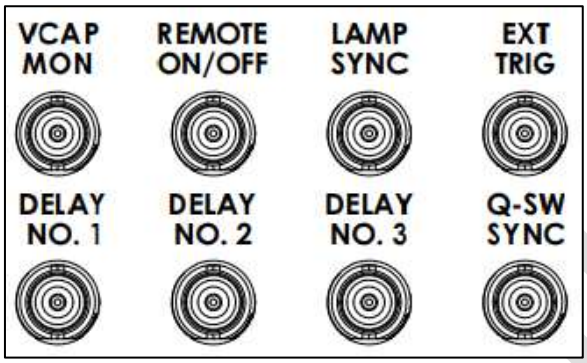

Figure 21, Rear Panel BNC Connections

Table 4, BNC Signal Descriptions

BNC	SIGNAL NAME	DESCRIPTION
1	VCAP MON	Analog output signal of the capacitor bank monitor, 1.0 V out = 100 VDC on the internal capacitor bank for 800 & 1 kV systems. 1.0 V out = 50 VDC on the 500 V system.
2	REMOTE ON/OFF	Remote on/off input via an opto-coupler, internal 3.3 kΩ pull-up to +24 VDC, shorting to ground stops system pulsing. Can be used with a footswitch.
3	LAMP SYNC	Lamp initial TTL output signal for time zero (T_0) timing reference, 4.0 V, 260 µS typical pulse width typical. Capable of driving 2.5 V into 50Ω.
4	EXT TRIG	External trigger TTL input via an opto-couple synchronizes system lamp pulsing with an external timing source, 3 to 5 Volt input, 100 mA maximum
5	DELAY NO. 1	DELAY 1 TTL output signal, 4.0 V, delay setting of 10-1000 µs after LAMP SYNC. Capable of driving 2.5 V into 50 Ω.
6	DELAY NO. 2	DELAY 2 TTL output signal, 4.0 V, delay setting of 10-1000 µs after LAMP SYNC. Capable of driving 2.5 V into 50 Ω.
7	DELAY NO. 3	DELAY 3 TTL output signal, 4.0 V, delay setting of 10-1000 µs after LAMP SYNC. Capable of driving 2.5 V into 50 Ω.
8	Q-SW SYNC	Q-Switch driver synchronizing TTL output signal, 4.0 V, delay setting 10-1000 µs after LAMP SYNC. Capable of driving 2.5 V into 50 Ω.

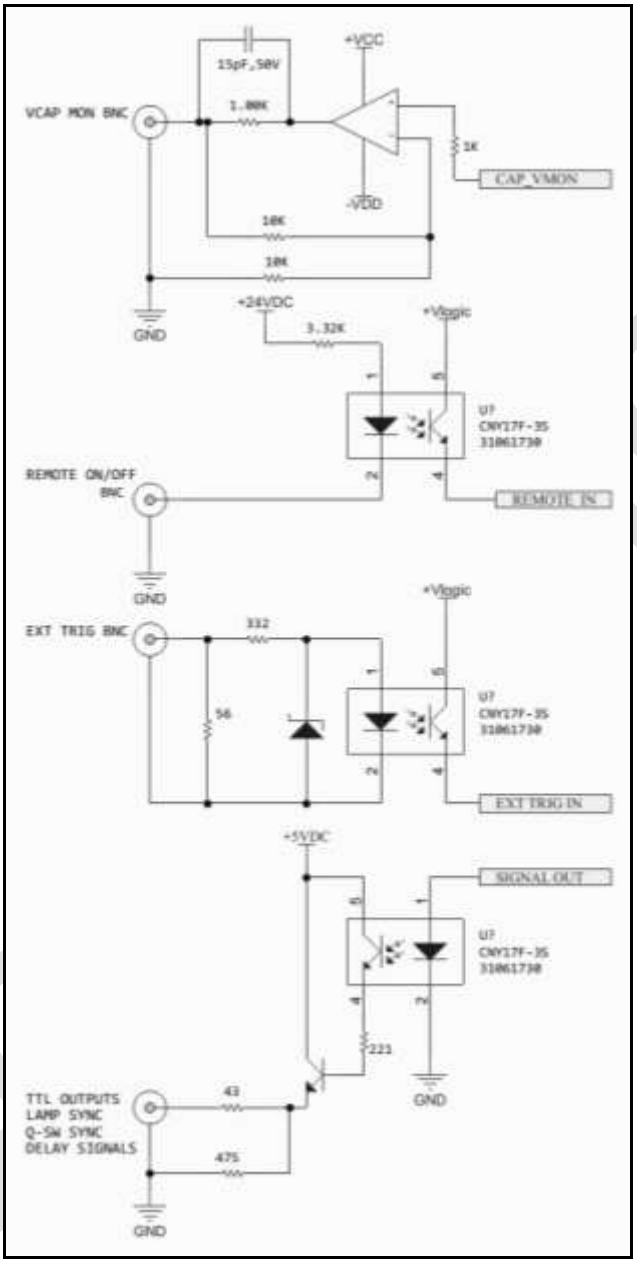

Figure 22, BNC Signal Circuits