



# Operation and Installation Manual

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## HVR-SYSTEM

Integrated Benchtop Driver and  
Pockels Cell Controller

**HIGH VOLTAGE DRIVER**

MAY 2021



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**WARNINGS**

High voltage - do not attempt to service or modify this equipment – death or serious injury can occur. Service should only be performed by qualified service personnel.

This equipment must only be used by qualified personnel. This device produces high voltage pulses. Normal precautions for working with high voltage circuits must be followed.

When operating in a laser, this equipment is part of a system that generates high energy pulses of laser light that can cause serious injury.

The pulses produced by the driver are very fast - the wiring between the driver and the Pockels cell, and the cell itself, can be expected to produce a great deal of EMI. It is the user's responsibility to ensure that systems incorporating this driver do not cause interference.

## I Introduction

### Description

The HVR-System is an integrated turnkey system which includes a high voltage switch, control circuitry and power supplies. It only requires an AC power source and a trigger signal to operate. The HVR-System can drive Pockels cells at 1/4 or 1/2 wave condition, producing pulses up to 7.5 kV and up to 200 kHz. Each HVR-System is fitted with power supplies selected for the amplitude and rep rate specified at the time of ordering.

### Specifications

Input power	88-264 VAC, 47-63 Hz
Output voltage	0-6000 V or 0-7500 V depending on model
Output pulse width	100 ns-5.0 $\mu$ s (determined by trigger pulse width)
Output rise/fall time	10-15 ns depending on output voltage and load
Load capacitance	Nominal 10 pF for rated rise/fall times. Unit has been tested at 100 pF load with rise/fall times < 50 ns
Repetition rate	Maximum rep rate varies with the model specified 0-50 kHz fan cooled, 50-200 kHz water cooled
Trigger input	5 V, 50 ohm input impedance, 100 ns-5.0 $\mu$ s pulse width Trigger to output delay = 80-100 ns

## II Installation

### Power Requirements

A properly grounded AC input from 88-264 VAC, 47-63 Hz is required.

### Trigger Input

The external trigger input must be a 5 volt TTL signal with a minimum pulse width of 100 ns, and a maximum pulse width of 5  $\mu$ s. At lower repetition rates, a wider pulse width may be possible as long as the duty cycle is less than 20% (ratio of ON time to OFF time). It is recommended that the trigger or pulse generator have a fast rise time to minimize jitter.

### Pockels Cell Leads

The Pockels cell leads should be connected to the center pin of the HN connectors on the rear panel of the HVR. The leads should be rated 5 kV minimum and kept as short as possible. The maximum lead length is 3 feet. The mating HN connector is Amphenol P/N 082-804 (Mouser P/N 523-82-804). Belden RG-8U high voltage cable P/N 8237 (Mouser P/N 566-8237-100) is recommended.

### Grounding

For safety, the HVR-System should be connected to earth ground via the input power connector.

**Caution:** Do not connect either output lead to ground or damage to the driver will occur.

### Cooling

Fan cooling is built into the HVR-System. Take care not to block airflow at the front or rear of the cabinet. The maximum ambient air temperature for operation is 40°C.

Water cooling is standard on high rep rate units. It is recommended that the water chiller be set to 25°C at 1.0 gal/minute minimum. Connectors for the chiller are 9.5 mm or 3/8" (0.375") diameter.

## III Operation

### Power the Unit

Apply power and turn the unit on. The power switch is illuminated when it is turned on.

### Trigger Signal

Connect the trigger source to the front panel BNC connector. Set the trigger pulse width and repetition rate to the desired output pulse width and rep rate.

**Caution:** The pulse width must be 100 ns or greater, or damage to the driver may occur if the ON and OFF pulses overlap. The maximum pulse width is 5.0  $\mu$ s, but it may need to be less at high rep rates. In any instance, the duty cycle (ratio of ON to OFF time) must be less than 20% or damage to the driver may occur. For example: 1  $\mu$ s ON time (set by pulse width) and 4  $\mu$ s OFF time (set by rep rate) represents a 20% duty cycle because it is on 1 out of every 5  $\mu$ s. The rep rate of a 5  $\mu$ s period is 200 kHz.

### Setting the Output Voltage

The output voltage is adjustable via a front panel potentiometer next to the LED display. The output voltage can be set before it is applied to the driver.

### Verify Settings

Once you verify that the trigger and output voltage are set correctly, press the Enable button to apply high voltage to the driver and the Pockels cell. To turn the high voltage off, press the Disable button. The high voltage to the cell will decay with each trigger pulse. To stop the output pulses instantly, use the trigger ON/OFF toggle switch.

**Caution:** There are instances where decaying pulses may damage optical components. In those instances it is best to use the trigger ON/OFF switch to instantly stop the output pulses.

**Warning:** To avoid injury, always turn off the trigger and disable the high voltage before making connections or adjustments to the Pockels cell.

## IV Measuring the Output Waveform

Equipment needed:

- 400 MHz oscilloscope with 2 inputs
- 2 of 100x scope probes
- Pulse generator

Measuring the electrical output performance of the driver requires a 400 MHz or faster oscilloscope and a pair of low capacitance, high speed 100x high voltage probes. The probe tip capacitance adds to the load capacitance, and this needs to be accounted for when making measurements.

Connect the probe tips to the output leads and connect the probe ground clips to the circuit ground or chassis ground. Keep the ground connections as short as possible to reduce ringing on the waveform.

**Caution:** Do not connect the scope grounds to either of the output connectors or damage to the driver will occur.

Set the pulse generator to produce a 1  $\mu$ s pulse of 5 V amplitude. Connect the pulse generator to the HVR trigger input via the front panel BNC connector.

Set the HVR voltage to 2000 V and press the Enable button on the front panel.

Set the scope to display both waveforms. One output is positive going, the other is negative going. Figure 1 below shows that channel 1 is -1000 V and channel 2 is +1000 V.

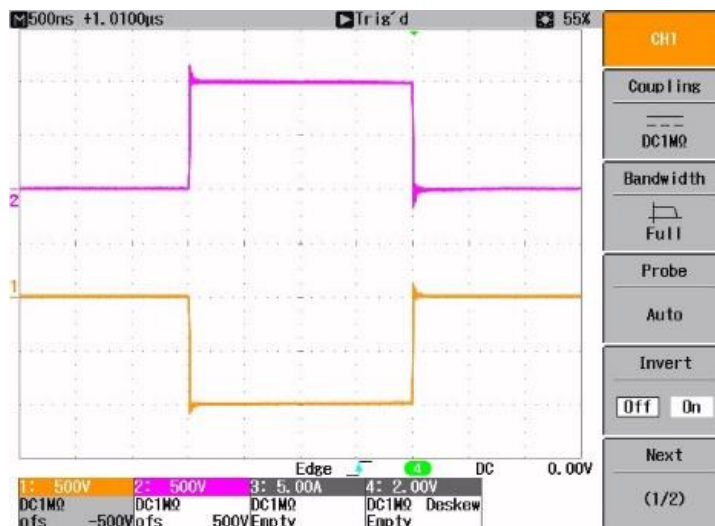


Figure 1

Use the MATH function on the scope to measure the channels differentially (A+B or A-B). Figure 2 below shows the display with the MATH function utilized.

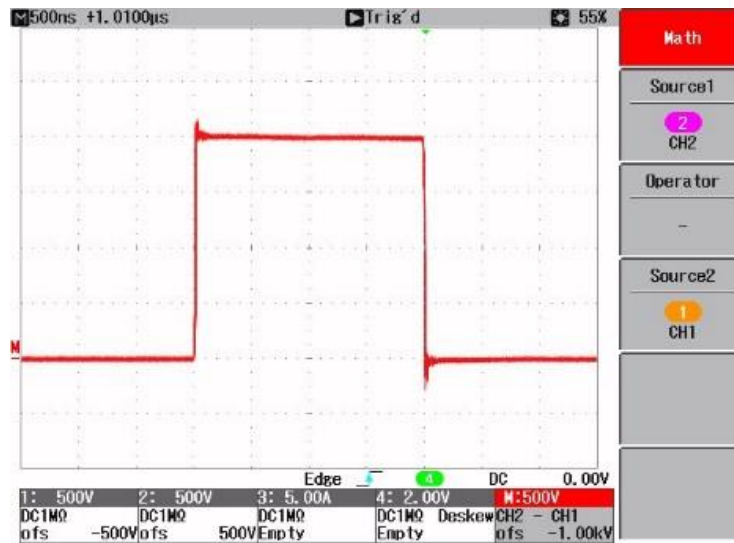


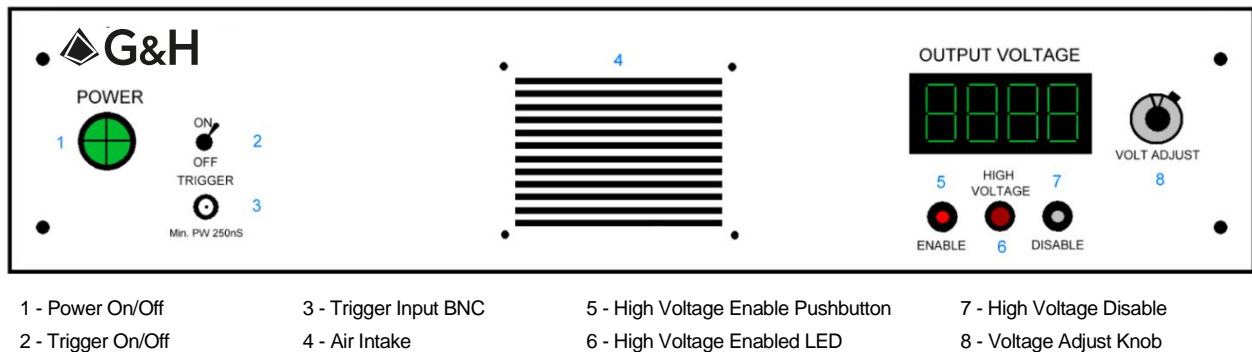
Figure 2

Measure the rise time and fall time by setting your scope cursors to the 10% and 90% amplitude points on your waveform. Higher output voltages will produce greater rise and fall times. Also, the greater your cell capacitance, the greater the rise and fall times.

Turn off the trigger and disable the high voltage before shutting down the HVR.



## V HVR Front Panel Controls



## VI Troubleshooting

**Warning:** High voltage - do not attempt to service or modify this equipment - death or serious injury can occur. Service should only be performed by qualified service personnel. This equipment must only be used by qualified personnel. This device produces high voltage pulses. Normal precautions for working with high voltage circuits must be followed.

### No Output

If the POWER switch illuminates but the voltage display does not, there is an internal fault and the HVR requires service. Please return the complete HVR unit to us for service.

### Low Output

The internal high voltage supplies may be current limiting. Reduce the repetition rate and see if the amplitude increases. Each HVR-System is fitted with power supplies selected for the amplitude and rep rate specified at the time of ordering. The model number also designates the maximum values for your system. The first two digits indicate the max output voltage (in kV) and the last three digits indicate the max rep rate (in kHz). For example, model HVR-60050 is limited to 6 kV at 50 kHz, and a model number of HVR-75100 is limited to 7.5 kV at 100 kHz.

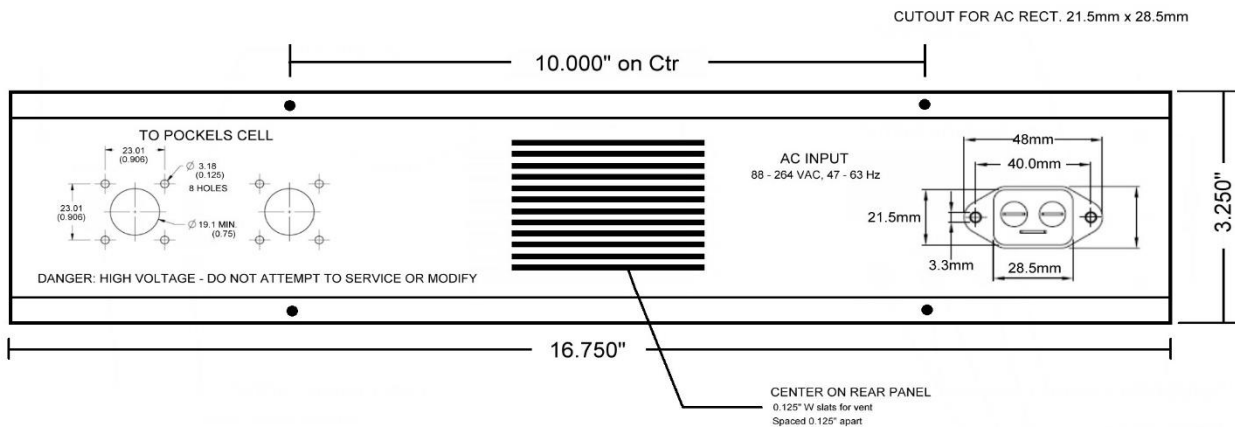
### Slow Rise/Fall Time

The published rise time and fall time are specified with up to a 10 pF load. Although the HVR can be operated with a higher load capacitance, the rise time and fall time will increase with load capacitance. The HVR has been tested with up to 100 pF of load capacitance.

### Irregular Waveform

Normally, the output waveform is a top-hat shape (see Figure 2). If the output waveform is irregular there may be a fault with your load (excess leakage current) or the HVR itself. Turn off the trigger and high voltage, remove your load and check the output waveform with no load. If it is not a top-hat waveform, return the HVR to G&H for service.

## HVR 19" Rack System - Rear Panel



For further information

[info@gandh.com](mailto:info@gandh.com)
[gandh.com](http://gandh.com)