Airity

FLARE

High-voltage nanosecond pulser

Model: HVP 10k-01-10k

USER MANUAL

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Overview

The Airity Flare nanosecond pulsers are high-voltage systems optimized for compact applications where high efficiency is important. The pulser features:

- Low internal energy storage
- An isolated output
- Voltage up to 10 kV and pulse width of 200–400 ns depending pulse setting and load impedance
- Ground referenced enclosure for safety and thermal transfer

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Airity Technologies pulsers are presently offered for laboratory and research purposes only and have been developed based on specific customer requirements at this time. It is assumed that this specialized equipment will be used only by qualified personnel with prior experience with high voltage systems. It is the responsibility of the operator to exercise care and common sense with this highly versatile equipment and to follow necessary safety precautions when incorporating the pulser with a system and load.

Safety Guidelines

Danger:

- Working with high voltages can be lethal
- Knowledge of high-voltage systems is required for operation
- Never operate without both outputs connected to a load
- Never touch either output connector while the pulser is operating
- Only move the pulser after disconnecting all power sources
- Wear appropriate eye and ear protection while using the pulser

Theory of Operation

Airity Flare pulsers have an internal voltage transformation and a pulse stage that provide a voltage gain of 100–130x depending on load and pulse width setting. The exact pulse magnitude can be measured for a given load using an isolated or differential high-voltage probe. A TTL level input port is provided for flexibility in pulse frequency and repetition. Average power should be limited to about 12.5 W during continuous operation. For guidance on specific use cases, please contact info@airitytech.com for assistance.

Power inputs and control signals

1. Pulse signal

A conventional signal generator providing TTL level signals in pulse waveform mode can be used to generate the pulse signal to be amplified. Some examples of signal generators sufficient for this use are:

- Siglent SDG1062X
- Keysight 33210A

2. Logic power

A standard 15 V dc lab power supply can be used to provide "housekeeping" power for the internal logic of the pulser.

3. Input power

A conventional lab type dc power supply can be used to provide the main input power for the pulser. Airity pulsers provide approximately 110x unloaded gain. This power supply can be used to adjust the output pulse voltage between 0 and about 10 kV. For example, 87 V_{in} creates approximately a 10 kV pulse depending on load. For most cases, this supply will not need to provide more than a few hundred milliamperes. It is important that the input voltage supply has current limiting capability.

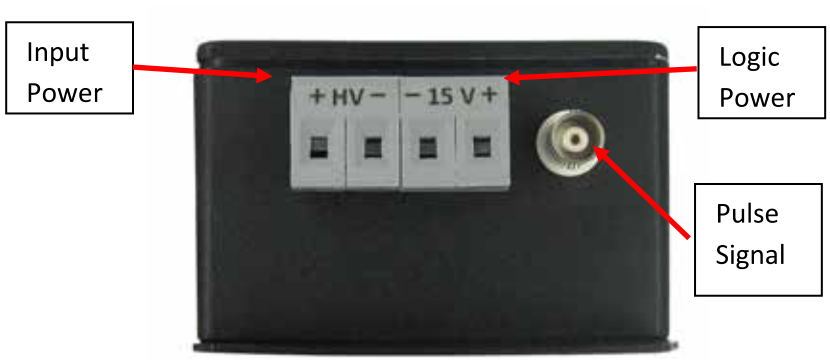

Figure 1. Front view of the Airity Flare nanosecond pulser indicating the location of the Pulse signal BNC connector (top right), the Logic power connectors (middle two sockets labeled plus and minus 15 V) and the input power connectors (left two sockets labeled plus and minus HV). The high voltage output leads are located on the opposite side.

Figure 2. Top view of the pulser. Signal and input voltage headers are shown on the left side while the high voltage output cables are shown on the right.

Method of operation

While the pulser has various protections incorporated into the design, the steps below should be followed to achieve proper operation and prevent damage to the pulser unit. To disable the pulser reverse the sequence, turning of the "input power" supply first.

1. Pulse signal: TTL level input signal from external signal generator
   a. Ensure signal generator is in high impedance mode ("high-Z")
   b. Set waveform to pulse mode
   c. Set pulse width to 220 ns
   d. Set pulse voltage to 0–5 V (5 V peak-to-peak with a +2.5 V offset)
   e. Set repetition frequency as desired, e.g., 10 kHz
      i. Repetition frequency should be limited such that average input power does not exceed 12.5 W
   f. Turn signal on
      i. CAUTION: Do not change or turn off the signal generator while the input power is present. Certain signal generators produce unpredictable behavior when turning off or changing the pulse. In some cases, the pulse signal can remain high for long periods of time potentially causing pulser failure.
2. Logic power: 15 Vdc supply
   a. Set the output voltage limit to 15 V
      i. Do not exceed 15 V or damage could occur
      ii. For some supplies, it is best to set the limits prior to connecting to the pulser if the output must be on for the limits to be set.
   b. Set the output current limit to 200 mA
   c. Enable the output voltage
3. Input power: 0–100 Vdc supply
   a. Set the output current limit to 200–500 mA
   b. For safest operation, increase the voltage from 0 V when enabling the main power.
   c. Monitor power to avoid exceeding 12.5 W
      i. If more than 12.5 W is required, please contact info@airitytech.com

Appendix

The following figures demonstrate the voltage gain, safe operating range, and typical pulse waveform for the Airity Flare nanosecond pulser. Please refer to the figures for setting the input voltage and frequency to achieve the target output voltage and safe operation.

Voltage gain

The change in output voltage vs input voltage is shown in Fig. 3 for the optimal input pulse width of 220 ns. The nominal input voltage to peak output voltage (open circuit) gain is 110x. The output voltage varies with the input pulse width but the gain is independent of the repetition frequency.

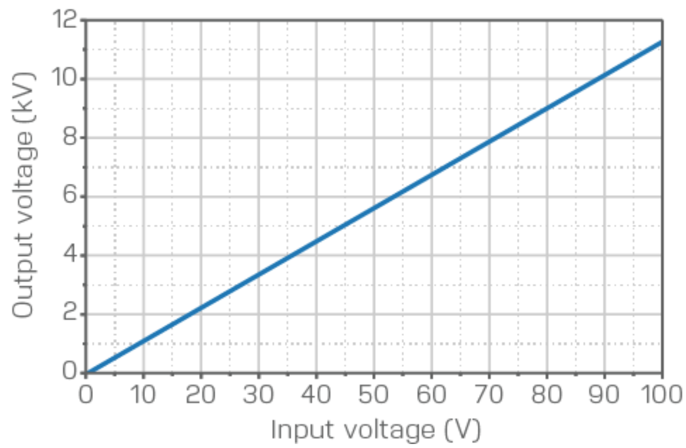

Figure 3. Open circuit output pulse peak voltage vs input voltage.

Range of safe operation

The pulser is guaranteed to operate within the power, frequency and output voltage range demonstrated in Fig. 4, which shows the area of safe operation. The curves demonstrate the different peak voltages and corresponding repetition frequencies the pulser can be operate, such that the input power remains within the safe operating region marked by the green box.

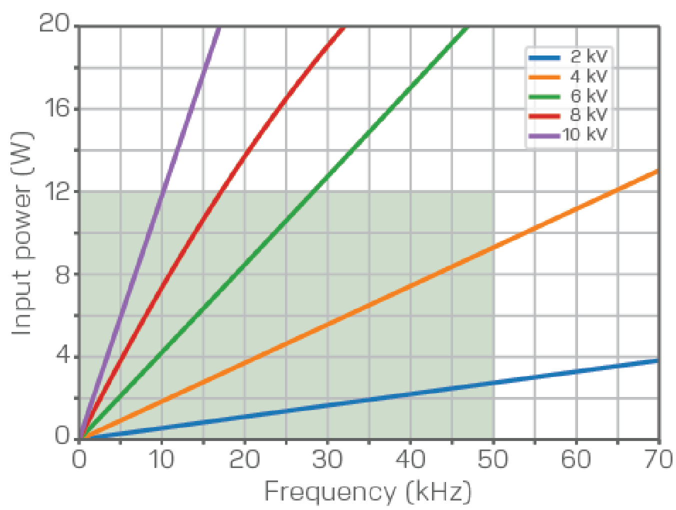

Figure 4. Safe operating frequency range for different peak open-circuit output voltages. The pulser is thermally limited to ~12 W input power for continuous operation.

Pulse waveform

The pulse waveform between the output terminals during generating plasma is shown in Fig. 5. The output pulse waveform and width are somewhat dependent on the nature of the load the pulser is connected to. On certain higher impedance loads, the size of the inductance loop at the output may result in a few cycles of damped “ringing” oscillations and can cause the output pulse width to vary from 200–400 ns. These factors can also affect the peak voltage available from the pulser. It is always recommended to keep the pulser as close as possible to the load to minimize the effects of the inductance loop.

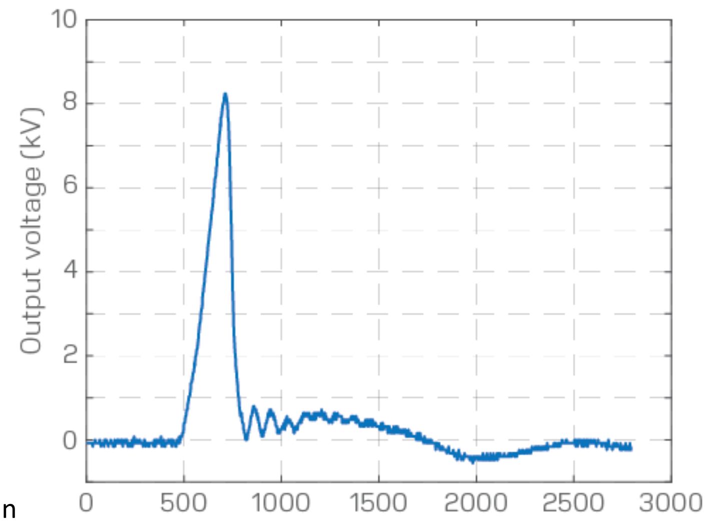

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Figure 5. Example output pulse with 87 V input voltage, 220 ns input pulse width, generating an arc discharge.