Operation Of The PVX-41XX and PVM-41XX Pulse Generators With Common Pulse (+HV) and Bias (-HV) DC Power Supply Polarities

ABSTRACT

DC power supplies of the same polarity (i.e. both positive or both negative polarity) may be used for the Pulse and Bias DC supply inputs of the PVX-41XX and PVM-41XX pulse generators. How-ever most high voltage DC power supplies cannot regulate voltages of the same polarity from a sepa-rate source. To operate with power supplies of common polarity, the bias, or lower voltage (-HV or V_{LOW}) supply must be provided with an additional current flow path to ground. If this path is not pro-vided, the output voltage may not remain at the -HV In potential when the pulse generator is not gated, but can be charged up to the potential of the V_{HIGH} (+HV In) supply. This technical note describes how to install a current path to ground to mitigate this problem.

DEI's high voltage pulse generators designed for driving high impedance and capacitive loads (the PVX-41XX and PVM-41XX models) may be operated with the pulse (+HV or V_{HIGH}) and bias (-HV or V_{LOW}) DC power supply inputs at a common polarity (i.e. -HV In at +500V and +HV In at +1500V, or -HV In at -1000V and +HV In at -500V).

However most high voltage DC power supplies cannot regulate voltages of the same polarity from a separate source. Positive power supplies sink (draw) electrons from ground, while nega-tive power supplies source (push) electrons to ground. To operate with power supplies of com-mon polarity, the lower voltage (-HV or V_{LOW}) supply must be provided with an additional cur-rent flow path to ground. If this path is not pro-vided, the output voltage may not remain at the -HV In potential when the pulse generator is not gated, but can be charged up to the potential of the V_{HIGH} (+HV In) supply due to leakage current within the pulse generator. This is often ob-served if the load does not draw current, or as the pulse repetition frequency is increased.

The path to ground can be accomplished with a shunt resistor (i.e. a resistor from the -HV In power supply input to ground) in low power appli-cations, or with an active shunt regulator for high power applications.

To determine the value and size of the shunt re-sistor, three things must be known:

1. The maximum pulse repetition frequency;
2. The maximum differential voltage (V_{HIGH} - V_{LOW});
3. Total load capacitance (including the load, interconnect cable, and strays)

As the load is capacitive, what charge goes into the load must also come out. The formula CV^2F (where C is the total load capacitance, V is the differential voltage between the V_{HIGH} and V_{LOW} supplies, and F is the pulse repetition frequency) provides the minimum power that must be dissi-pated in the resistor or shunt regulator from switching the capacitive load.

From the power calculated above, the discharge current is calculated using the formula:

$$\frac{P}{V}$$

Where P is the power calculated above and V is the bias (-V) voltage .

For example, if the calculated power is 1W, and the -V voltage is 100V, then the discharge current is:

$$\frac{P}{V} = \frac{1}{100} = 10\ mA$$

The value for the shunt resistor can be found using the formula:

$$R_{SHUNT} = \frac{V_{BIAS}}{I_{HVPS}} = \frac{100V}{10mA} = 10{,}000\Omega$$

As this bias is not regulated and can vary with operating parameters, a regulated power supply must be used to maintain a constant voltage. However if the power supply current increases beyond the 10mA assumed maximum, then the bias voltage will no longer be controlled by the power supply. Therefore if the bleeder resistor value is reduced by a factor of 2, then there will always be current drawn from the bias power supply, and regulation will be maintained. Hence in this example, a 5KΩ resistor would be chosen. DC current from the V_{LOW} DC supply will also flow in the shunt resistor. This power can be calculated by the formula:

$$\frac{V^2}{R} = \frac{100^2}{5{,}000} = 2W$$

Where V is the V_{LOW} voltage, and R is the resistance of the shunt resistor.

For reliability reasons, it is recommended that power dissipation capability of the resistor be doubled. Therefore in the example given above, a 5KΩ 5W resistor would be chosen.

In determining DC power supply requirements, the V_{LOW} (-HV In) DC power supply must be able to provide the power dissipated in the shunt resistor (2W, in this example), and the V_{HIGH} (+HV In) DC power supply must be able to provide the CV^2F power.

Please note that this potential problem does not occur if the input DC power supplies are of different polarities (i.e. -HV in t -1000V and +HV In at +500V), or if one of the DC supply inputs is grounded (i.e. -HV In is connected to ground and +HV In is at +1500V). Furthermore, depending on the DC power supply used, at low pulse repetition rates with small capacitive loads, this problem may not be observed because of the small internal paths to ground found within the DC power supply.

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