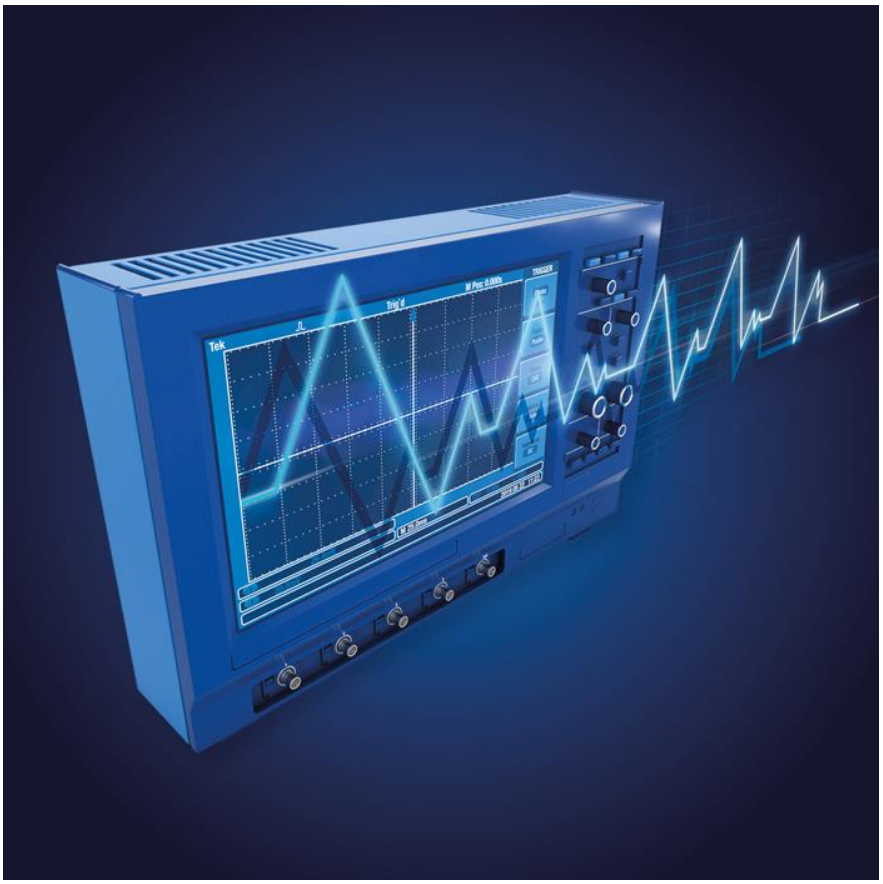
Whitepaper

DC/DC Converters with 20kVDC Isolation



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Abstract

This whitepaper discusses the applications and hazards of using high DC voltages and explains how high isolation DC/DC converters can be used to enhance safety.

Introduction

There are many DC high voltage applications in industry, medicine, materials science and electronics production. Security at border controls relies heavily on X-ray scanners for checked-in luggage and parcels, mass-spectroscopy systems for 'sniffing' out explosive compounds and compact linear accelerators (LINACs) to scan through vehicles to detect smuggled goods, stowaways and illegal weapons. In medicine, not only are high voltage DC supplies required for X-Ray and CT diagnostics, but also for oncology treatment, 3D imaging for reconstructive surgery and image-guided operations. As the population ages, diagnostic tools such as nuclear imaging, bone densitometry and dental imaging are becoming increasingly necessary to investigate dementia, osteoporosis and tooth disease – all common age-related illnesses. In industry, X-ray detectors permit liquid and solids level measurement in production plants, without the risk of contamination or leaks caused by puncturing the tank to insert a sensor, which also makes them useful for hygienic food production. In research institutes, sputtering, ion deposition, and laser and plasma beams allow novel compounds and structures to be created or analysed. Not only are HV DC supplies needed for the beam electronics, but also for the high-vacuum molecular pumps that these systems depend upon.

The need for very high isolation DC/DC converters

All of these different detection systems have one thing in common: a high voltage DC supply. The most common method used to generate a continuous high voltage DC supply is to use a regulated low voltage source to feed a high voltage multiplier (Figure 1). The high output voltage is sensed by a long divider chain and fed back to control the LV power supply. The output current is measured between the chassis common ground and the floating ground at the input to the multiplier:

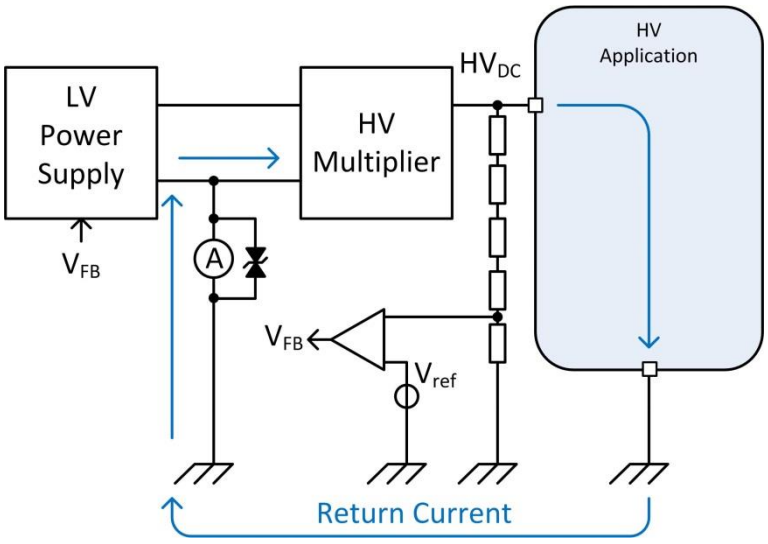

Figure 1: Typical HV DC supply with voltage feedback and ground current monitoring

This topology is simple, cheap and reliable as long as the chassis grounds are all well connected and at the same potential. However, if an external sensor is added to the system, for example, to measure the hardness of the vacuum inside the application, then there is the possibility of a secondary leakage current flow through the ground-referenced sensor output. This current is deducted from the return current, so giving a false reading (Figure 2). In addition, a potentially hazardous leakage voltage could develop across any potential differences between the chassis ground and the sensor ground.

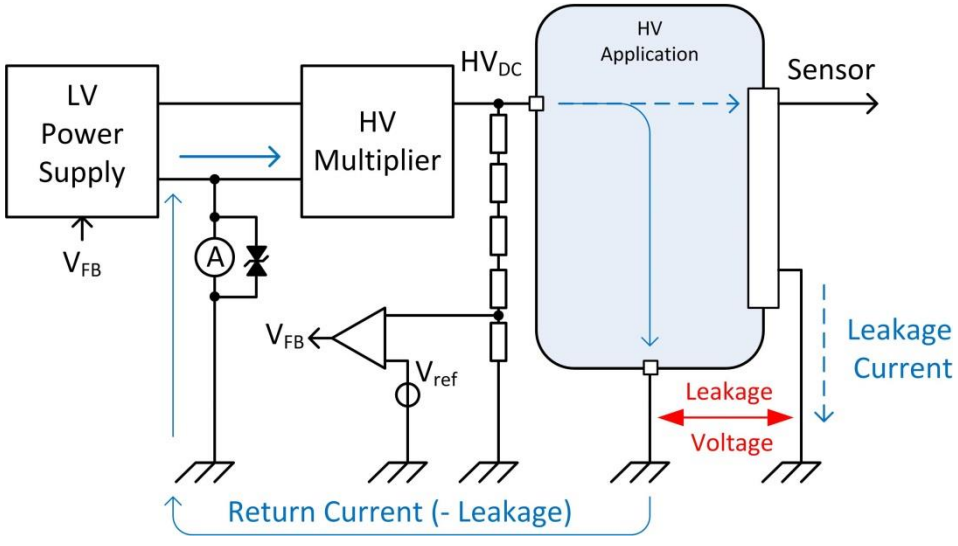

Figure 2: False return current reading due to leakage currents

A solution to this problem would be to isolate the sensor output so that the leakage current path is completely blocked, but this requires an isolated DC power supply capable of withstanding very high voltage differences across the isolation boundary (Figure 3).

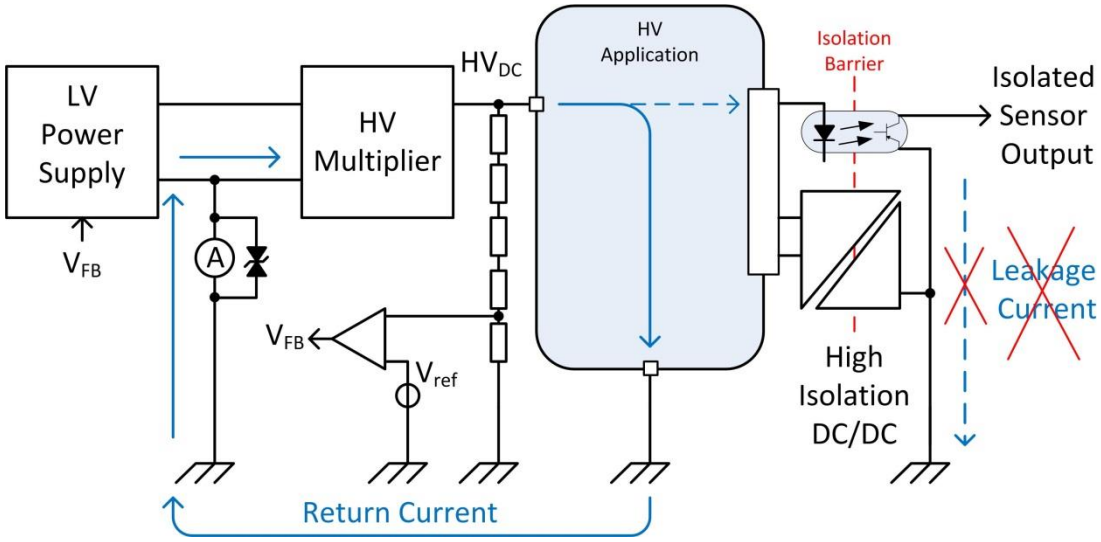

Figure 3: Use of isolated DC/DC and optocoupler to eliminate leakage currents

The IEEE guideline for Recommended Practice for Safety in High Voltage and High-Power Testing (IEEE 510-1883) requires that "...measuring devices should be properly insulated for the voltage of the supply." The RECOM Power RHV2 and RHV3 DC/DC converters have been designed with such demanding applications in mind. They feature 20 kVDC reinforced isolation (12.5 kVAC/1 minute) and have a gap between the input and output pins of more than 30mm to reduce the possibility of an arc-over. The output is available with single or dual polarity to supply a wide range of sensors, amplifiers or transducers. As some HV applications run at elevated temperatures due to the heat generated by the X-ray target or the vacuum pumping system, the RHV2 series (2W) is certified over the full industrial temperature range of -40°C to +85°C without derating. The RHV3 offers 1W more output power (3W) at the price of a reduced operating range to +80°C without derating.

High isolation is not only needed for high voltage power supplies, but also, the gate drivers for high power switching circuits using IGBT, SiC or GaN transistors need an highly isolated DC/DC power supply, especially on the high-side or multi-level legs, where switching voltages as high as 6500V are used for traction applications. The isolated DC/DC converter supplies the power for the isolated gate driver which sits directly on top of the switching node, thus the insulation barrier in the DC/DC converter must withstand

the full AC voltage between the output side and the grounded input side. In some applications, the DC/DC also provides safety isolation.

In gate driver applications, not only the isolation withstand voltage is important but also the input/output capacitance. If the coupling capacitance is not very low, then AC current will flow across the boundary, dissipating energy and raising the temperature of the insulation. This could lead to an early isolation failure. The RHV2 and RHV3 series feature an extremely low coupling capacitance of only 4pF maximum, making them especially useful for high voltage gate driver power supplies.

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