

## Are there benefits to having isolation between the voltages of multiple output power supplies?

In this paper, which is intended for electronics engineers and designers working with power systems, Rob Hutton, Product Manager, TDK-Lambda EMEA, asks: are there any benefits of having isolation between the voltages of multiple output power supplies, and if so, how can it be used to improve system performance?

### References

[www.emea.lambda.tdk.com/qm](http://www.emea.lambda.tdk.com/qm)  
[www.emea.lambda.tdk.com/mu](http://www.emea.lambda.tdk.com/mu)

# Are there benefits to having isolation between the voltages of multiple output power supplies?

Rob Hutton, Product Manager, TDK-Lambda EMEA

The voltages on a multiple output power supply may come from the manufacturer with pre-configured polarities. The outputs could be fixed at +5V, +12V and -12V for example, sharing a common 0V terminal with no isolation between the outputs. Other types of power supplies, on the other hand, may have one, two, or all three of the outputs isolated from each other. But are there any benefits of having isolation, and if so, how can it be used to improve system performance?

## Power supplies with no isolation between output voltages

Low wattage multiple output power supplies below 300W tend to have a common 0V connection with the polarity of the outputs fixed. A single power transformer is used with secondary windings or voltage taps to derive each output voltage. This enables a simple, low-cost structure for high-volume production. One drawback to this approach is that the voltage adjustment is limited to the main high power output and can affect the voltage levels of the other outputs through cross-regulation.

An alternative way to generate multiple outputs is to use an AC-DC power supply and derive additional voltages using non-isolated DC-DC converters or regulators, see Figure 1. It can be seen that all the output voltages share a common connection, which is indicated by the black lines.

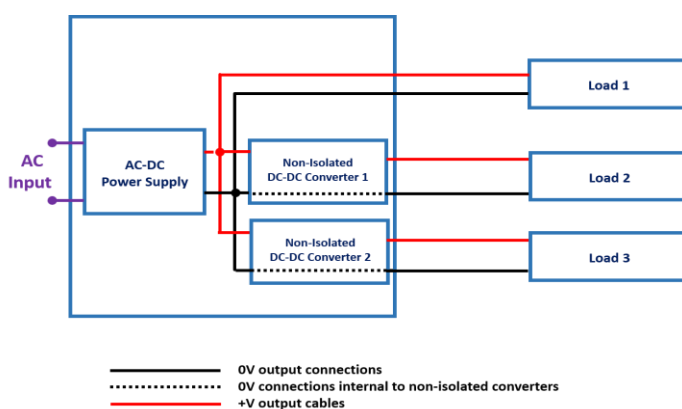
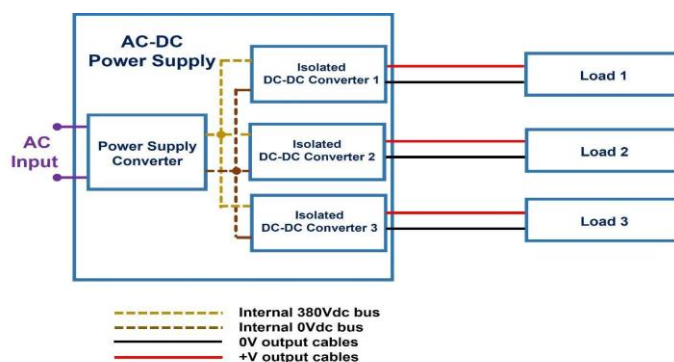


Figure 1: Multiple outputs using non-isolated DC-DC converters with fixed polarity outputs

## Power supplies with isolated output voltages

The TDK-Lambda [QM series](#) and the recently introduced 1U high [MU4 series](#) use an AC-DC converter to generate a primary side 380Vdc bus voltage and isolated DC-DC modules to provide the output voltages, see Figure 2. Most modular power supplies also have isolation between the individual output voltages, partially due to their topology and construction; this is commonly referred to as a ‘floating output’.



*Figure 2: Modular power supply block diagram with floating outputs*

Above 300W, modular or configurable power supplies have proven a popular way to provide multiple output voltages for systems in medical, industrial and test and measurement environments. The TDK-Lambda QM series, for example, has a standard set of output modules and converters, enabling power supplies to be offered with ratings of 550W to 2000W and up to 18 outputs.

Using the TDK-Lambda online Quick Product Finder, engineers can enter their desired output voltage and current combinations. A part number is automatically generated to allow a purchase order to be placed. Then the product is assembled, tested, and shipped. The power modules often have a wide adjustment range to accommodate non-standard voltages. All combinations are safety certificated, including medical.

## The advantages of isolation between output voltages

There are many advantages of having isolation between the output voltages of a multiple output power supply.

**Flexibility:** Supplying a power supply with fully floating outputs enables the user to derive positive or negative voltages as required by their system. No pre-ordering is required. If +24V, +15V, and +15V is needed for one system and +24V, +15V, and -15V for another, the same part number can be used with a simple wiring harness change. (Figure 3a). With fixed polarity outputs, a second model would need to be ordered and stocked. (Figure 3b).

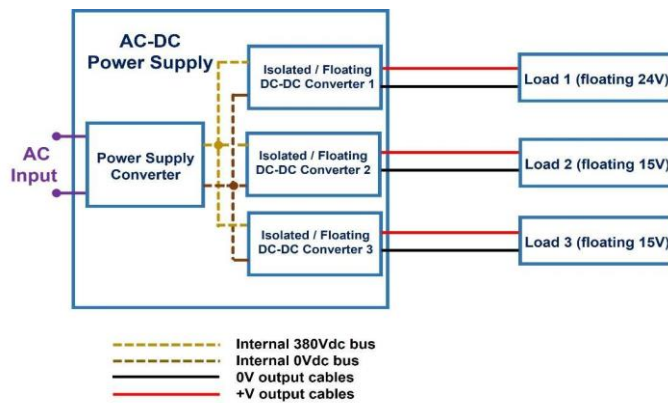


Figure 3a: Power supply with floating outputs

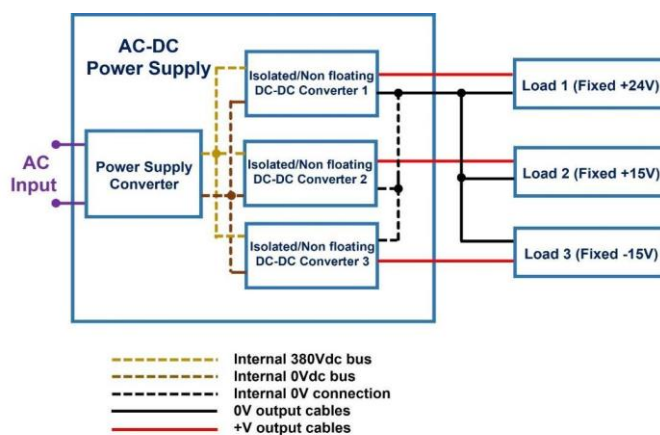


Figure 3b: Power supply with fixed outputs

If the output voltages are floating, they can be connected in series to generate higher voltages. Our 24V, 15V, 15V configuration, for instance, could be used to provide 24V and 30V by series connection of the two 15V outputs. However, when doing so, consideration of the maximum output to chassis ground insulation voltage has to be taken into account - see the power supply datasheet for more details.

**Better load regulation:** When a floating output has positive and negative remote sense capability, it can compensate for voltage drops in both the positive and negative load wiring. A non-floating output can only compensate for a voltage drop in the positive wire. The performance of a voltage-sensitive load could be affected.

**Reducing the effect of noise generating loads:** When one load in a system generates significant electrical noise, a floating output can isolate that noise from more sensitive loads in the system. Additional common mode filtering can be added to just that output. However, when loads share a common connection, those noise currents may be present on all the outputs and be more difficult to filter out.

**Medical applications:** In certain medical systems, an output may be required to be fully isolated from earth ground by 1,500Vac for Means of Patient Protection (MOPP). This is possible with the QM and MU4 series, which have 1xMOPP isolation from output to ground. This type of isolation may also be required in other industrial applications.

**Avoiding ground loops:** Many systems have the negative input of the loads connected to earth ground. A central ground 'star point' connection is often used to avoid noise currents and spikes from circulating around the system wiring. This is easier to achieve and more flexible to apply with floating outputs, see Figure 4, rather than with non-floating outputs, see Figure 5, where there are multiple current paths through the 0V cables and power supply.

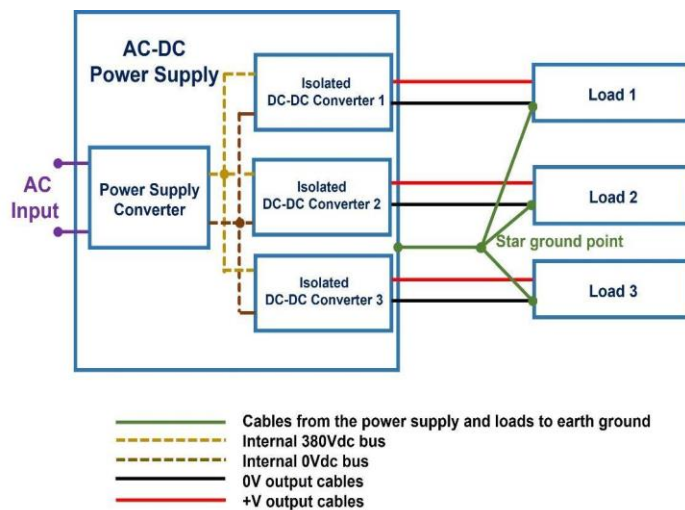


Figure 4: Modular power supply with star point grounding

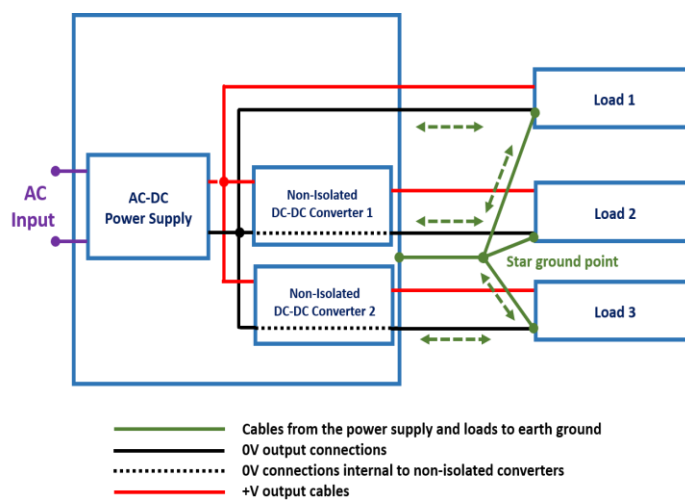


Figure 5: Non-isolated DC-DC converter supply with star point grounding

**Output monitoring and control functions:** Floating outputs inherently use optocouplers to provide isolation for DC OK and remote on/off signals. Non-floating power supplies often have the above signals referenced to the common 0V. Care must be taken to avoid noise from the power cables from interfering with the signal voltages or output currents flowing through the signal cables. 'Daisy chaining' signals between power supplies and other devices is easier to do when the signals are isolated. On a non-floating power supply, inhibiting just the main output is not a simple task, without disabling all the other outputs.

In some applications, particularly those with low power requirements for the auxiliary outputs, fully floating outputs are not required. As system complexity increases, with multiple power supplies interacting, EMI (Electromagnetic Interference) and immunity problems can arise. A modular power supply though can provide up to 18 outputs, replacing several individual power supplies. Having isolation between outputs can help avoid noise issues and simplify system design.

For more information about power supplies from TDK-Lambda, please visit:

[www.emea.lambda.tdk.com/qm](http://www.emea.lambda.tdk.com/qm)

[www.emea.lambda.tdk.com/mu](http://www.emea.lambda.tdk.com/mu)

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