

OBSOLETE PRODUCT
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Series and Parallel Operation of the PF600-1

In this application note, you will find considerations for series and parallel configuration of the PF600-1. Additional information on the PF600-1, including features and complete specifications can be found on our website at <http://www.murata-ps.com>.

Series and Parallel Operation of PF600-1

SERIES OPERATION

If operating multiple PF600-1 modules in series, observe the following precautions and restrictions:

1. The total output voltage will exceed SELV safety limits, and must be treated as hazardous. In any series connection, ensure that the voltage difference between the negative output terminal of each unit and its auxiliary secondary pins (Output 2, DC-OK, Shutdown) is held below 60V. This may mean that these functions cannot be used, or require optoisolators, as suggested in section 4 below.
2. The Output Monitor (DC-OK) should be used only with particular care, noting that it is referenced to the negative side of the output of *each unit*. Optoisolators could be used, for example, powered by the respective auxiliary outputs. Connect the receive transistors in series to provide a combined signal.
3. Allow sufficient time after applying input power (or otherwise enabling the output) for the full voltage to be reached before applying more than 30% load. The optoisolator-based arrangement above could provide a suitable command for the load to be applied. If this is not observed, any of the series-connected units that has not reached full voltage may trip, and may not recover in the presence of a load.
4. With no more than two units connected in series, the Shutdown inputs may be connected in series. Check that the shorting device is suitable for the maximum total voltage of 30V. When shorted, both units will be shut

down. Alternatively, connect the Shutdown inputs in parallel using Schottky gating diodes to apply the shutdown short. If directly connected in parallel, the thermal protection of some units may be jeopardized. With more than two units, an optoisolator may be used to shut down each unit while complying with item 1, above. Ensure that the drive current to all transmit diodes is sufficient to sink 10mA at 0.8V on the receive transistors.

PARALLEL OPERATION

When connected in parallel, the safety and voltage isolation problems do not arise, but similar concerns do arise about the sharing of load. It is now current, not voltage, that must be distributed.

1. Allow sufficient time after applying input power (or otherwise enabling the output) for the full voltage to be reached before connecting a load (more than 30% of a single unit's rating; more restrictive than for series operation).

If gating diodes are fitted in series with the output, as described in section 4 below, the logic levels from the Output Monitor pins should be used to switch the connected loads. Ideally, combine the signals with a logic gate (discrete diodes or an IC), as described in section 3, below. This guarantees that all module outputs are established before load is applied.

If the main outputs are directly connected, as will be the case if the purpose of parallelling is to increase the available power, the Output Monitor signals cannot be meaningfully combined. Use any one to start the powered equipment. The delay incorporated in this signal should be sufficient to ensure that all outputs are active by the time any Output Monitor signal goes active.

Depending on the nature of the load, it may not be necessary to use the Output Monitor in this way. The first of the parallellled units to start can run in current limit for a short time, waiting for the other units to start. However, should the system trip for any reason, such as under an overload condition, it may not recover, or may do so only after a number of failed attempts when one module starts but trips before another is able to pick up part of the load. The higher the load as a proportion of the total module capacity, the slower and less likely will be a successful restart.

2. The output voltage varies by about 2V from light load to full load, providing passive load sharing. (From about 20% to 50% load, little change in voltage occurs, but the resulting poor sharing in this region should be of no concern.) As the units warm up, the voltage falls by about 1V per 50°C. This will also help to balance the load.

3. Since they are referred to a common level, all the auxiliary pins may be used without the isolation-rating concerns of series operation. The shutdown pins may be series-connected or, with gating diodes, parallel-connected.

If gating diodes are being used, the Output Monitor pins may be combined, but require an OR function, either discrete or logic gate (OR or NOR, according to the polarity required). If gating diodes are NOT used, any one of the output monitor signals may be used directly; there is no point in combining them.

The Auxiliary outputs may be connected in parallel to obtain a redundant or higher-rated supply. (They may also be connected in series, if there is any reason to do so.)

4. The units will function in parallel without series gating diodes. This will provide increased power and/or redundancy, with protection against all faults except an internally-shortened output. The most likely cause of a shorted output is the failure of two output rectifier diodes. Experience to date is that a single failure does not cause a second device to fail, making this failure mode unlikely.

If it is necessary to protect against all possible failure modes in a redundant system, gating diodes may be fitted in series with each output. A 60V 20A Schottky device is recommended, with heatsinking to remove 10W per device under the worst conditions. A standard diode of at least this rating will also work, but will probably lose more power.