Testing Solar Inverters using DC Power Supply

This application note will discuss the different types of solar inverters and DC voltage/current injection with the use of a DC power supply. Solar inverters are a key component in a solar power system where technology is able to convert DC (direct current) electricity provided from the solar array PV (photovoltaic) electricity into AC (alternating current) electricity. With this conversion solar inverters will provide AC electricity for residential use, commercial use, or be connected to the utility grid for electricity feedback.

As part of the solar inverter manufacturer's test protocol, functional electrical routine testing will be completed simulating DC electricity from the solar arrays with the use of a DC power supply. Basically, individual PV cells produce low voltage. The low voltage PV cells are placed in series to create modules that would produce higher voltage. Next, PV modules are placed in series to create even higher voltages. Solar manufacturers want to simulate the PV module being placed in series when testing these inverters. The 42000 series DC programmable power sources have an output that can be floated off ground to allow them to be placed in series. This allows the units to be placed in series with Viso (isolated voltage), up to a maximum voltage of 800V. Each DC programmable source then acts like a PV module. This allows manufacturers to better simulate real life operation into the inverter being tested. Proper electrical testing will define the efficiency and proper functional operation of the solar inverter.

What are the different types of solar inverters?
There are three known classification types of solar inverters:

1. **Stand-alone inverter**s are mainly utilized in a stand-alone connected system where the DC electricity charge generated from the solar array will be transferred from the batteries to the inverter, and convert into AC (alternating current) electricity ready for usage. A charge controller will monitor the current flow to the battery and the inverter.

2. **Grid tie inverters** are mainly connected to a utility grid. AC electricity produced from the inverter can transfer power back into the utility grid electrical system. Electrical configuration for this system will directly be wired to the grid for residential and commercial usage along with the solar PV arrays. Batteries are sometimes utilized in this configuration to store energy while energy transfers back to the grid utility system. Grid tie inverters are designed to be used in a grid tie connected system and can't be utilized in a stand-alone system.

3. **Battery backup inverters** are designed to be utilized in a backup system. The intent of the design is mainly to manage and control the energy in case of a power outage. Ideally, charge controller is part of the design of the inverter. The system will ensure voltage/current from the batteries will distribute the energy as needed for residential or commercial usage.

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Maximum Voltage and Current Output from DC Power Supply
QuadTech's 42000 series DC power supply can be utilized to deliver low voltage/low current or high voltage/high current to test solar inverters applications. Below is a table for "Serial" or "Parallel" configuration for maximum voltage output or maximum current output from QuadTech's 42000 series DC power supply. Five QuadTech 42000 series power supplies can be connected up in series or parallel to deliver maximum voltage output or maximum current output. As shown in Table 1, "Serial" configuration will provide maximum voltage output voltage and parallel configuration will provide maximum current output.

Table 1: Listing of maximum connecting voltage and current in series/parallel operation for the 42000 Series Power Supplies.

42000 Series Model	Serial		Parallel	
	Max. Devices	Max. Output Voltage (V)	Max. Devices	Max. Output Current (A)
42006-30-80	5	150	5	400
42006-100-25	5	500	5	125
42006-300-8	5	800	5	40
42012-40-120	5	200	5	600
42012-80-60	5	400	5	300
42012-100-50	5	500	5	250
42012-600-8	5	800	5	40
42024-80-60	5	400	5	300
42024-100-50	5	500	5	250
42050-100-100	5	500	5	500

QuadTech's 42000 series can also be used as a standalone DC power supply to test solar inverters. Maximum output voltage and maximum output current will be determined based on maximum power of the DC power supply. For example: 420060-30-80 maximum available power output is 600W. The applied output voltage/current can be delivered to the device under test (solar inverter) as long the maximum power consumption does not exceed 600W. Maximum power output can be determined by calculating Voltage x Current = Power. This will also help the end user correctly determine proper rating power supply for the specific application.

There are various voltage and current input requirements for many different solar inverter manufacturers. Required test signals can be a combination of low voltage/high current or high voltage/low current. By delivering a simulated DC test signal to the inverter, solar inverter manufacturers will be able to monitor the input electrical characteristic of the inverter such as: Maximum array open-circuit voltage, MPPT Voltage range, MPPT (maximum power point tracker) operating range, and Maximum Input Current. In addition to the output, manufacturers can also monitor electrical characteristic such as: AC output nominal voltage, AC output voltage range, AC frequency, and AC frequency range.

As shown below in Figure 1, five QuadTech 42012-80-60 DC power supplies in a series will provide test voltage output up to 400V. Serial connection of the DC power supply will provide higher voltage level if needed to achieve the inverters electrical input requirement. QuadTech's 42000 series can also

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be wired in parallel to output maximum test current as shown in Figure 2. For example, QuadTech 42012-80-60 will be able to supply up to 300A of test current with configuration as shown in Figure 2.

Figure 1. Series Configuration

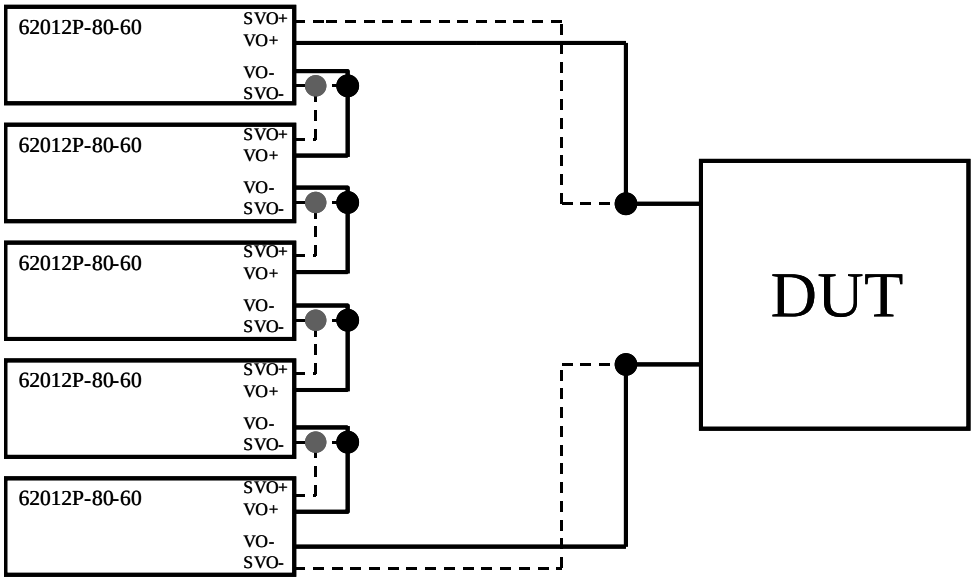
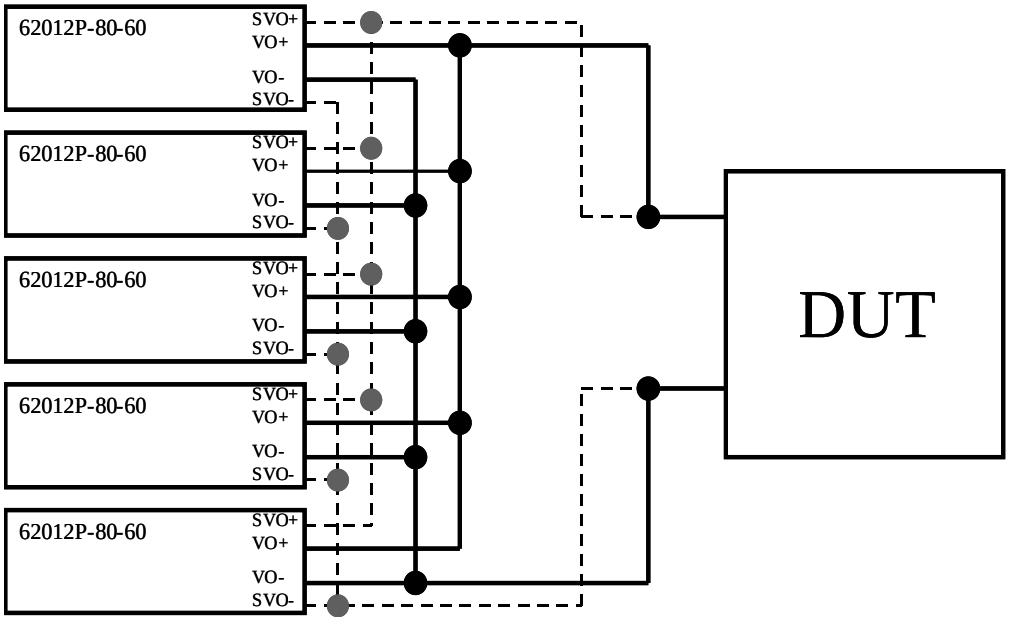
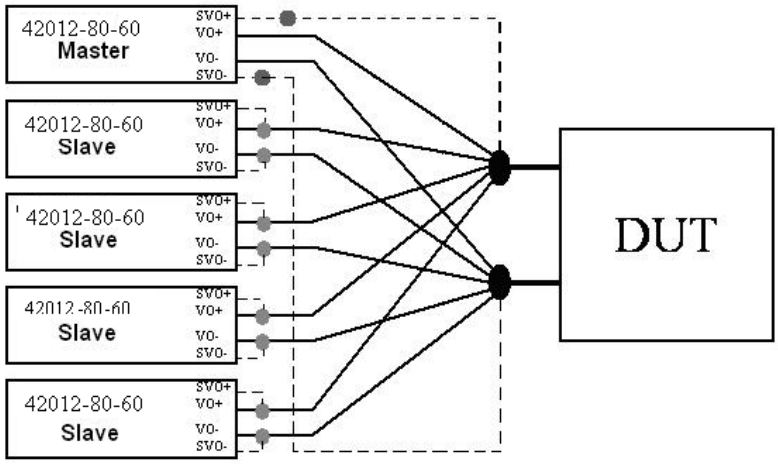


Figure 2. Parallel Configuration



Parallel configuration as shown in Figure 3 (below) is suggested for model 42006-30-80 & 42012-40-120 for maximum current output. QuadTech DC power supply model 42006-30-80 can deliver current up to 400A and model 42012-40-120 can deliver current up to 600A.

Figure 3. Parallel Configuration



Different Types of Solar Inverter-Connected Systems

Figure 4 (below) is an example where a solar inverter is implemented as part of an OFF grid solar power system. Configuration shown in Figure 4 will transfer the DC charge generated from the PV solar module to the solar inverter, charging the battery as well. DC charged from the solar module will be converted to an AC signal once it has passed through the inverter. This provides AC electricity that is connected to a main circuit panel for the residential use. Nominal output voltage and frequency will be based on solar inverter design.

Figure 4. OFF Grid System using Solar Inverter and Battery Backup

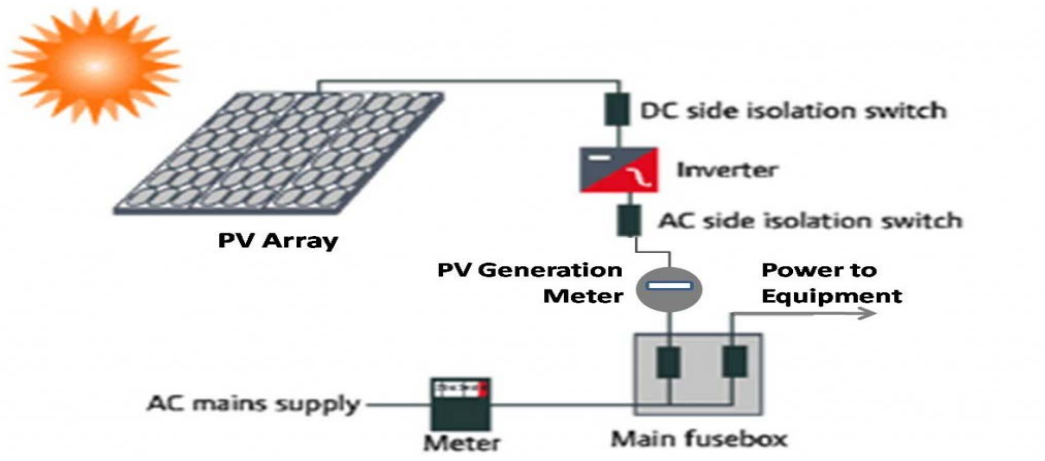
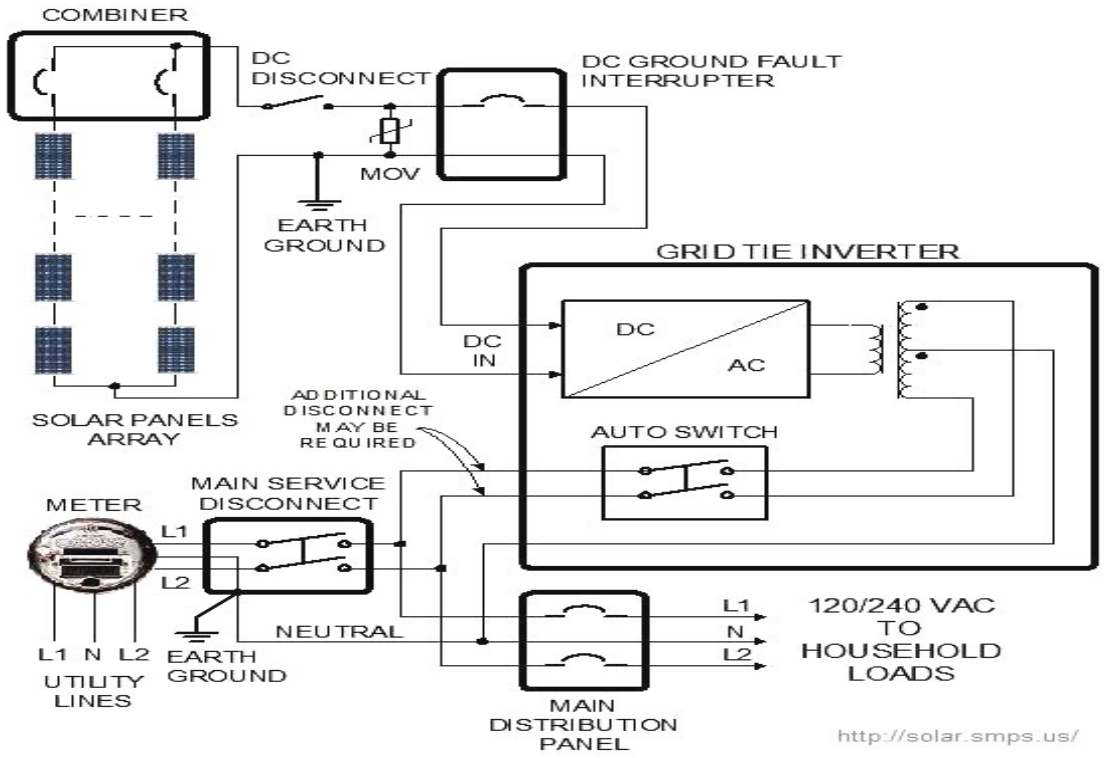


Figure 5 (below) is a diagram of a grid tie inverter connected in a solar system configuration. This configuration will provide single phase or split phase AC electricity for residential usage.

Figure 5. Grid tie inverter



Credits and Reference:
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