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Programmable DC Power Supply (Solar Array Simulation)

PROGRAMMABLE DC POWER SUPPLY (SOLAR ARRAY SIMULATION) MODEL 62150H-600S/1000S

The latest programmable solar array simulator power supply 62150H-600S & 1000S released by Chroma provides simulation of Voc (open circuit voltage) up to 1000V and Isc (short circuit current) up to 25A. The 62150H provides an industry leading power density in a small 3U high package. The solar array simulator is highly stable and has a fast transient response design, which are both advantageos to MPPT performance evaluation on PV inverter devices.

The 62150H-600S/1000S has many unique advantages including high speed & precision digitizing measurement circuits with a 100kHz A/D, 25kHz D/A controlled I-V curve and a digital filter mechanism. It can simulate an I-V curve accurately and response the mains ripple effect from the PV inverter. In addition, the built-in SAS I-V model in the standalone unit can easily program the Voc, Isc, Vmp, and Imp parameters for I-V curve simulation, without a PC controller.

The real solar array is influenced by various weather conditions such as irradiation, temperature, rain and shade by trees or clouds, which will affect the I-V curve output. The 62150H-600S/1000S is capable of storing up to 100 I-V curves into the simulator memory, with a programmed time interval range of 1-15,000 seconds. It can simulate the I-V curve from the early morning to nightfall for PV inverter testing or dynamic I-V curve transient testing.

The 62150H-600S/1000S has a built-in 16 bit digital control and precision voltage & current measurement circuits with a voltage accuracy of 0.05% + 0.05% F.S. and a current accuracy of 0.1% + 0.1% F.S.. It is ideal for real time MPPT analysis and tracking monitoring for PV inverters through our softpanel. The user can also enable the data recording function on the softpanel during the static MPPT performance test.

When high power solar array simulation is required it is common to connect two or more power modules in parallel. The 62150H-600S/1000S with a current range up to 25A and a voltage range up to 1000V offers a high power density envelope maximum of 15kW in a 3U package. It can easily parallel up to ten units in a Master/Slave configuration to provide 150kW with current sharing and synchronized control signals for commercial PV inverter (10kW – 100kW) testing. The 62000H series supplies have a smart Master/Slave control mode that makes the parallel operation fast and simple. In this mode, the master scales values and downloads data to slave units so that the programming is as simple as using a standalone unit.

The 62000H series dc power supplies are very easy to operate from the front panel keypad or from the remote controller via USB/RS232/RS485/APG (standard) and GPIB & Ethernet (optional). Its compact size (3U) makes it ideal for both benchtop and standard racking.

APG | RS-485 | RS-232 | Ethernet | GPIB | USB | CE

MODEL 62150H-600S/1000S

Key Features :

- Voltage range : 0 ~600V&1000V
- 3U/15kW high power density module with easy master/slave parallel operation up to 150kW
- Fast transient response solar array simulation
- Simulation of multiple solar cell material's I-V characteristic (fill factor)
- Simulation of dynamic irradiation intensity and temperature level from clear day to cloud cover conditions
- Shadowed I-V curve output simulation
- Low leakage current (< 3mA)
- Precision V & I measurements
- Auto I-V program: 100 I-V curves & Dwell time 1-15,000s
- Static & dynamic MPPT efficiency test
- Data recorded via softpanel
- Standard USB / RS232 / RS485 interface
- Optional GPIB / Ethernet interface
- Real time analysis of PV inverter's MPPT tracking via softpanel
- Free graphic user interface - softpanel for operation
- Real world weather simulation fast I-V curve update rate : 1s
- Build-in dynamic MPPT test profile of EN50530, Sandia, CGC/GF004

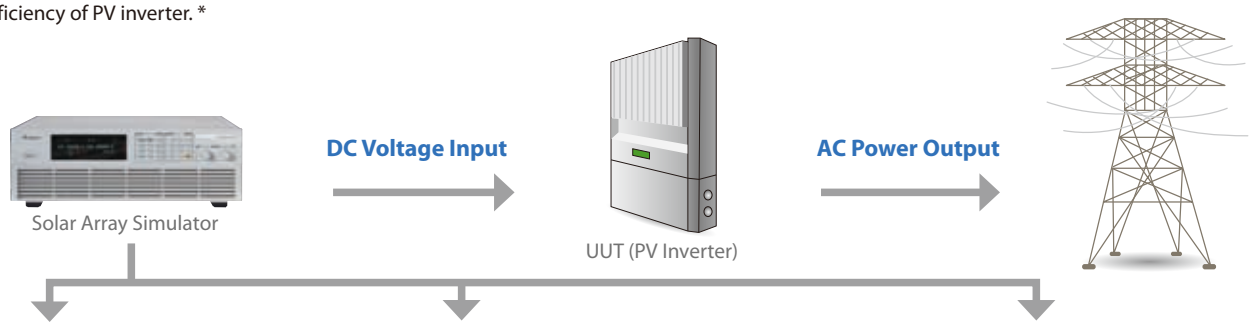
Chroma

SOLAR ARRAY I-V CURVE SIMULATION POWER SUPPLY

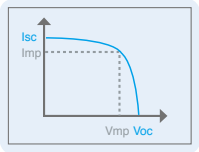
The Model 62150H-600S/1000S has a built in SAS model that can easily program the Voc, Isc, Vmp, Imp parameters to simulate different solar cell materials I-V characteristic outputs with fast response time. Moreover, the TABLE mode is capable of saving a 128 point array of user programmed voltages and currents via a remote interface. It can easily create a shadowed I-V curve and the I-V PROGRAM mode can save up to 100 I-V curves and dwell time intervals (1-15,000s) in memory. These advantages provide steady repetitive control conditions required for PV Inverter design as well as for verification testing. The solar array simulator is ideal for the following testing:

- Design and verify the maximum power tracking circuit and algorithm of the PV inverter.
- Verify the high/low limit of operating input voltage allowed for the PV inverter.
- Verify the high/low limit of operating input voltage allowed for the inverter's maximum power point.
- Verify the static maximum power point tracking efficiency of the PV inverter.
- Measure and verify the overall efficiency & conversion efficiency of PV inverter. *
- Verify the maximum power point tracking performance of the inverter for dynamic curves. (EN50530, Sandia, CGC/GF004 standard)
- Verify the maximum power point tracking performance of the inverter under different time period conditions spanning from morning to nightfall.
- Verify the maximum power point tracking mechanism of the inverter for the I-V curve when the solar array is shaded by clouds or trees.
- Simulate the I-V curve under the actual environmental temperatures within burn-in room to do inverter burn-in testing.

*Requires an extra power meter.



SAS Mode



I-V Program Mode

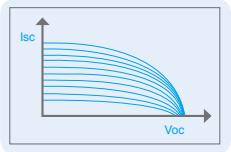
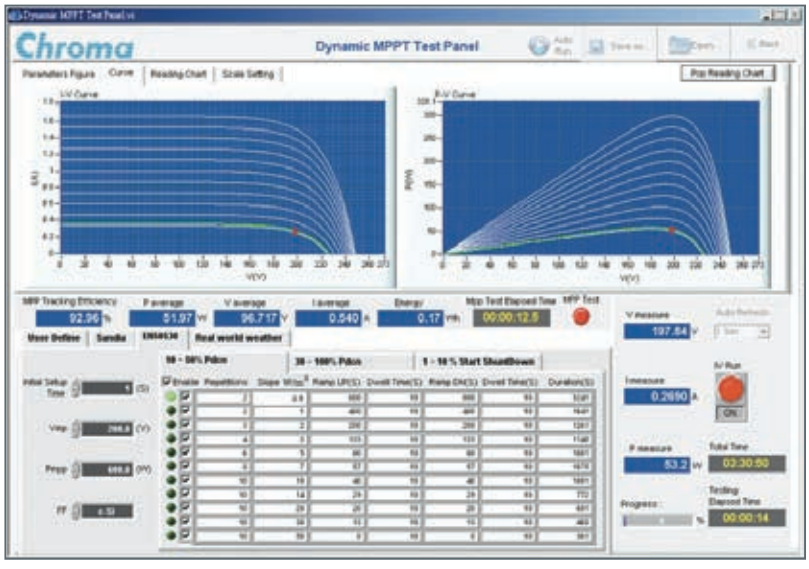


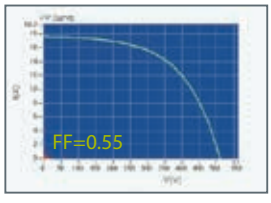
Table Mode

Point	1	2	3	4	5	6	7	.....	128
Voltage(V)	0	30	60	90	120	150	180	.....	600
Current(A)	11	10	9	8	7	6	5	.....	0

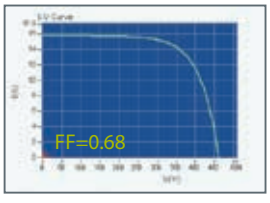
SOLAR ARRAY I-V CURVE SIMULATION SOFTPANEL



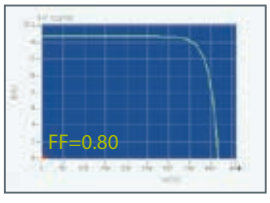
Solar Array Simulation Softpanel



Thin-Film



Standard Crystalline Array



High-efficiency Crystalline

The model 62150H-600S/1000S includes a graphical user Interface software through remote digital interface (USB / GPIB / Ethernet / RS232) control. The user can easily program the I-V curve of the 62150H-600S/1000S as well as the I-V & P-V curves for real-time testing. In addition it will display the MPPT status for the PV inverter. Readings and the report function with real-time monitoring using the softpanel are shown left.

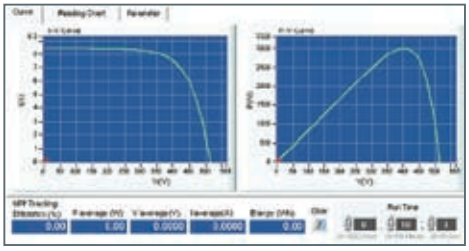
SIMULATES DIFFERENT SOLAR CELL MATERIALS I-V CHARACTERISTIC (FILL FACTOR)

The purpose of the PV inverter is to convert the dc voltage (from solar array) to the ac power (utility). The better a PV inverter can adapt to the various irradiation & temperature conditions of sun, the more power that can be fed into the utility grid over time. So, the MPPT performance is a very important factor for PV generation system. The model 62150H-600S/1000S is capable of simulating different types of standard crystalline, multi-crystalline and thin-film fill factor* parameters to verify the MPPT tracking algorithm mechanism and efficiency.

*Fill Factor = (Imp*Vmp)/(Isc*Voc)

STATIC MPPT EFFICIENCY TESTING

The 62150H-600S DC power supply with solar array simulation can program the I-V curve through SAS mode and table mode via front panel or softpanel easily and up to 100 I-V curves can be stored in the unit. The user can recall the I-V curve from 62150H-600S afterwards for testing and monitoring the MPPT performance of PV inverter with the real-time tracking feature. The softpanel allows the user to set the duration for static MPPT efficiency testing. Each curve test time should be set at between 60s-600s for best MPPT efficiency performance analysis.

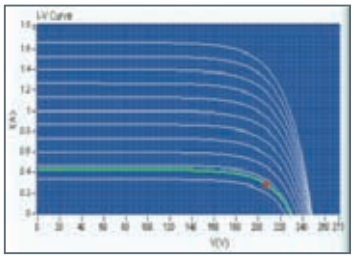


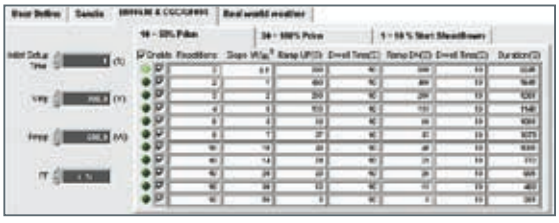
$$\eta_{MPPT} = \frac{1}{P_{mpp} \cdot T_M} \sum V_{dc} \cdot I_{dc} \cdot \Delta T$$

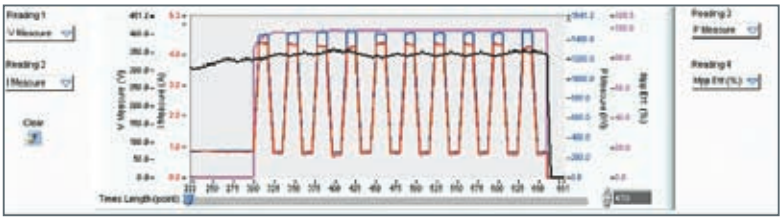
Vdc = Sampled value of the inverter's input voltage
Idc = Sampled value of the inverter's input current
Tm = Overall measuring period
Pmpp = MPPT power provided by the solar array simulator power supply

DYNAMIC MPPT EFFICIENCY TESTING

The latest test standards EN50530, CGC/GF004 & Sandia have provided a procedure for testing patterns of the dynamic MPPT efficiency of inverters, those standards can accelerate the MPP tracking algorithm mechanism to the optimal for PV inverter manufactures. The advanced Dynamic MPPT Test function complies with EN50530, CGC/GF004, Sandia test regulations and can be controlled via the graphical softpanel by selecting CGC/GF004 or Sandia or EN50530 I-V mathematical expressions and test items. This function simulates the irradiation intensity and temperature change of the I-V curve under actual weather variations to test the PV inverter’s dynamic MPPT performance. The GUI will calculate the MPPT performance for analysis after running the test. A test data recording function is integrated into the software where users can edit and control the test parameters to be recorded such as voltage, current, power, watt and MPPT performance along with the sampling interval (1 - 10,000s) and total time length to facilitate the analysis and validation of the PV inverter.

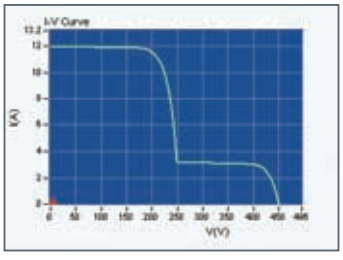


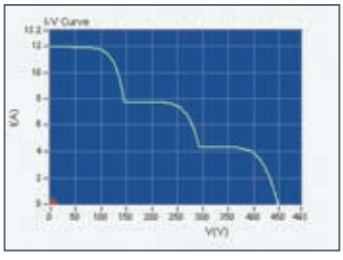


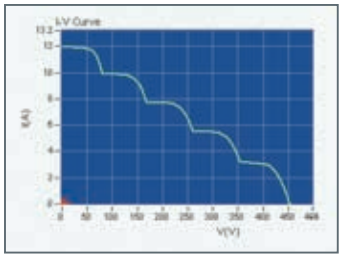


SHADOW I-V CURVE SIMULATION

The table mode allows the user to create 128 points of I-V curve data consisting of voltage and current in Excel file format. This information is uploaded to the 62150H-600S memory via the softpanel. The user is able to program various I-V curves such as the shadow I-V curve simulation, which is used to verify the maximum power tracking capability of the PV inverter based on the I-V curve when the solar cell is shaded by clouds or trees.

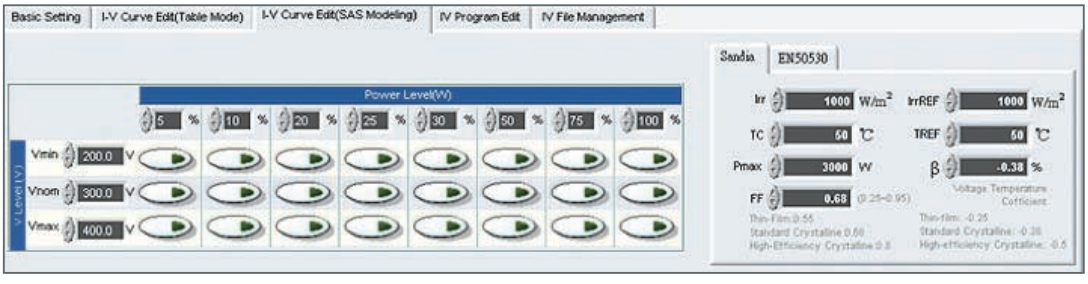






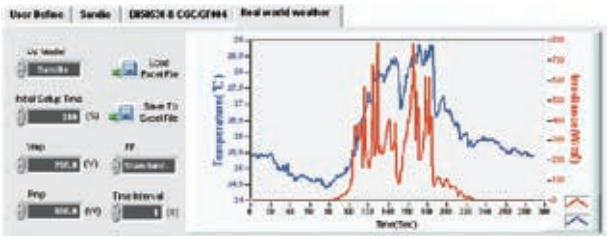
EVALUATING THE PV INVERTER'S CONVERSION EFFICIENCY *

The photovoltaic I-V curve model of Sandia Lab and EN50530's built in the softpanel allows the user to input the maximum dc input power (Pmax), I-V Fill Factor, Vmin, Vnom and Vmax desired to test the PV Inverter. Click the maximum power percentage value (5%, 10%, 20%, 25%, 30%, 50%, 75%, 100%) desired directly and , the softpanel will produce the tested solar cell I-V curve automatically. Next, download it to the standalone unit to start simulating the I-V curve for the PV Inverter to test the conversion efficiency. *Required an extra power meter.



REAL WORLD WEATHER SIMULATION

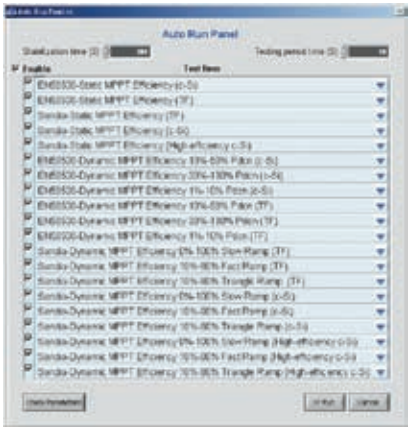
The real world weather simulation function allows the user to import real conditions of irradiation and temperature profiles of a whole day from excel file to Softpanel, in order to simulate the irradiation intensity and temperature level from early morning to nightfall. It can also set the interval time resolution to 1s for I-V curve update rate and enable the user to perform MPPT tracking tests under the simulation of actual weather environments.



AUTO RUN FUNCTION OF STATIC & DYNAMIC MPPT TESTING

In order to easily test the static & dynamic MPPT performance of standard EN50530 & Sandia for PV inverter, the SoftPanel has an auto run function, which the user only has to set the Vmin, Vnom, Vmax, Pmax, Stabilization time &Testing period time parameter and testing items of EN50530 & Sandia, then the softpanel can run tests automatically and generate reports after finished.

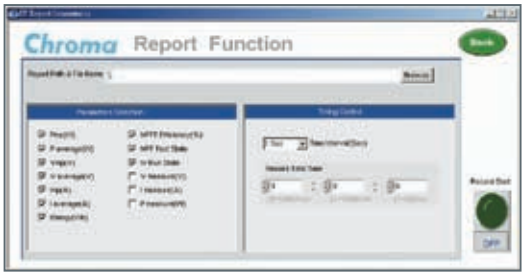
EN50530 Dynamic MPPT Efficiency Test Report (30%~100%)							
From-to W/m²	**Delta W/m²**		**Pmp Value (W)**	**Vnom (V)**	**c-Si technology**	**Waiting time setting (S)**	
300-1000	700		2000.00	350.00		300	
#number	Slope W/m²	Ramp UP (S)	Dwell time (S)	Ramp DN (S)	Dwell time (S)	Duration (S)	MPPT Efficiency (%)
10	10.0	70	10	70	10	1900	99.89
10	14.0	50	10	50	10	1500	99.90
10	20.0	35	10	35	10	1200	99.87
10	30.0	23	10	23	10	967	99.84
10	50.0	14	10	14	10	780	99.86
10	100.0	7	10	7	10	640	99.71
					Total	6987 s	99.84
						01 : 56 : 27 h	



EN50530 Static MPPT Efficiency Test Report									
MPPT voltage of the simulated I/U characteristic of the PV generator	**Simulated I/U characteristic**	**Pmp Value(W)=1000.00**							
		0.050	0.100	0.200	0.250	0.300	0.500	0.750	1.000
Umin = 200.0	c-Si	99.510	98.703	99.589	99.728	99.533	99.868	99.930	99.908
Unom = 300.0	c-Si	99.478	99.609	99.661	99.702	99.791	99.896	99.837	99.848
Umax = 400.0	c-Si	99.452	99.040	99.701	99.036	99.779	99.751	99.908	99.936

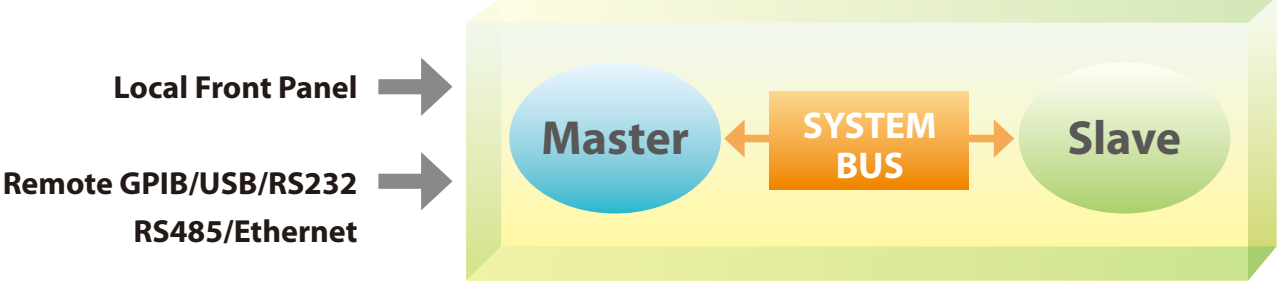
REPORT FUNCTION

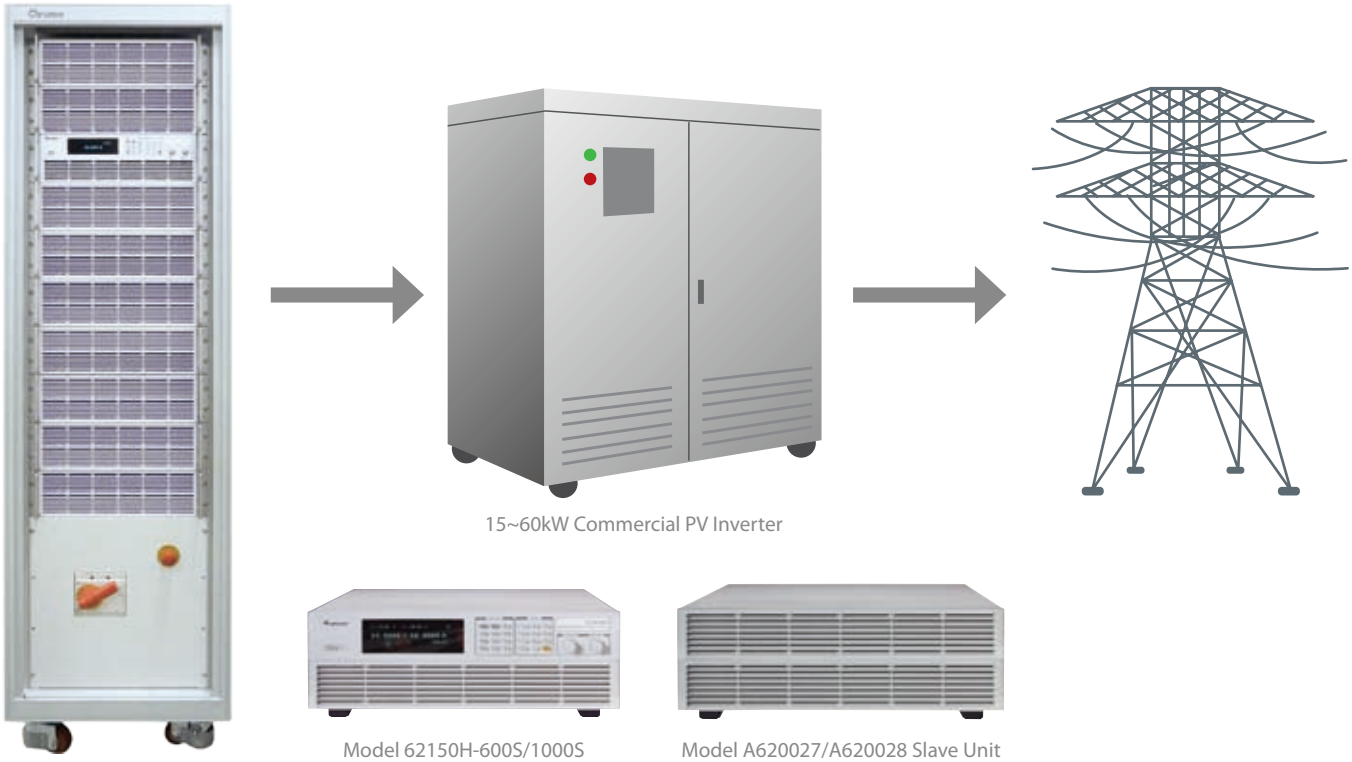
The softpanel also provides data recording capabilities, which include: voltage, current, power, energy and MPPT efficiency and the corresponding parameter sampling time (1s~10000s) for the recording process. The report can be utilized for R&D design characterization verification, QA verification and production quality control.



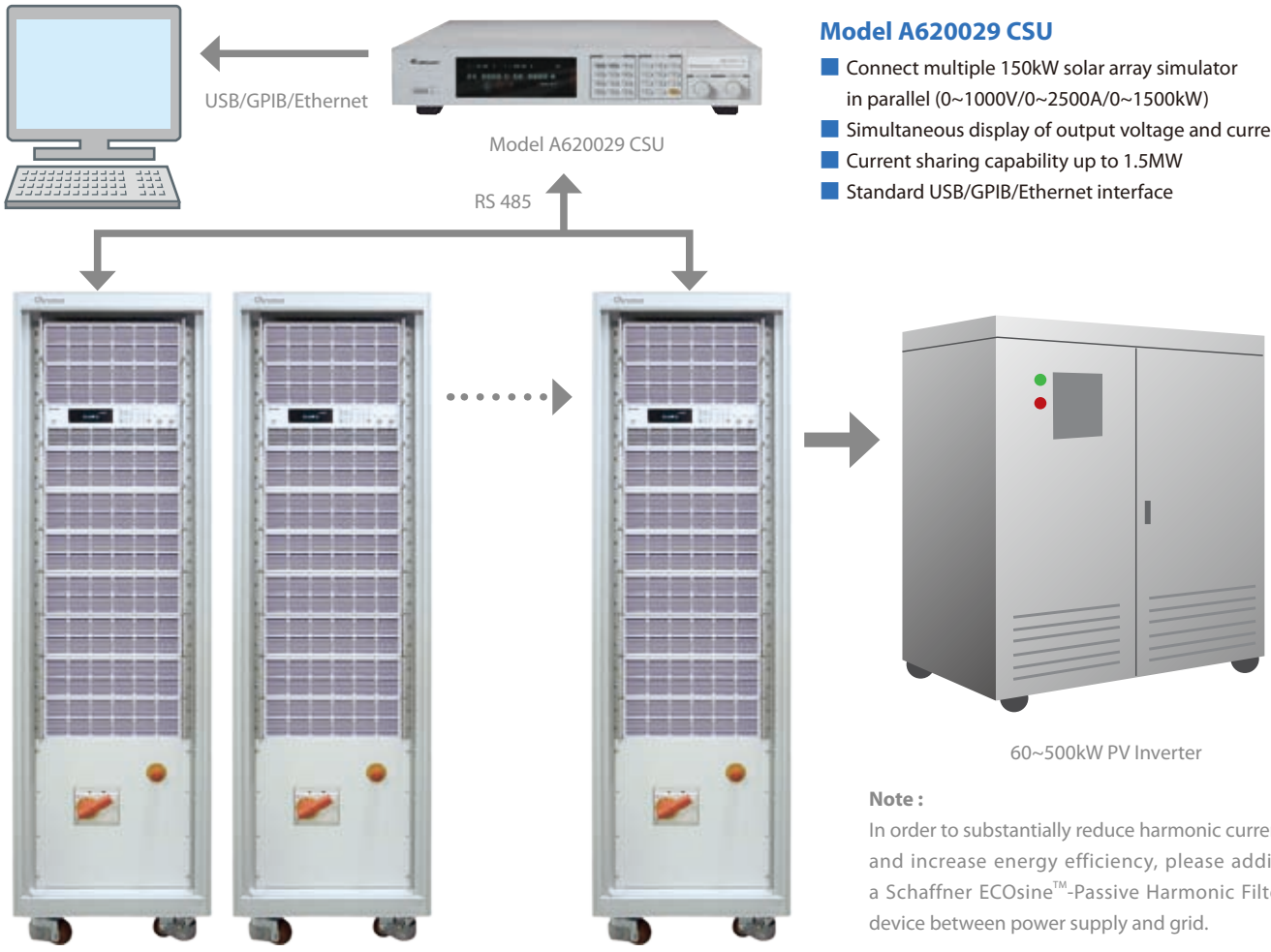
MASTER / SLAVE PARALLEL OPERATION UP TO 150KW

When high power is required, it is common to connect two or more power supplies in parallel. The 62000H series supplies have a smart master / slave control mode making the parallel operation fast and simple. In this mode, the master scales values and downloads data to slave units with a high speed sync signal process and automatic current sharing control.





CUSTOMIZATION SOLAR ARRAY SIMULATOR UP TO 600KW

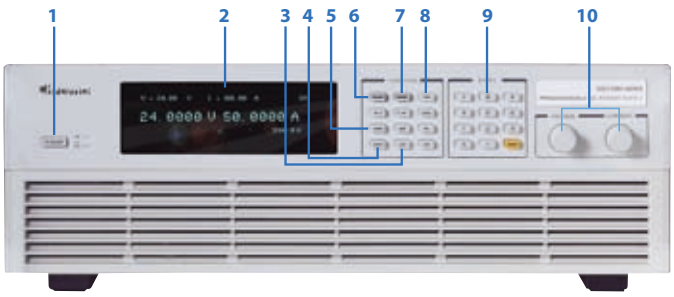


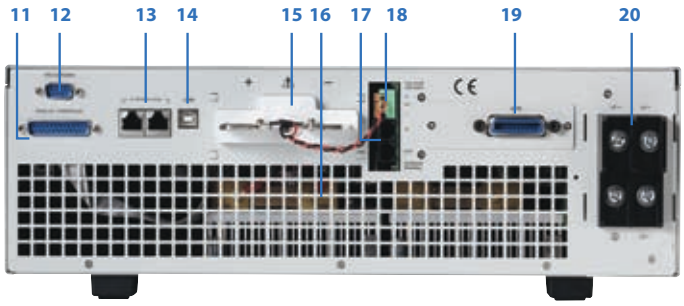
Model A620029 CSU

- Connect multiple 150kW solar array simulator in parallel (0~1000V/0~2500A/0~1500kW)
- Simultaneous display of output voltage and current
- Current sharing capability up to 1.5MW
- Standard USB/GPIB/Ethernet interface

Note :
In order to substantially reduce harmonic currents and increase energy efficiency, please adding a Schaffner ECOsine™-Passive Harmonic Filters device between power supply and grid.

PANEL DESCRIPTION





1. **POWER Switch**
2. **VFD Display**
   Display setting, readings and operating status
3. **LOCK Key**
   Lock all settings
4. **OUTPUT Key**
   Enable or disable the output
5. **CONFIG Key**
   Set the system configuration
6. **VOLTAGE Key**
   Set the output voltage
7. **CURRENT Key**
   Set the output current
8. **PROG Key**
   Program the sequence
9. **NUMERIC Key**
   Set the data
10. **ROTARY Key**
    Adjust the V&I and set the parameter

11. **Analog programming interface**
    For analog level to program and monitor output voltage & current
12. **RS-232 or RS-485 Interface (alternative)**
13. **System Bus**
    For master/slave parallel and series control
14. **USB Interface**
15. **OUTPUT Terminal**
    Connect the output cable to a UUT
16. **System Fan**
    With fan speed control
17. **Current Sharing Terminal**
    Connect the cable to slave unit
18. **Sense Terminal**
    Connect the UUT for voltage compensation
19. **GPIB or ETHERNET Interface (optional)**
20. **AC Input Terminal**

ORDERING INFORMATION

Power Rating	62000H Series Programmable DC Power Supply
5kW	**62050H-600S** : Programmable DC Power Supply 600V/8.5A/5kW with Solar Array Simulation
10kW	**62100H-600S** : Programmable DC Power Supply 600V/17A/10kW with Solar Array Simulation
15kW	**62150H-600S** : Programmable DC Power Supply 600V/25A/15kW with Solar Array Simulation
	62150H-1000S : Programmable DC Power Supply 1000V/15A/15kW with Solar Array Simulation
Options	**A620024** : GPIB Interface for 62000H series (Factory installed)
	A620025 : Ethernet Interface for 62000H series (Factory installed)
	A620026 : Rack Mounting kit for 62000H series
	A620027 : Parallelable Power Stage 15kW for 62150H-600S
	A620028 : Parallelable Power Stage 15kW for 62150H-1000S
	***A620029** : Control and Supervisor Unit for 150kW~600kW

Note 1 : GPIB or Ethernet Interface (alternative) , please specified at time of order.

Note 2 : Call for more information regarding the customized solar array simulator of 150kW~600kW.

*Call for Availability.

ELECTRICAL SPECIFICATIONS-WITH SOLAR ARRAY SIMULATION

MODEL	62050H-600S	62100H-600S	62150H-600S	62150H-1000S
Output Ratings				
Output Voltage	0-600V	0-600V	0-600V	0-1000V
Output Current	0-8.5A	0-17A	0-25A	0-15A
Output Power	5000W	10000W	15000W	15000W
Line Regulation				
Voltage	+/- 0.01% F.S.			
Current	+/- 0.05% F.S.			
Load Regulation				
Voltage	+/- 0.05% F.S.			
Current	+/- 0.1% F.S.			
Voltage Measurement				
Range	120V / 600V	120V / 600V	120V / 600V	200V / 1000V
Accuracy	0.05% + 0.05%F.S.			
Current Measurement				
Range	3.4A / 8.5A	6.8A / 17A	10A / 25A	6A / 15A
Accuracy	0.1% + 0.1%F.S.			
Output Noise&Ripple				
Voltage Noise(P-P)	1500 mV	1500 mV	1500 mV	2550 mV
Voltage Ripple(rms)	650 mV	650 mV	650 mV	1950 mV
Current Ripple(rms)	150 mA	300 mA	450 mA	270mA
OVP Adjustment Range				
Range	0-110% programmable from front panel, remote digital inputs.			
Accuracy	+/- 1% of full-scale output			
Programming Response Time				
Rise Time: 50%F.S. CC Load	30ms	30ms	30ms	25ms
Rise Time: No Load	30ms	30ms	30ms	25ms
Fall Time: 50%F.S. CC Load	30ms	30ms	30ms	25ms
Fall Time: 10%F.S. CC Load	100ms	100ms	100ms	80ms
Fall Time: No Load	1.2s	1.2s	1.2s	3s
Slew Rate Control				
Voltage Slew Rate Range	0.001V/ms - 20V/ms	0.001V/ms - 20V/ms	0.001V/ms - 20V/ms	0.001V/ms - 40V/ms
Current Slew Rate Range	0.001A/ms - 0.1A/ms, or INF	0.001A/ms - 0.1A/ms, or INF	0.001A/ms - 0.1A/ms, or INF	0.001A/ms - 0.1A/ms, or INF
Minimum Transition Time	0.5ms			
Transient response time	Recovers within 1ms to +/- 0.75% of steady-state output for a 50% to 100% or 100% to 50% load change(1A/us)			
Efficiency	0.87(Typical)			
Programming & Measurement Resolution				
Voltage (Front Panel)	10 mV	10 mV	10 mV	100mV
Current (Front Panel)	1mA	1mA	1mA	1mA
Voltage (Digital Interface)	0.002% of Vmax			
Current (Digital Interface)	0.002% of Imax			
Voltage (Analog Interface)	0.04% of Vmax			
Current (Analog Interface)	0.04% of Imax			
Programming Accuracy				
Voltage (Front Panel and Digital Interface)	0.1% of Vmax			
Current (Front Panel and Digital Interface)	0.3% of Imax			
Voltage (Analog Interface)	0.2% of Vmax			
Current (Analog Interface)	0.3% of Imax			
Parallel Operation*1	Master / Slave control via CAN for 10 units up to 150kW. (Parallel: ten units)			
Auto Sequencing(I-V program)				
Number of program	10			
Number of sequence	100			
Dwell time Range	1s ~ 15,000S			
Trig. Source	Manual / Auto			

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Note*1 : There is parallel mode for DC power supply when the I-V curve function is enabled.

GENERAL SPECIFICATIONS

MODEL		62050H-600S	62100H-600S	62150H-600S	62150H-1000S
Remote Interface					
Analog programming		Standard			
USB		Standard			
RS232		Standard			
RS485		Standard			
GPIB		Optional			
Ethernet		Optional			
System bus(CAN)		Standard for master/slave control			
GPIB Command Response Time					
Vout setting		GPIB send command to DC source receiver <20ms			
Measure V&I		Under GPIB command using Measure <25ms			
Analog Interface (I/O)					
Voltage and Current Programming inputs (I/P)		0-10Vdc / 0-5Vdc / 0-5k ohm / 4-20 mA of F.S.			
Voltage and Current monitor output (O/P)		0-10Vdc / 0-5Vdc / 4-20mA of F.S.			
External ON/OFF (I/P)		TTL:Active Low or High(Selective)			
DC_ON Signal (O/P)		Level by user define. (Time delay = 1 ms at voltage slew rate of 10V/ms.)			
CV or CC mode Indicator (O/P)		TTL Level High=CV mode ; TTL Level Low= CC mode			
OTP Indicator (O/P)		TTL: Active Low			
System Fault indicator(O/P)		TTL: Active Low			
Auxiliary power supply(O/P)		Nominal supply voltage : 12Vdc / Maximum current sink capability: 10mA			
Safety interlock(I/P)		Time accuracy: <100ms			
Remote inhibit(I/P)		TTL: Active Low			
Auto Sequencing(List Mode)					
Number of program		10			
Number of sequence		100			
Dwell time Range		5ms - 15000S			
Trig. Source		Manual / Auto / External			
Auto Sequencing (Step Mode)					
Start voltage		0 to Full scale			
End voltage		0 to Full scale			
Run time		10ms - 99hours			
Input Specification					
AC Input Volatage 3Phase, 3Wire+Ground		200/220 Vac (Opevating Rang 180 ~ 242 Vac) ; 380/400 Vac (Opevating Rang 342 ~ 440 Vac)			
AC Fequency range		47 ~ 63Hz			
Max Current (each phase)	200/220Vac	39A	69A	93A	93A
	380/400Vac	22A	37A	50A	50A
General Specification					
Maximum Remote Sense Line Drop Compensation		2% of full scale voltage per line (4% total)			
Operating Temperature Range		0°C ~ 40°C			
Storage Temperature Range		-40°C ~ +85°C			
Dimension (HxWxD)		132.8 mm x 428 mm x 610 mm / 5.23 x 16.85 x 24.02 inch			
Weight		Approx. 23 kg / 55.70 lbs	Approx. 29 kg / 63.88 lbs	Approx. 35 kg / 77.09 lbs	Approx. 35 kg / 77.09 lbs
Approval		CE	CE	CE	CE

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