



## APPLICATIONS

- Industrial equipment
- Telecommunications
- Test and measurement
- Automation
- Peripherals
- Audio/broadcast
- Linear and rotary motion

## FEATURES

- Wide input voltage range from DC to 440Hz AC
- Standard output voltages of 2.2 to 51 VDC
- Efficiencies up to 86% typical
- Extra-Low 1U profile: 1.6 inch
- Intelligent Variable Fan Speed Control
- High power density design of 18 Watts/cubic inch
- 1 to 6 isolated outputs with full user configurability
- 1300W @ 115 VAC or 1600W @ 230VAC of total output power
- Zero-load operation
- Single-wire current sharing
- Universal input AC range
- Individual control signals on each module
- Auxiliary power 5V (1A)



Rear Module Connection Area



Supply Front View

**Figure 1. LPM616 Expanded Views**

## 1. Description

The LPM616 Series is a modular 1600-watt AC-DC power supply that provides a market-leading power density of 18 watts per cubic inch and has an extra low 1U profile. The LPM616 offers the flexibility of a modular architecture and the combination of high efficiency and high power density.

Designed for use where a unique set of voltage and current requirements are needed, the supply's six slots can be configured with PCB-based output modules to deliver up to six outputs. The LPM output modules operate in any chassis position and can provide up to 1600 watts total power from a 150 VAC input and 1300 watts from a 100 VAC input. Forced-air cooling with airflow direction from front to back is provided by internal fans.

For LPM616 supplies using less than the six-slot capability, blanking plates are installed for safety purposes and to optimize airflow within the chassis. The supplies are pre-set with default output module settings or with the customer's desired output settings prior to delivery. The LPM616 chassis can be populated with the output modules listed in *Table 1*.

**Table 1. Module Selection**

MODULE	NO. OF SLOTS REQUIRED	FACTORY-SET SINGLE-OUTPUT (VDC)	MODULE ADJUSTABLE RANGE (VDC)	MAX. OUTPUT CURRENT (AMPS)	MAX. OUTPUT POWER Note 2 (WATTS)
A	1	5	2.2 to 5.2	53	266
B	1	12	5.2 to 15	22	266
C	1	24	15 to 32	11	266
D	1	48	32 to 51	5.5	266
0	1	Blank Panel Slot Cover			

**NOTE 1:** To determine your desired power supply's part number, please refer to *Figure 2* for a detailed part number description. Use the **LPM616 Product Configurator** located in the Modular Section on our website, or use our contacts page to locate a contact or distributor for further assistance.

**NOTE 2:** Values given for high line, from 150 VAC. By low line is the module output power derated to 183 W ( $V_{in}=85-100VAC$ ), resp. 217 W ( $V_{in}=100-150VAC$ ).

### 1.1 Output Voltage and Current Limit Adjustments

Each LPM616 module's output voltage and current limit is adjustable by means of a trimmer located on the module and accessible through the adjustment holes located on the bottom of the power supply (see *Figure 10*). We dissuade to change current limits, which are factory preset.

### 1.2 Parallel Connections

Depending on certain situations where current requirements exceed one module's capability, the configurator will process a solution using parallel connections. Paralleling busbars are available to make the connections requiring higher current needs. For proper current sharing function it is necessary to interconnect Current Share pins of all modules by signal wires. For more details read the *Output Signal Connector* and *Accessories* section.

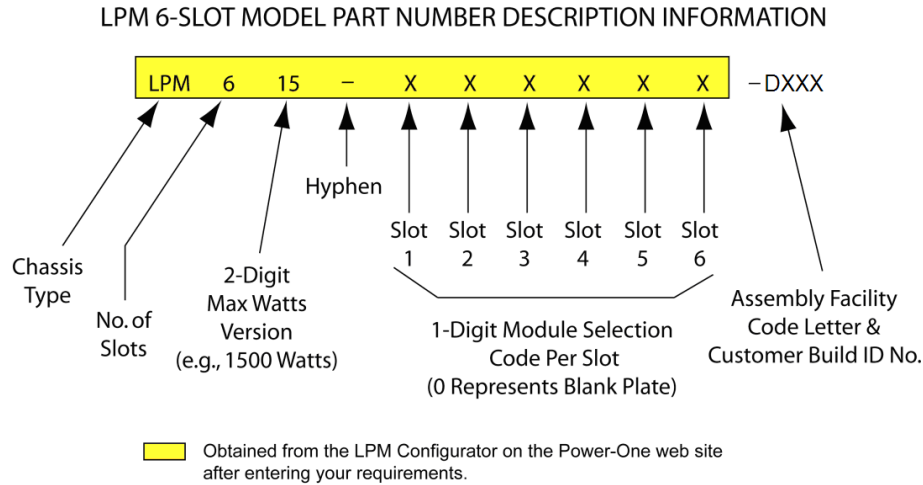
## 2. Part Numbering and Ordering Information

### 2.1 Chassis Identification Numbering

First left-to-right sequence of the part number (4 characters):

- LPM616 ..... Low Profile Modular 6-slot, 1600W, with single-phase AC input. (see Figure 2)

Note: Chassis and modules are RoHS-6 compliant.



**Figure 2. LPM 6-Slot Part Number Structure**

**Example:** After entering your requirements, the web Configurator optimized part number recommended could be: LPM616-000DAC-DXXX which represents: Low Profile Modular Series with single-phase AC input, 6-slot, 1600W chassis with modules of: 3x blank panel, modules D, A, C in slots 1 to 6, respectively. Besides the blank panels in slots 1-3, the example's modules in this case would represent desired DC output voltages as follows: Slot 4 = D for 48V, Slot 5 = A for 3.3V and Slot 6 = C for 24V.

Assembly facility code and customer build ID No. are established during actual power supply assembly.

## 3. Safety specifications

### 3.1 Safety approvals

- UL/CSA 60950-1 2<sup>nd</sup> + A1
- IEC 60950-1 2<sup>nd</sup> + A1
- EN 60950-1 2<sup>nd</sup> + A1
- CE Mark for LVD



Note: Agency approval is limited to 50-60 Hz. If PSU is used on 400 Hz, then unit must be permanently connected to Protective Earth before connecting the supply due to high leakage current.

### 3.2 Insulation Safety Ratings

TEST POINTS	MINIMUM TEST VOLTAGE	INSULATION SAFETY RATING
Input-to-Chassis	2120 Vdc / min. 1s	Basic Insulation
Input-to-Output	4240 Vdc / min. 1s	Reinforced Insulation
Outputs-to-Chassis	50 Vdc / min. 1s	Functional Insulation
Output-to-Output	50 Vdc / min. 1s	Functional Insulation

#### 4. Environmental and Reliability specifications

##### 4.1 Environmental specification

PARAMETER	CONDITIONS / DESCRIPTION	MIN.	NOM.	MAX.	UNITS
Cooling	Internal DC fans, airflow is from the front of the supply and exhausts from the rear connector area				
Audible Noise	Single unit, 6 modules assembled and full loaded, on a table at 1m distance		56	70	dBa
Operating Temperature	Full power; derated linearly from 100% load @ 50°C to 50% load @ 70°C	-20	25	50	°C
Storage Temperature		-40		75	°C
Humidity	95% relative humidity @ 25 °C, non-condensing				
Vibration	Operating: Swept 5-500-5Hz profile, 3 axis, 5 sweep cycles per axis			1	Gpk
	Non-operating: Swept 5-500-5Hz profile, 3 axis, 5 sweep cycles per axis			4	Gpk
Shock	Operating: 11ms, half sine, 10 shocks per face			20	Gpk
	Non-operating: 11ms, half sine, 3 shocks per face			40	Gpk
Altitude	Operating altitude			10,000	Ft.

##### 4.2 Reliability

PARAMETER	CONDITIONS / DESCRIPTION	MIN.	NOM.	MAX.	UNITS
Calculated MTBF	According to MIL-HDBK217, Ground benign 30 °C	250,000			hours
Demonstrated MTBF	Tamb=25°C	250,000			hours

#### 5. Fault Protection

PARAMETER	CONDITIONS / DESCRIPTION	MIN.	NOM.	MAX.	UNITS
Input Fuse	One fuse, non-user serviceable, located on line leg of AC input, Fast Acting type		20		A
Inrush Current Limitation	Provided by NTC	See Input specification section			
Short Circuit Protection	Provided by Current Limit circuit			120	% Io_nom
Output Overvoltage Protection	Hiccup on 5 and 12V Modules Latching on 24V and 48V modules	10		25	% Vo_nom
Over Temperature	By nominal load, OT with auto restart		60	65	°C amb

## 6. EMC specifications

### 6.1 EMC Immunity

PARAMETER	CONDITIONS / DESCRIPTION	CRITERION
Electrostatic Discharge (ESD)	IEC/EN61000-4-2; GR-1089 R2-1, R2-2, R2-3 Level 4: contact: $\pm 8$ kV, air: $\pm 15$ kV	Perform, criterion B
RF Susceptibility	IEC/EN 61000-4-3; Level 3: 10 V/m; 80 MHz to 1000 MHz; AM 80%, 1 kHz radiated; RF electromagnetic field	Perform, criterion A
Fast transient / burst	IEC/EN 61000-4-4; Level 3; $\pm 2$ kV, 5kHz electrical fast transient / burst immunity test	Perform, criterion B
Surge	IEC61000-4-5, level 3; line to earth: $\pm 2$ kV, line to line: $\pm 1$ kV surge immunity test	Perform, criterion B
RF conducted disturbance	IEC/EN 61000-4-6; Level 3; GR-108; 10V, 0.15 to 80MHz, AM 80%, 1kHz	Perform, criterion A
Voltage dips / short interruptions	IEC/EN 61000-4-11; Voltage dips, interruptions and variations. (Interpretation: dip below $V_i$ min with $P_o$ nom = hold-up time 10 ms)	
	1a: Dip 30%, 100ms	Perform, criterion B
	1a: Dip 30%, 200ms	Perform, criterion B
	1a: Dip 60%, 10ms	Perform, criterion A
	1a: Dip 60%, 100ms	Perform, criterion B
	1a: Dip >95%, 10ms (interruption)	Perform, criterion A
	1a: Dip >95%, 100ms (interruption)	Perform, criterion B

### 6.2 EMC Emission

PARAMETER	CONDITIONS / DESCRIPTION	CRITERION
Conducted Emission EN55022, FCC	EN 55022, FCC – EN 55022, and CISPR 22 Class B, FCC 47CFR15 unintentional radiators; standalone at all nominal input voltages and measured in Po1: 0, 50%, 100%; signal connections open	Class B; min. 3dB/ $\mu$ V margin
Radiated Emission EN55022, FCC	EN 55022, FCC – EN 55022, and CISPR 22 Class B, FCC 47CFR15 unintentional radiators; standalone at all nominal input voltages and measured in Po1: 0, 50%, 100%; signal connections open	Radiated Class B QSP / AVG min. 3 dB margin
Input Current Harmonics	EN 61000-3-2, sine wave input, Class D; measured standalone at all $V_{in}$ nominal at power levels between 0 and rated	Pass

## 7. Electrical specifications

### 7.1 Input Specification

PARAMETER	CONDITIONS / DESCRIPTION	MIN.	NOM.	MAX.	UNITS
Input AC Voltage Range	Continuous Voltage Range Po=1100W from 85-100 VAC Po=1300W from 100-150 VAC Po=1600W from 150-264 VAC	85	115/230	264	VAC
Input DC Voltage Range	Po=1100W from 120-140 VDC Po=1300W from 140-210 VDC Po=1600W from 210-380 VDC	120		380	VDC
Input Overvoltage Range	At max. power, no input OVP shutdown			300	VAC
Ground continuity				0.1 <sup>1</sup>	Ohm
Leakage Current	@ 264 VAC, 60Hz, Standard Commercial			1.5	mA
Frequency	AC line	47	50/60/400	440	Hz
Power Factor	Active PFC meets requirements of EN 61000-3-2 at full load ,120/230 VAC input	0.98			
Input Current	Steady state, 85 VAC at 1100W			16	A rms
Inrush Current	180 VAC, Max Power, 25°C, acc. prETS300-132-1 230 VAC, Max Power, 25°C, acc. prETS300-132-1 (Repeat rate >1min)		60		A pk
Efficiency <sup>2</sup>	Vi = 230 VAC 100% loading	85	86		%
	Vi = 230 VAC 30-80% loading	81	82		%
	Vi = 115 VAC 100% loading	82	83		%
	Vi = 115 VAC 30-80% loading	78	79		%

<sup>1</sup> For any combination of output modules, any valid load and voltage setting

<sup>2</sup> Efficiency typical for standard configuration AABBCD and nominal output voltage settings

## 7.2 Output Specification

PARAMETER	CONDITIONS/DESCRIPTION	MIN.	NOM.	MAX.	UNITS
Output Power	Two fans for internal cooling		1600		W
Output DC Voltages / Modules	All output modules work in any chassis position and are max 1U high PCB-based	-			
Current Share	Active single-wire current share. Maximum difference in currents between two modules – percentage of one module nominal current.			±10	%
Line Regulation	Input from 85 to 264 VAC, 80% load		1.0		% Vo_nom
Load Regulation	From 0-100% load, Input >180VAC, Vo_nom		1.0		% Vo_nom
Thermal Drift	After 15 minute warm-up period		0.02		%/°C
Total Regulation	Variation of line, load and temperature drift		2.0		% Vo_nom
Output Adjustment Range		See Module Selection Table 1			
Dynamic Response	Deviation for 10-90% or 90-10% load changes at a rate of 1A/μs, (constant current mode, Vo reach 1% band around Voset)			4% 2000μs	-
	Deviation for 50-100% or 100-50% load steps with 1A/μs rate. (constant current mode, Vo reach 1% band around Voset)			3% 400μs	-
Output Ripple & Noise	BW = 20MHz; Filter 10nF/10uF; over line and load, 25°C			1% of Vo_nom	mVpk-pk
CM Noise	Output to chassis, over line and load (Measured across 50 Ohms, with 10μH / 10nF in parallel)		220	500	mVpp
Overshoot	Output voltage overshoot at turn-on		4		% Vo_nom
Turn-On Characteristics	Turn ON at minimum and nominal output current	Monotonic characteristic			-
Turn-Off Characteristics	Turn OFF at minimum and nominal output current	Monotonic characteristic			-
Turn-On Time	Time required for output within regulation after initial application of AC input			1.5	s
	Time required for output within regulation after removing inhibit			100	ms
Hold-up Time	Vo is required to stay within 95% regulation after AC is removed. Measured from the last AC peak, VAC min and full load.	10			ms
Remote Sense	Total compensation for cable losses		250	500	mV



### 7.3 Input - Signals, Features and Indicators description

Signal Name	Pin	Description
Auxiliary Output - 5V -	1,2 vs 3,4 (RTN_D)	Output defined when voltage of AC line is over 85VAC. Standby nominal voltage is 5.0V, nominal current is 1.0A. Current protected output over point 1.5A. Pin referenced to logic return RTN_D.
Input AC Indication - PFAIL -	5	Open Collector output pin with 20mA pull-down capability referenced to logic return RTN_D (TTL logic level). PFAIL OPEN OR HIGH state indicates the warning that the input is out of the limit ( the input voltage falls below 85Vac or rises over 264Vac ) 5 ms before the output goes below the lower regulation limit. PFAIL will turn-off the green Input OK LED. PFAIL LOW state indicates that the input voltage is within the operating range.
Fan Fail / OTP Indication - FAN_FAIL -	6	Open Collector output pin with 20mA pull-down capability referenced to logic return RTN_D (TTL logic level). FAN_FAIL OPEN OR HIGH state indicates the fan fail / over temperature condition min. 100 ms before the unit shuts-down. A fan fail / OTP will turn-off the green FAN OK LED. FAN_FAIL LOW state indicates normal fan operation, no OTP.

### 7.4 Output - Signals, Features and Indicators description

Signal Name	Pin	Description
Output Good indication - PG_HI -	5	Open collector output with 5mA pull-down capability protected by 5.1V zener diode. Referenced to PG_LO. PG_HI OPEN OR HIGH state indicates that the module output voltage is below lower regulation limit. A PG_HI fail state turns the GREEN DC OK LED to RED. PG_HI LOW state indicates that the module output voltage is within normal operation limits.
Output Enable function - EN_HI -	6	Input internally pulled up and protected by 5.1V zener diode. Pin sourcing capability is 2mA referenced to EN_LO. EN_HI OPEN OR HIGH state ENABLES the module output. EN_HI LOW state INHIBITES the module output.
Positive sense wire - VS+ -	1	Output voltage sense wire. Internally connected to Vout+ via 51 Ω. It is recommended to connect sense wire at positive load point.
Negative sense wire - VS- -	3	Output voltage sense wire. Internally connected to Vout- via 51 Ω. It is recommended to connect sense wire at negative load point.
Current share - CS -	4	Common wire for parallel connected modules to achieve proper current sharing between the modules. Referenced to PG_LO or EN_LO. Interconnect CS pin on all parallel working modules. Active current share pin enables control of output voltage. Pulling-up this pin to 5V is possible to increase the output voltage. Pull-down of this pin has no effect. Voltage on this pin is 3.0V at nominal module current.



## 7.5 Visual Alarms description

Alarm Name	LED position	Description
Input AC Good	Front panel – LED2 (see figure 6)	ON state LED indicates operation within specified input voltage range. GREEN LED indicator goes to an OFF condition on PFAIL signal failure state.
Fan Good	Front panel – LED1 (see figure 6)	ON state LED indicates normal fan operation and no OTP status. GREEN LED indicator goes to an OFF condition on FAN_FAIL / OTP signal failure state.
Output Good	Module connector / rear side (see figure 7)	GREEN LED indicates that module output voltage is within normal operation limits. GREEN LED indicator goes to RED on PG_HI signal failure state.

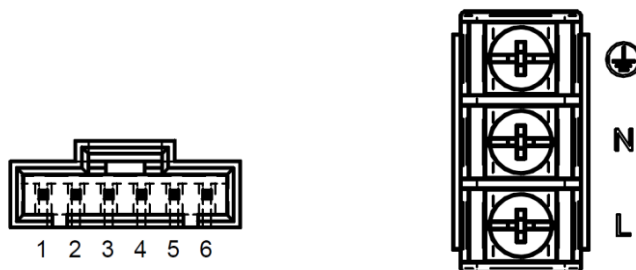
## 8. Connector Details

### 8.1 Input Connector Information

LPM616 front panel connectors pinout refers to *Figure 4* and *chapter 8.2* and *8.3*.

Connector is Cvilux part number: CI3306P1H10, the mating part is Cvilux CI3306S0010, Molex 50-57-9406 or Taiwan King Pin P553L-06(LF).

Note: See chapter *10.1 Mating Connections and cables* for Input cable information.



**Figure 4. LPM616 Front Panel Connectors Pinout View**

### 8.2 Input Connector - Power Pinout, Screws M4 x 6 mm

Signal Name	Pin #	Type	Recommended wires	V max I max
Earth		Earth / Chassis	Min. 1,5 mm <sup>2</sup> e.g. <a href="#">Interpower 86230120</a> Max. torque on screws: 1,5 Nm	264 Vrms 16 Arms
AC Neutral	N	Input Power AC		
AC Line	L	Input Power AC Fused		

Caution: During the operation must be the input power connector protected by the plastic cover! The cover may be removed ( by the help of a screwdriver ) only when the input cable is disconnected from the mains.

### 8.3 Signal Connector – Pinout (Mating connector: Molex 50-57-9406, pins: Molex 16-02-0082)

Signal Name	Pin #	Wire Color	Type	Signal reference	Low level High level	V max I max
+5V	1	Red	Aux Output	RTN_D	-	5.0Vdc 1.0Adc
+5V	2	Red	Aux Output	RTN_D	-	
RTN_D	3	Black	Logic Reference Potential	-	-	-
RTN_D	4	Black	Logic Reference Potential	-	-	-
PFAIL	5	Yellow	Open Collector Output + ZD 5.6V	RTN_D	<400mV@ 20mA Pull up	- 20mA
FAN_FAIL	6	Green	Open Collector Output + ZD 5.6V	RTN_D	<400mV@ 20mA Pull up	- 20mA

### 8.4 Module Outputs A, B Bus-Bar Pinout

Signal Name	Pin #	Type	Signal reference	Low level High level	V max I max
Vout+	Vout+	Output Power DC	Vout-	-	See Module Selection Table 1
Vout-	Vout-	Output Power DC	-	-	See Module Selection Table 1

### 8.5 Module Output C Signal Connector Pinout

The output C connector provides signal information across its 8-pin output.

Connector type: JST S08B-PUDSS-1

Mating part: JST housing PUDP-08V-S, pins SPUD-001T-P0.5 (AWG 26-22) or SPUD-002T-P0.5 (AWG 28-24)

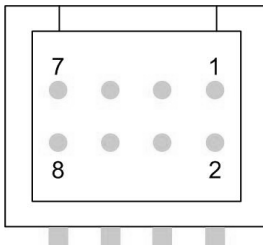


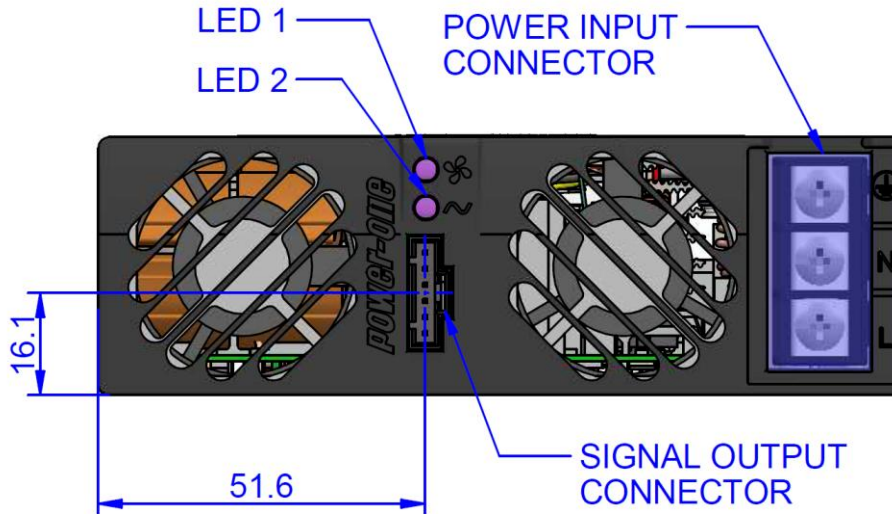
Figure 5. Module Output C Signal Connector Pinout

Signal Name	Pin #	Type	Signal reference	Low level High level	V max I max
VS+	1	Output voltage sense wire. Internally connected to Vout+ via 51 $\Omega$ .	Vout+	-	0.5V 10mA
PG_LO	2	Reference for PG_HI internally connected to signal ground.	-	-	- 10mA
VS-	3	Output voltage sense wire. Internally connected to Vout- via 51 $\Omega$ .	Vout-	-	0.5V 10mA
CS	4	Active Current Share pin.	PG_LO / EN_LO	-	5V -
PG_HI	5	Open collector output, protected by 5.1V zener diode.	PG_LO / EN_LO	<400mV@5mA Pull up	- 5mA
EN_HI	6	Input internally pulled up and protected by 5.1V zener diode.	PG_LO / EN_LO	<400mV@2mA Open	- 2mA
EN_LO	7	Reference for EN_HI internally connected to signal ground.	-	-	- 10mA
N/C	8	-	-	-	-

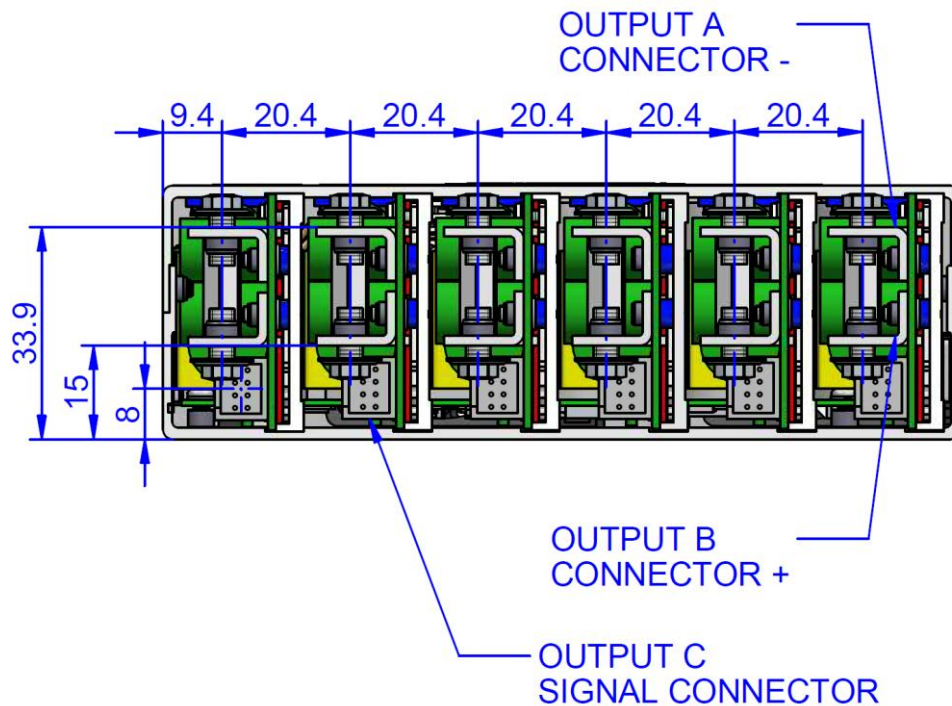
## 9. Mechanical Drawings

- **Overall Dimensions:** 11.9" x 5" x 1.6" (303.7 x 127 x 40.64mm)
- **Weight:** 1.94 kg (including 6 modules)

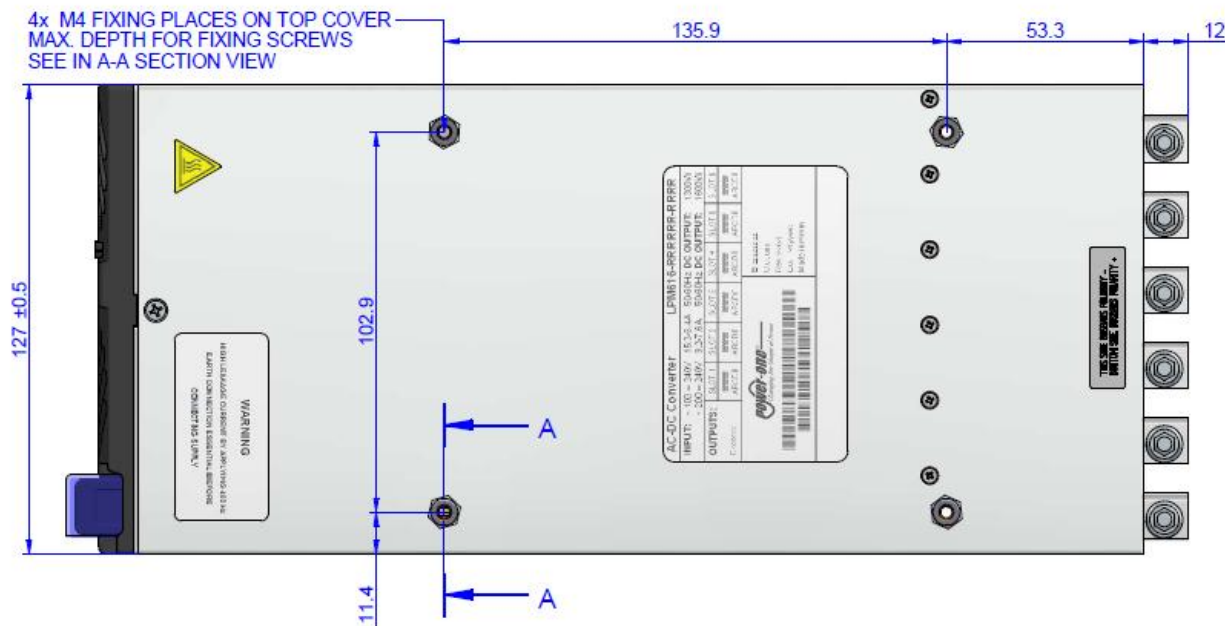
All drawing dimensions are shown in millimeters, unless otherwise notated.



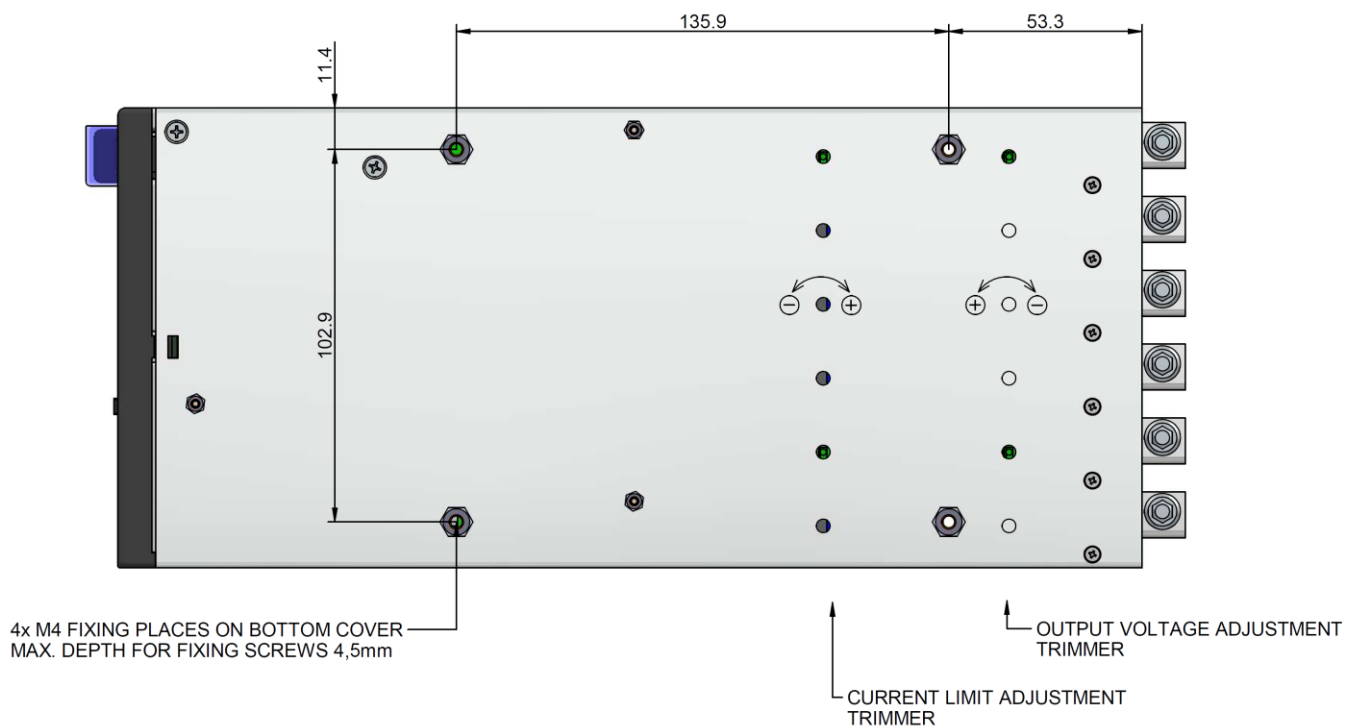
**Figure 6. Front View**



**Figure 8. Side View**



**Figure 9. Top View**



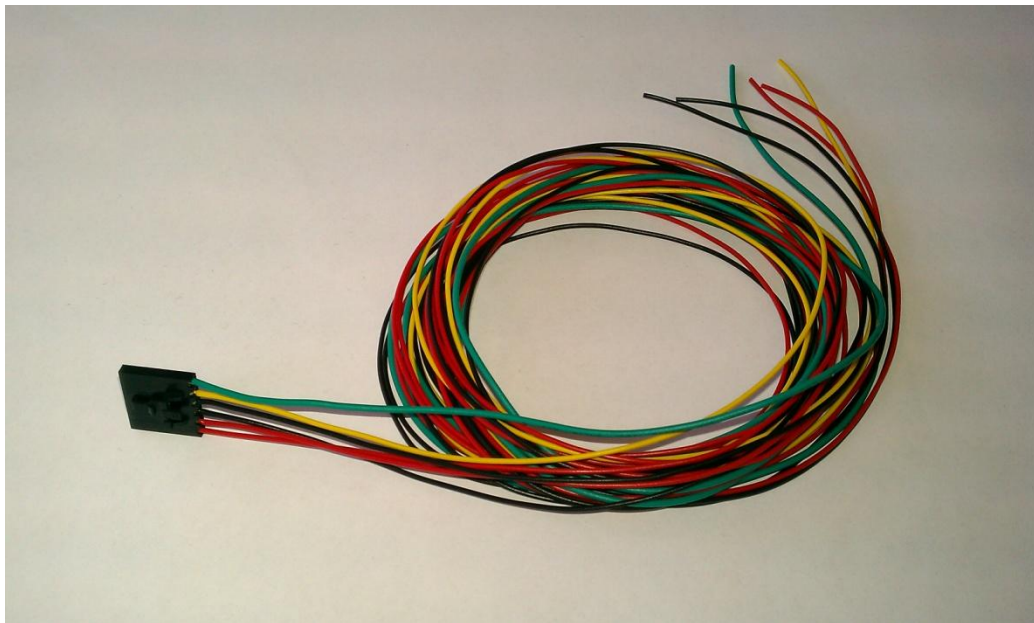
**Figure 10. Bottom View**

## 10. Accessories

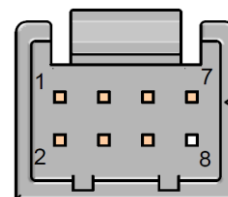
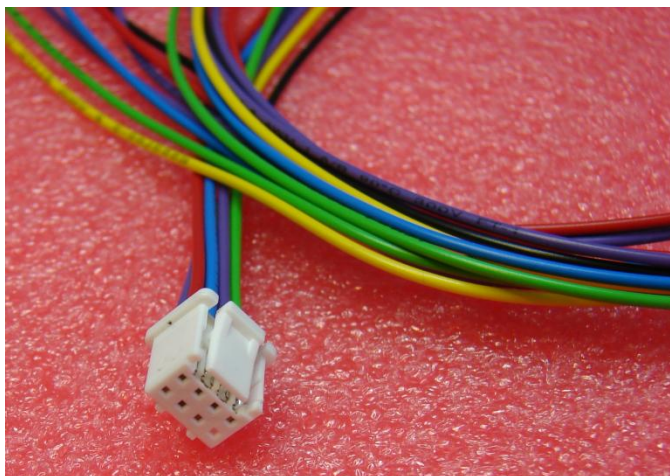
### 10.1 Mating Connections and Cables

All the power and signal cables and mating connectors are not included in the LPM616 standard package. These all need to be extra ordered.

- Front panel Signal cable: Power-One accessory LPM000-LEAD-03, see *figure 11*.
- Output Signal cable: Power-One accessory LPM000-LEAD-02, see *figure 12*.
- Output signal mating connector: JST-PU08-S, JST-SPUD-001T-P0.5
- Output Power Cable: 14AWG – 10AWG depend on the output current, min. 85°C thermal class



**Figure 11. LPM000-LEAD-03 Output Leads**






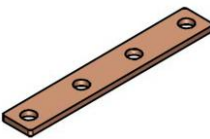
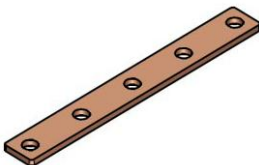
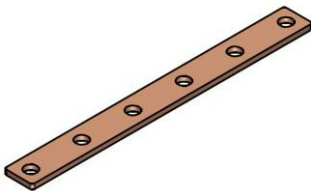
**Figure 12. LPM000-LEAD-02 Output Leads**



### 10.2 Signal Output wire colors

Pin #	Signal Name	Wire Color
1.	VS+	Red
2.	PG_LO	Violet
3.	VS-	Blue
4.	CS	Yellow
5.	PG_HI	Violet
6.	EN_HI	Black
7.	EN_LO	Green
8.	N/C	-

### 10.3 Paralleling Busbars

Item	Description	Model
LPM000-BBAR-01	Busbar with 1 opening for module connection and one for cable connection screw M6x8mm, max. 250A. <sup>1</sup>	
LPM000-BBAR-02	Busbar for parallel connection of two modules.	
LPM000-BBAR-03	Busbar for parallel connection of three modules.	
LPM000-BBAR-04	Busbar for parallel connection of four modules.	
LPM000-BBAR-05	Busbar for parallel connection of five modules.	
LPM000-BBAR-06	Busbar for parallel connection of six modules.	

Notes: <sup>1</sup> For load current over 250A use two of LPM000-BBAR-01 and two cables for each pole.

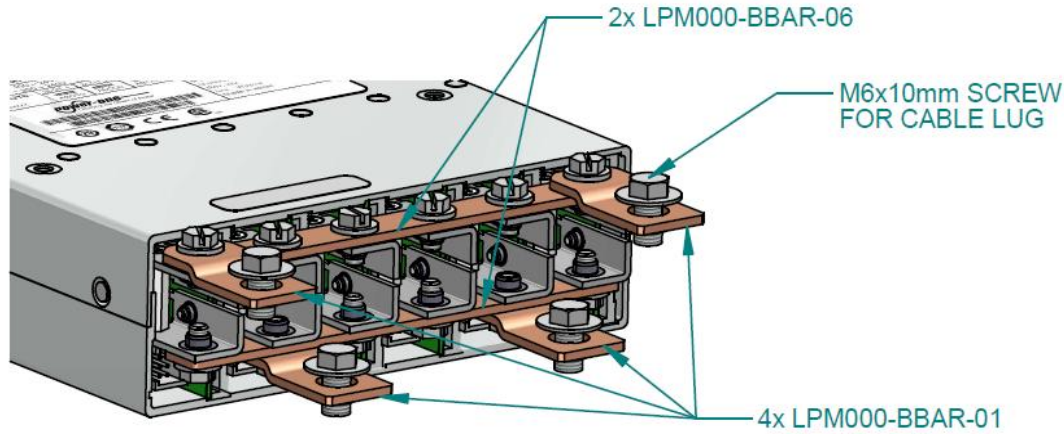
<sup>2</sup> by using busbars (paralleling modules) you will need also the signal output leads LPM000-LEAD-02, one for each module connected by the same busbar. The interconnection is shown in Fig.16 (especially all pins 4 - CS and all pins 2,7 - SGND must be reconnected).



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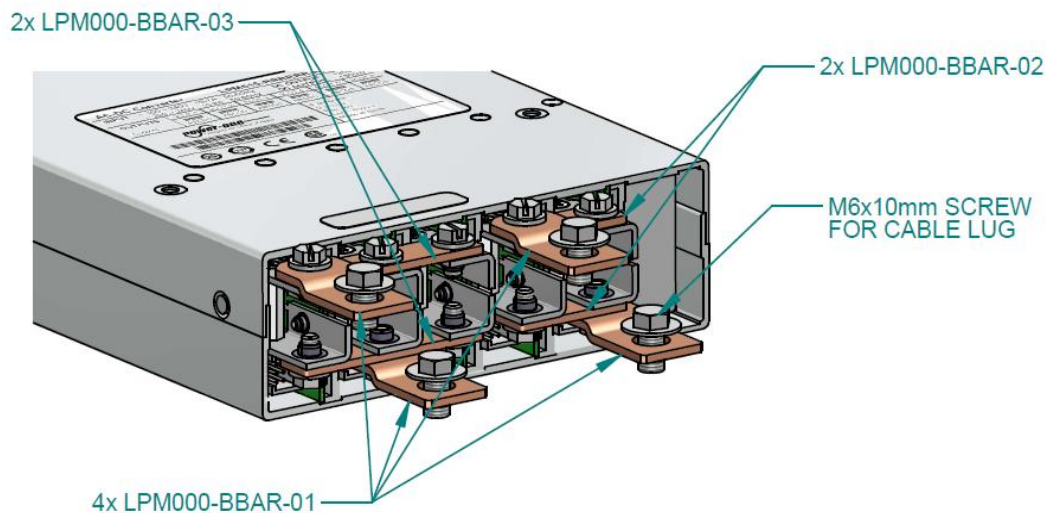
**[www.power-one.com](http://www.power-one.com)**

Note that for 300A output current (LPM616-AAAAAA-DXXX on *Figure 14*) this is the most preferred arrangement to achieve the best thermal flow. Connect two power cables for each pole ( $2 \times 70\text{mm}^2$ ). Use 105°C thermal class isolation.

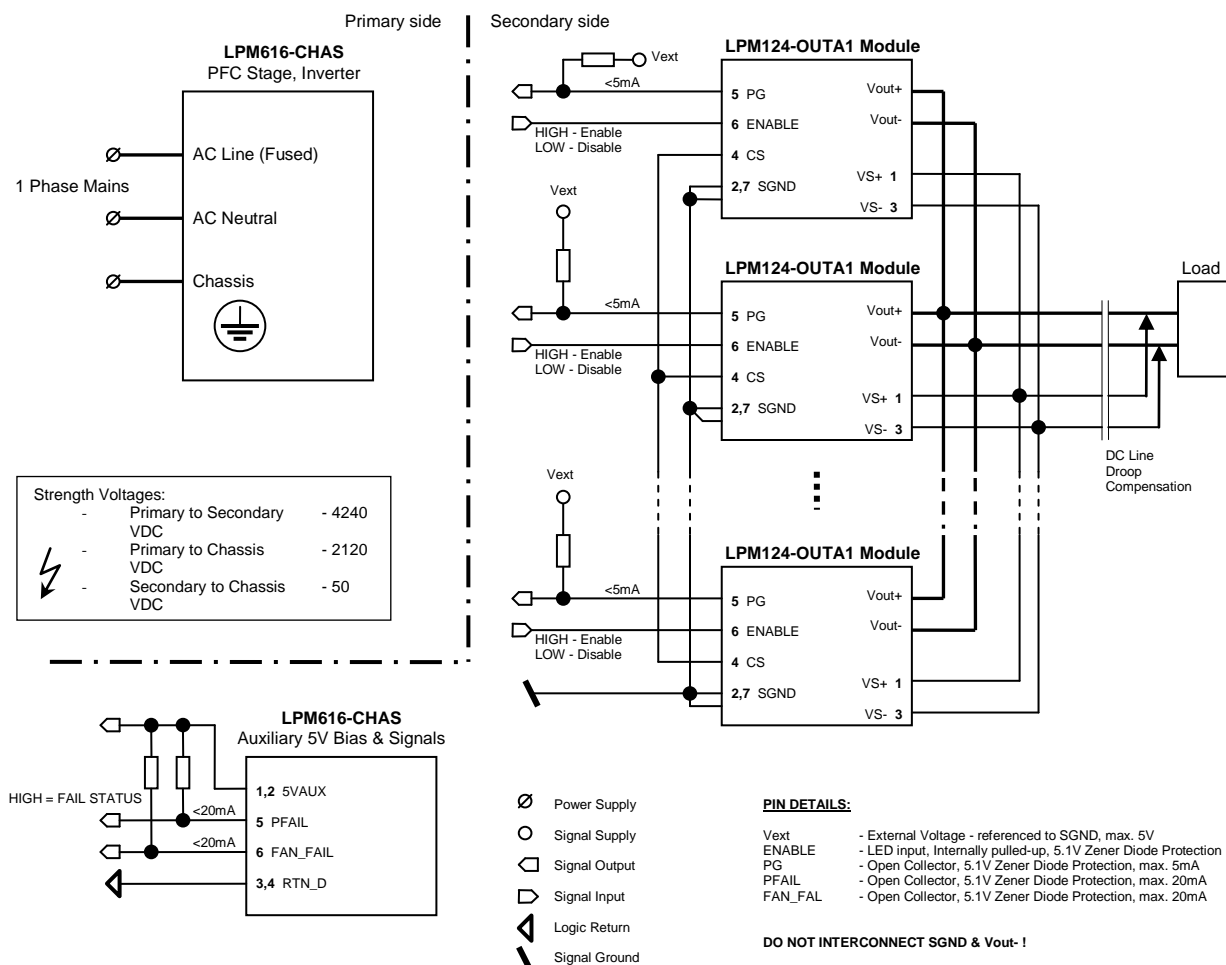


**Figure 14. LPM616-AAAAAA-DXXX Output Busbars arrangement**

Another example of configuration LPM616-BBCC0-DXXX is shown on *Figure 15*.



**Figure 15. LPM616-BBCC0-DXXX Output Busbars arrangement**



**Figure 16. LPM616 – Paralleling Connection Diagram**

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