APPLICATION NOTE

LPM Serial / Parallel Configuration

Introduction

This application note will show how to configure the LPM409 / LPM616 modular supplies in a series and parallel connection scheme. For a serial connection scheme see Figure 1. For a parallel connection scheme, see Figure 2.

Table 1 shows all the different variations of output modules available.

There is a section at the end of this document that will answer different questions regarding a series or parallel output configured supply as well as some general application questions.

LPM Model

LPM DESCRIPTION

The LPM409 Series is a modular 900-watt AC-DC power supply that provides a market-leading power density of 14 watts per cubic inch and has an extra low 1U profile. The LPM409 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 four slots can be configured with PCB-based output modules to deliver up to four outputs from single output modules or 8 outputs using all dual modules or a combination of single and dual output modules. The LPM output modules operate in any chassis position and can provide up to 900 watts total power from a 150 VAC input and 700 watts from an 85 VAC input. Forced-air cooling with airflow direction from front to back is provided by an internal fan.

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 or 12 outputs using all dual modules or a combination of single and dual output modules. 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.

SERIES CONNECTION OF MODULES

To increase the output voltage, it is possible to connect modules in series. The output of LPM chassis is rated as SELV circuit, so the output voltages are guaranteed to be less than 60 VDC. The series combination of modules can exceed this SELV voltage, so in this case the users must take adequate precautions. The maximal total voltage must not exceed 200 V. This 200 VDC rating is based on the Y caps from the plus and minus outputs to chassis ground. The recommendation for a series connection is to use the same modules with same output current rating. Series busbars LPM000-BBAR-09 are available to make the connections requiring higher voltage needs.

SERIES CONFIGURATION

Vout total is equal to Vo1 + Vo2 + Vo3…. The total power is Vout total times the output current rating of one of the modules.

Example:
Vo1 = 12 volts at 22 amps, Vo2 = 12 volts at 22 amps and Vo3 = to 12 volts at 22 amps

Three 12 volt outputs configured in series is equal to 36 VDC. The output current of each module is 22 amps so the total power is 36 VDC times 22 amps = 792 watts.

See Table 1 (below) for module voltage and current ratings. It is important to use the same modules when configuring them in series. For the example above, the end user would use 3 F modules with the output set at 12 volts.

MODULE	P/N	NO. OF SLOTS REQUIRED	FACTORY-SET SINGLE-OUTPUT (VDC)	MODULE ADJUSTABLE RANGE (VDC)	MAX. OUTPUT CURRENT (AMPS)	MAX. OUTPUT POWER (WATTS)
E	LPM126-OUTA1-05	1	5	2.0 to 5.3	53	265
F	LPM126-OUTA1-12	1	12	5.2 to 15	22	265
G	LPM126-OUTA1-24	1	24	14 to 30	11	265
H	LPM126-OUTA1-36	1	36	29 to 44	7.4	265
J	LPM126-OUTA1-48	1	48	43 to 54	5,5	265
K	LPM109-OUTA1-10	1	15	1.5 to 15	6	90
L	LPM109-OUTA1-20	1	30	3 to 32	3	90
M	LPM118-OUTA2-10	1	15	2x 1.5 to 15	2x 6	2x 90
N	LPM118-OUTA2-20	1	30	2x 3 to 32	2x 3	2x 90
0	LPM000-BLAN	1	Blank Panel (Slot Cover)			

Table 1. Module selection

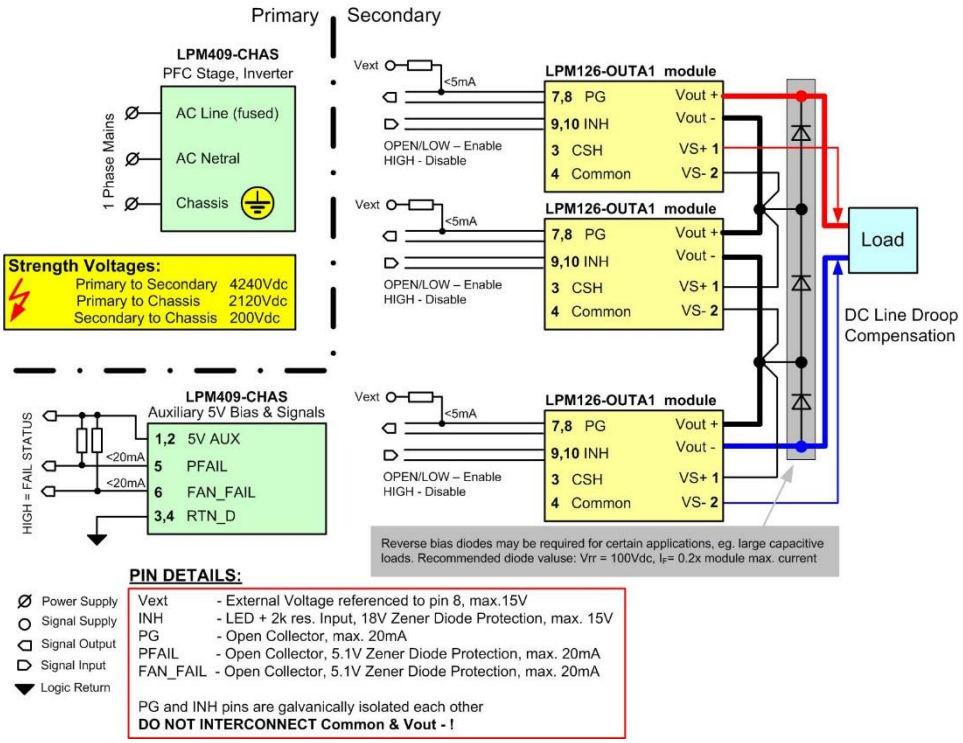

Figure 1. LPM -Serial connection diagram using LPM126 modules

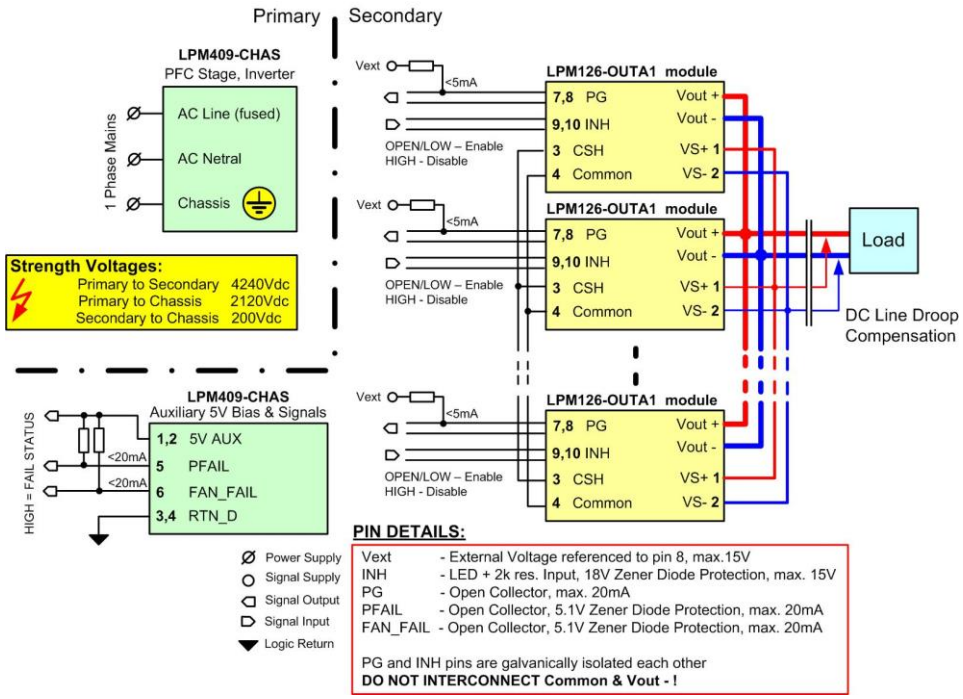

Figure 2. LPM-Parallel connection diagram using LPM126 modules

PARALLEL CONNECTION OF MODULES

Depending on certain situations where current requirements exceed one module's capability, the configurator will process a solution using parallel connections. Paralleling busbars LPM000-BBAR-07, LPM000-BBAR-08 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 parallel modules by signal wires LPM000-LEAD-04. More than 1 LPM chassis may be able to be connected in parallel. Please contact Power-One for comments.
For more details, read the Output Signal Connector and Accessories sections.

PARALLEL CONFIGURATION

Vout total is equal to Vo1, Vo2, Vo3…. The total power is equal to Vout1 times I out total.
I total is equal to Iout1, plus I out2, plus I out3…

Example:
Vo1 = 12 volts at 22 amps, Vo2 = 12 volts at 22 amps and Vo3 = to 12 volts at 22 amps

Three 12 volt outputs configured in parallel is equal to 12 volts. The total output current of each module is 22 amps so the total power is 12 Vdc times 66 amps = 792 watts.

See Table 1 for module voltage and current ratings. It is important to use the same modules when configuring them in parallel. For the example above the end user would use 3 F modules with the output set at 12 volts.

FREQUENTLY ASKED QUESTIONS AND TIPS

Q: How does one adjust the output voltage of an already paralleled configured supply?
A: 1) Start by removing all the connectors and output cabling from each output module.
2) Remove all the parallel busbars
Note: The user must not open the unit! (The HV test would be lost.)
3) Measure the voltage direct on the output pins of the module.
4) Let the output run for approximately 5 minutes so that thermal stability has been reached.
5) On the bottom of the supply, you will find a hole that allows access to an output adjustment pot. See figure 3 below for adjustment pot location. By no load condition set the voltage 1% higher than required value by loading.
6) Repeat this same process for all the before paralleled output modules in the chassis. All the output modules need to be set individually.
7) When all of the output modules have been set, reconnect all the parallel busbars, the remote sense connections and the current share pins together. Add the load wires.

Q: Is it OK to use only one output of the dual output module?
A: Yes

Q: On a dual output module, can the outputs be put in series?
A: Yes but not in parallel.

Q: Can dual output modules be set for two different voltages or do they need to be the same voltage?
A: Yes, the outputs can be set for different output voltage levels.

Q: Are the dual output modules galvanically isolated?
A: Yes, the outputs are isolated, also the signals at the common signal connector are isolated.

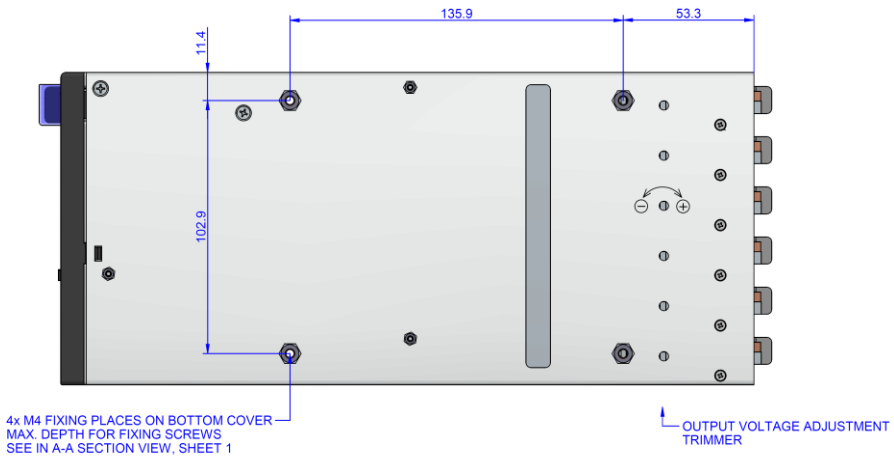

Figure 3. Bottom view

Q: What is the power rating of each output module?
A: The single output high power modules are rated at 265W, the low power single modules are rated at 90W and the dual output modules are rated at 2 X 90 watts. The total output power of the chassis is determined by the input AC voltage.
(e.g. LPM409-max. 900 W for high-line and 700W for low-line, LPM616, 1600 W for a high-line condition and 1300 W for a low-line condition). Note the high-line voltage would be 230Vac while the low-line would be 115 VAC.

Q: What is the maximum voltage if you put the 48 V modules in series? Is there a limit to how many pcs you can put in series?
A: As described in the datasheet, the maximal voltage must not exceed 200V, so the limit is 4 pcs in series.

Q: Are protection diodes or output voltage clamps needed across each output of a series configured supply?
A: Yes. Diodes should be placed across each output module that is connected in series. A good suggestion would be to use a Schottky diode with a 100 volt, 5 amp rating.

Q: How should the remote sense lines be connected in a paralleled output configuration?
A: Each module has a plus remote sense lead and a negative remote sense lead, VS+, VS-. These 2 leads should be run from each output module and terminated as close to the load as possible. See figure 2. These remote sense wires do not carry high current, so a wire gauge of 18 AWG to 22 AWG can be used. (or use our standard LPM000-LEAD-04 cable) These 2 wires should be twisted together to minimize any noise pickup. The total compensation for wires losses is 0.5 volts max. See figure 3 for help in determining the needed wire gauge to minimize wire losses.

Q: How should the remote sense lines be connected in a series output configuration?
A: Each module has a plus remote sense lead and a negative remote sense lead, VS+, VS-. For a series output configuration see figure 1. These remote sense wires do not carry high current, so a wire gauge of 18 AWG to 22 AWG can be used. (or use our standard LPM000-LEAD-04 cable)

Q: How should an additional output capacitance be attached in both a series and parallel configuration scheme?
A: If an additional output capacitor is needed, it should only be connected right across the output load. There is no need to add a capacitor across each series configured output, nor across each paralleled output, but only across the load.

Q: When operating outputs in parallel, is there a current share tolerance.
A: Yes, 10%.

Q: How should the remote enable pins to be connected?
A: For a series connection, see Figure1, for a parallel connection see Figure 2.

Q: What are the activation levels of the enable pins?
A: INH_HI OPEN or LOW state ENABLES the module's output. INH_HI HIGH state INHIBITS the module's output.

