

# Application Notes

## THERMAL CONSIDERATIONS

(LP / P / HP / LF / LM / F / M / XP Series)

To use these PICO Series at full power one has to get rid of dissipated losses in the modules. Although the high efficiency of these units minimizes the heat loss; The exposed area, depending on the ambient temperature, may not be enough to keep the case temperature at an acceptable value if natural convection is used. The additional heat may be removed by a heat sink, forced air, or both. Internal losses produce heat which is moved toward the case and must be removed. Depending on the thickness and the material used, there is always a temperature gradient from inside to the case which may be calculated by:

$$[1] \quad T_{ric} = \frac{T_i - T_c}{Q} \quad \text{where,}$$

**T<sub>ric</sub>** = Thermal Resistance from inside to case

**T<sub>i</sub>** = Inside Temperature in Degrees C

**T<sub>c</sub>** = Case Temperature in Degrees C

**Q** = Dissipated Power in the module in watts

The specification given in the data sheet of these units are such that at 85° C case the T<sub>i</sub>; (inside temperature of components) is acceptable for proper operation. The user of these modules then has the task to keep the case temperature at or below 85° C. The temperature rise of the case depends on how efficiently the heat is removed. If the process is very efficient the thermal resistance is low and the case to ambient temperature gradient is low. The thermal resistance from the case to the air is given by:

$$T_{rca} = \frac{T_c - T_a}{Q} \quad \text{and}$$

$$Q = P_{in} - P_{out} = P_{out} \left( \frac{1}{\eta} - 1 \right)$$

$$[2] \quad T_c - T_a = \Delta T = T_{rca} P_{out} \left( \frac{1}{\eta} - 1 \right)$$

$T_{rca}$  = Thermal Resistance of case to air

$P_{out}$  = Output Power in watts

$\eta$  = Efficiency

$T_c$  = Case temperature in Degrees C

$T_a$  = Ambient Temperature in Degrees C

The following table shows the Thermal Resistance in free air as well as with forced cooling with or without heat sinks.

<b>Table 1: Thermal resistance case to air (° C/W)</b>									
	Series LP/LF/LM			Series P			HP/XP/M Series, also Series P High Voltage Only		
	Baseplate	Heatsink LCV	Heatsink LCH	Baseplate	Heatsink CV	Heatsink CH	Baseplate	Heatsink CV	Heatsink CH
Free Air	7.9	4.2	4.0	4.7	3.2	2.7	5.1	3.5	3.0
200 LFM	4.9	1.6	1.6	2.5	1.5	0.9	2.8	1.8	1.0
400 LFM	2.5	1.3	1.3	1.6	1.0	0.6	1.8	1.1	0.7
600 LFM	2.2	0.9	0.9	1.3	1.7	0.5	1.4	0.8	0.55
800 LFM	1.5	0.7	0.7	1.1	0.6	0.4	1.2	0.65	0.45
1000 LFM	1.2	0.6	0.6	0.9	0.5	0.36	1.0	0.55	0.40

## TYPICAL EXAMPLES

**Example 1:** What would be the maximum output power for a LP Series unit at an ambient temperature of 50°C with an efficiency of 85%

A) If the module is used in free air?

From Table I:  $T_{ra} = 7.9$

Using Relation (2)

$$85 - 50 = 7.9 P_{out} \left[ \frac{1}{0.85} - 1 \right]$$

$$P_{out} = \frac{35}{7.9 [0.176]} = 25 \text{ WATTS}$$

B) If the module is used in an area with forced air at 200 LFM with no heatsink?

$T_{ra} = 4.9$

$$P_{out} = \frac{35}{4.9 [0.176]} = 40 \text{ WATTS}$$

C) If the module with heatsink (LCV) is used in free air?

$T_{ra} = 4.2$

$$P_{out} = \frac{35}{4.2 [0.176]} = 47 \text{ WATTS}$$

**Example 2:** A P Series module has an efficiency of 87%. What is the maximum ambient temperature if 100 watts of power is needed?

A) In free air?

From Table I:  $T_{ra} = 4.7$

Using Relation (2)

$$\Delta T = 4.7 (100) \left[ \frac{1}{0.87} - 1 \right] = 70^\circ\text{C}$$

$$T_a = 85 - 70 = 15^\circ\text{C}$$

B) In free air with heatsink (CV)?

$T_{ra} = 3.2$

$$\Delta T = 3.2 (100) \left[ \frac{1}{0.87} - 1 \right] = 48^\circ\text{C}$$

$$T_a = 85 - 48 = 37^\circ\text{C}$$

C) Forced air with 400 LFM?

$T_{ra} = 1.6$

$$\Delta T = 1.6 (100) \left[ \frac{1}{0.87} - 1 \right] = 24^\circ\text{C}$$

$$T_a = 85 - 24 = 61^\circ\text{C}$$

**Example 3:** At a maximum ambient temperature of 50°C and an efficiency of 87%, how could a Series HP unit be used if 150 watts of output power is required?

Using relation (2), we should first find the thermal resistance from case to air.

$$\Delta T = T_{ra} (150) \left[ \frac{1}{0.87} - 1 \right]$$

$$85 - 50 = T_{ra} (22.41)$$

$$T_{ra} = 1.56 \text{ max.}$$

A) If no heatsink is used?

From Table I, 600 LFM of airflow is required.

B) If a CV heatsink is used?

300 LFM of airflow is required

C) If a CH heatsink is used?

150 LFM of airflow is required

## Output Voltage Trimming:

The output voltage of Pico's LP, P, and HP units can be adjusted to within  $\pm 5\%$  of the nominal setting by placing a resistor between the "TRIM UP" and the "TRIM DOWN" pins respectively.

Due to internal tolerances, the values presented in the table are typical. To quickly select the right resistance to achieve the desired adjustment, a multi-turn trimmer potentiometer (1M ohms) is recommended. Keep the trim resistor leads as short as possible to eliminate the stray inductance which will effect the trimming results.



\* For LP/LF/LM Models: Trim up by adding the resistor between the Trim Pin and the -Input. Use these same resistors values.

*Typical Resistance Range for Trim UP and Trim Down				
% Change in Vout	1%	2%	3%	5%
Trim to Trim Up Resistance	300K Ohms	150K Ohms	50K Ohms	20K Ohms
Trim to Trim Down Resistance	1M Ohms	500K Ohms	250K Ohms	100K Ohms

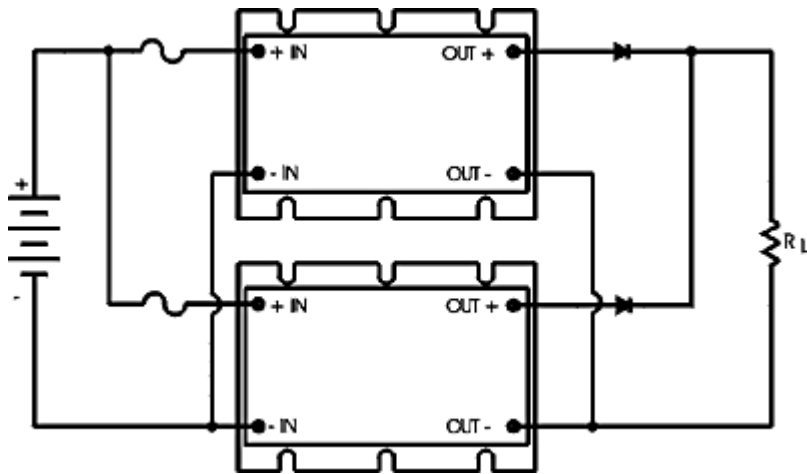
## Parallel Operation

Special care must be exercised when operating these units in parallel, since these modules deliver comparatively high currents (especially the low voltage outputs of 3.3, 5.0, 5.2, and 12 volts).

For parallel operation, the corresponding pins of the units must be connected together. The paths of these connections should be as direct as possible. The path to the load also should have the lowest possible resistance; otherwise unacceptable losses and load regulation will occur. For instance, a 1 milli-ohm resistance and a 100 ampere load will cause 10 watts of line losses as well as additional load regulation.

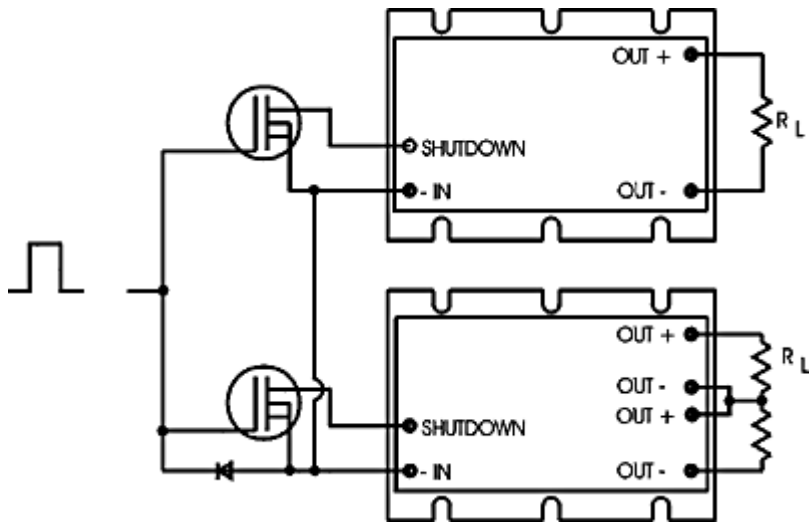
If the parallel configuration is for redundant operations, schottky diodes should be used at the output of each module as shown.

For parallel operation, add suffix P to Part #. Example: PA5SP, PB5SP, PC5SP, PD5SP.



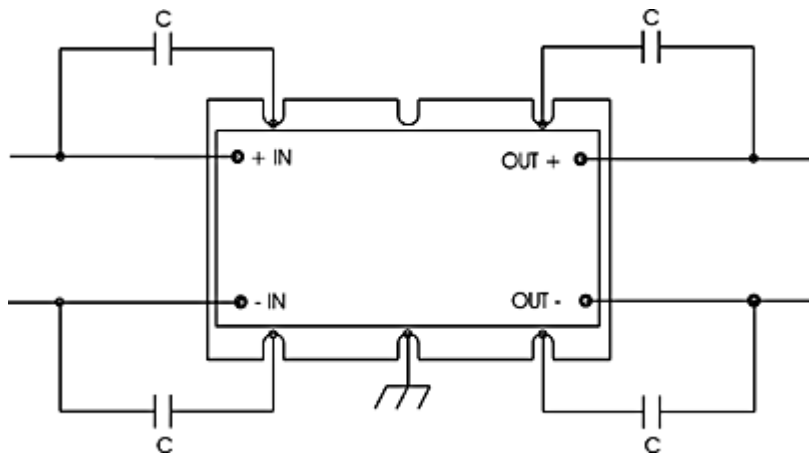
## Use of a Shutdown Pin

With the help of a shutdown pin, one may turn the unit on and off. If the voltage across the shutdown pin with respect to the -input pin is reduced to 0.15 volts or lower, the converter shuts off. When more than one module has to be shut down at the same time, one must use a circuit similar to the one below.



## Noise Reduction

For additional noise reduction, a circuit as shown below is suggested. If further reduction is required, filters at the input and output may be required. Please call the factory.



## Overload Protection

There is an overload protection of 10% to 20% above the maximum load current installed in each unit. If there is a large capacitive load, or if the unit

initially requires a much larger starting current than the peak power available, please call the factory for further consultation. Special units with different overload protection may be required.

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For immediate engineering assistance or to place an order:

**Call Toll Free: 800-431-1064**

**PICO Electronics, Inc.**

143 Sparks Ave. Pelham, NY 10803-1837

Tel: 914-738-1400 or Fax: 914-738-8225