PPM50W-28V

(115Vac, 47- 800Hz Input)

50W, 28V/1.8A , AC to DC

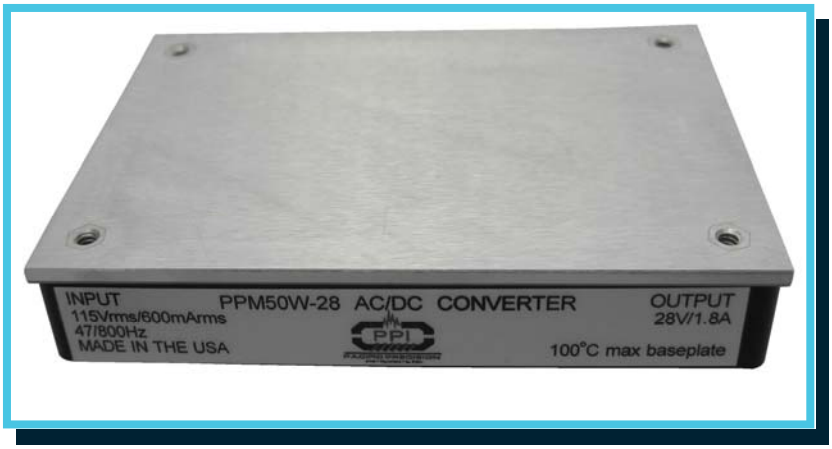
PFC Converter Module

Targeting low power, low profile avionics' applications, the **PPM50W-28V** module provides an isolated 28Vdc output with an integral PFC input converter stage. It meets the most stringent airborne requirements including those for variable frequency 115Vac generator systems over the wide frequency range of 360-800Hz and RTCA/DO-160F category M emissions (see note 4).

Utilizing thermal-clad circuit board technology and low profile planar magnetics, thermal gradients between heat dissipating components and the module baseplate are minimized while maintaining a low 0.53" profile.

The **PPM50W-28V** is capable of providing uninterrupted ride-through at full output load during momentary input AC brown-out conditions by connecting external electrolytic capacitors to the PFC output pins provided. Standard protection features are built-in in to assure years of fault-tolerant and reliable operation in the harshest environments.

Weighing less than 6 ounces, the **PPM50W-28V** is housed in a silicon-based encapsulated enclosure with outer dimensions of 3.5" x 2.4" x 0.53". Four corner mounting holes are included to facilitate system mounting. The **PPM50W-28V** is intended for low-profile PCB mount applications where the topside baseplate can be flush mounted to LRU chassis sidewalls or a stand-alone heatsink.



FEATURES

	Meets both RTCA/DO-160F, section 16, and Airbus ABD0100.1.8 issue D for power factor and input current harmonic distortion levels over the wide frequency operating range (360Hz – 800Hz) at 30W to 50W output
	Wide input range: 96Vrms – 134Vrms, 47 – 800Hz
	Complies with RTCA/DO-160F for conducted emissions, susceptibility and power input (section 16), see note 4
	Active inrush current limiting: 5Apk typical, 7Apk maximum
	Size: 3.5" x 2.4" x 0.53", Weight: less than 6 ounces
	Tightly regulated isolated output: 28V/ 1.8A
	Overcurrent protection with foldback current limiting
	Output overvoltage protection
	PFC output overvoltage protection with automatic restart (internal 200Vdc PFC output)
	Over-temperature shutdown with automatic restart (baseplate at or above 100°C)
	Separate low current 9V output provided for powering auxiliary circuits
	DC output valid status line (TTL)
	AC valid status line (TTL)

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PERFORMANCE SUMMARY

PARAMETER	SPECIFICATIONS
Voltage regulation	+28Vdc +2,-1%
Rated output current	1.8A
Pk-Pk Ripple + Noise (20MHz)	280mVpp maximum
Module Efficiency	73% typical
Output overcurrent threshold (1)	2.1A typical
Output overvoltage set-point (2)	33V +/- 3%
PFC output overvoltage set-point (2)	246V +/- 3%
Isolation Voltage (3) (Input to Output & Input to Chassis)	1500Vac minimum
Minimum load (5)	100mA
MTBF (Aic, 30°C case)	tbd

Notes:

1. 2.1A typical (2.25A maximum) with foldback current limiting and auto recovery into full load
2. Auto recovery
3. 1500Vac, 60Hz for 60 seconds without arc or damage; 2.0mArms maximum leakage current (line-to-earth capacitors installed)
4. Requires external filter components installed on power lines for full compliance, see application section for details
5. 100mA minimum load necessary to assure proper output regulation. No module damage will occur if the minimum load is not applied; output may fluctuate low if minimum load is not applied

TEMPERATURE CHARACTERISTICS

*AIRFLOW (LFM)	THERMAL IMPEDANCE (Θ_{s-a}) (no external heatsink)
0 LFM	5.5 °C/W
250 LFM	1.5 °C/W
500 LFM	0.9 °C/W

* Air velocity measured using a digital anemometer positioned within an airflow duct 4" X 3" above top of module

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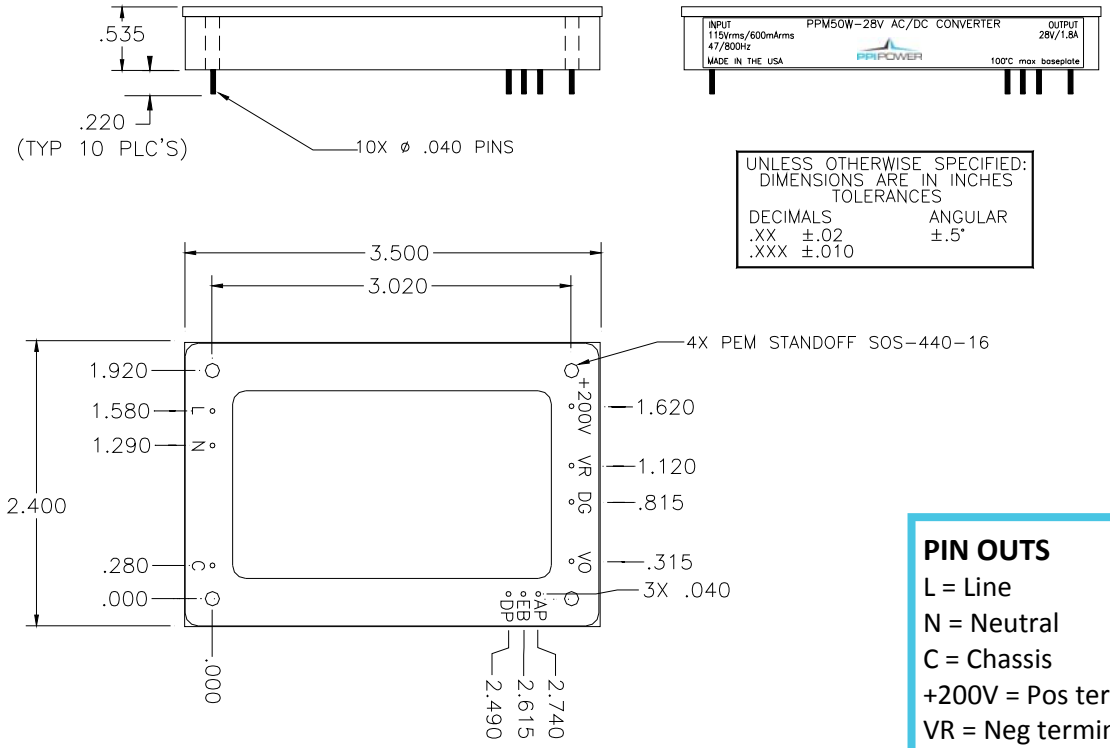
MECHANICAL DIAGRAM



PIN OUTS

L = Line
N = Neutral
C = Chassis
+200V = Pos terminal of ext Ch/u
VR = Neg terminal of ext Ch/u
DG = 28V Return
VO = 28V Output
AP = ACPF-L
EB = 9V Aux output
DP = DCPF-L

*** BASEPLATE FLATNESS**

Maximum warpage not to exceed
0.02" per 3.5" unit length.

A DETAILED OUTLINE DRAWING CAN BE FURNISHED UPON REQUEST

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ELECTRICAL SPECIFICATIONS

Unless otherwise specified the following test conditions apply: Ta = 25°C, constant active load applied to the 28V output, Ch/u (external) = 220uF, Vin = 115Vrms, 360Hz – 800Hz, <1.25% sinusoid. Application note power line filter installed external to module.

INPUT CHARACTERISTICS

PARAMETER	PPM50W-28V	REMARKS	NOTES
INPUT VOLTAGE RANGE	**96 – 134Vrms**	**Complies with normal / abnormal input voltages per DO-160F, sect. 16.**	**2**
INPUT FREQUENCY RANGE	**47 – 800Hz**	**Reduced distortion performance below 360Hz.**	**2**
EFFICIENCY	**70% minimum**	**Full 50W ouput load. 73% typical full load efficiency.**	**2**
LEAKAGE CURRENT	**< 1mArms**	**AC Line / Neutral to Chassis at 115Vrms / 400Hz. No external filter.**	**1**
INRUSH CURRENT	**< 7Apk**	**Cold start; 5Apk typical.**	**2**
TOTAL HARMONIC DISTORTION (INPUT CURRENT)	**< 5.5%**	**Pout > 35W.**	**2**
INDIVIDUAL HARMONICS AC CLEAN	**EVEN: <1% If / n (n < 10) EVEN: <0.1%If (n ≥ 10) ODD: <30% If / n ODD TRIPLENS:<15% If /n**	**If = Fundamental current Vthd < 1.25%, n = order of harmonic (1 - 40) Pout > 35W. Harmonics < 10mA disregarded.**	**1**
INDIVIDUAL HARMONICS DISTORTED INPUT	**EVEN: <1% If / n + 1.25Vn (n < 10) EVEN: <0.1%If + 1.25Vn (n ≥ 10) ODD: <30% If / n + 1.25Vn ODD TRIPLENS:<15% If /n+1.25Vn**	**If = Fundamental current Vthd > 10% (clipped method), n = order of harmonic (1 - 40) Vn = corresponding input voltage harmonic. Pout > 35W. Harmonics < 10mA disregarded.**	**1**
QUIESCENT POWER	**7.7W**	**3W load applied to output.**	**1**
POWER FACTOR	**0.98 min**	**Pout > 35W.**	**2**
CREST FACTOR (CURRENT)	**1.314 – 1.514**	**Ratio of peak / RMS.**	**1**

INPUT CHARACTERISTICS—CONTINUED

PARAMETER	PPM50W-28V	REMARKS	NOTES
START-UP TIME	**< 750mSec**	**Output within proper regulation.**	**2**
CONDUCTED EMISSIONS	**RTCA/DO-160F**	**Section 21, category M.**	**1**
STORAGE TEMPERATURE RANGE	**-55°C to +100°C**	**Non-operational.**	**1**
OPERATING TEMPERATURE RANGE	**-15°C to +70°C**	**Observe maximum baseplate temperature of +100°C.**	**1**
OVERTEMPERATURE SHUTDOWN	**100°C ± 5°C**	**Module's 28V output is inhibited at or above 100°C. Auto restart occurs at ~ 90°C baseplate temperature.**	**1**

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OUTPUT CHARACTERISTICS

PARAMETER	PPM50W-28V	REMARKS	NOTES
RATED OUTPUT POWER	50W	Continuous. Observe maximum allowable baseplate temperature; see application information for details.	2
OUTPUT VOLTAGE	28Vdc +2,-1%	Min load to full load.	2
OUTPUT OVERCURRENT THRESHOLD	2.1A typical, 2.25A maximum	Output voltage will foldback, auto-recovery. No damage will occur to module during indefinite output short circuit conditions.	2
TEMPERATURE STABILITY COEEFICIENT	0.05% / °C	Output voltage variation with temperature (500uV / °C).	1
OUTPUT RIPPLE + NOISE	280mVpp maximum	20MHz bandwidth. 100mVpp typical. Can be reduced with external capacitors, see application notes.	2
LINE REGULATION	<0.5%	Output deviation for +/- 20% step change in input voltage.	1
LOAD REGULATION	Output remains in regulation	50% step change in output load. Full load to half load or half load to full load. 10uSec rise/fall time.	1
MINIMUM LOAD	2.8W (100mA)	Module requires minimum load in order to regulate output properly. No damage or overvoltage will occur if minimum load is not provided.	2
HOLD-UP TIME	200mSec minimum	Full 50W output load, external 1060uF hold-up capacitance attached.	2
MINIMUM EXTERNAL HOLD-UP CAPACITANCE	220uF, 250Vdc	Module may be damaged if operated without proper hold-up capacitor installed.	
MAXIMUM EXTERNAL HOLD-UP CAPACITANCE	1500uF	Specified in order to not overstress the internal inrush current limiting circuit	1
ISOLATION VOLTAGE INPUT TO CHASSIS	1500Vac, 60Hz	No arcing or damage for 60-second test duration (2.0mArms max leakage).	2
ISOLATION VOLTAGE INPUT TO OUTPUT	1500Vac, 60Hz	No arcing or damage for 60-second test duration (2.0mArms max leakage).	2
ISOLATION VOLTAGE OUTPUT TO CHASSIS	250Vdc	No arcing or damage for 60-second test duration (100Mohm min).	1

OUTPUT CHARACTERISTICS—CONTINUED

PARAMETER	PPM50W-28V	REMARKS	NOTES
DCPWRFAIL-L (DP)	Transitions to TTL low (0.5Vmax) when 28Vdc output is detected outside of proper regulation window	TTL level, 3mA max sink current. Time to activation on a fault is 1mSec typical, 2.5mSec maximum.	2
ACPWRFAIL-L (AP)	Transitions to TTL low (0.5Vmax) upon detection of loss of input AC	TTL level, 3mA max sink current, 25mSec maximum delay time to activate on loss of input AC.	2
PFC 200Vdc OUTPUT	200Vdc ± 3%	10W ≤ Pout < 50W.	2, 3
MINIMUM DC/DC CONVERTER OPERATING VOLTAGE (Vf)	110Vdc	Minimum amplitude for PFC output that will guarantee proper output regulation for the 28V output.	1
OUTPUT OVERVOLTAGE PROTECTION	33V ± 3%	Pulse by pulse protection (inner loop), auto-restart.	1
OUTPUT OVERVOLTAGE PROTECTION (PFC 200Vdc OUTPUT)	246V ± 3%	PFC output is clamped to this level if control loop regulation is lost, auto-recovery.	1
OUTPUT VOLTAGE ADJUSTMENT	None		--

Notes:

1. Ensured by design, not 100% tested in production.
2. 100% tested for specification compliance in production.
3. 200Vdc PFC output voltage tolerance is +/-5% for Pout < 10W.

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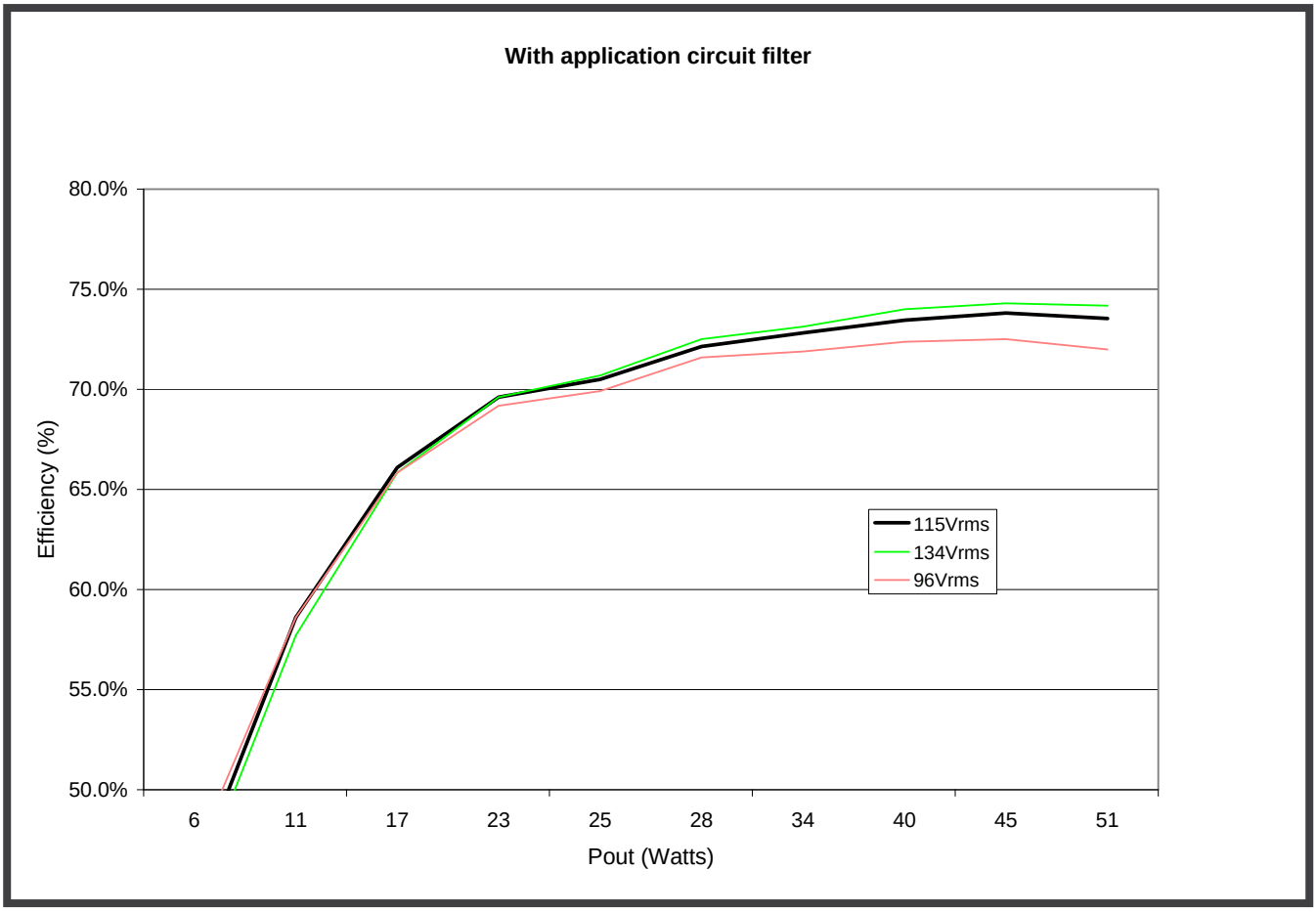
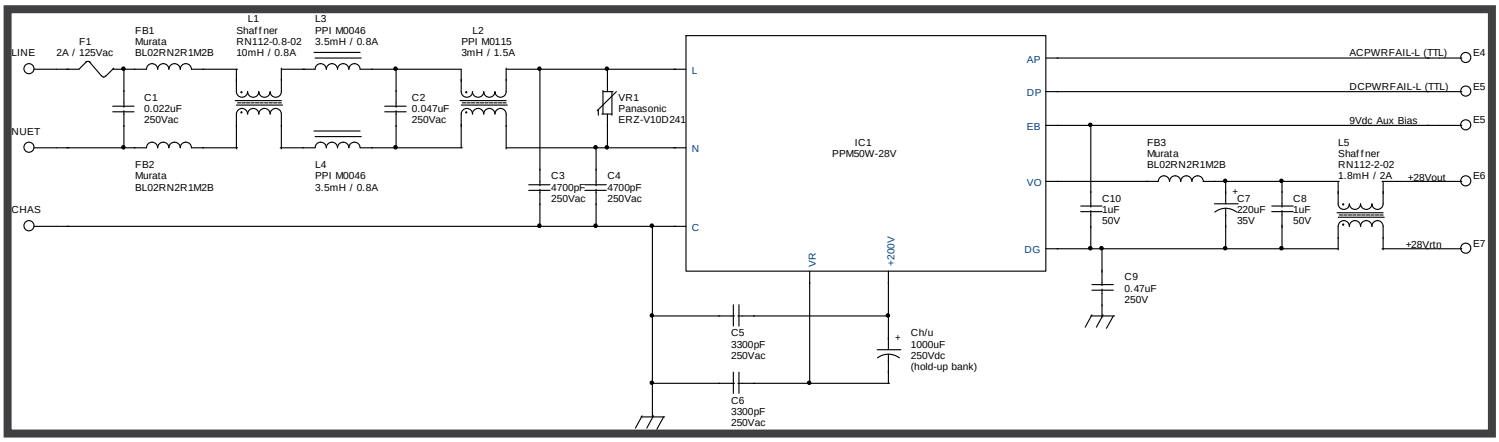
EFFICIENCY CURVE



APPLICATIONS' INFORMATION



Typical Application Circuit

EXTERNAL CAPACITANCE AND HOLD-UP TIME

Capacitor(s) must be placed between the +200V pin and the VR pin; failure to do while operating the module will cause sporadic operation and may result in permanent module damage. Use of polarized snap-mount, 105°C, 250Vdc, 20%, aluminum electrolytic capacitors is recommended. A minimum value of 220uF is required with a ripple current rating of at least 500mA. In order to minimize circulating common-mode currents flowing back to the AC power source it is recommended that trace lengths to the hold-up capacitors be kept to a minimum and safety rated ceramic bypass capacitors be installed between the module's +200V / VR pins and local chassis ground.

In order to provide hold-up time with external capacitors, required capacitance can be determined using the following formula:

$E = P * (t + t_{restart}) = (0.81) * \{½ C_{h/u} (Vi^2 - Vf^2)\}$

Where,
P = output power (Watts)
t = desired hold-up time (Seconds)
$t_{restart}$ = warm start delay of approximately 20mSec upon reapplication of input AC
$C_{h/u}$ = external hold-up capacitance (Farads)
0.81 factor constitutes internal DC/DC converter efficiency
Vi = Minimum PFC voltage of 194Vdc (200Vdc - 3%)
Vf = 110 Volts

$E = P * (t + t_{restart}) = (0.81) * \{½ C_{h/u} (Vi^2 - Vf^2)\}$

In order to hold up 50W external power for 200mSec requires:

$C_{h/u} = \{(50W) (200mSec + 20mSec)\} ÷ \{(1/2) (0.81) (194V^2 - 110V^2)\} = 1,064uF$

For the example above, a total nominal capacitance of 1330uF would be necessary to assure the required capacitance of 1064uF was achieved. Warm start delay occurs for AC power interrupts greater than 25mSec as a result of combination of time to reactivate PFC control circuitry, reinitiation of PFC soft-start cycle and reaching module power limit.

PLACEMENT, FLATNESS AND MOUNTING

The PPM50W series modules may be flush mounted and soldered to a PCB. The baseplate (topside) may be mounted to a flat surface for heatsinking or to a stand-alone heatsink. If mounting the baseplate to a flat surface a thermal interface pad is recommended as some warpage of the module's aluminum baseplate may exist. Warpage of the baseplate surface (including bow and twist) occurs in the manufacturing of the internal thermal clad circuit board and is a result of high temperatures required during the lamination process as well as during the panel cutting process. Baseplate warpage is limited to 0.02" per 3.5" unit length. Temperature activated thermally conductive interface pads, such as Chomeric's T725 series, are suitable interface pads for this application.

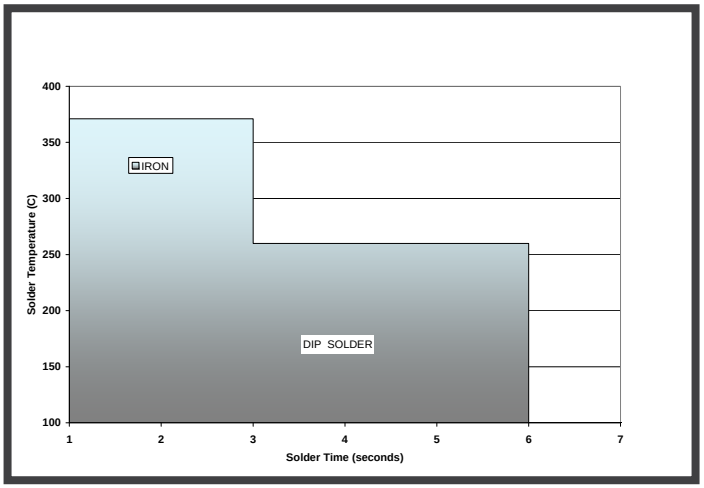
The PPM50W module contains 4 corner threaded #4 mounting holes (see mechanical diagram for details). The standard mounting hole configuration is partially threaded; threaded approximately 0.31" through from the baseplate side of the module.

SOLDERING INFORMATION

In order to minimize mechanical force exerted on the module pins, the module should be mechanically fastened to the printed circuit board prior to soldering each of the I/O pins. Interconnection using pin-sockets is not recommended as damage may occur to the module if interconnection to the L, N, +200V or VR pins were to become intermittent or momentarily disconnected.

The AC input and DC output pins are soldered internally to the module's horizontal aluminum printed circuit board using a high temperature solder that allows for application of high heat for long time durations when soldering the module to an external circuit board without concern for re-flow of the internal solder joints.

The module's three signal pins (AP, EB, DP) require extra care when soldering as they are soldered to a different circuit board within the module and may be re-flowed it too much heat is applied for too long. For these three signal pins, the allowable heat application versus time duration curve is shown below and should be adhered to in order to prevent re-flowing the module pin's internal solder joints.



ROUTING CONSIDERATIONS

Input filter components (C1, C2, L1-L4) should be located in close proximity to the AC entry point for the (upper) unit. Location of bypass capacitors (C3-C6, C9) should be located in close proximity to their respective module pins. A chassis ground plane should be used on the component layer directly beneath the module with minimal lead lengths attaching to all bypass capacitors. Assure there is at least 4.2mm between primary referenced and secondary referenced signals; this will require creating voids in the chassis plane around the secondary referenced pins such that the cumulative isolation distance is 4.2mm minimum. Secondary referenced signals include AP, EB, DP, VO and DG. Avoid routing secondary referenced signals directly beneath module on component layer.

CAPACITIVE LOADING AND PROPER POWER-UP CONSIDERATIONS

Avoid applying full (1.8A) load current to the module's output prior to allowing the output to reach at least 10Vdc to avoid module latch-up when starting. Module latch-up can occur under certain power-up modes (e.g., low line) if the module enters internal power-limit prior to its internal bias voltages reaching minimum operating levels. If implementing active loading on the modules output (constant current sink), assure that the turn-on voltage of the active load instrument is set to at least 10Vdc. If implementing external bulk capacitors on the module's 28V output, assure proper power-up under all input line and output load conditions.

EMI CONSIDERATIONS

Use of a chassis ground plane beneath module on either component layer or first internal circuit board layer beneath component layer of PCB is recommended. Assure that sufficient isolation distance exists between chassis plane and each of the modules input and output pins such that there is at least 4.2mm between primary referenced and secondary referenced signals. Incorporating the filter or an equivalent filter shown in the application circuit is necessary for EMI compliance. Reduce or eliminate line-to-line capacitance (C1 or C2) for applications operating at low power levels (<25W output) as they may have an adverse effect on input current harmonic distortion at higher line frequencies (e.g., 800Hz).

Incorporate safety recognized decoupling capacitors (class X1, Y2) on primary referenced terminals (L, N, +200V, and VR) with respect to chassis plane in close proximity to respective module terminals.

In order to reduce 400kHz ripple and differential switching noise on the 28Vdc output, adding a parallel combination of low ESR electrolytic and MLCC ceramic capacitors from VO to DC is recommended. Recommended low ESR electrolytic capacitors include United Chemicon MVE series and Panasonic ECJ series for the MLCC capacitors.

THERMAL CONSIDERATIONS

There is no derating required for module output power up to the module baseplate temperature of 100°C. Beyond this temperature the module will shutdown. In order to assure the baseplate temperature remains below 100°C additional heatsinking or forced airflow may be required. In order to estimate baseplate temperature and whether external heatsinking or airflow is necessary, apply the following formulas:

$T_{baseplate} = T_{ambient} + (P_{diss})(\Theta_{s-a})$

Where:
$T_{baseplate}$ = module baseplate temperature in °C,
$T_{ambient}$ = ambient air temperature in °C,
Θ_{s-a} = thermal resistance from module baseplate to ambient air in °C/W without external heatsink,
eff = worst case module efficiency from efficiency curve,
$P_{diss} = \{(P_{out} \div eff) - P_{out}\}$ in watts

As an example,
Assume a desired output power of 50W at low line operation (96Vrms) with a maximum ambient temperature of 70°C. The following formula would apply:

$T_{baseplate} = 70°C + \{(50W / 0.72) - 50W)\} (5.5°C/W) = 177°C$

Therefore either an external heatsink would be required or forced airflow such that Θ_{s-a} was reduced to:

$\Theta_{s-a} < \{(T_{baseplate} - T_{ambient}) \div P_{diss}\}$

$\Theta_{s-a} < \{100°C - 70°C\} \div \{(50W / 0.72) - 50W)\} < 1.54°C/W$

This is equivalent to the thermal resistance obtained when using no heatsink with 250LFM airflow directed across module baseplate.