PFC50W-5V-3.3V

(115Vac, 47- 800Hz Input)

25W, 5V/2.3A & 3.3V/4A Dual Output,

Airborne PFC Power Module

Targeting low power avionics' applications, the **PFC50W-5V-3.3V** module provides two isolated low voltage outputs 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-160E category M emissions.

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 0.75" profile.

The **PFC50W-5V-3.3V** is capable of providing uninterrupted ride-through at full output load during momentary input AC brown-out conditions for up to 20mSec. Hold-up time is readily expanded 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 18 ounces, the **PFC50W-5V-3.3V** is housed in a silicon-based encapsulated enclosure with outer dimensions of 5.0" x 3.0" x 0.75". Four corner mounting holes are included to facilitate system mounting. The **PFC50W-5V-3.3V** 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-160E, 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)
	Wide input range: 96Vrms – 134Vrms, 47 – 800Hz
	Complies with RTCA/DO-160E for conducted emissions, susceptibility and power input (section 16)
	Active inrush current limiting: 5Apk typical, 7Apk maximum
	Size: 5.0" x 3.0" x 0.75", Weight: less than 18 ounces
	Dual regulated isolated outputs: 5V/2.3A & 3.3V/4A
	Overcurrent protection on each output with auto recovery
	Output overvoltage protection (5V output only, automatic restart)
	PFC output overvoltage protection with automatic restart (internal 200Vdc PFC output)
	Over-temperature shutdown with automatic restart (baseplate at or above 100°C)
	DC output valid status line (TTL)
	AC valid status line (TTL)
	MTBF: 40,000 Hours, Aic category, 30°C case temperature (MIL-HDBK-217F)

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PPI POWER

PERFORMANCE SUMMARY

PARAMETER	VALUE (TYPICAL)		
	Module	5V Output	3.3V Output
Voltage regulation	--	+5.1Vdc ± 2%	+3.3V ± 3%
Rated output power (1)	25W	--	--
Rated output current (2)	--	2.3A	4A
Minimum load	--	0mA	0mA
Pk-Pk Ripple + Noise (20MHz)	--	50mVpp	50mVpp
Module Efficiency	65%	--	--
Output ride-through / full load (3)	--	20mSec	20mSec
Output overcurrent threshold (4)	--	5.8A	5.6A
Output overvoltage set-point (5)	--	5.6V	--
PFC output overvoltage set-point (5)	246V	--	--
Isolation Voltage (6) (Input to Output & Input to Chassis)	1500Vac	--	--
MTBF (Aic, 30°C case)	40,000 Hours	--	--

Notes:

1. Combined output power limit is 25W. Maximum current draw for the 3.3V output is 4A
2. Up to 5A can be drawn from the 5V output if the 3.3V output is not loaded
3. Expandable by external capacitors
4. 3.3V output is foldback current limited with auto recovery into full load; 5V output is pulse-retry current limited with auto recovery into full load
5. Auto recovery
6. 1500Vac for 60 seconds without arc or damage; 3.0mArms maximum leakage current (line-to-earth capacitors installed)

TEMPERATURE CHARACTERISTICS

*AIRFLOW (LFM)	THERMAL IMPEDANCE (Θ_{s-a}) (no external heatsink)
0 LFM	3.4 °C/W
250 LFM	1.0 °C/W
500 LFM	0.6 °C/W

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

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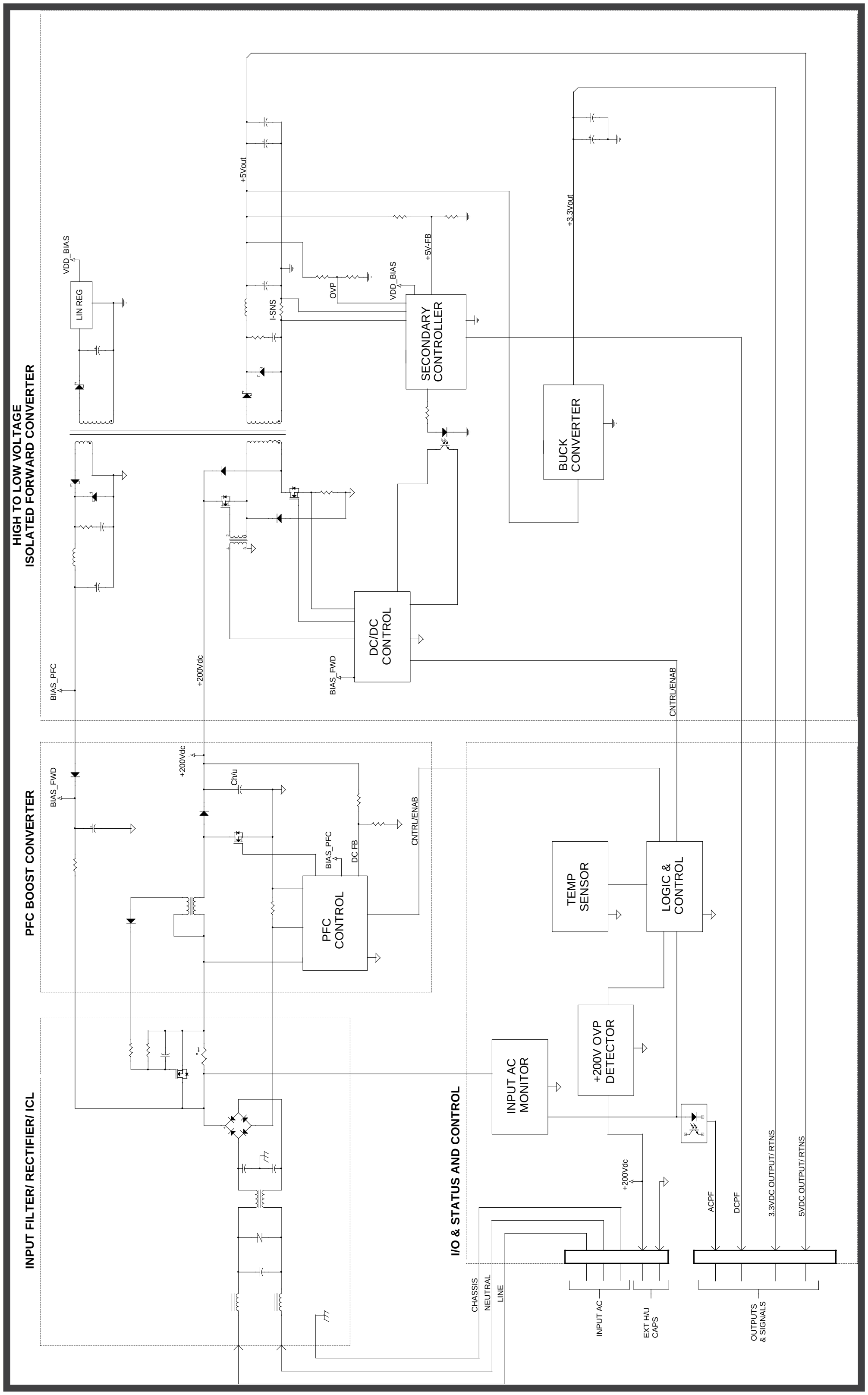
BLOCK DIAGRAM



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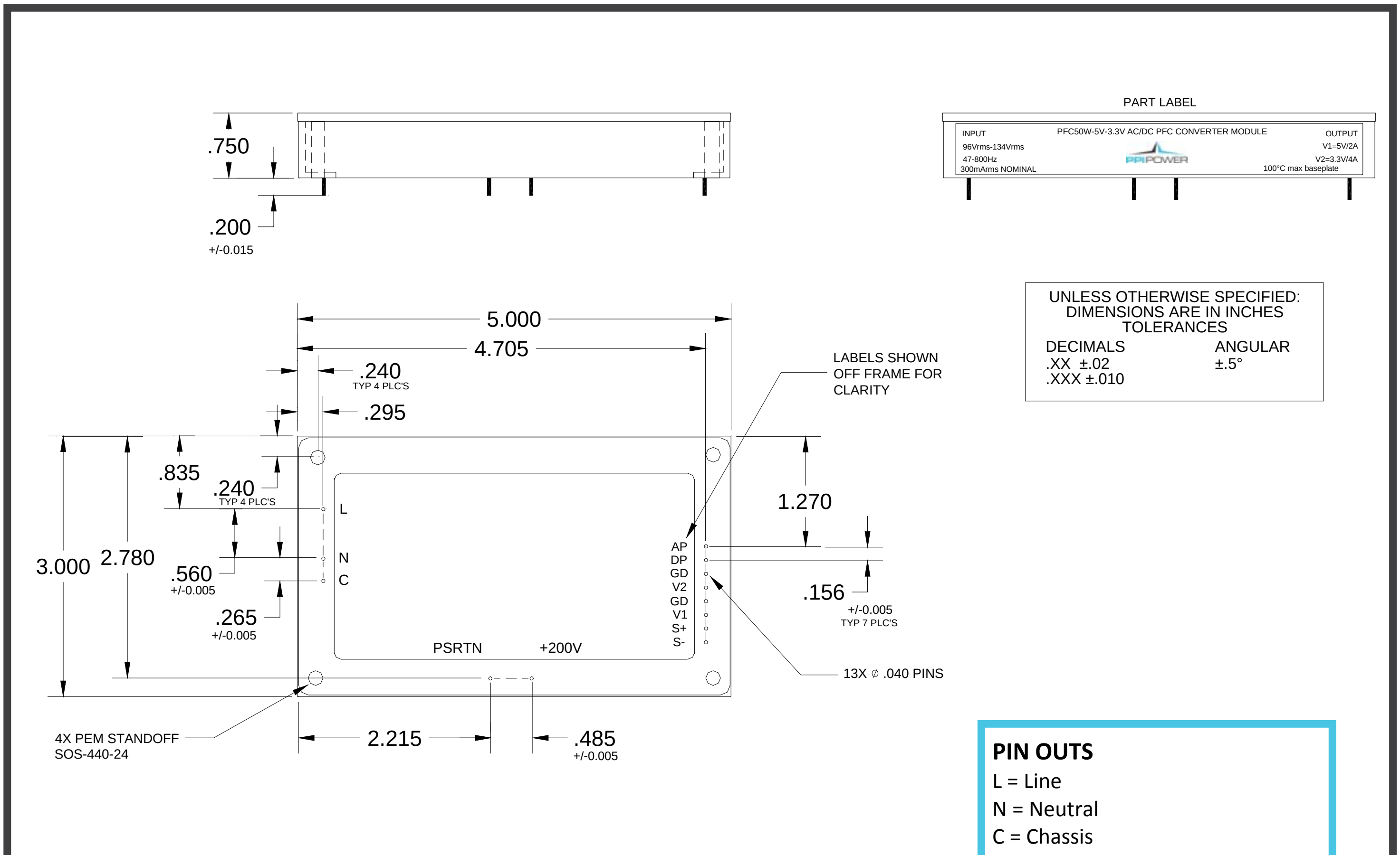
MECHANICAL DIAGRAM



PIN OUTS

L = Line
N = Neutral
C = Chassis
+200V = Pos terminal of ext Ch/u
PSRTN = Neg terminal of ext Ch/u
AP = ACPF-L
DP = DCPF-L
GD = Output DC Return
V2 = 3.3V Output
GD = Output DC Return
V1 = 5V Output
S+ = No Connect (no pin)
S- = No Connect (no pin)

* **BASEPLATE FLATNESS**

Maximum warpage not to exceed 0.04” per 5” unit length.

A DETAILED OUTLINE DRAWING CAN BE FURNISHED UPON REQUEST

ELECTRICAL SPECIFICATIONS

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

INPUT CHARACTERISTICS

PARAMETER	PFC50W-5V-3.3V	REMARKS	NOTES
INPUT VOLTAGE RANGE	**97 – 134Vrms**	**Complies with normal / abnormal input voltages per DO-160E, sect. 16.**	**2**
MUST START VOLTAGE	**97Vrms minimum**	**Module will start and remained enabled for input voltage in the range of 97Vrms < Vin < 134Vrms.**	**2**
INPUT FREQUENCY RANGE	**47 – 800Hz**	**Reduced distortion performance below 360Hz.**	**2**
EFFICIENCY	**60% minimum**	**50% to 100% output loading (12.5W to 25W); 65% typical full load efficiency.**	**2**
LEAKAGE CURRENT	**< 2mArms**	**AC Line / Neutral to Chassis at 115Vrms / 400Hz.**	**1**
INRUSH CURRENT	**< 7Apk**	**Cold or warm start; 5Apk typical.**	**2**
TOTAL HARMONIC DISTORTION (INPUT CURRENT)	**< 5.5%**	**50% to 100% output load (12.5W to 25W).**	**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) 40% to 100% output load (10W-25W) Harmonics < 5mA are disregarded.**	**1, 6**
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 40% to 100% output load (10W-25W) Harmonics < 5mA are disregarded.**	**1, 6**
POWER FACTOR	**0.85 min**	**50% to 100% output load (12.5W to 25W).**	**2**

PPI POWER

INPUT CHARACTERISTICS—CONTINUED

PARAMETER	PFC50W-5V-3.3V	REMARKS	NOTES
CREST FACTOR (CURRENT)	1.314 – 1.514	Ratio of peak / RMS.	1
START-UP TIME	< 750mSec	Outputs within proper regulation.	2
CONDUCTED EMISSIONS	RTCA/DO-160E	Section 21, category M.	1
STORAGE TEMP RANGE	-55°C to +100°C	Non-operational.	1
OPERATING TEMP RANGE	-15°C to +70°C	Observe maximum baseplate temperature of +100°C.	1
LOW TEMP INHIBIT	-22°C ± 3°C	Supply is inhibited at or below -22°C. Auto restart occurs when temperature rises above -22°C.	1
OVERTEMPERATURE SHUTDOWN	100°C ± 4°C	Supply is inhibited at or above 100°C. Auto restart occurs at ~ 80°C baseplate temperature.	1

OUTPUT CHARACTERISTICS

PARAMETER	PFC50W-5V-3.3V	REMARKS	NOTES
RATED OUTPUT POWER	25W	Continuous.	2
OUTPUT VOLTAGE	5.1Vdc ± 2% 3.3Vdc ± 3%	Any load combination within maximum limits of specified output current.	2
OUTPUT OVERCURRENT THRESHOLD	5V output: 5.8A 3.3V output: 5.6A	Output voltage will foldback, auto-recovery. No damage will occur to module during indefinite output short circuit conditions.	2, 3
TEMPERATURE STABILITY COEEFICIENT	0.05% / °C	Output voltage variation with temperature (500uV / °C).	1
OUTPUT RIPPLE + NOISE	100mVpp each output	50mVpp typical with external capacitors, see application notes. 20MHz bandwidth.	2
LINE REGULATION	<0.5%	Output deviation for +/- 20% step change in input voltage.	1
LOAD REGULATION	Outputs remain in regulation	50% step change in either output load.	1, 4
MINIMUM LOAD	0W		2
HOLD-UP TIME	20mSec minimum	No external hold-up capacitor attached. Requires external 250V rated capacitors to extend hold-up time.	1

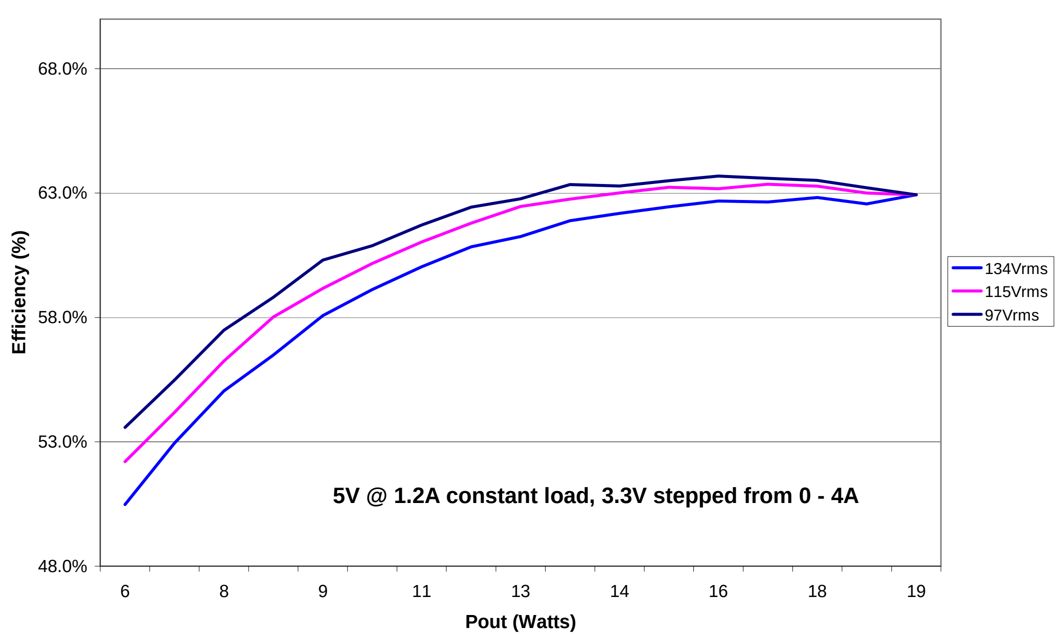
OUTPUT CHARACTERISTICS—CONTINUED

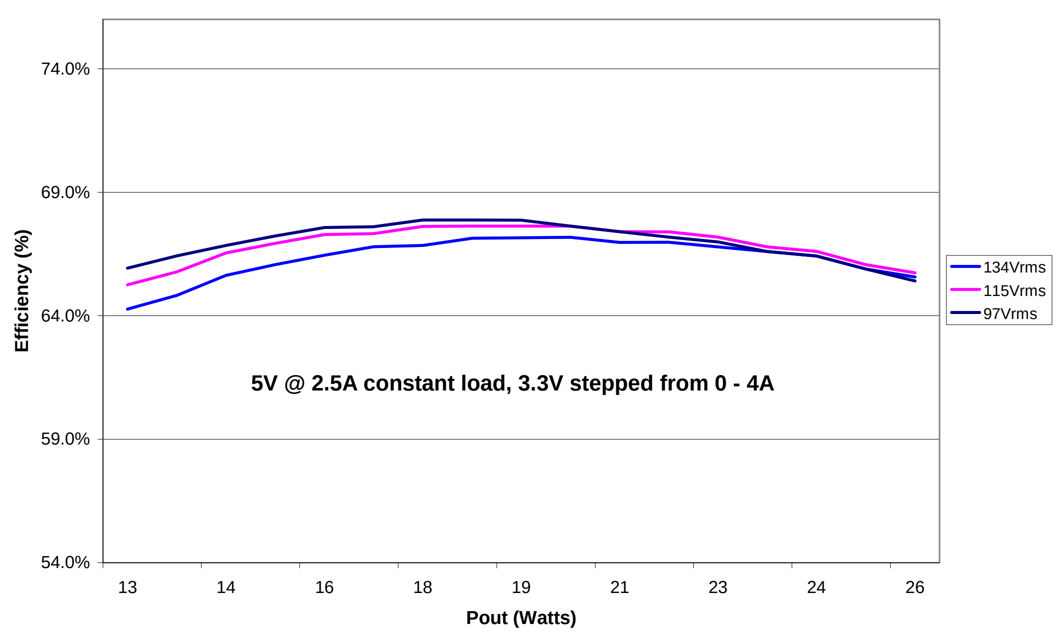
PARAMETER	PFC50W-5V-3.3V	REMARKS	NOTES
HOLD-UP TIME	105mSec minimum	With 220uF external hold-up capacitor.	2
MAXIMUM EXTERNAL HOLD-UP CAPACITANCE	1200uF	Specified in order to not overstress the internal inrush current limiting circuit.	1
ISOLATION VOLTAGE INPUT TO CHASSIS	1500Vac, 60Hz	No arcing or damage for 60-second test duration (3.0mArms max leakage).	2,7
ISOLATION VOLTAGE INPUT TO OUTPUT	1500Vac, 60Hz	No arcing or damage for 60-second test duration (3.0mArms max leakage).	2,8
ISOLATION VOLTAGE OUTPUT TO CHASSIS	250Vdc	No arcing or damage for 60-second test duration (100Mohm min).	1
DCPWRFAIL-L (DP)	0.5Vmaximum when 5Vdc 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)	0.5Vmaximum when AC input is detected below 92Vrms	TTL level, 3mA max sink current, 15mSec delay time to activate on input AC interrupts.	2
PFC 200Vdc OUTPUT	200Vdc ± 3%	10W ≤ Pout < 25W.	2, 5
MINIMUM DC/DC CONVERTER OPERATING VOLTAGE	100Vdc	Minimum amplitude for PFC output that will guarantee proper output regulation for the low voltage outputs.	1
OUTPUT OVERVOLTAGE PROTECTION	5.6Vdc ± 3%	Pulse by pulse protection (inner loop), auto-restart.	1
OUTPUT OVERVOLTAGE PROTECTION (PFC 200Vdc OUTPUT)	246Vdc ± 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. During an overload condition on the +5V output (low impedance or short circuit), all module power capacity will move to this output. The +3.3V output may disable during the time the +5V is overloaded. Each output will resume proper regulation into full output load once the fault condition clears.
4. 3.3V output remains within 3% window of output value at application of transient load; if output value is 1% low at application of 50% step change in load, output may drop to -4% of nominal set point of 3.30V (3.17V).
5. 200Vdc PFC output voltage tolerance is +/-5% for Pout < 10W.
6. Meets harmonic distortion requirements per DO160E, section 16, subparagraph 16.7.1.2 for A(WF) equipment category (at 360Hz and 800Hz) whereas If = maximum fundamental current of module that is measured during maximum steady-state power demand (occurring when Pout = 25W). Individual harmonic currents less than 5mArms are disregarded.
7. When performing input to chassis isolation voltage testing at the module level it is recommended to tie the primary referenced terminals: Line, Neutral, LI, DD, +200V and PSRTN together and hi-pot all of these with respect to chassis ground.
8. When performing input to output isolation voltage testing at the module level it is recommended to tie the primary referenced terminals: Line, Neutral, LI, DD, +200V and PSRTN together and hi-pot all of these with respect to all of the secondary referenced terminals which are also tied together (this includes AP, DP, GD, VO, SB, S+ and S-).

EFFICIENCY CURVES





To inquire about price, delivery and module options information please contact PPI sales department.

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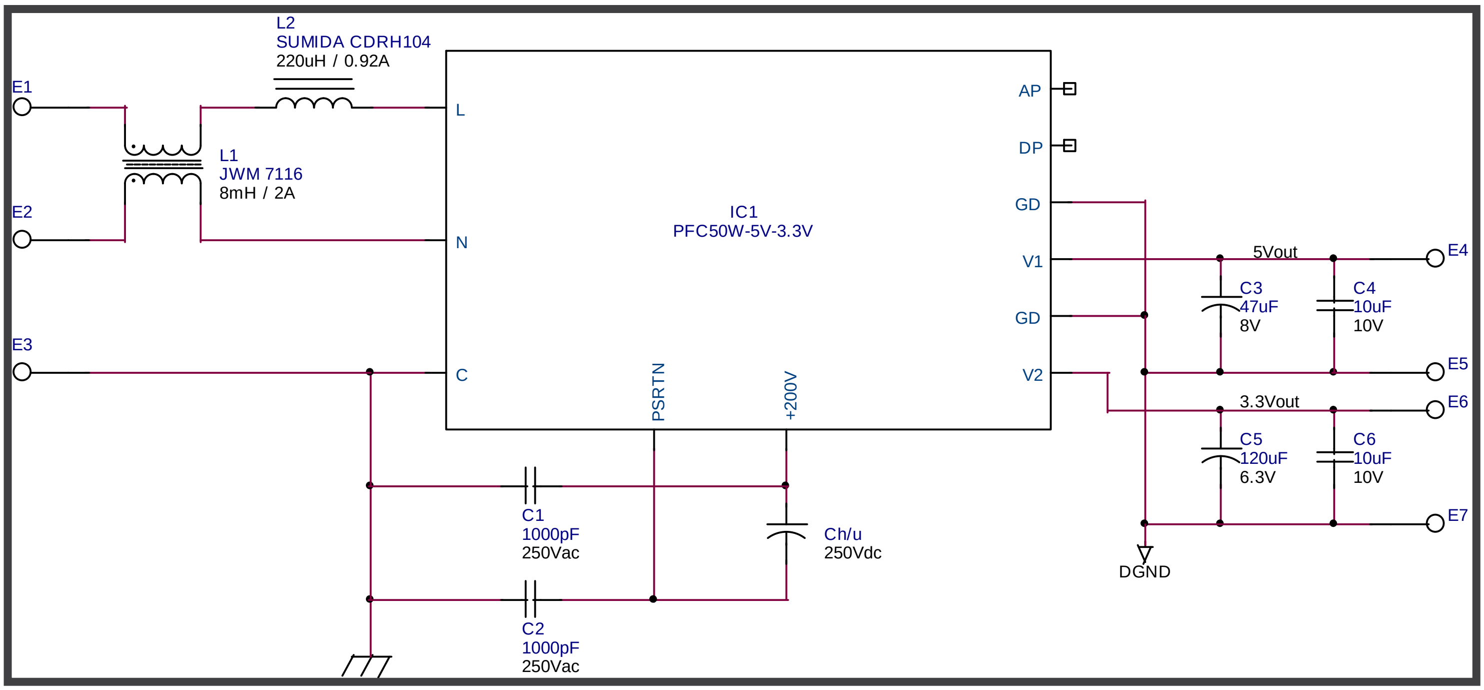
APPLICATIONS' INFORMATION



Typical Application Circuit

HOLD-UP TIME

The PFC50W series module provides two interconnecting pins in order to extend hold-up time with external capacitors. In order to extend module hold-up time, polarized 250V (minimum) electrolytic capacitors must be connected externally between the module's +200Vpin and PSRTN pin. Required external capacitance can be determined using the following formula:

$E = P * (t + t_{restart}) = (0.75) * \{½\ C_{h/u\ (total)}\ (Vi^2 - Vf^2)\}$

Where,
P = output power (Watts)
t = desired hold-up time (Seconds)
$t_{restart}$ = warm start delay of approximately 20mSec upon reapplication of input AC
$C_{h/u\ (total)}$ = total hold-up capacitance (Farads), includes internal 35uF (minimum) and external capacitance
$C_{h/u\ (ext)}$ = external hold-up capacitance (Farads)
0.75 factor constitutes internal DC/DC converter efficiency
Vi = Minimum PFC voltage of 194Vdc (200Vdc - 3%)
Vf = 100 Volts

In order to hold up 25W external power for 200mSec requires:

$C_{h/u\ (total)} = \{(25W)\ (200mSec + 20mSec)\} \div \{(1/2)\ (0.75)\ (194V^2 - 100V^2)\} = 531uF$

$C_{h/u\ (ext)} = C_{h/u\ (total)} – 35uF = 531uF – 35uF = 496uF$ (minimum)

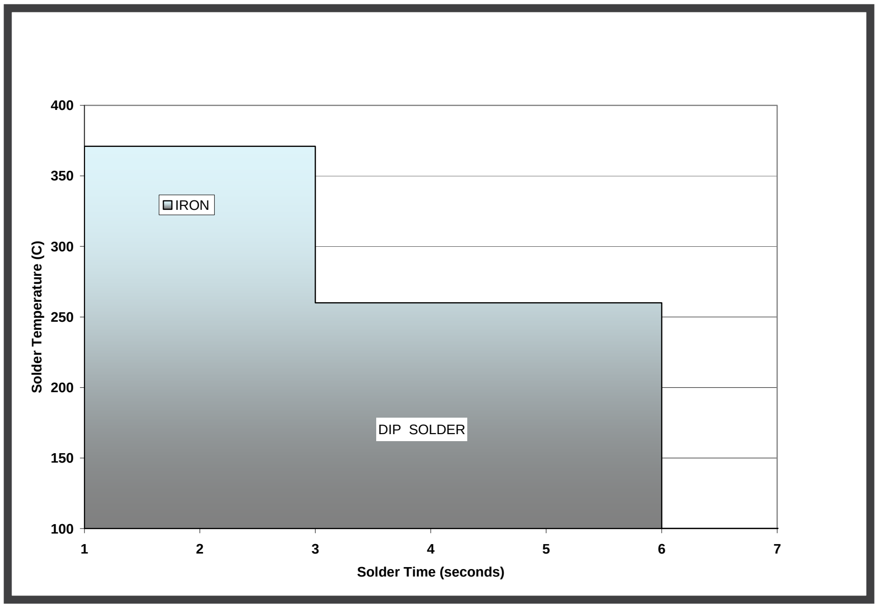
PLACEMENT, FLATNESS AND MOUNTING

The PFC50W 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 0.04" per 5" unit length. Temperature activated thermally conductive interface pads, such as Chomeric's T725 series, are suitable interface pads for this application.

The PFC50W module contains 4 corner threaded #4 mounting holes (see mechanical diagram for details). The standard mounting hole configuration is partially threaded; threaded approximately 0.44" 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. The pins are soldered internally to the module's horizontal through-hole 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 allowable heat application versus time duration curve is shown below and should be adhered to in order to prevent re-flow of the module pins internal solder joints.



ROUTING CONSIDERATIONS

Assure there is at least 4.2mm between primary referenced and secondary referenced signals. Secondary referenced signals include AP, DP, V1, V2 and GD. Avoid routing secondary referenced signals directly beneath module on component layer.

EMI CONSIDERATIONS

Use of a chassis ground plane beneath module on the first internal circuit board layer (beneath component layer) of supply 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. Although the PFC50W series modules contain internal common-mode and differential mode input filtering the use of a small external inductive based line filter is recommended for EMI compliance. Avoid adding line-to-line capacitance at low power levels (<20W output) as they may have an adverse effect on input current harmonic distortion at higher line frequencies (e.g., 800Hz). See application circuit for suggested filter arrangement.

If external hold-up capacitors are more than 3 inches away from module, 1000pF decoupling capacitors (line-to-earth rated) should be installed between the +200V signal and chassis ground and the PSRTN signal and chassis ground in close proximity to respective module terminals.

In order to reduce differential switching noise on each of the DC output voltages, adding a parallel combination of low ESR electrolytic and MLCC ceramic capacitors from V1 to GD and V2 to GD is recommended. Suitable low ESR electrolytic capacitors include United Chemicon PXA series or Panasonic CD or S series (SP Cap); MLCC capacitors include Panasonic ECJ series.

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 appropriate curve,
$P_{diss} = \{(P_{out} \div eff) - P_{out}\}$ in watts

As an example,
Assume a desired output power of 25W at low line operation (97Vrms) with a maximum ambient temperature of 70°C. The following formula would apply:

$T_{baseplate}$ = 70°C + {(25W / 0.65) – 25W)} (3.4°C/W) = 116°C

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

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

Θ_{s-a} < {100°C - 70°C} ÷ {(25W / 0.65) – 25W)} < 2.2°C/W