AIT00ZPFC 150W AC-DC Converter Module

The AIT00ZPFC-01NL Power Factor Correction module is part of Astec's family of advanced modular power supply components. Featuring high reliability and convenient control and monitoring functions, these modules are designed to reduce product development time and enhance system performance. The PFC is designed to work over 100-122Vac, and provide unity power factor with very low levels of harmonic distortion in line current. The AIT00ZPFC-01NL is RTCA-DO-160 harmonic compliant at 115Vac input and also IEC1000-3-2 compliance at 50Hz and 800Hz input.

Special Features

- **Unity Power Factor**
- **High Efficiency - up to 91%**
- **Universal input voltage and frequency range**
- **Up to 150W output power**
- **Conforming to IEC 1000-3-2 Compliance at 50Hz**
- **100°C baseplate operating temperature**
- **RTCA-DO-160 harmonic compliant at 115Vac input, full load @ 400Hz and 800Hz**
- **Internal active switch bypassing external inrush current components**
- **High Reliability - over 1 million hours MTBF @ baseplate temperature 50ºC**

Environmental Specifications

- **Operating temperature: -20°C to +100°C (Baseplate)**
- **Start up temperature: -40°C to +100°C (Baseplate)**
- **Storage temperature: -40°C to +120°C**

Electrical Parameters

Input

Input range	**100 – 122VAC**
Input Surge	**170Vac / 500ms**
Efficiency	**91%@ 115Vac, 150W (Typical)**
Total Harmonic Distortion	**10%**

Control

Enable TTL compatible
(Negative enable options)

Output

Output Voltage
Io =0.38A / Vi = 115Vac 393V typ

Maximum output Power

Vin	**< 100Vac**	**100W**
Vin	**100Vac-122Vac**	**150W**

Output voltage Adjust range	**78% - 100% of nominal output**
Overvoltage Protection	**430V**

AIT00ZPFC-01NL PFC Power Supply

THIS SPECIFICATION COVERS THE REQUIREMENTS

FOR A SWITCHING POWER SUPPLY WITH

90---132 VAC INPUT CAPABILITY AND

150 WATTS (0.38 A) NON-ISOLATED OUTPUT WITH 115 V INPUT

Model No.	Internal Code	Serial Number Prefix	I/P Voltage	O/P Voltage	O/P Power
AIT00ZPFC-01NL	AIT00ZPFC-01NL		V_{IN}>90V	+393V	100 W
			V_{IN}>100V	+393V	150 W

ELECTRICAL SPECIFICATIONS

Standard test conditions on a single unit:

Tambient: 25 °C
Vin: 85-122Vac
Vout: 389-397V

L1 AC input pin	AC input line / return
L2 AC input pin	AC input return / line. A 0.47uF, 275VAC X2 capacitor is recommended to be put across the AC input.
OUTPUT pin +ve	+ve output load
OUTPUT pin –ve	-ve output load. A bulk capacitor of minimum 2 x 220uF, 450V is recommended be put across the DC output.
INRUSH	A power resistor of 10 to 40 Ohm of 10watt or above should be connected from this pin to the +ve output pin. An internal MOSFET bypasses this external thermistor/ resistor during normal operation.
V_ADJ	Used to adjust the output voltage. With this pin shorted to S GND, the output voltage is 393V. With a resistor connected to S GND, the output voltage can be adjusted between 303V to 393V.
LD_ENABLE	This output signal can drive an opto-coupler to provide an isolated signal for the system to enable the load.
LE_ADJ	This pin is used to program the operation point of the LD_EN pin signal. When LE_ADJ is shorted to GND, the LD_EN will turn off when Vout drops to 250V. When LE_ADJ is open, the LD_EN will turn off when Vout drops to 180V A resistor connected to ground the LD_EN signal can be programmed to turn-off when the output voltage falls to a desired voltage between these two limits of 180 Volt and 250 Volt.
PF_ENABLE	Pull this pin low to GND to enable the PFC.
T_MON	This pin outputs a voltage corresponding to the base plate temperature at 10mV per degree K.

INPUT

	Parameter	Min	Nom	Max	Unit
a)	Vin Range	90	115	132	Vrms
b)	Vin Frequency	47	400	800	Hz
c)	Input under-voltage				
	(i) power on	90	94	98	Vac
	(ii) power off (absolute)	81	85.5	90	Vac
d)	Input Line Current				
	Nom-line (115V)	—	—	2.1	Arms
	Nom-line (115V at NO LOAD)	—	—	0.1	Arms

e) Power Factor, PF
@ AC frequency 50Hz
The PSM shall conform to the power factor requirements as defined in Airbus ABD0100.1.8, Section 2.4.2.5.

At 115Vac 360Hz; Io = Full Load	0.99	—	—
At 115Vac 400Hz; Io = Full Load	0.99	—	—
At 115Vac 800Hz; Io = Full Load	0.97	—	—

f) Total Harmonic Distortion, THD

@ AC frequency 360Hz; 400Hz; 800Hz Vin=115Vac Pout=150Watts	—	—	10	%
@ AC frequency 360Hz; 400Hz; 800Hz Vin=115Vac of THD 5% Pout=150Watts	—	—	15	%

g)	Operating temperature	-20	—	100	ºC (BP temperature)
h)	AC Watts Maximum @ full load	—	—	165	W
i)	Efficiency Minimum	91	—	—	%
j)	Maximum Total Output Power	—	—	150	W
k)	In-rush Current Max. @ 115Vrms	—	—	6.7	A

OUTPUT

	Parameter	Min	Nom	Max	Unit
a)	Output Voltage (V_ADJ short to S_GND)	390	393	397	V
b)	Output Voltage (V_ADJ open)	300	303	306	V
c)	Output Power	—	—	150	W
d)	Efficiency	91	—	—	%
e)	Startup Time	—	—	600	ms
f)	Power Limit	—	—	120	%
g	Over Voltage Protection	—	—	430	V

LOAD DC TO DC MODULE ENABLE(LD_ENABLE)

a) LD_ENABLE output voltage, Vld-enable

Signal High, Ild-enable(source)=0mA	11	12	13	V
Signal Low, Ild-enable(sink)=10mA	0	—	0.4	V

b) LD_ENABLE output current, Ild-enable(source)

Signal High, LD_EN shorted to GND	1	2	3	mA

PFC MODULE ENABLE(PF_ENABLE)

a) PF_ENABLE input low voltage, Vlo

	0	—	0.8	V
b) PF_ENABLE input high voltage, Vhi	2	—	6	V
c) PF_ENABLE input low current, Ilo (Source current) PF_EN=0.8 Vdc	—	—	500	uA

PROTECTION

a) Over voltage protection (Over voltage protection will be non-Latching)	400	—	430	V

b) Short circuit protection
This protection is NOT provided.

c) Over temperature protection
The AIT00ZPFC-01NL shall be internally disabled when the Base Plate temperature reaches 120C maximum, and will recover automatically when the temperature drops to below 99C.

TEMPERATURE RANGE

a) Operating (BP temperature) : -20 to +100°C.
b) Non-Operating : -40 to +120°C.

HUMIDITY

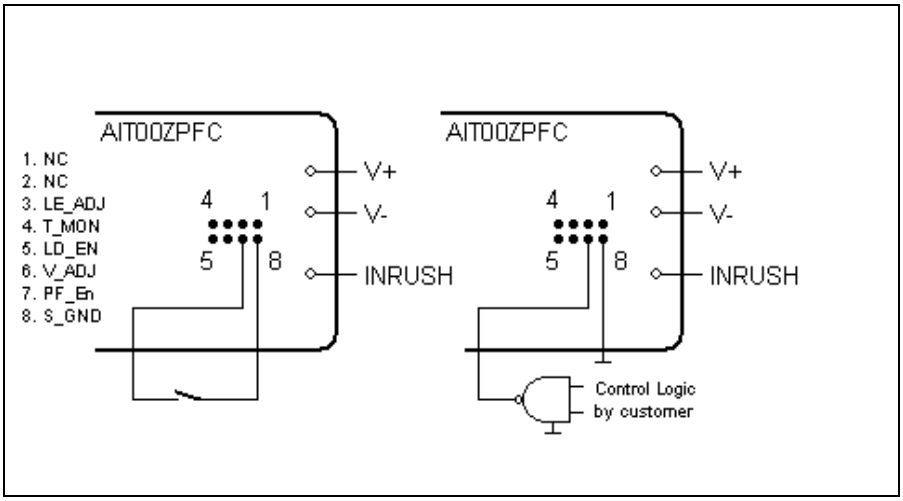
a) Operating : 15 ~ 90% relative humidity (non-condensing at 40 deg C)
b) Non-Operating : 0 ~ 95% relative humidity (non-condensing at 50 deg C)

Function Description

PFC Enable Input (PF ENABLE)

The enable pin is a TTL compatible input used to turn the output of the module on or off.

The AIT00ZPFC-01NL is a negative logic module, the output is enabled when the PF ENABLE is connected to S GND or driven to a logic low < 0.8V (but not negative). The output is disabled when the PF ENABLE is open or driven to a logic high > 2.0V.



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S GND (Signal Ground)

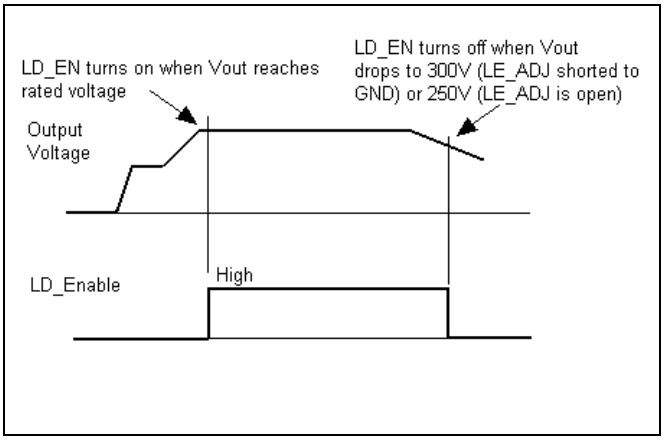
The S GND pin is connected to the internal common ground of the module. It is also internally connected to the –O/P terminals.

NOTE:

When connecting S GND to external circuitry care must be taken to ensure that the current flowing through this pin is kept below 25mA.

DC-DC Converter Module Enable Output (LD ENABLE)

After the PFC power up sequence, the power to the load can be enabled. This can be performed manually or the PFC can automatically enable the load using the LD ENABLE signal.



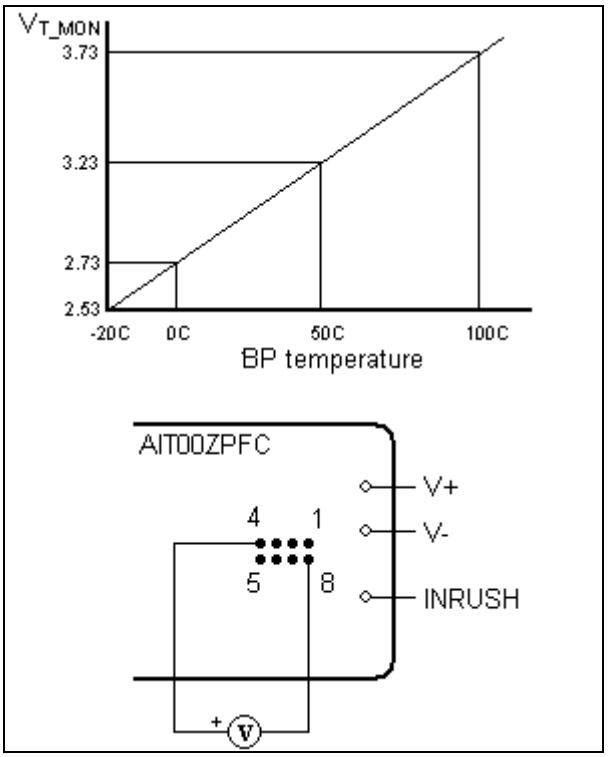
Initially the load is disabled and the LD ENABLE (pin 5) is at 0.4V (LOW). When the PFC power up sequence has completed, the LD ENABLE voltage goes HIGH. And the LD ENABLE will stay high as long as Vin is above 175Vac or Vout is above 250V, even if PF_ENABLE is in disable mode**.**

Temperature Monitoring (TEMP MON)

The TEMP MON pin provides an indication of the module's internal temperature. The voltage at the TEMP MON pin is proportional to the temperature of the module baseplate at 10mV per °C, where:

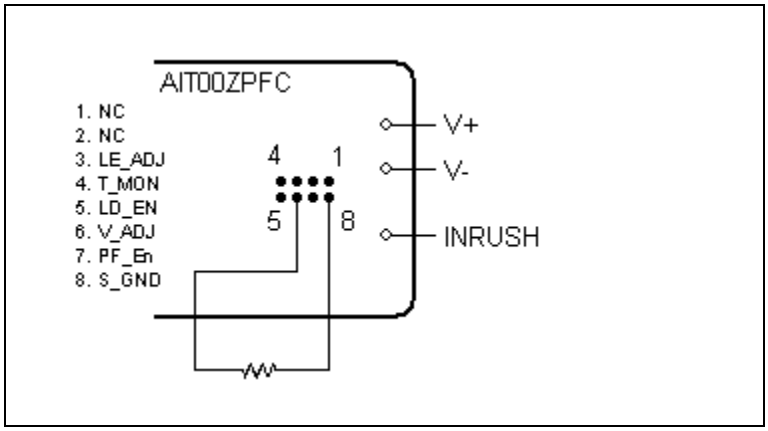
Module temperature (°C) = (Vtemp mon X 100) - 273

The temperature monitor signal can be used by thermal management systems (e.g. to control a variable speed fan). It can also be used for overtemperature warning circuits and for thermal design verification of prototype power supplies and heatsink.


VT_MON
3.73
3.23
2.73
2.53
-20C
0C
50C
100C
BP temperature
AIT00ZPFC
V+
V-
INRUSH
4
1
5
8
+
V

Output Voltage Adjust (V ADJ)

The output voltage of the module may be accurately adjusted from 79% to 100% of the nominal output voltage. Adjustment can be made using a resistor connected as below.



V_out Required	Resistor to V_adj	
305	420	k_Ohm
310	200	k_Ohm
315	130	k_Ohm
320	91	k_Ohm
325	68	k_Ohm
330	51	k_Ohm
335	42	k_Ohm
340	33	k_Ohm
345	27	k_Ohm
350	22	k_Ohm
355	18	k_Ohm
360	13	k_Ohm
365	11	k_Ohm
370	8.2	k_Ohm
375	6.2	k_Ohm
380	4.3	k_Ohm
385	2.7	k_Ohm

DESIGN CONSIDERATIONS

Maximum Output Power Vs Input Voltage

The maximum output power draw from the PFC unit should not exceed the limits as guided below:

115VAC input 150W

Efficiency Vs Input Voltage and Output Power

Below is a reference indication of the efficiency under different conditions:

Input Voltage	Pout	Efficiency
(Vac)	(W)	(%)
115	150	91

Input Undervoltage Protection

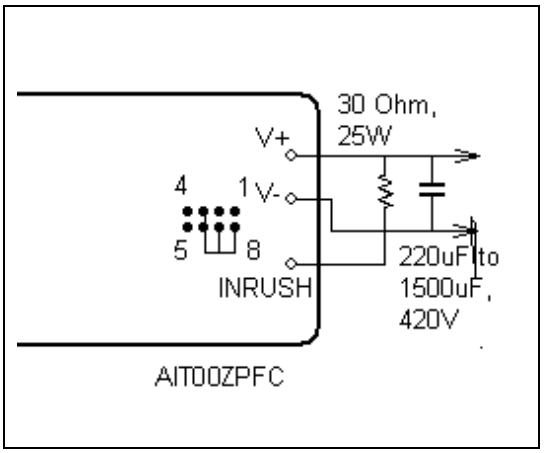
An input undervoltage protection circuit protects the module under low input voltage conditions. Hysteresis is built into the PFC Series module to allow for high levels of variation on the input supply voltage without causing the module to cycle on and off. PFC modules will operate when the input exceeds 95Vac and turn off below 85Vac (norminal).

Input Fusing

ASTEC modules do not have an in-line fuse fitted internally. In order to comply with CSA, VDE and UL safety regulations it is recommended that a fuse of 250Vac, 5A or below with fast type can be fitted at the module's input.

Output Capacitor

The PFC requires an output hold-up capacitor of between 220uF and 1500uF to prevent the module from disabling due to fluctuations in output voltage. Ideally the capacitor should be connected directly to the PFC output pins. If this is not possible the connection must be less than 50mm from the pins.



Selecting an External Output Capacitor

The output capacitor value is determined by the following factors :
1. RMS ripple current.
2. Peak-to-peak output ripple voltage.
3. Hold-up time.
4. Expected lifetime of the capacitor.

RMS ripple current

The maximum permissible rms ripple current for the output capacitor should be greater than the rms ripple current for the application. The ripple current for the PFC module can be approximated as

$$I_{rms} = (P_O/Eff) \times 1/\sqrt{(V_O \times V_{rms})}$$

where :

P_O = output power (W)

Eff = efficiency

V_O = output voltage (V)

V_{rms} = input rms voltage (V)

This gives the ripple current at 125KHz. The maximum ripple current for capacitors is usually specified at 120Hz. To convert from 125KHz to 120Hz the Irms figure should be divided by 1.3 .

Peak to Peak Output Ripple Voltage

The ac input causes a ripple on the output voltage. The size of the ripple is inversely proportional to the size of the capacitor. Therefore the maximum allowable ripple voltage should be decided in order to calculate the size of capacitor required. This may be calculated using the following equation:

$$C_O = P_O / (2\pi f \times Eff \times V_O \times V_{ripple})$$

where :

C_O = output capacitance (µF)

Eff = efficiency

f = input voltage frequency (Hz)

V_O = output voltage (V)

V_{ripple} = output ripple voltage (V)

Hold-Up Time Requirement

The output capacitor value is different for different hold-up time requirements. The minimum capacitance corresponding to the required hold-up time of a system comprised of ASTEC DC/DC power modules and an PFC module can be calculated as follows:

$$C_{O\,min} = (2 \times P_O \times T_{hold})/[(V_O - V_{ripple})^2 - (V_{min})^2]$$

where :

$C_{O\,min}$ = output capacitance (µF)

P_O = output power (W)

T_{hold} = hold up time (sec)

V_O = output voltage (V)

V_{ripple} = output ripple voltage (V)

For example:

A PFC module driving **1 AIT04RF300-L modules which output power is 125W**. Efficiency of the **AIT04RF300-L** module is 90%, the minimum input voltage is 250V, the output voltage of the PFC is 390V, the required hold-up time is 200mS and the peak-to-peak voltage V_{ripple} is chosen to be 16V.

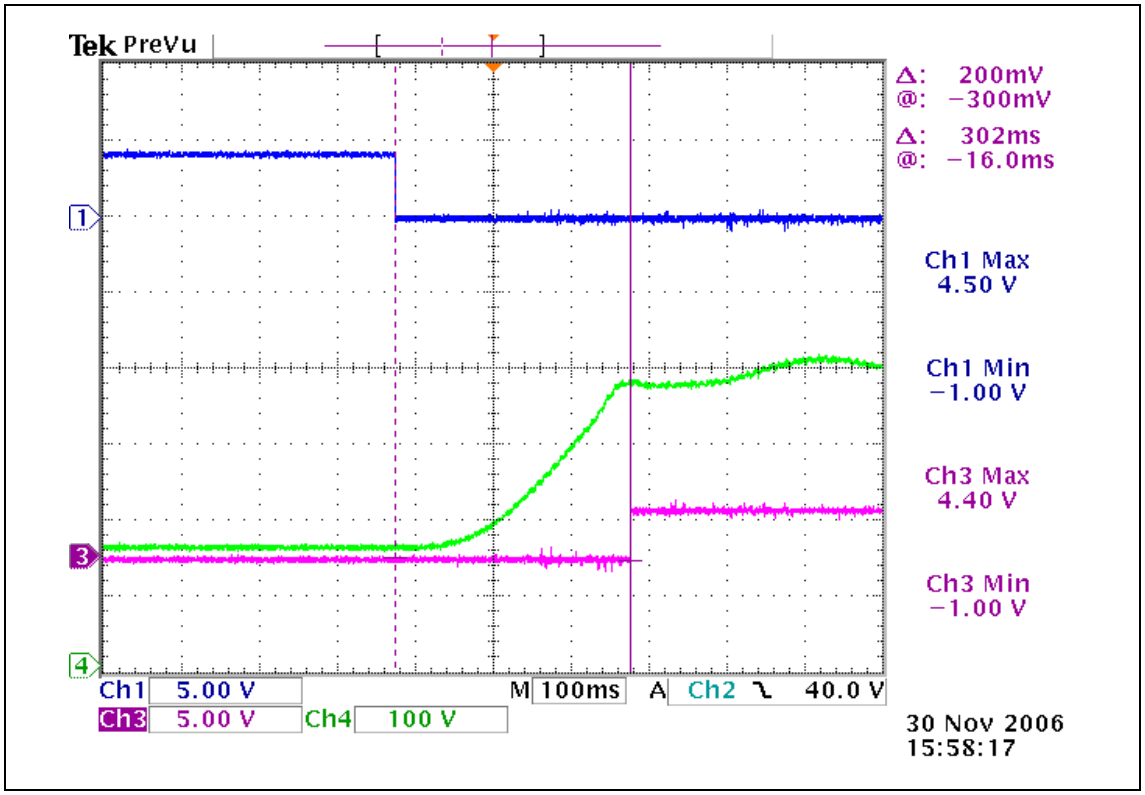
$$C_{O\ min} = \frac{2 \times (125/0.9) \times 0.2}{[(390-16)^2-250^2]} = 717\mu F \quad ((220\ \mu F+220\ \mu F+220\ \mu F+220\ \mu F) \pm 20\%)$$

This figure is the minimum capacitance. To allow for capacitor tolerances and aging effects the actual value should generally be around 1.5 times greater.

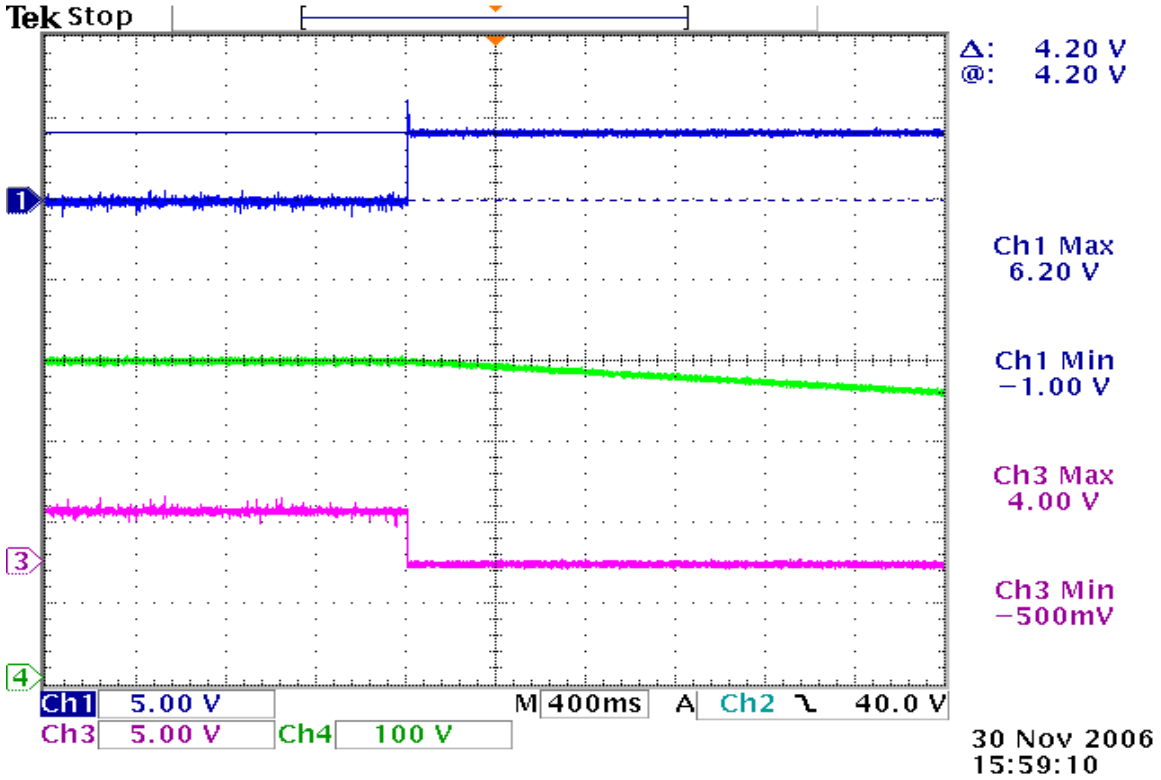
PF & Load Enable Connections and Timing

The PFC module must be supplied with a PF ENABLE signal to initiate the start-up sequence. The output of the LD ENABLE pin goes HIGH (ON) once the PFC has completed the start-up sequence.

It is recommended that the LD ENABLE signals is always used to enable the load, however, if the load is to be enabled manually it is essential that the ton time has expired before enabling occurs.



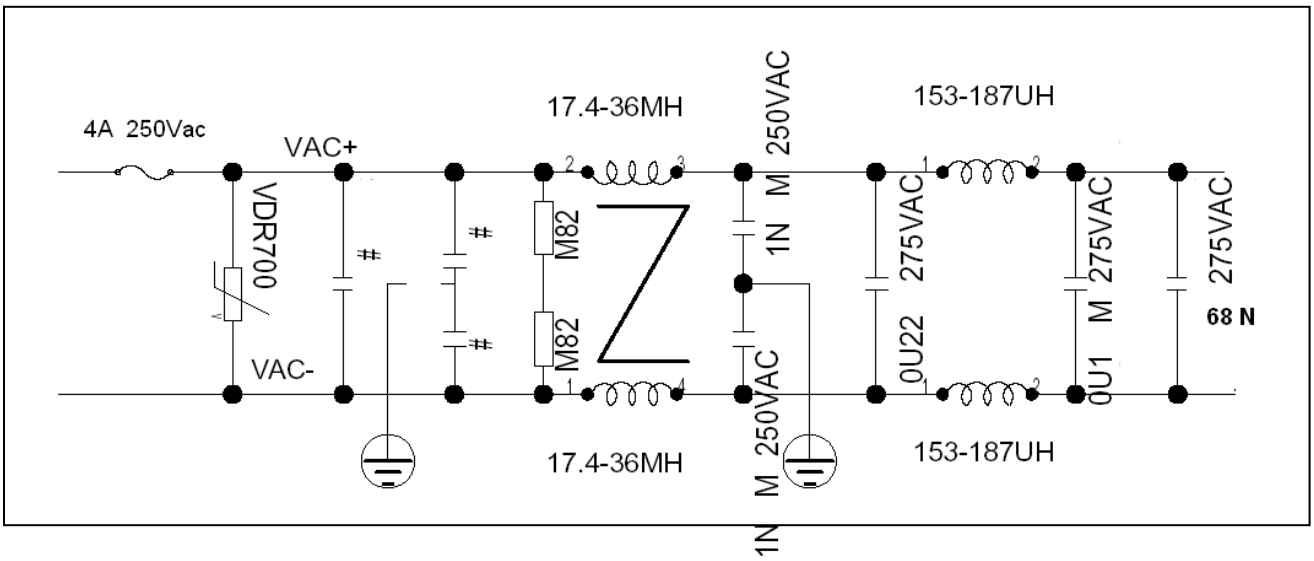
PF_enable and LD_enable @PF turn-on (Ch1: PF_enable, Ch3: LD_enable)



PF_enable and LD_enable @ PF turn-off (Ch1: PF_enable, Ch3: LD_enable)

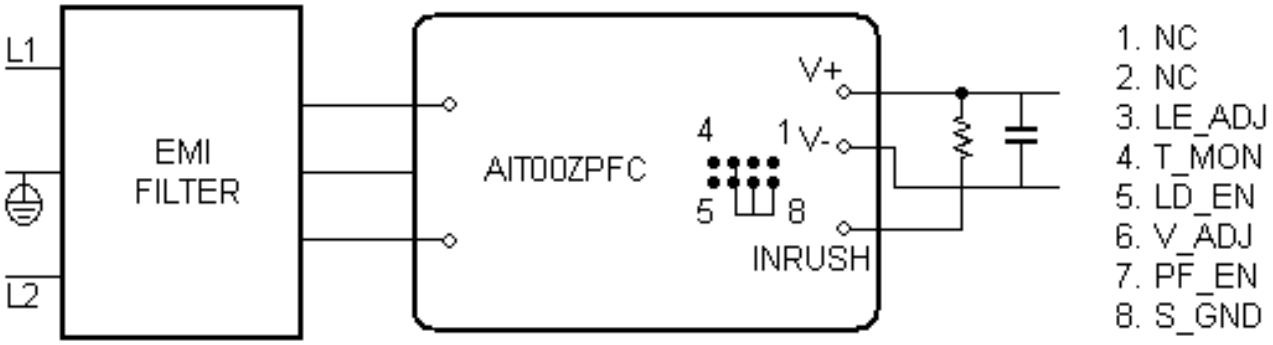
Conducted EMI

The PFC modules will require additional EMI filtering to enable the system to meet relevant EMI standards. This should be accounted for when calculating the maximum EMI 'Y' capacitance to meet ground leakage current specifications. An example filter circuit is shown below.

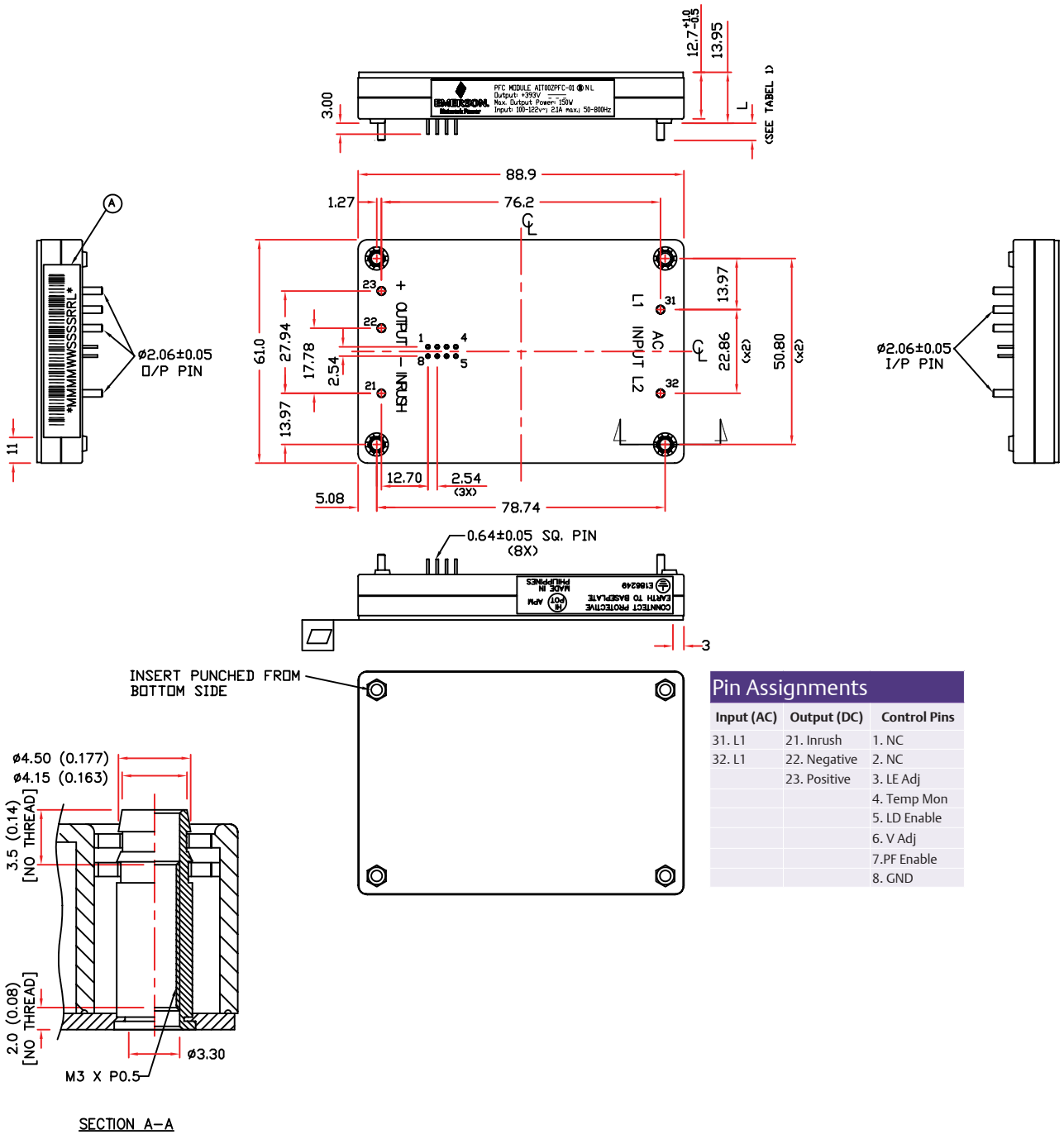


APPLICATION EXAMPLE

PFC module connection example:



OUTLINE DRAWING



Pin Assignments		
Input (AC)	**Output (DC)**	**Control Pins**
31. L1	21. Inrush	1. NC
32. L1	22. Negative	2. NC
	23. Positive	3. LE Adj
		4. Temp Mon
		5. LD Enable
		6. V Adj
		7.PF Enable
		8. GND