86005-360

(90—260Vac; 47- 800Hz Input)

600W, Single Phase, Universal Input,

PFC Boost Converter Module

The **86005-360** PFC boost converter module, when configured with external filter and hold-up capacitors, contains all the circuitry necessary for complete power line compliance with aeronautics specification RTCA/DO-160E and Airbus ABD0100.1.8 issue D, over the wide input frequency range (A(WF)). Housed within a 5-sided aluminum enclosure, the **86005-360** is embedded with a high quality silicon-based thermal encapsulant facilitating optimum performance within the harshest environments. Providing line rectification, minimized input current harmonic distortion content, active inrush current limiting and near unity power factor; the **86005-360** is ideal for avionics' applications where power demands are in the 300W-600W range.

The **86005-360** will operate from virtually any single phase AC power source worldwide. It provides a standard 360Vdc output compatible with a broad range of off-the-shelf DC/DC converter modules. Utilizing a modular approach, system power supplies are easily configured with a few individual components required. Tedious design and development cycles normally associated with custom power solutions are no longer necessary with this approach. Reliable, compliant power supplies can be configured in weeks, not months, without the need for specialized Power Supply Engineers.

FEATURES

	EXCEEDS AERONAUTICS' SPECIFICATION RTCA/DO-160E, SECTION 16, AND AIRBUS SPECIFICATION ABD0100.1.8 FOR POWER FACTOR AND INPUT CURRENT HARMONIC DISTORTION LEVELS @ 360 - 800Hz
	UNIVERSAL INPUT VOLTAGE: 90 - 260Vrms; 47 - 800Hz
	STANDARD 360Vdc OUTPUT COMPATIBLE WITH BROAD RANGE OF *OFF-THE-SHELF* DC/DC CONVERTER MODULES
	COMPLIES WITH RTCA/D0-160E, CATEGORY M FOR CONDUCTED EMISSIONS & SUSCEPTIBILITY (WITH EXTERNAL FILTER)
	EFFICIENCY: 91% TYPICAL @ 115Vrms INPUT; 96% TYPICAL @ 240Vrms INPUT
	VL94V-0 FLAMMABILITY CLASSIFICATION
	RUGGEDIZED SILICON-BASED ENCAPSULATED CONSTRUCTION
	SIZE: 5.41" x 2.98" x 1.68", WEIGHT: 32oz.
	ACTIVE INRUSH CURRENT LIMITING
	OVERVOLTAGE AND THERMAL PROTECTION

86005-360

(90—260Vac; 47- 800Hz Input)

600W, Single Phase, Universal Input,

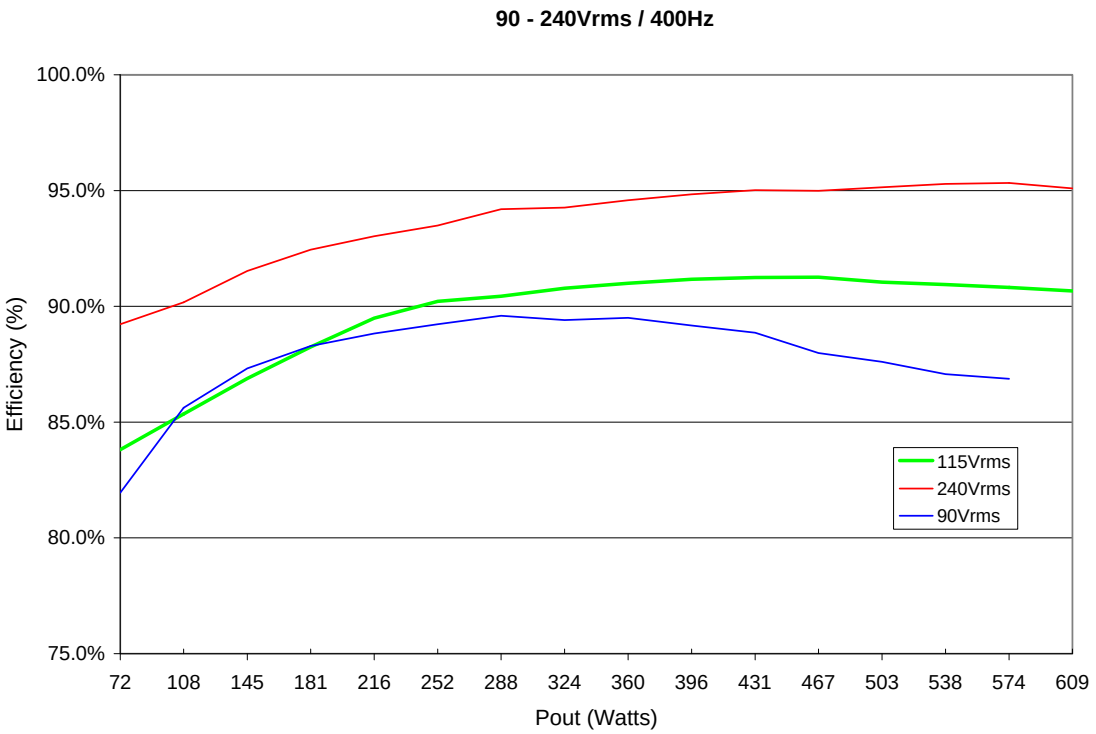
PFC Boost Converter Module

TEMPERATURE CHARACTERISTICS

*AIRFLOW (LFM)	THERMAL IMPEDANCE (Θs-a) (°C/W)
0 LFM	1.60
250 LFM	0.73
500 LFM	0.56

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

EFFICIENCY CURVES



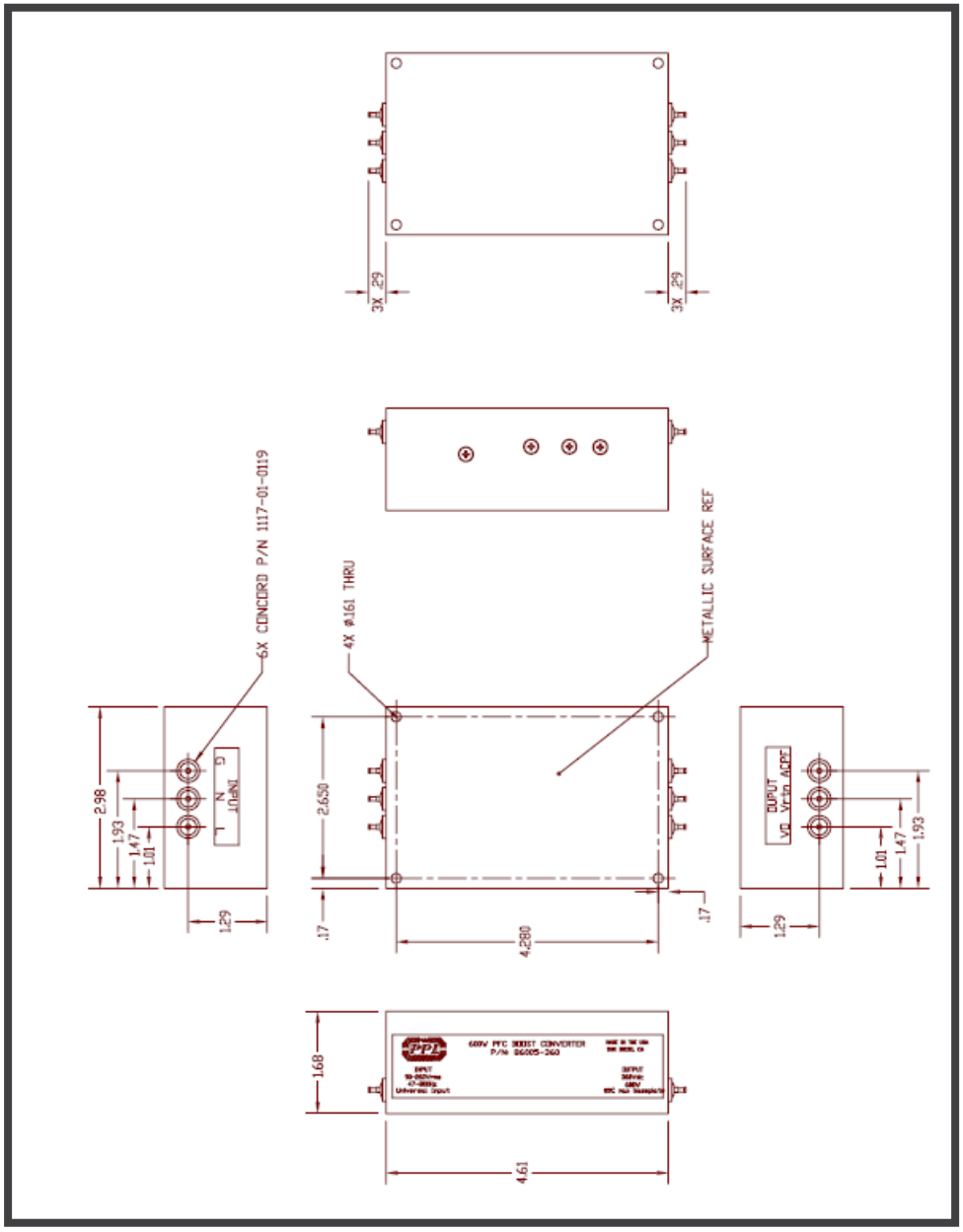
86005-360

(90—260Vac; 47- 800Hz Input)

600W, Single Phase, Universal Input,

PFC Boost Converter Module

MECHANICAL DIAGRAM



86005-360

(90—260Vac; 47- 800Hz Input)

600W, Single Phase, Universal Input,

PFC Boost Converter Module

ELECTRICAL SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE FOLLOWING TEST CONDITIONS APPLY: T_A=25°C. COMBINATION OF CONSTANT ACTIVE AND RESISTIVE LOAD APPLIED TO OUTPUT IN PARALLEL WITH 470uF CAPACITOR. INPUT VOLTAGE = 115Vrms, 400Hz, < 1.25% THD SINUSOID.

INPUT CHARACTERISTICS

PARAMETER	*86005-360*	*REMARKS*	*NOTES*
INPUT VOLTAGE RANGE	90 - 260Vrms	COMPLIES WITH NORMAL/ABNORMAL INPUT VOLTAGES PER RTCA/DO-160E, SECTION 16	2
INPUT FREQUENCY RANGE	47 - 800Hz	COMPLIES WITH DO-160E, SECTION 16, FOR A(WF) EQUIPMENT. OPERATES AT 47 - 360Hz WITH REDUCED DISTORTION PERFORMANCE.	2
CONTINUOS OUTPUT POWER	600W @ 97Vrms – 260Vrms 550W @ 90Vrms – 96Vrms	OBSERVE MAXIMUM BASEPLATE TEMPERATURE.	2
LEAKAGE CURRENT	< 5mArms	AC LINE/NEUTRAL TO CHASSIS, Vin = 115Vrms / 400Hz.	1
INRUSH CURRENT Vin = 115Vrms, 360Hz – 800Hz	16Arms (22.6Apk)	COLD START, Vin = 115Vrms / 400Hz.	2
INRUSH CURRENT Vin = 240Vrms, 50Hz	28.3Arms (40Apk)	COLD START, Vin = 240Vrms / 50Hz	1
MAXIMUM INPUT CAPACITANCE	0.76uF	LINE-TO-LINE, X2 CLASS	1
TOTAL HARMONIC DISTORTION (INPUT CURRENT)	5% maximum	115Vrms / 360Hz – 800Hz Vthd $\leq$ 1.25% FOR ALL Pout $\geq$ 300W	2
INDIVIDUAL HARMONICS - AC CLEAN	EVEN: < 1% I_f / n, (n < 10) EVEN: < 0.1% I_f , (n $\geq$ 10) ODD: < 30% I_f / n ODD TRIPLENS: < 15% I_f / n	Vin = 115Vrms, 360Hz – 800Hz; WITH EXT FILTER (See App Notes). Vthd $\leq$ 1.25% n = ORDER OF HARMONIC, 1 THRU 99; I_f = FUNDAMENTAL CURRENT FOR ALL Pout $\geq$ 300W and INDIVIDUAL HARMONICS > 5mArms	1
INDIVIDUAL HARMONICS - DISTORTED INPUT	EVEN: < 1% I_f / n + Vn (n < 10) EVEN: <0.1% I_f + Vn (n $\geq$ 10) ODD: < 30% I_f / n + Vn ODD TRIPLENS: < 15% I_f / n + Vn	Vin = 115Vrms, 360 - 800Hz; WITH EXT FILTER (See App Notes). Vthd $\geq$ 10%, Vn = CORRESPONDING INPUT VOLTAGE HARMONIC n = ORDER OF HARMONIC, 1 THRU 99; I_f = FUNDAMENTAL CURRENT FOR ALL Pout $\geq$ 300W and INDIVIDUAL HARMONICS > 5mArms	1
POWER FACTOR	0.90 min	Pout > 150W; WITH EXT FILTER (See App Notes).	2
CREST FACTOR (CURRENT)	1.314 - 1.514	RATIO OF PEAK/RMS	1
START-UP TIME (Tamb = 25°C)	< 1.4 Seconds	Vout > 200Vdc, Cout = 3,000uF, Pout = 600W	2
START-UP TIME (Tamb = -40°C)	< 8.0 Seconds	Vout > 200Vdc, Cout = 3,000uF, Pout = 600W	1
CONDUCTED EMISSIONS	RTCA DO160E, Section 21, Category M	REQUIRES EXTERNAL FILTER. SEE APPLICATION NOTES FOR DETAILS.	1

INPUT CHARACTERISTICS—CONTINUED

PARAMETER	*86005-360*	*REMARKS*	*NOTES*
UNDER-VOLTAGE DISABLE	84Vrms +/-5Vrms	BOOST FUNCTION IS INHIBITED 500mSec AFTER INPUT VOLTAGE IS SENSED BELOW THIS VALUE. DURING INHIBIT, MODULE OUTPUT OPERATES AT √2*Vin(rms).	2
AMBIENT OPERATING TEMPERATURE RANGE	-40°C TO 70°C	ENCLOSURE TEMPERATURE. INTERNAL THERMOSTAT (80°C SET POINT) MAY ACTIVATE AT PROLONGED AMBIENT TEMPERATURES GREATER THAN 75°C AND HOLD FAULT CONDITION UNTIL THERMOSTAT RESETS. RESET HYSTERESIS IS BETWEEN 6°C AND 30°C OF INITIAL THERMOSTAT ACTIVATION TEMPERATURE.	1
AMBIENT STORAGE TEMPERATURE RANGE	-55°C TO 100°C	NON-OPERATIONAL.	1
MAXIMUM BASEPLATE TEMPERATURE	85°C	MAXIMUM ALLOWABLE SUSTAINED BASEPLATE TEMPERATURE WHEN OPERATING.	1
OVERTEMPERATURE PROTECTION	90°C ± 15°C	MODULE HOT SPOT TEMPERATURE WHILE THE MODULE IS OPERATING. HOT SPOT TEMPERATURE IS LOCATED ON THE SIDE OF THE MODULE ADJACENT TO THE FOUR COUNTERSUNK SCREWS. BOOST FUNCTION IS INHIBITED WHEN OVERTEMPERATURE FAULT IS DETECTED. DURING INHIBIT, MODULE OUTPUT OPERATES AT √2*Vin(rms). MODULE WILL AUTO RESTART AFTER COOLING DOWN.	1

OUTPUT CHARACTERISTICS

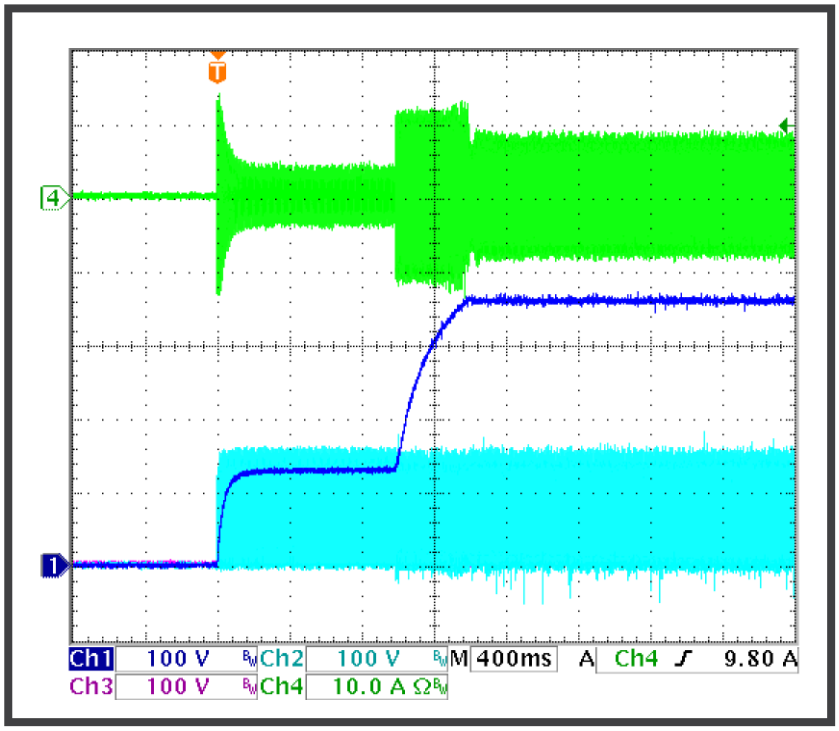
PARAMETER	*86005-360*	*REMARKS*	*NOTES*
RATED OUTPUT VOLTAGE	360Vdc+/-3%	Cout ≥ 470uF, ALL LINE AND LOAD CONDITIONS.	2
MINIMUM OUTPUT CURRENT	0Adc		2
OUTPUT RIPPLE + NOISE (pk-pk)	< 0.5%	Cout ≥ 1500uF, 20MHz BW, ALL LINE AND LOAD CONDITIONS.	1
LINE REGULATION	< 1%	OUTPUT DEVIATION FOR ± 20%, STEP CHANGE IN LINE VOLTAGE. Cout ≥ 470uF.	1
HOLD-UP TIME	0mSec	REQUIRES EXTERNAL HOLD-UP CAPACITOR TO EXTEND SUPPLY LEVEL HOLD-UP TIME; SEE APPLICATION NOTES FOR DETAILS.	1
WARM START DELAY (AFTER MOMENTARY INPUT AC POWER INTERRUPTS)	50mSec	MAXIMUM TIME DELAY BETWEEN THE TIME THE INPUT IS REAPPLIED AND WHEN THE OUTPUT BEGINS TO CHARGE POSITIVE FOLLOWING MOMENTARY POWER INTERRUPTS OF LESS THAN 400mSec.	2
MINIMUM OUTPUT CAPACITANCE	470uF	OBSERVE RIPPLE CURRENT REQUIREMENTS @ 800Hz & 100kHz FOR EXTERNAL OUTPUT CAPACITORS.	1
MAXIMUM OUTPUT CAPACITANCE	5,000uF	SPECIFIED FOR Vin = 115Vac; DERATE TO 1,250uF MAXIMUM FOR Vin = 240Vac.	1
ISOLATION VOLTAGE INPUT/OUTPUT TO CHASSIS	1500Vac / 60Hz / 60 Seconds 8mArms max leakage current	INPUT "Y" SUPPRESSION CAPACITORS INSTALLED. LEAKAGE CURRENT FOR ANY INPUT OR OUTPUT TERMINAL TO CHASSIS TERMINAL (or enclosure). NO ARCING OR DAMAGE WILL OCCUR.	2
ISOLATION VOLTAGE INPUT/OUTPUT TO CHASSIS	1500Vac / 60Hz / 60 Seconds 800uArms max leakage current	INPUT "Y" SUPPRESSION CAPACITORS REMOVED. LEAKAGE CURRENT FOR ANY INPUT OR OUTPUT TERMINAL TO CHASSIS TERMINAL (or enclosure). NO ARCING OR DAMAGE WILL OCCUR.	1
SHORT-CIRCUIT PROTECTION	NONE	FUSE INPUT WITH 10A FAST BLOW FUSE.	1
AC POWER FAIL STATUS "ACPWRFAIL-L"	TRANSITIONS TO 0.5V MAXIMUM WHEN LOSS OF INPUT AC IS DETECTED	TTL LEVEL, 8mA MAX SINK CURRENT, 25mSec DELAY TIME TO ACTIVATE ON INPUT AC INTERRUPTS.	2
OVERVOLTAGE PROTECTION	OVP SET-POINT: 420V ± 2%	OUTPUT VOLTAGE LIMITED; AUTO RECOVERY. BOOST FUNCTION IS INHIBITED WHEN OUTPUT VOLTAGE IS SENSED AT THIS VALUE. DURING INHIBIT, MODULE OPERATES AT √2*Vin(rms).	1

Notes:

1. **Ensured by design, not 100% tested in production.**
2. **100% tested for specification compliance in production.**

WAVEFORM DATA

Start-Up Profile (115Vrms / 400Hz, Cout = 3,000uF, Pout = 600W)

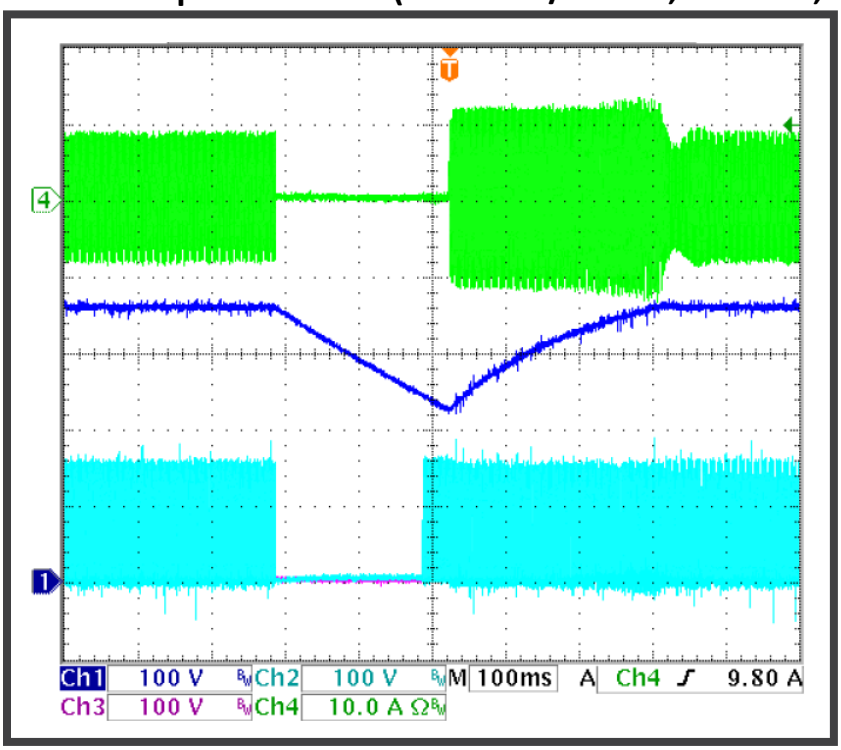


Input Current (CH4)

Output Voltage (CH1)

Input Voltage (CH2)

AC Interrupt = 200mSec (115Vrms / 400Hz, Cout = 3,000uF, Pout = 600W)



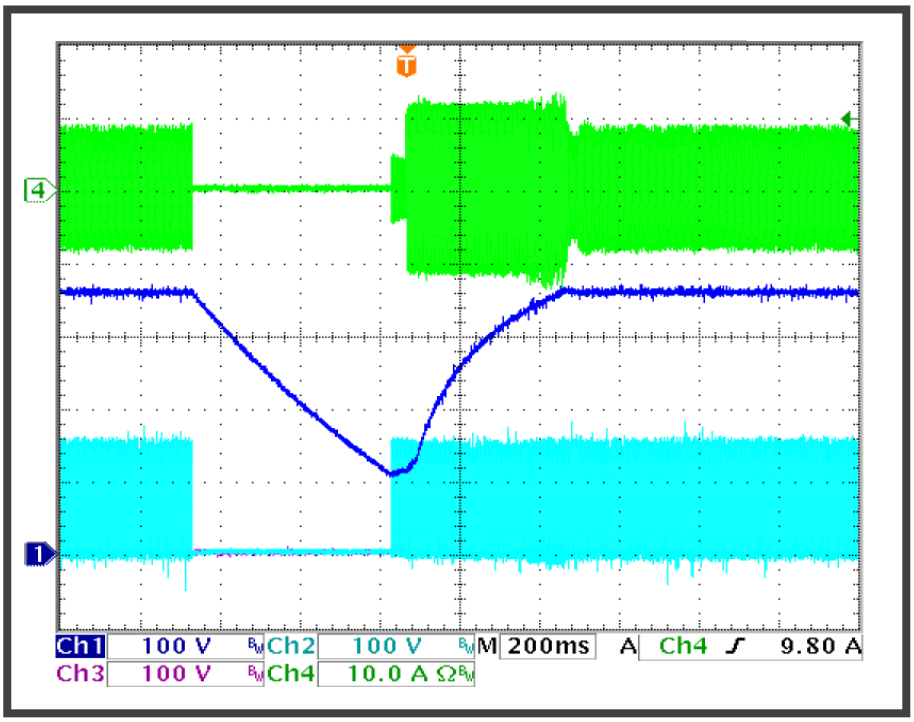
Input Current (CH4)

Output Voltage (CH1)

Input Voltage (CH2)

WAVEFORM DATA—CONTINUED

AC Interrupt = 500mSec (115Vrms / 400Hz, Cout = 3,000uF, Pout = 600W)

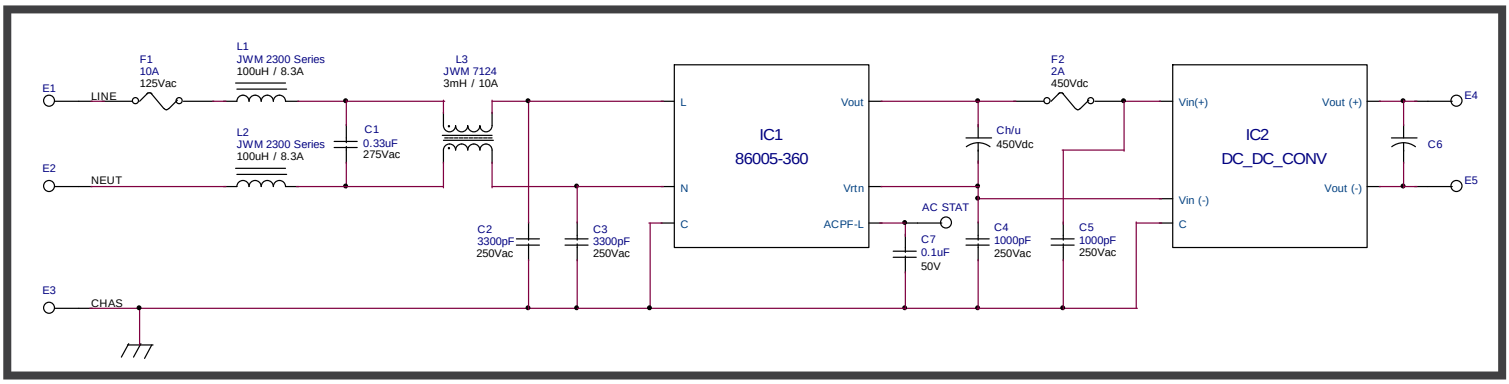


Input Current (CH4)

Output Voltage (CH1)

Input Voltage (CH2)

APPLICATION'S INFORMATION



Typical Application Circuit

HOLD-UP TIME

In order to extend configured power supply hold-up time, polarized 450V (minimum) electrolytic capacitors must be connected externally between the module's Vout and Vrtn pins. Required external capacitance can be determined using the following formula:

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

Where,
P = External (downstream) DC/DC converter input power (Watts)
t = Desired hold-up time (Seconds)
$t_{restart}$ = Warm start delay of approximately 40mSec (50mSec max) upon reapplication of input AC
$C_{h/u}$ = External hold-up capacitance (Farads)
Vi = Minimum PFC output voltage = 360 Volts – 3% = 349.2V
Vf = Undervoltage shutdown level for downstream DC/DC converter (typically 180 Volts)

In order to hold up 500W boost converter output power for 200mSec requires:
$C_{h/u} = \{(500W) (200mSec + 40mSec)\} \div \{(1/2) (349.2V^2 - 180V^2)\} = 2,680uF$

Use of 105°C, 450Vdc, 20% tolerance snap-mount aluminum electrolytic capacitors is recommended. For the example above, a total nominal capacitance of 3,350uF would be necessary to assure the required capacitance of 2,680uF was achieved. Warm start delay occurs for AC power interrupts less than ~400mSec as a result of combination of time to reactivate PFC control circuitry, reinitiation of PFC soft-start cycle and reaching module power limit.

EXTERNAL FILTER

The 86005-360 module requires an external filter on the AC lines for specification compliance. The filter shown in the typical application circuit above may be used for all applications requiring between 300W and 600W of output power. Alternately, PPI offers a special purpose encapsulated filter, PPI p/n 86005-FLTR, which has been customized for this PFC application and module. Please contact PPI sales for more information.

EMI CONSIDERATIONS

Use of a chassis ground plane or aluminum surface beneath the non-metallic (silicon) module side is recommended. Although the 86005-360 module contains a differential mode input filter and common-mode suppression capacitors, the use of an external line filter is required for compliance with conducted emissions. See application circuit for suggested filter arrangement and values. Avoid adding excessive line-to-line capacitance at lower power levels (<300W output) as this may have an adverse effect on input current harmonic distortion at higher line frequencies (e.g., 800Hz). One or more of the external hold-up capacitors should be installed in close proximity to the module's output terminals (within 2 – 3 inches is recommended).

THERMAL CONSIDERATIONS

There is no derating required for module output power up to the module's maximum baseplate temperature of 85°C. Beyond this temperature the module will shutdown. In order to assure the baseplate temperature remains below 85°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 formula:

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

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 400W at nominal line operation (115Vrms) with a maximum ambient temperature of 55°C. The following formula would apply:

$T_{baseplate} = 55°C + \{(400W / 0.915) - 400W)\} (1.6°C/W) = 114.5°C$

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

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

$\Theta_{s-a} < \{85°C - 55°C\} \div \{(400W / 0.915) - 400W)\} < 0.80°C/W$