ISOLATED DC-DC CONVERTER
CFB600W-110S SERIES
APPLICATION NOTE

Approved By:

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Contents

CFB600W-110S Series
Application Note V10 May 2018

1. Introduction

The CFB600W-110S series of DC-DC converters offers 600 watts of output power @ single output voltages of 12, 24, 28, 48VDC with industry standard full-brick. It has a wide (4:1) input voltage range of 43 to 160VDC (110VDC nominal) and 2250VDC basic isolation.

High efficiency up to 88%, allowing case operating temperature range of –40°C to 100°C. An optional heat sink is available to extend the full power range of the unit. Low no load power consumption (25mA), an ideal solution for energy critical systems.

Compliant with EN50155, EN45545, EN50121-3-2. The standard control functions include remote on/off (positive or negative) and +10%, -40% adjustable output voltage.

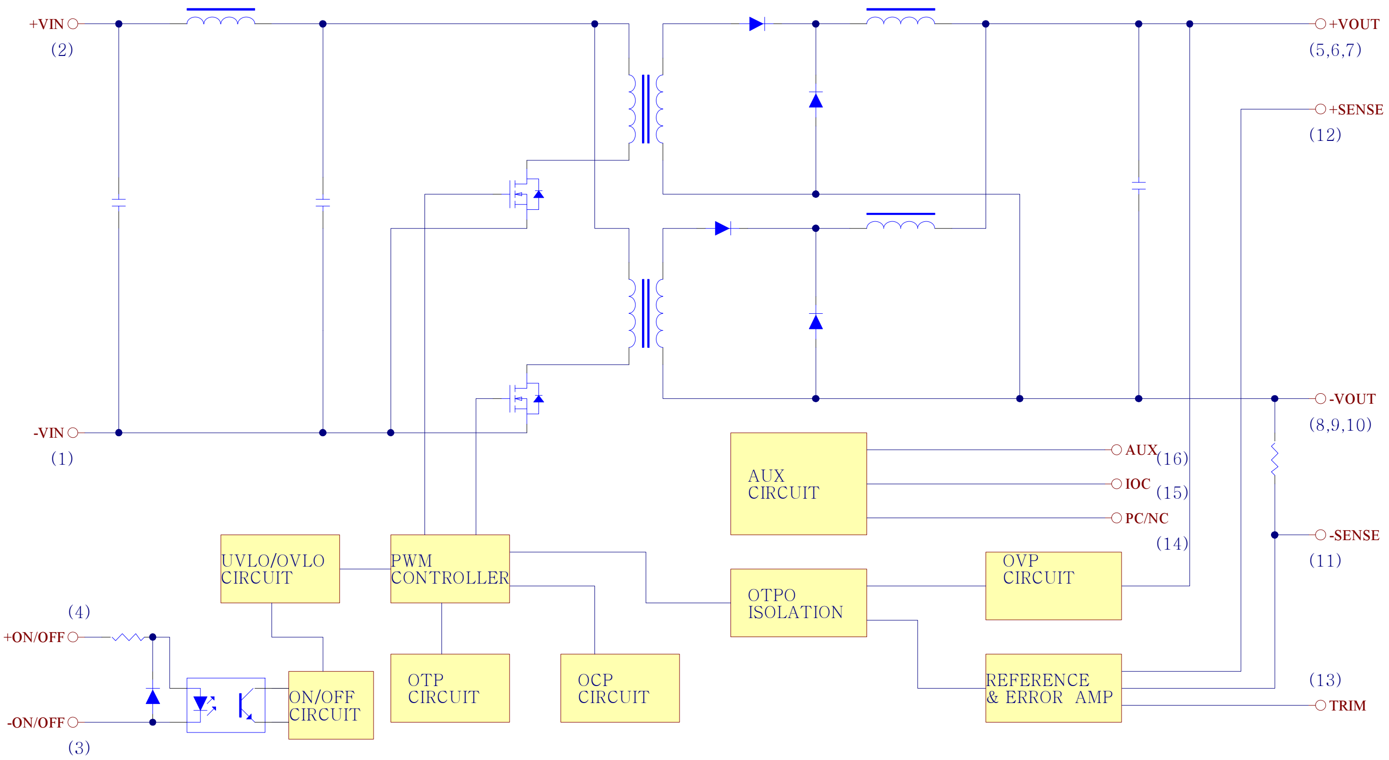
Fully protected against input UVLO (under voltage lock out), output over-current, output over-voltage and over-temperature and continuous short circuit conditions.

CFB600W-110S series is designed primarily for common railway applications of 72V, 96V, 110V nominal voltage and also suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. DC-DC Converter Features

- 600W Isolated Output
- Efficiency to 88%
- Regulated Outputs
- Isolated Remote On/Off
- Over Temperature Protection
- Over Voltage/Current Protection
- Continuous Short Circuit Protection
- Full-Brick Size Meet Industry Standard
- Meet EN50155 with External Circuits
- Shock & Vibration Meet EN50155 (EN61373)
- Meet UL60950-1 2nd (Basic Insulation)
- Fire & Smoke Meet EN45545-2

3. Electrical Block Diagram



4. Technical Specifications

(All specifications are typical at nominal input, full load at 25°C unless otherwise noted.)

ABSOLUTE MAXIMUM RATINGS

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only, functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage						
Continuous		All	-0.3		160	V_{dc}
Transient	100ms	All			180	V_{dc}
Operating Case Temperature		All	-40		100	°C
Storage Temperature		All	-55		105	°C
Input/Output Isolation Voltage	1 minute	All	2250			V_{dc}

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		All	43	110	160	V_{dc}
Input Under Voltage Lockout						
Turn-On Voltage Threshold		All	41	42	43	V_{dc}
Turn-Off Voltage Threshold		All	39	40	41	V_{dc}
Lockout Hysteresis Voltage		All		2		V_{dc}
Input Over Voltage Lockout						
Turn-On Voltage Threshold		All		NA		V_{dc}
Turn-Off Voltage Threshold		All		NA		V_{dc}
Lockout Hysteresis Voltage		All		NA		V_{dc}
Maximum Input Current	100% Load, V_{in}=43V	All		16		A
No-Load Input Current		110S12		25		mA
		110S24		25		
		110S28		25		
		110S48		25		
Input Filter	PI Filter	All				

OUTPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	V_{in}=Nominal V_{in}, I_o = I_{o_max}, Tc=25°C	110S12	11.88	12.00	12.12	V_{dc}
		110S24	23.76	24.00	24.24	
		110S28	27.72	28.00	28.28	
		110S48	47.52	48.00	48.48	

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Regulation						
Load Regulation	$I_o=I_{o\_min}$ to I_{o_max}	All			±0.5	%
Line Regulation	V_{in}=low line to high line	All			±0.2	%
Temperature Coefficient	T_C=-40°C to 100°C	All			±0.03	%/°C
Output Voltage Ripple and Noise						
Peak-to-Peak	20MHz bandwidth, Full load, 10uF tantalum and 1.0uF ceramic capacitors (48V: 10uF aluminum and 1.0uF ceramic capacitors) **See 6.10**	110S12 110S24 110S28 110S48			120 240 280 480	mV
RMS		110S12 110S24 110S28 110S48			60 100 100 200	mV
Operating Output Current Range		110S12 110S24 110S28 110S48	0 0 0 0		50 25 21.4 12.5	A
Output DC Current Limit Inception	Output Voltage=90% Nominal Output Voltage **See 5.3**	All	105		140	%
Power Good Signal(IOG)	Vout ready: low level, sink current	All			20	mA
	Vout not ready: open drain output, applied voltage	All			50	V
Output Capacitance	Full load (resistive)	110S12 110S24 110S28 110S48	470 470 470 470		10000 10000 10000 10000	uF

DYNAMIC CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	d_i/d_t=0.1A/us, Load change from 75% to 100% to 75% of Io,max	All		±3	±5	%
Setting Time (within 1% Vout nominal)	d_i/d_t=0.1A/us	All			500	us
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	$V_{on/off}$ to $10\%V_{o\_set}$	All			75	ms
Turn-On Delay Time, From Input	V_{in_min} to $10\%V_{o\_set}$	All		135	250	ms
Output Voltage Rise Time	$10\%V_{o\_set}$ to $90\%_{Vo\_set}$	All		25	50	ms

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=110V **See 6.6**	110S12 110S24 110S28 110S48		87 88 88 88		%

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Isolation Voltage	1 minute; input/output, input/case, input/remote, output/remote	All			2250	V_{dc}
	1 minute; output/case	All			1500	V_{dc}
Isolation Resistance		All	10			MΩ
Isolation Capacitance		All		4000		pF

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency		All		250		KHz
On/Off Control Negative Remote On/Off logic						
Logic Low (Module Off)		All	0		0.01	mA
Logic High (Module On)		All	1.0		10	mA
On/Off Control Positive Remote On/Off logic						
Logic High (Module Off)		All	1.0		10	mA
Logic High (Module On)		All	0		0.01	mA
Auxiliary Output Voltage		All	7	10	13	V
Auxiliary Output Current		All			20	mA
Load Share Accuracy (50%-100% load)		All	-10		+10	%
Off Converter Input Current	Shutdown input idle current	All			50	mA
Output Voltage Trim Range	P_{out}=max rated power	All	60		110	%
Output Over Voltage Protection		All	115	125	140	%
Over-Temperature Shutdown	Aluminum baseplate temperature	All		110		°C
Over Temperature Recovery		All		90		°C

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	I_o=100% of I_{o_max}; MIL-HDBK-217F_Notice 1, GB, 25°C	All		450		K hours
Weight		All		220		grams
Case Material	Plastic, DAP					
Baseplate Material	Aluminum					
Potting Material	UL 94V-0					
Pin Material	Base: Copper Plating: Nickel with Matte Tin					
Shock/Vibration	MIL-STD-810F / EN61373					
Humidity	95% RH max. Non Condensing					
Altitude	2000m Operating Altitude , 12000m Transport Altitude					
Thermal Shock	MIL-STD-810F					
EMI	Meets EN50155(EN50121-3-2) with external input filter, see 7.2					
ESD	EN61000-4-2 Air ±8kV, Contact ±6kV					Perf. Criteria B
Radiated immunity	EN61000-4-3 80~1000MHz, 20V/m					Perf. Criteria A
Fast Transient	EN61000-4-4 On power input port, ±2kV, external input capacitor required, see 7.1					Perf. Criteria A
Surge	EN61000-4-5 Line to earth, ±2kV, Line to line, ±1kV					Perf. Criteria B
Conducted immunity	EN61000-4-6 0.15~80MHz, 10V					Perf. Criteria A
Interruptions of Voltage Supply	EN50155 Class S2：10ms Interruptions					Perf. Criteria B
Supply Change Over	EN50155 Class C2：During a supply break of 30 ms					Perf. Criteria B

5. Main Features and Functions

5.1 Operating Temperature Range

The CFB600W-110S series converters can be operated within a wide case temperature range of -40°C to 100°C. Consideration must be given to the de-rating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from full brick models is influenced by usual factors, such as:

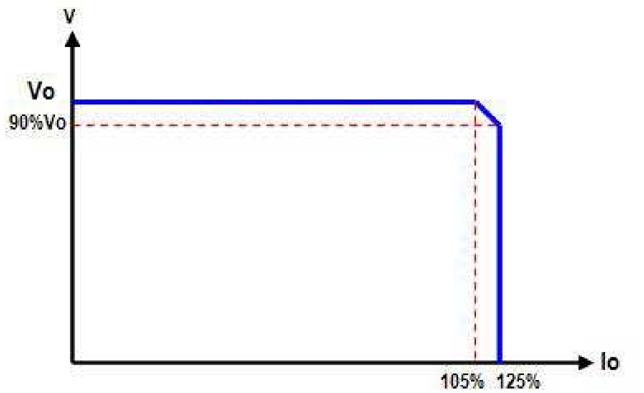
- Input voltage range
- Output load current
- Forced air or natural convection
- Heat sink optional

5.2 Output Voltage Adjustment

Section 6.8 describes in detail how to trim the output voltage with respect to its set point. The output voltage on all models is adjustable within the range of 60% to 110%.

5.3 Over Current Protection

The converter is protected against over current or short circuit conditions. At the instance of current-limit inception, the module enters a constant current mode of operation. While the fault condition exists, the module will remain in this constant current mode, and can remain in this mode until the fault is cleared. The unit operates normally once the output current is reduced back into its specified range



5.4 Output Over Voltage Protection

The converter is protected against output over voltage conditions. When the output voltage is higher than the specified range, the module enters a hiccup mode of operation.

5.5 Remote On/Off

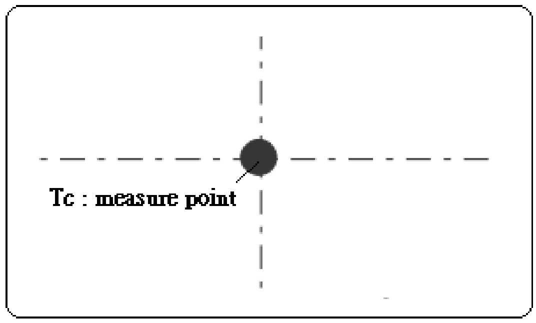
The On/Off input pins permit the user to turn the power module on or off via a system signal from the primary side or the secondary side. Two remote on/off options are available. Negative logic turns the module on as long as a current (1-10mA) is flowing between +on/off and –on/off and inactive when no current is flowing. Positive logic turns the module off as long as a current (1-10mA) is flowing between +on/off and –on/off and active when no current is flowing. **See 6.14**

5.6 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the CHB600W-110S unit. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

5.7 Over Temperature Protection

These modules have an over temperature protection circuit to safeguard against thermal damage. Shutdown occurs with the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below over temperature recovery threshold. Please measure case temperature of the center part of aluminum baseplate.

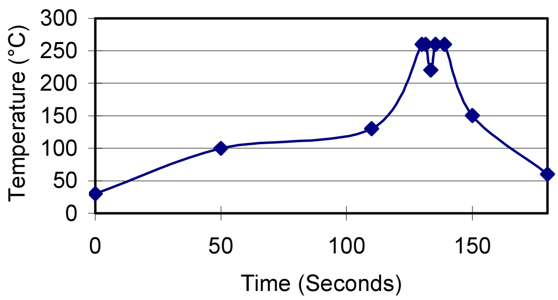


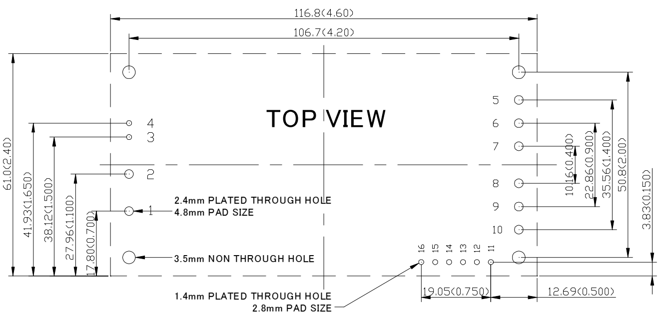
6. Applications

6.1 Recommended Layout, PCB Footprint and Soldering Information

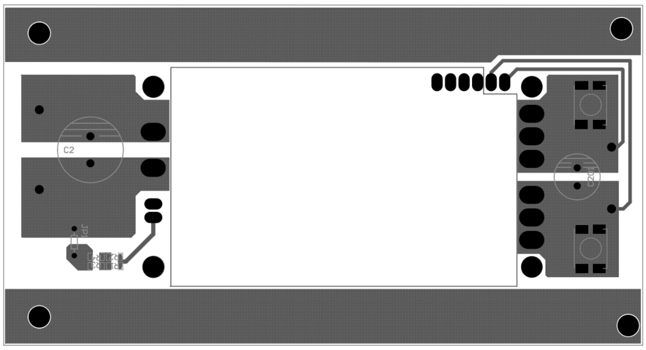
The system designer or end user must ensure that metal and other components in the vicinity of the converter meet the spacing requirements for which the system is approved. Low resistance and inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds.
Clean the soldered side of the module with a brush, Prevent liquid from getting into the module. Do not clean by soaking the module into liquid. Do not allow solvent to come in contact with product labels or resin case as this may changed the color of the resin case or cause deletion of the letters printed on the product label. After cleaning, dry the modules well.
The suggested soldering iron is 450℃ for up to 5seconds(less than 50W). Furthermore, the recommended soldering profile and PCB layout are shown below.

Lead Free Wave Soldering Profile



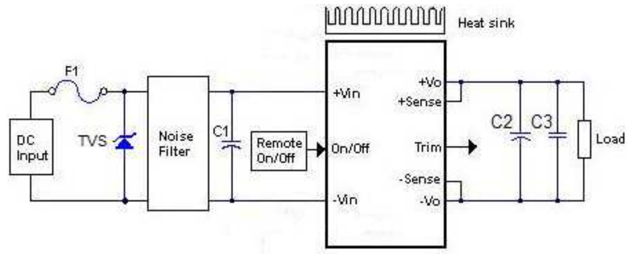


Recommend PCB Pad layout



6.2 Connection for standard use

The connection for standard use is shown below. An external input capacitor (C1) 220uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 470uF aluminum and 1uF ceramic capacitor.
The CFB600W-110S series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 20A fast acting fuse for all models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).

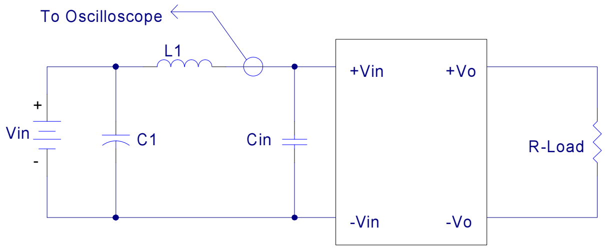


Symbol	Component	Reference
F1	Input fuse	**Section 7.1**
C1	External capacitor on input side	**Note**
C2,C3	External capacitor on the output side	**Section 6.12/6.13**
Noise Filter	External input noise filter	**Section 7.2**
Remote On/Off	External Remote On/Off control	**Section 6.14**
Trim	External output voltage adjustment	**Section 6.10**
Heat sink	External heat sink	**Section 6.4/6.5/6.6/6.7**
+Sense/-Sense	--	**Section 6.11**

Note:
If the impedance of input line is high, C1 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃

6.3 Input Capacitance at the Power Module

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown as below represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L1).



L1: 12uH
C1: 220uF ESR<0.14ohm @100KHz
Cin: 220uF ESR<0.14ohm @100KHz

6.4 Convection Requirements for Cooling

To predict the approximate cooling needed for the half brick module, refer to the power derating curves in **section 6.6**. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed 100°C as measured at the center of the top of the case (thus verifying proper cooling)

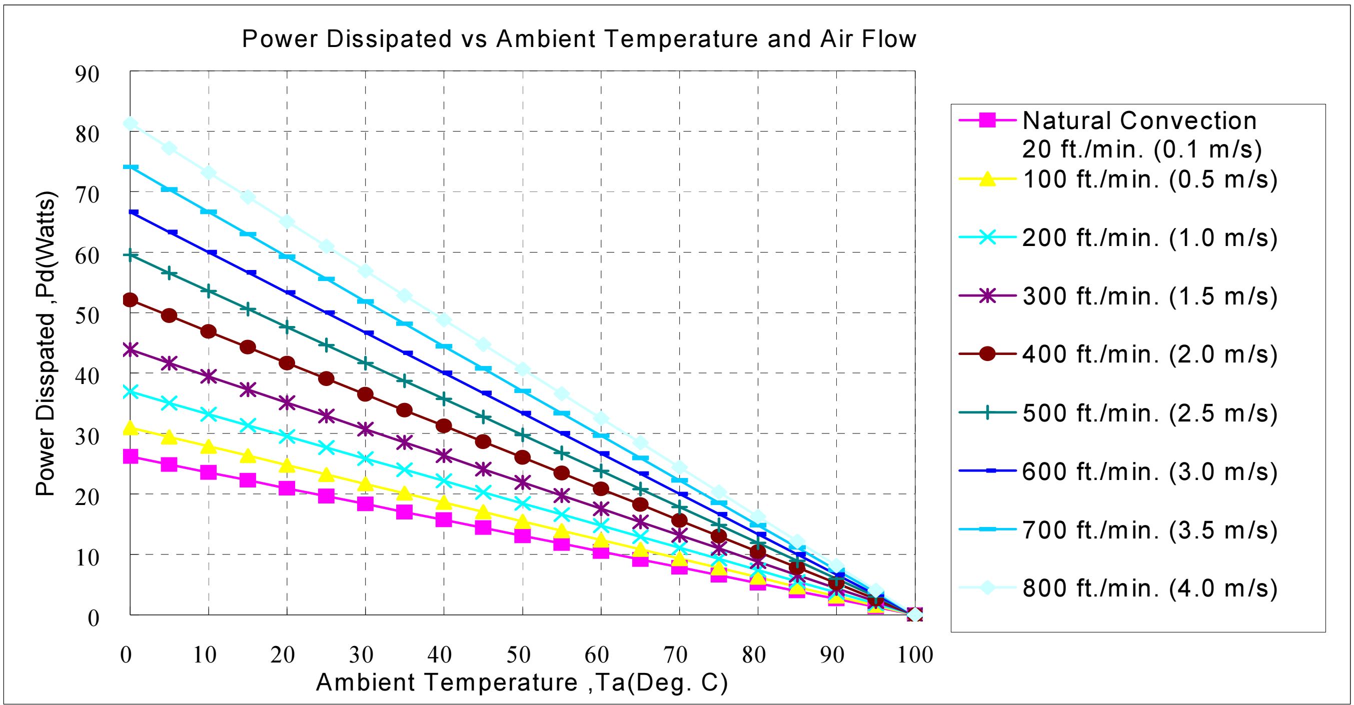
6.5 Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The test data is presented in **section 6.6**. The power output of the module should not be allowed to exceed rated power (V_{o_set} x I_{o_max})

6.6 Power De-rating

The operating case temperature range of CFB600W-110S series is -40℃ to +100℃. When operating the CFB600W-110S series, proper de-rating or cooling is needed. The maximum case temperature under any operating condition should not be exceeded 100℃.

The following curve is the de-rating curve of CFB600W-110S series without heat sink.



Example:

What is the minimum airflow necessary for a CFB600W-110S12 operating at nominal line, an output current of 30A, and a maximum ambient temperature of 40℃

Solution:
Given:

V_{in}=110V_{dc}, V_o=12V_{dc}, Io=30A

Determine Power dissipation (P_d):

Pd =Pi-Po=Po(1-η)/η

Pd =12×30×(1-0.87)/0.87=54Watts

Determine airflow:

Given: P_d =54W and Ta=30℃

Check above Power de-rating curve:

minimum airflow= 800 ft./min.

Verifying: The maximum temperature rise

△T = Pd × Rca=54×1.23=66.42℃

The maximum case temperature Tc=Ta+△T=96.42℃ <100℃

Where:

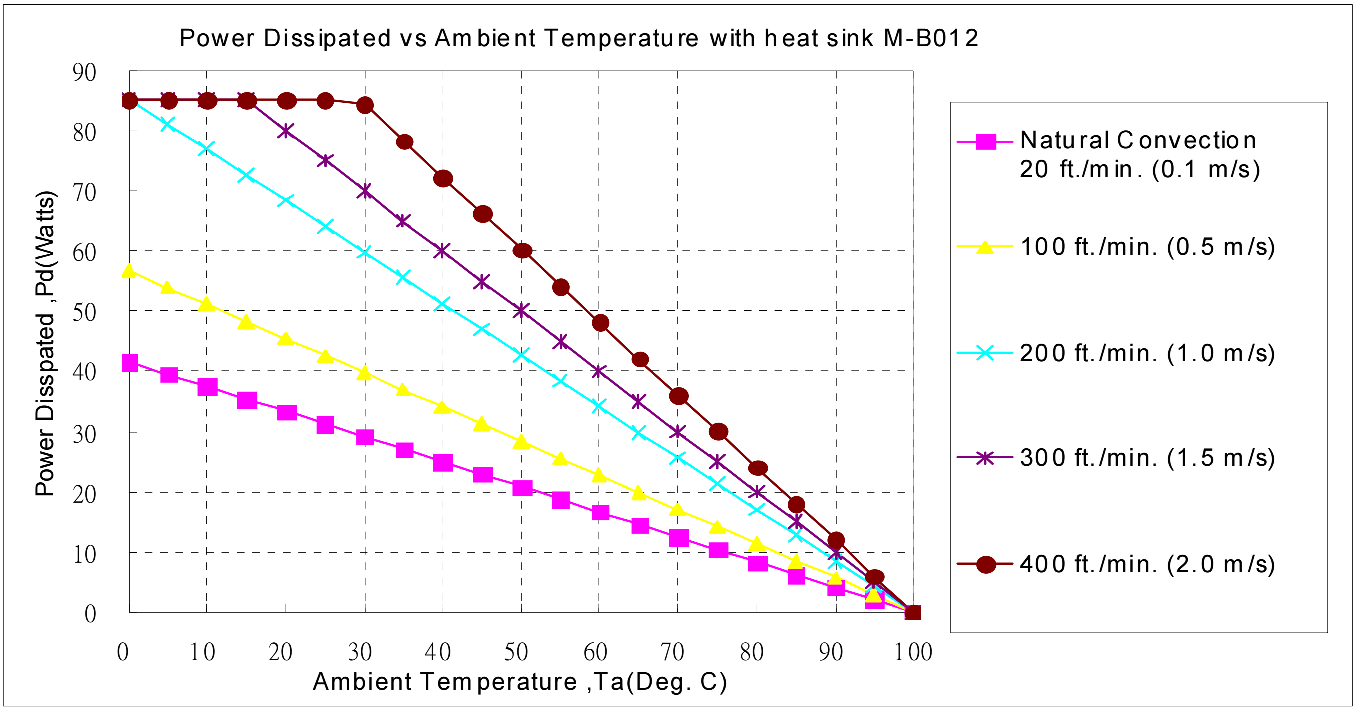
The R_{ca} is thermal resistance from case to ambience.

The Ta is ambient temperature and the Tc is case temperature.

Chart of Thermal Resistance vs Air Flow

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	3.82 ℃/W
100 ft./min. (0.5m/s)	3.23 ℃/W
200 ft./min. (1.0m/s)	2.71 ℃/W
300 ft./min. (1.5m/s)	2.28 ℃/W
400 ft./min. (2.0m/s)	1.92 ℃/W
500 ft./min. (2.5m/s)	1.68 ℃/W
600 ft./min. (3.0m/s)	1.50 ℃/W
700 ft./min. (3.5m/s)	1.35 ℃/W
800 ft./min. (4.0m/s)	1.23 ℃/W

The following curve is the de-rating curve of CFB600W-110S series with heat sink M-B012.



Forced Convection Power De-rating with Heat Sink M-B012

Example:

What is the minimum airflow necessary for a CFB600W-110S12 operating at nominal line, an output current of 37A, and a maximum ambient temperature of 40℃.

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	2.4 ℃/W
100 ft./min. (0.5m/s)	1.76 ℃/W
200 ft./min. (1.0m/s)	1.17 ℃/W
300 ft./min. (1.5m/s)	1.00 ℃/W
400 ft./min. (2.0m/s)	0.83 ℃/W

Solution:
Given:

V_{in}=48V_{dc}, Vo=12V_{dc}, Io=37A

Determine Power dissipation (P_d):

Pd=Pi-Po=Po(1-η)/η

Pd=12x37x(1-0.87)/0.87=66.4Watts (Chart of Thermal Resistance vs Air Flow)

Determine airflow:

Given: Pd=66.4W and Ta=40℃

Check above Power de-rating curve:

minimum airflow= 400 ft./min.

Verifying:

The maximum temperature rise △T = Pd × Rca=66.4×0.83=55.1℃

The maximum case temperature Tc=Ta+△T=95.1℃ <100℃

Where:

The Rca is thermal resistance from case to ambience.

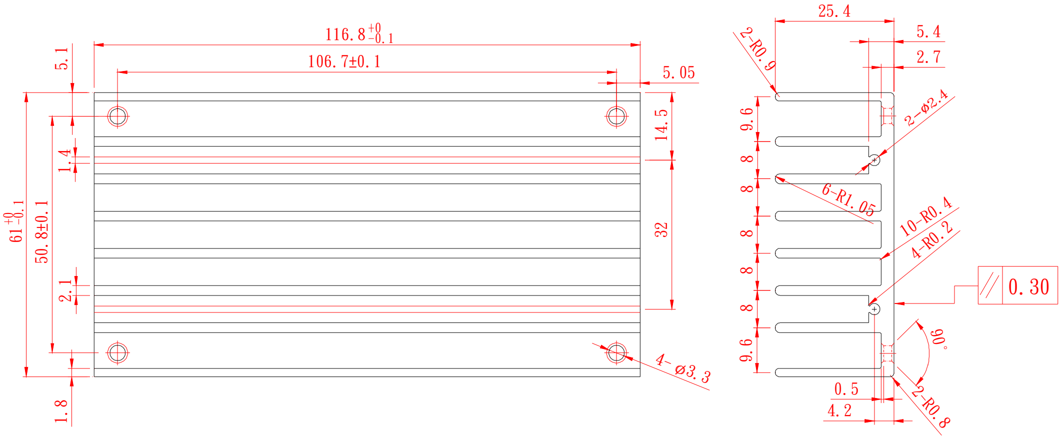
The Ta is ambient temperature and the Tc is case temperature.

6.7 Full Brick Heat Sinks:

Heat-sink M-B012

All Dimension In mm

Longitudinal Fins

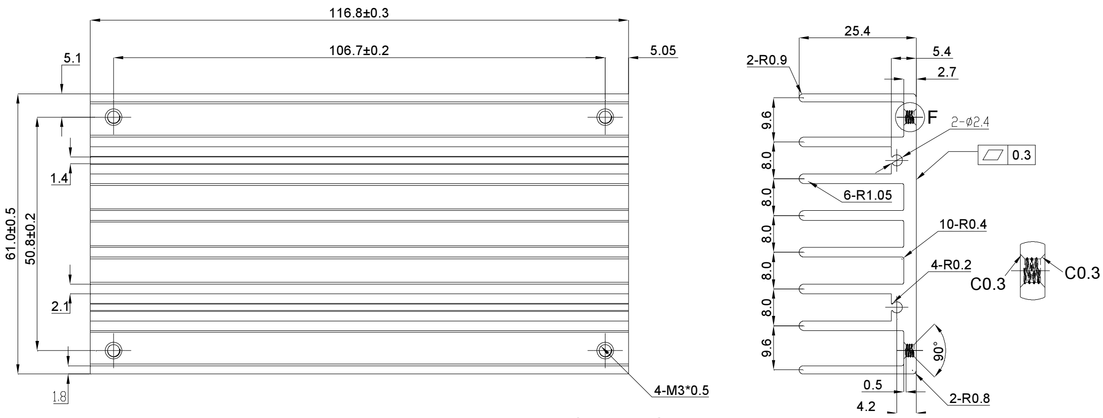


Heat Sink (Clear Mounting Inserts Φ3.3mm Through): 116.8*61*25.4(M-B012) (G6620090204)
Thermal PAD: PMP-P400 60*115.8*0.25mm (G6135041073)
Screw: M3*20L (G75A1300052)
Nut: NH+WOM3*P0.5N(G75A2440392)

Heat-sink M-C997

All Dimension In mm

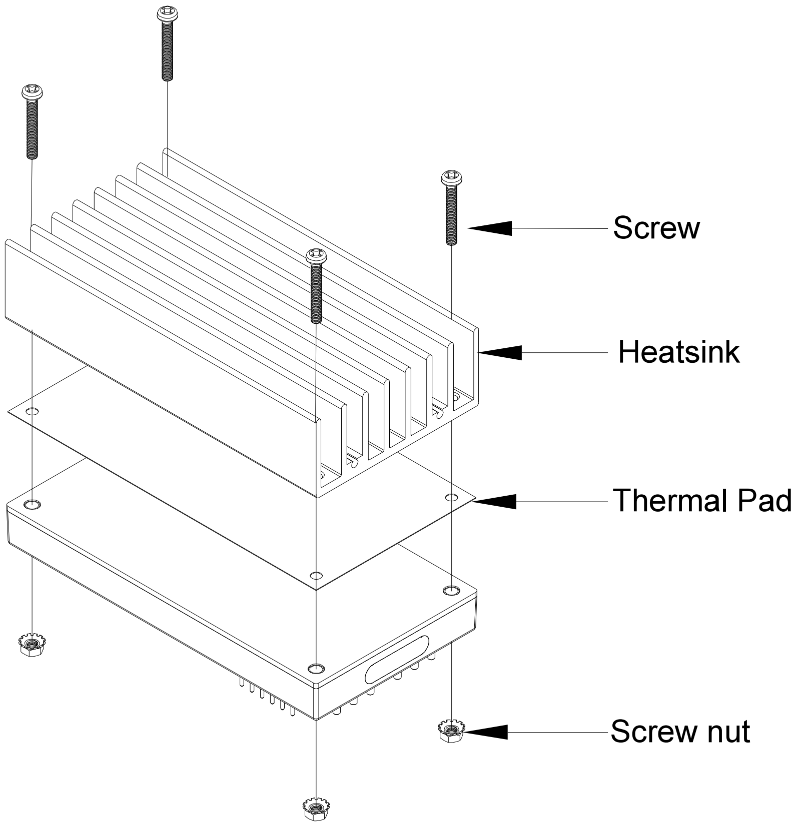
Longitudinal Fins



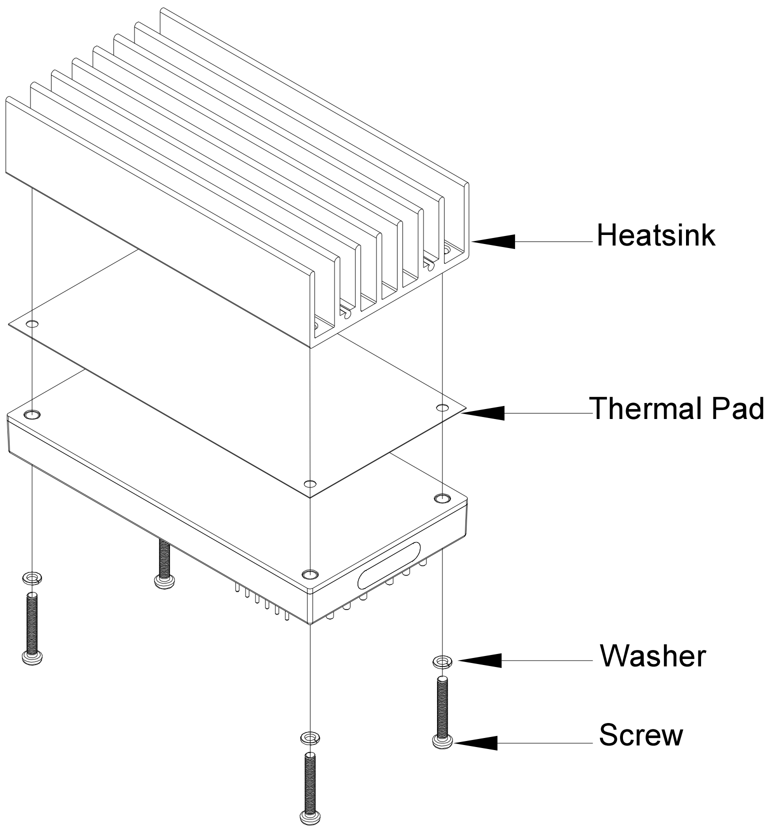
Heat Sink (Mounting Inserts M3*0.5 Through): 116.8*61*25.4(M-C997) (G6620980201)
Thermal PAD: PMP-P400 60*115.8*0.25mm (G6135041073)
Screw: M3*20L (G75A1300052)
Washer: WS3.2N (G75A47A0752)

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	2.4 ℃/W
100 ft./min. (0.5m/s)	1.76 ℃/W
200 ft./min. (1.0m/s)	1.17 ℃/W
300 ft./min. (1.5m/s)	1.00 ℃/W
400 ft./min. (2.0m/s)	0.83 ℃/W

Full Brick Heat Sink Assembly

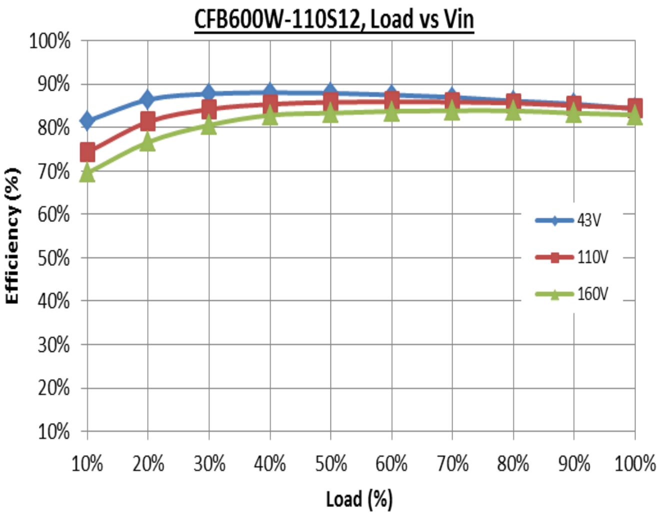


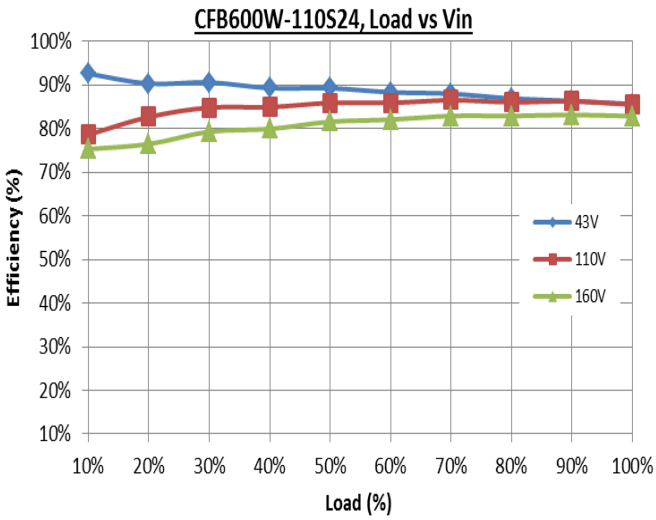
Heat Sink: M-B012
Thermal PAD: PMP-P400 60*115.8*0.25mm
(G6135041073)
Screw: M3*20L (G75A1300052)
Nut: NH+WOM3*P0.5N(G75A2440392)

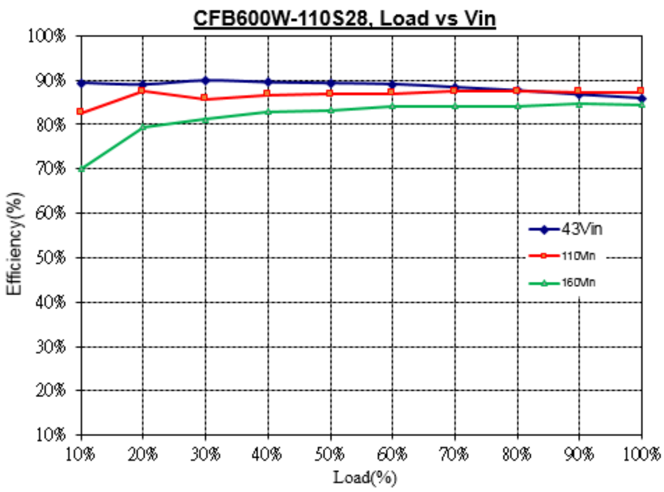


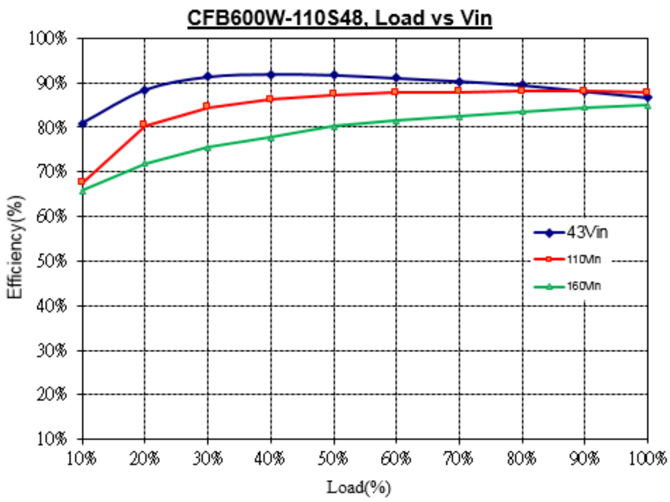
Heat Sink: M-C997
Thermal PAD: PMP-P400 60*115.8*0.25mm
(G6135041073)
Screw: M3*20L (G75A1300052)
Washer: WS3.2N (G75A47A0752)

6.8 Efficiency VS. Load









6.9 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown below. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test. we can calculate:

- Efficiency
- Load regulation and line regulation.

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Vin \times Iin} \times 100\%$$

Where:

V_o is output voltage,

I_o is output current,

V_{in} is input voltage,

I_{in} is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where:

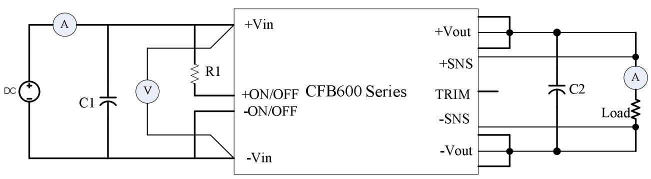
V_{FL} is the output voltage at full load

V_{NL} is the output voltage at no load

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where: V_{HL} is the output voltage of maximum input voltage at full load. V_{LL} is the output voltage of minimum input voltage at full load.



CFB600W-110S series Test Setup

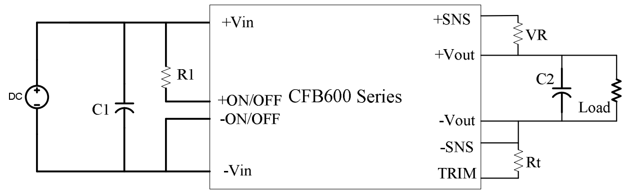
Recommend C1and C2 Value

C1:220uF/100V

C2:470uF/100V

6.10 Output Voltage Adjustment

The Trim input permits the user to adjust the output voltage up or down according to the trim range specification (60% to 110% of nominal output). This is accomplished by connecting an external resistor between the +Vout and +Sense pin for trim up and between the TRIM and –Sense pin for trim down, see Figure



Output voltage trim circuit configuration

The Trim pin should be left open if trimming is not being used. The output voltage can be determined by the following equations:

$$Vf = \frac{1.24 \times (\frac{Rt \times 33}{Rt + 33})}{7.68 + \frac{Rt \times 33}{Rt + 33}}$$

$$Vout = (Vo + VR) \times Vf$$

Unit: KΩ

Vo: Nominal Output Voltage

Recommend Rt=6.8KΩ

For example, to trim-up the output voltage of 24V module (CFB600W-110S24) by 5% to 25.2V, to trim-down by 20% to 19.2V,

The value R_{trim_up} is calculated as follows:

Rt=6.8KΩ, Vf=0.525V,

$$Vf = \frac{1.24 \times (\frac{6.8 \times 33}{6.8 + 33})}{7.68 + \frac{6.8 \times 33}{6.8 + 33}} = 0.525$$

$$25.2 = (24 + VR) \times 0.525, VR = 24K\Omega$$

The value of R_{trim_down} defined as:

$$19.2 = (24 + VR) \times 0.525, VR = 12.57K\Omega$$

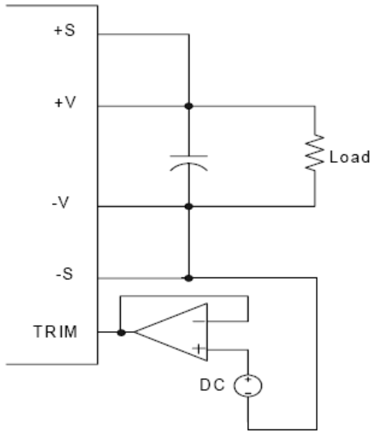
The typical value of R_{trim_up}

Trim up %	12V	24V	28V	48V
	Rtrim_up (KΩ)			
1%	0.049	0.106	0.272	0.196
2%	0.168	0.345	0.55	0.673
3%	0.288	0.583	0.829	1.15
4%	0.407	0.822	1.107	1.627
5%	0.526	1.061	1.385	2.104
6%	0.645	1.299	1.664	2.582
7%	0.765	1.538	1.942	3.059
8%	0.884	1.776	2.221	3.536
9%	1.003	2.015	2.499	4.013
10%	1.123	2.253	2.777	4.49

The typical value of R_{trim_down}

Trim Down %	12V	24V	28V	48V
	R_{trim_down} (KΩ)			
1%	387.92	396.61	603.07	387.92
2%	235.74	238.95	301.84	235.74
3%	168.34	169.98	199.92	168.34
4%	130.30	131.30	148.68	130.30
5%	105.88	106.54	117.84	105.88
6%	88.87	89.34	97.24	88.87
7%	76.34	76.69	82.50	76.34
8%	66.73	67.00	71.44	66.73
9%	59.12	59.33	62.83	59.12
10%	52.95	53.12	55.94	52.95
11%	47.84	47.99	50.30	47.84
12%	43.55	43.67	45.60	43.55
13%	39.88	39.99	41.62	39.88
14%	36.72	36.81	38.21	36.72
15%	33.97	34.04	35.25	33.97
16%	31.54	31.61	32.66	31.54
17%	29.40	29.46	30.38	29.40
18%	27.48	27.53	28.35	27.48
19%	25.76	25.81	26.53	25.76
20%	24.21	24.25	24.89	24.21
21%	22.80	22.83	23.41	22.80
22%	21.51	21.54	22.07	21.51
23%	20.34	20.37	20.84	20.34
24%	19.26	19.28	19.71	19.26
25%	18.26	18.28	18.67	18.26
26%	17.34	17.36	17.72	17.34
27%	16.48	16.50	16.83	16.48
28%	15.69	15.71	16.01	15.69
29%	14.95	14.97	15.24	14.95
30%	14.26	14.27	14.53	14.26
31%	13.61	13.62	13.86	13.61
32%	13.00	13.01	13.23	13.00
33%	12.43	12.44	12.64	12.43
34%	11.89	11.90	12.09	11.89
35%	11.38	11.39	11.56	11.38
36%	10.90	10.91	11.07	10.90
37%	10.44	10.45	10.60	10.44
38%	10.01	10.02	10.16	10.01
39%	9.599	9.608	9.739	9.599
40%	9.209	9.217	9.34	9.209

The output voltage can also be adjustment by using external DC voltage



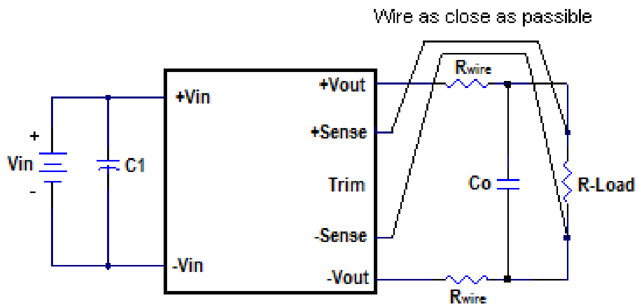
*Output Voltage = TRIM Terminal Voltage * Nominal Output Voltage*

6.11 Output Remote Sensing

The CFB600W-110S SERIES converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the CFB600W-110S series in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load. The remote-sense voltage range is:

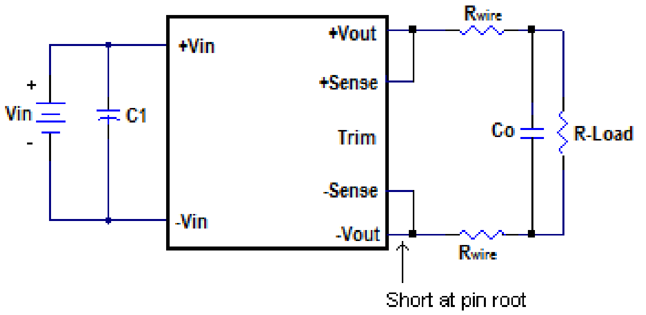
$[(+V_{out}) - (-V_{out})] - [(+Sense) - (-Sense)] \leqq 10\%$ of $V_{o\_nominal}$

When remote sense is in use, the sense should be connected by twisted-pair wire or shield wire. If the sensing patterns short, heave current flows and the pattern may be damaged. Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 400mm. This is shown in the schematic below.



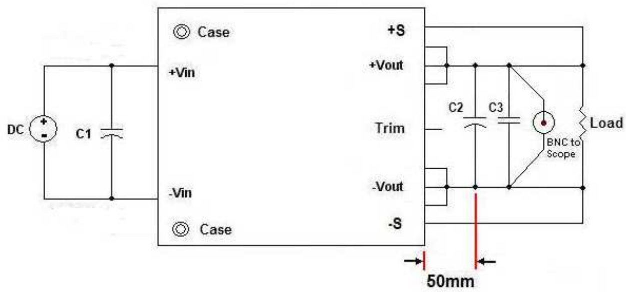
If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module. Wire between +Sense and +Vout and between -Sense and –Vout as short as possible. Loop wiring should be avoided.

The converter might become unstable by noise coming from poor wiring. This is shown in the schematic below.



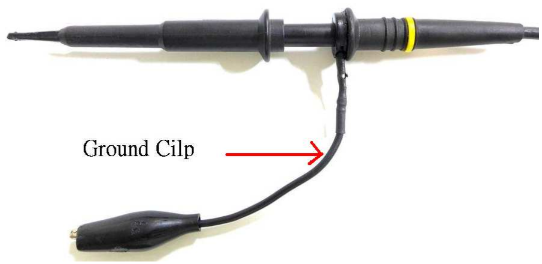
Note: Although the output voltage can be varied (increased or decreased) by both remote sense and trim, the maximum variation for the output voltage is the larger of the two values not the sum of the values. The output power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. Using remote sense and trim can cause the output voltage to increase and consequently increase the power output of the module if output current remains unchanged. Always ensure that the output power of the module remains at or below the maximum rated power. Also be aware that if $V_{o.set}$ is below nominal value, $P_{out.max}$ will also decrease accordingly because $I_{o.max}$ is an absolute limit. Thus, $P_{out.max} = V_{o.set} \times I_{o.max}$ is also an absolute limit.

6.12 Output Ripple and Noise

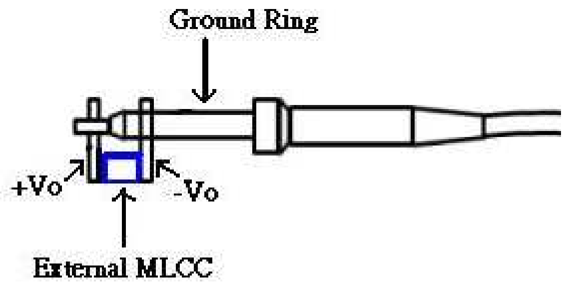


Output ripple and noise measured with 10uF tantalum capacitor(48Vo:10uF aluminum capacitor) and 1uF ceramic capacitor across output. A 20 MHz bandwidth oscilloscope is normally used for the measurement.

The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.



Another method is shown in below, in case of coaxial-cable/BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.



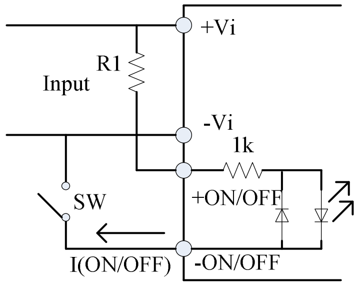
6.13 Output Capacitance

The converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load (<100mm). PCB design emphasizes low resistance and inductance tracks in consideration of high current applications. Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. Cincon's converters are designed to work with load capacitance to see technical specifications.

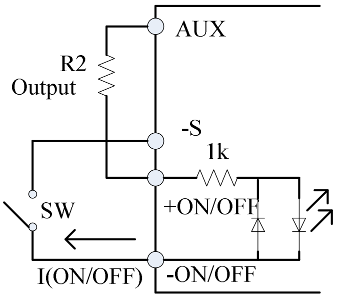
6.14 On/Off Control

The converter's on/off can be controlled from the input side or the output side.
Output voltage turns on when current is made to through on/off terminals which can be reached by opening or closing the switches. The maximum current through the on/off pin is 10mA, setting the resistor value to avoid the maximum current through the on/off pins.

(A) Controlling the on/off terminal from the input side, recommend R1 value is 42K (1W) for 110Vin.

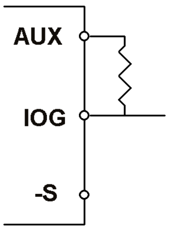


(B) Controlling the on/off terminal from the output side, Recommend R2 value is 5.1k (0.1W).

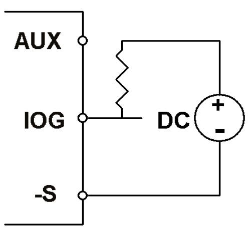


6.15 IOG signal

Normal and abnormal operation of the converter can be monitored by using the I.O.G signal. Output of this signal monitor is located at the secondary side and is open collector output, you can use the signal by the internal aux power supply or the the external DC supply as the following figures. the ground reference is the –sense.



By internal AUX



By external DC supply

This signal is low when the converter is normally operating and high when the converter is disabled or when the converter is abnormally operating.

6.16 Auxiliary Power for output signal

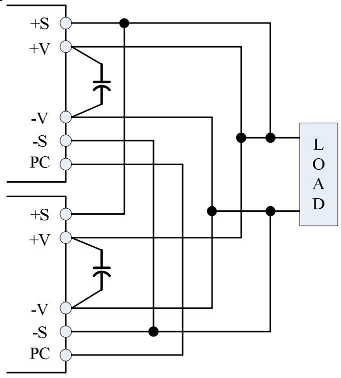
The auxiliary power supply output is within 7-13V with maximum current of 20 mA. Ground reference is the –sense Pin.

6.17 Parallel Operation

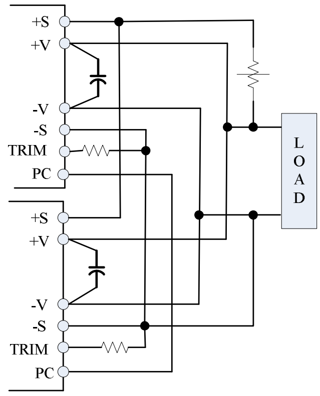
The CFB600W-110S series are also designed for parallel operation. When paralleled, the load current can be equally shared between the modules by connecting the PC pins together.

There are two different parallel operations for CFB600W-110S series, one is parallel operation when load can't be supplied by only one power unit; the other is the N+1 redundant operation which is high reliable for load of N units by using N+1 units.

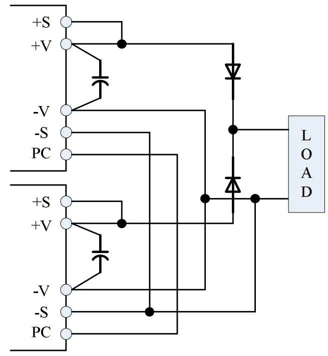
(a) parallel operation



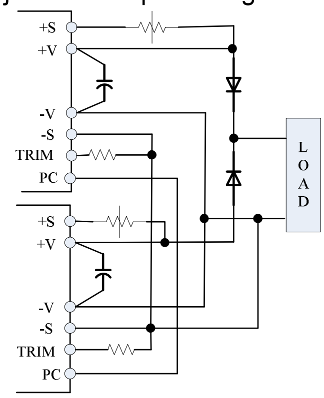
(b) Parallel operation with programmed and adjustable output



(c) N+1 redundant connection



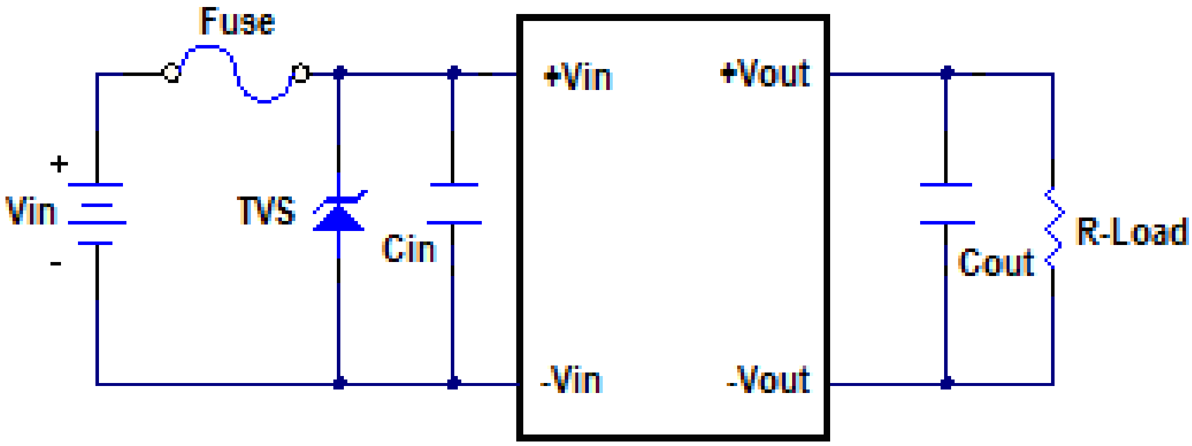
(d) N+1 redundant connection with programmed output and adjustable output voltage



7. Safety & EMC

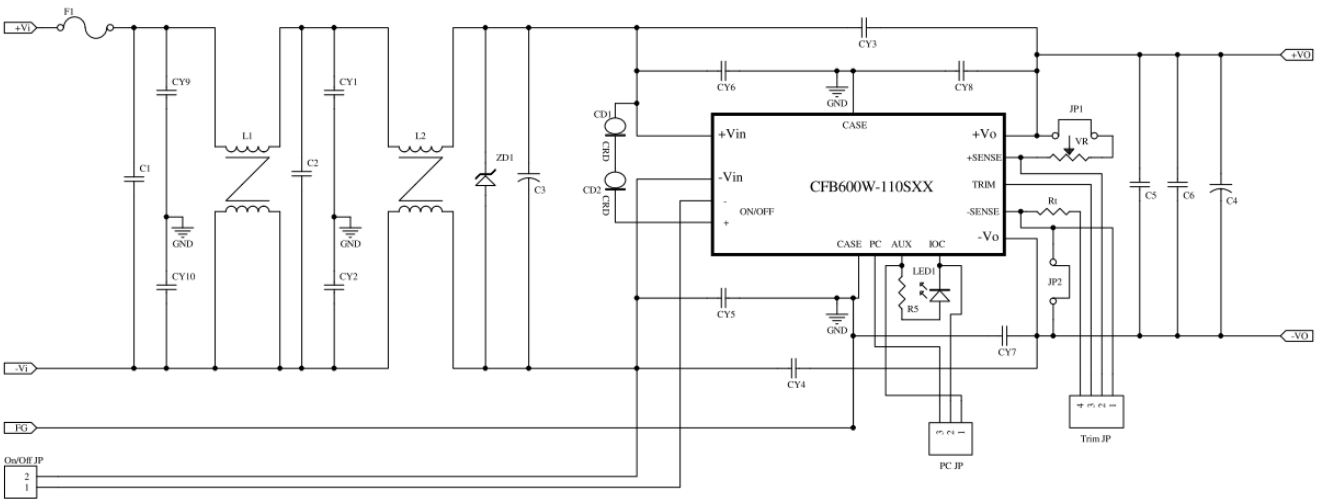
7.1 Input Fusing and Safety Considerations

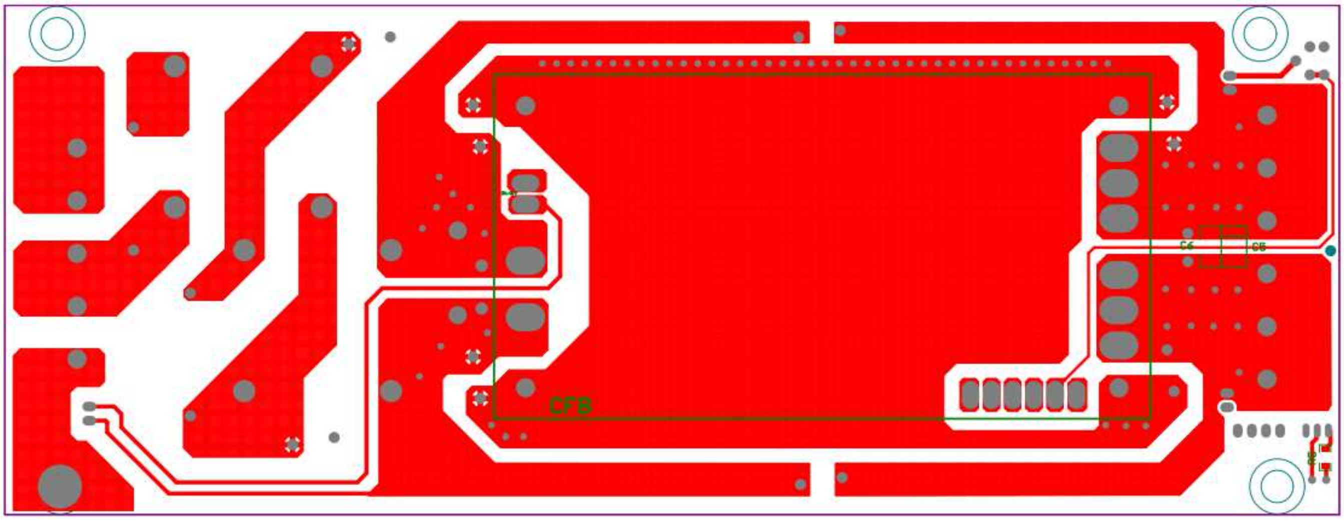
The CFB600W-110S series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 20A time delay fuse for 110V_{in} models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).



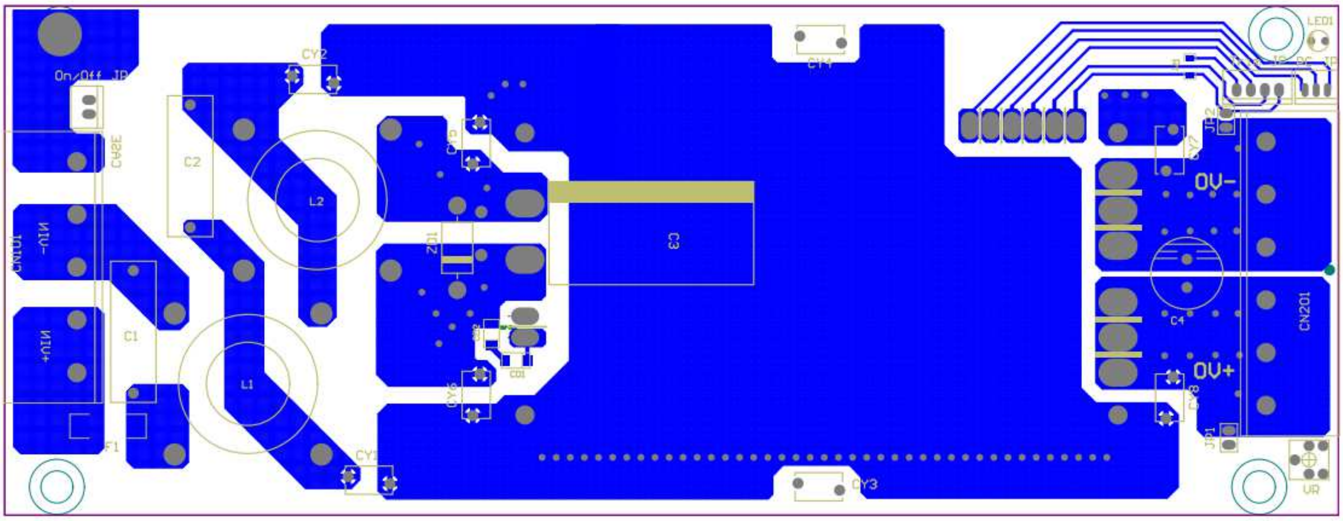
7.2 EMC Considerations

(1)Suggested Circuits for Conducted EMI meet EN50155 (EN50121-3-2)





EMI test board bottom side



EMI test board top side

MODEL NO.	C1	C2	C3	C4	C5	C6	CY1	CY2	CY3	CY4	CD1
CFB600W-110S12 CFB600W-110S24	X2 CAP 0.47uF	X2 CAP 0.47uF	220uF/200V YXF	470uF/50V KY	10uF/50V	1uF/50V	Y1 CAP 470pF	Y1 CAP 470pF	Y1 CAP 2200pF	Y1 CAP 2200pF	S-152T
	CY5	**CY6**	**CY7**	**CY8**	**CY9**	**CY10**	**L1**	**L2**	**F1**	**ZD1**	**CD2**
	Y1 CAP 4700pF	Y1 CAP 4700pF	Y1 CAP 10000pF	Y1 CAP 10000pF	NC	NC	3.8mH	3.8mH	JP	1.5KE180A	S-152T
CFB600W-110S28	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**CY1**	**CY2**	**CY3**	**CY4**	**CD1**
	X2 CAP 0.47uF	X2 CAP 0.47uF	220uF/200V YXF	470uF/50V KY	10uF/50V	1uF/50V	Y1 CAP 470pF	Y1 CAP 470pF	Y1 CAP 1000pF	Y1 CAP 1000pF	S-152T
	CY5	**CY6**	**CY7**	**CY8**	**CY9**	**CY10**	**L1**	**L2**	**F1**	**ZD1**	**CD2**
	Y1 CAP 4700pF	Y1 CAP 4700pF	Y1 CAP 10000pF	Y1 CAP 10000pF	NC	NC	3.8mH	3.8mH	JP	1.5KE180A	S-152T
CFB600W-110S48	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**CY1**	**CY2**	**CY3**	**CY4**	**CD1**
	X2 CAP 0.47uF	X2 CAP 0.47uF	220uF/200V YXF	470uF/63V KY	4.7uF/100V	1uF/100V	Y1 CAP 470pF	Y1 CAP 470pF	Y1 CAP 1000pF	Y1 CAP 1000pF	S-152T
	CY5	**CY6**	**CY7**	**CY8**	**CY9**	**CY10**	**L1**	**L2**	**F1**	**ZD1**	**CD2**
	Y1 CAP 4700pF	Y1 CAP 4700pF	Y1 CAP 10000pF	Y1 CAP 10000pF	Y1 CAP 4700pF	Y1 CAP 4700pF	3.8mH	3.8mH	JP	1.5KE180A	S-152T

Note:

C1, C2: PCX2337 0.47uF/275V or equivalent.

C3, C4: ALUMINUM CAP or equivalent.

C5: VISHAY 293D TANTALUM CHIP CAP. D"<0.8R or equivalent.

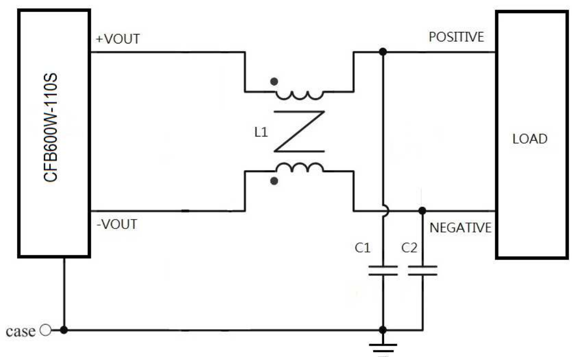
C6: CHIP CAP. 1812 or equivalent.

CD1, CD2: SEMITEC CURRENT DIODE or equivalent.

L1, L2: FERRITE CORE FERROXCUBE T29/19/15-3E6 Φ1.2mm*2/18T or equivalent.

ZD1: LITTELFUSE TVS or equivalent.

(2) The external filter is required for output conducted noise meet EN50155: EN50121-3-2:2015



MODEL NO	C1	C2	L1
CFB600W-110S12 CFB600W-110S24 CFB600W-110S28	Y1 CAP 10000pF	Y1 CAP 10000pF	1.0mH
CFB600W-110S48	Y1 CAP 10000pF	Y1 CAP 10000pF	2.2mH

Note:

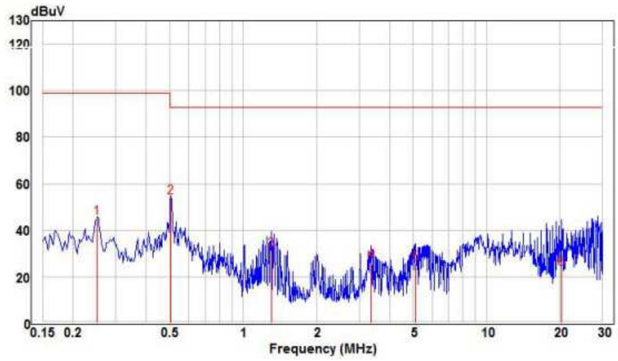
L1: 1.0mH FERRITE CORE FERROXCUBE T29/19/15-3E6Φ1.0mm*3/9T or equivalent.

2.2mH FERRITE CORE FERROXCUBE T29/19/15-3E6Φ1.2mm*1/14T or equivalent.

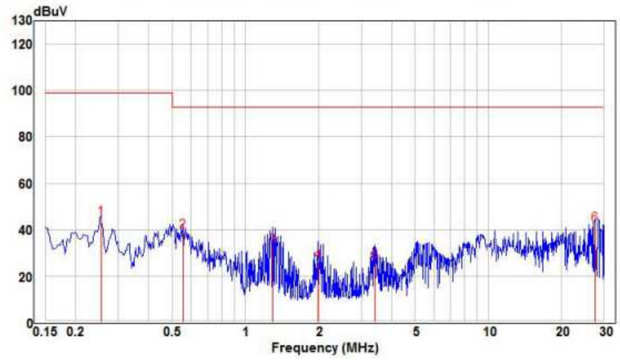
Conducted Emission (Input):

CFB600W-110S12

Line:

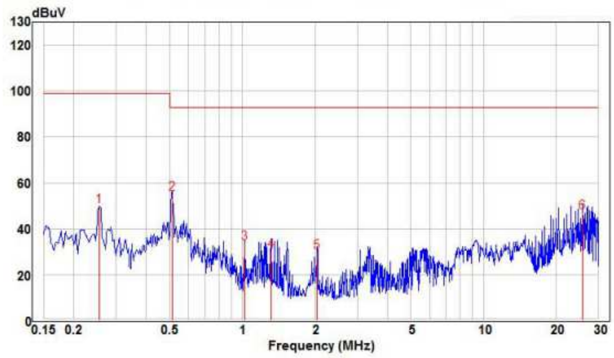


Neutral:

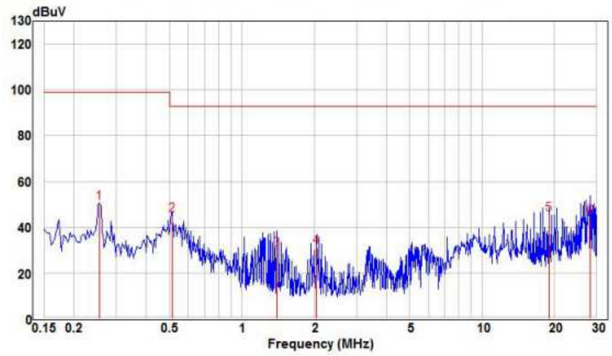


CFB600W-110S24

Line:

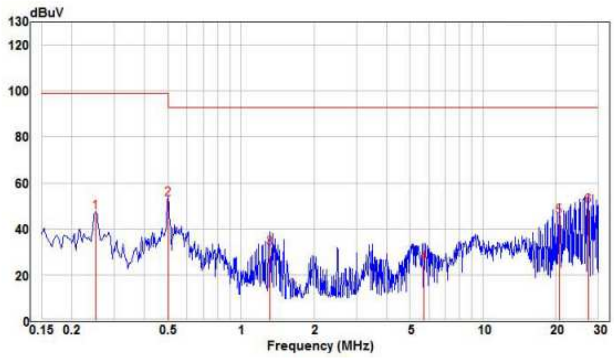


Neutral:

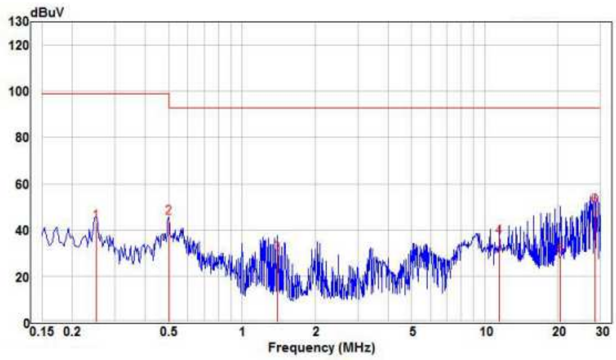


CFB600W-110S28

Line:

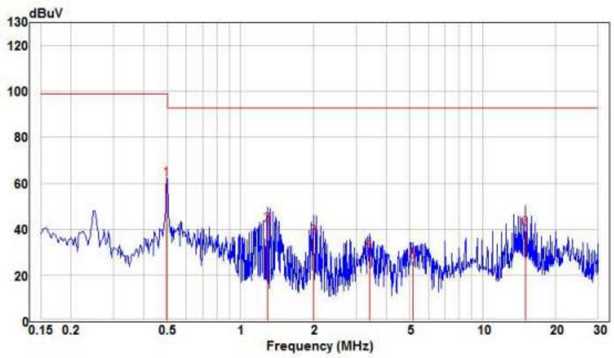


Neutral:

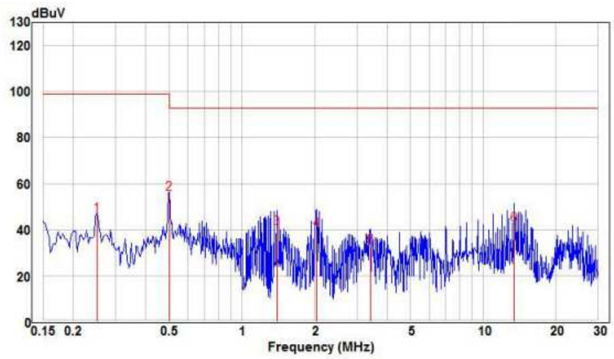


CFB600W-110S48

Line:



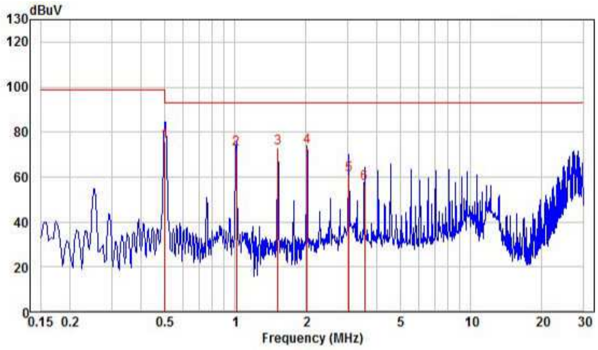
Neutral:



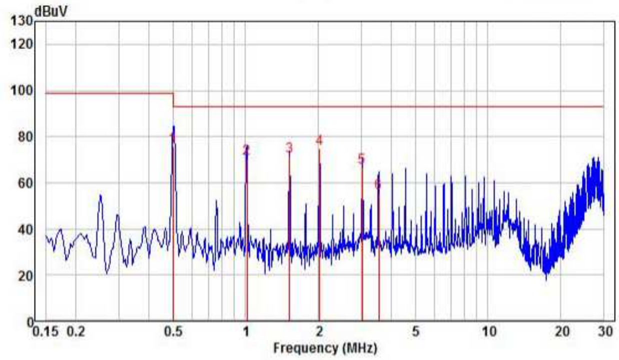
Conducted Emission (Output):

CFB600W-110S12

Positive:

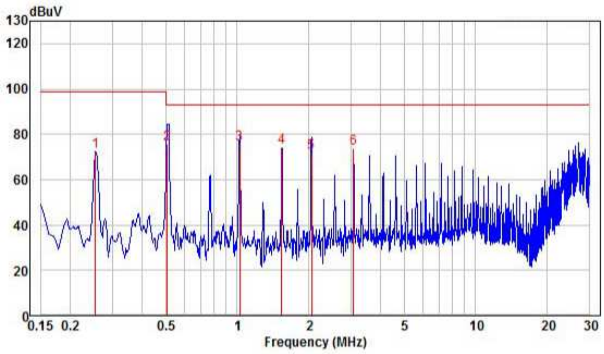


Negative:

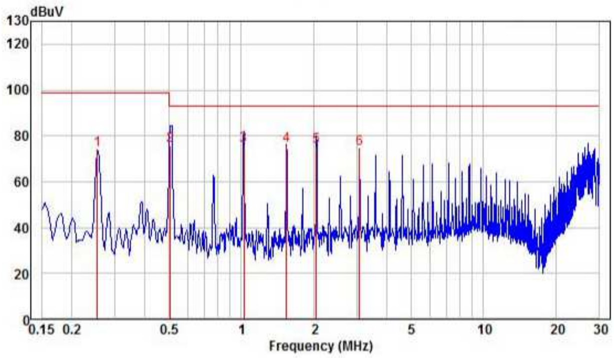


CFB600W-110S24

Positive:

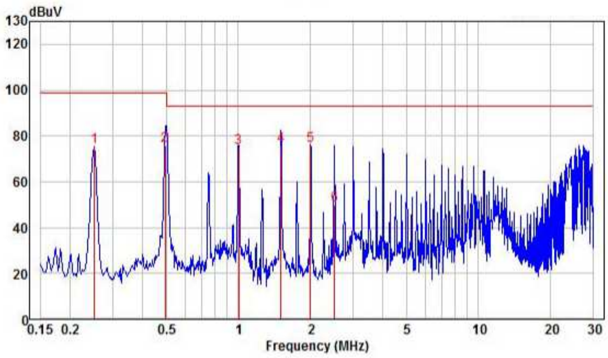


Negative:

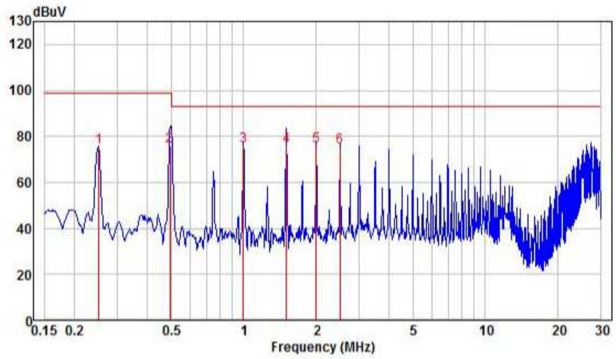


CFB600W-110S28

Positive:

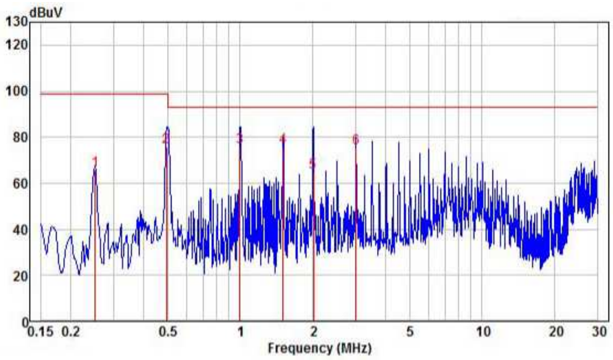


Negative:

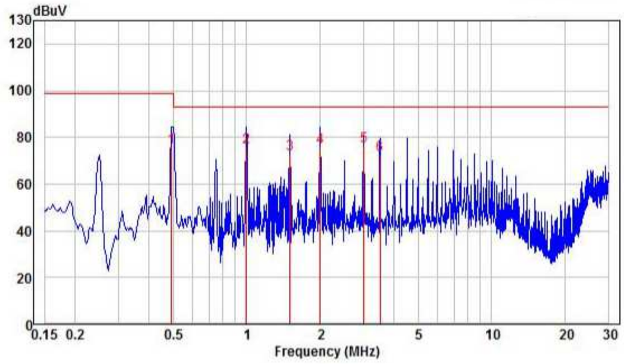


CFB600W-110S48

Positive:



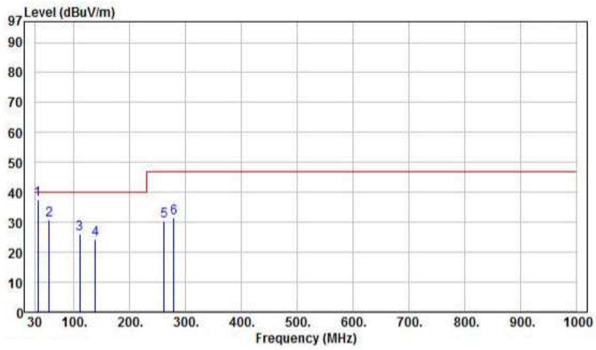
Negative:



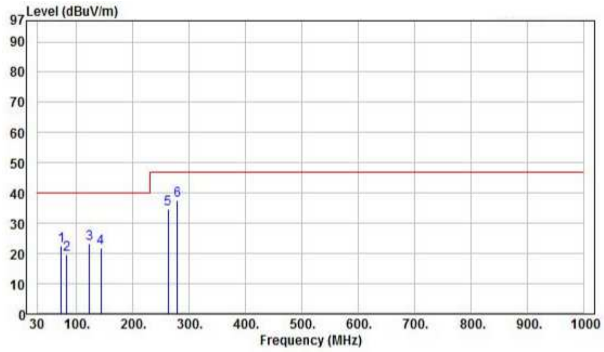
Radiated Emission:

CHB600W-110S12

Vertical

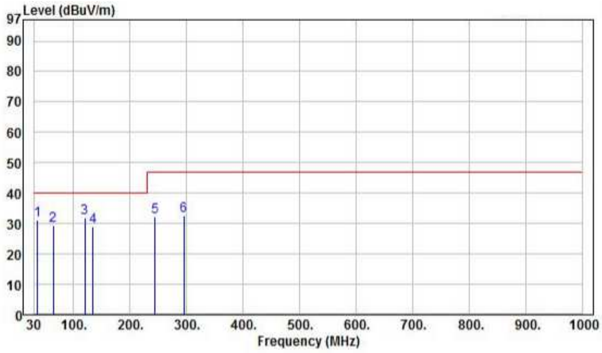


Horizontal



CHB600W-110S24

Vertical



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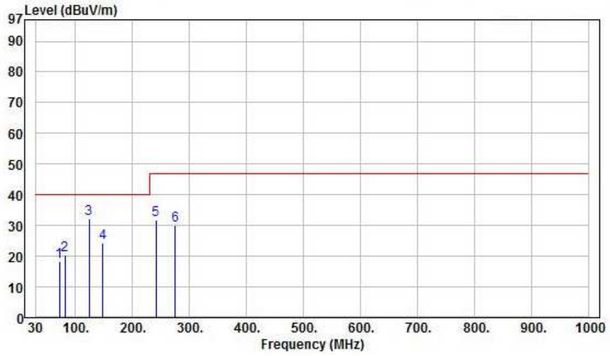
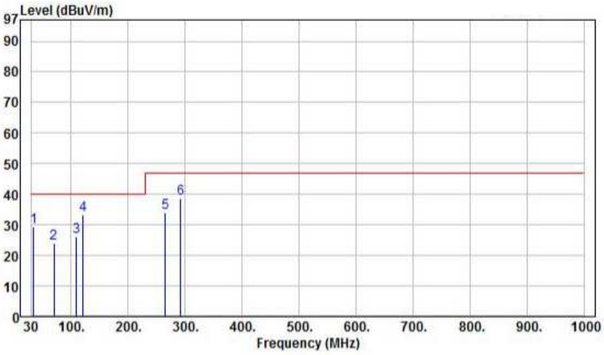


CHB600W-110S28

Vertical



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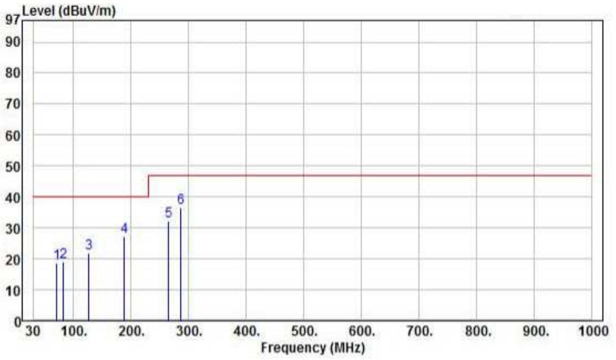
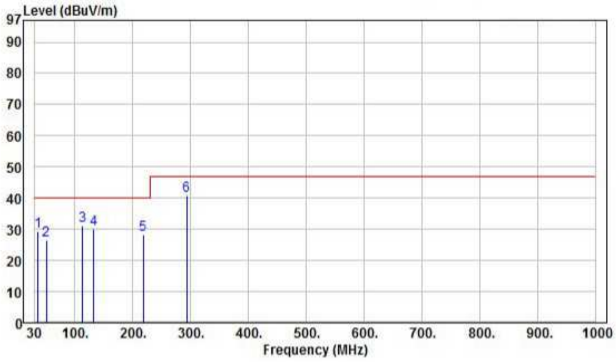
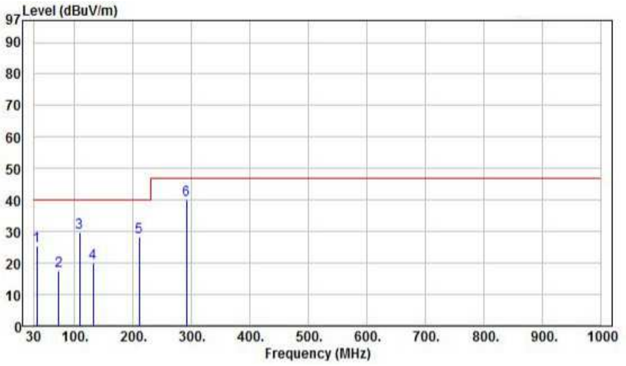


CHB600W-110S48

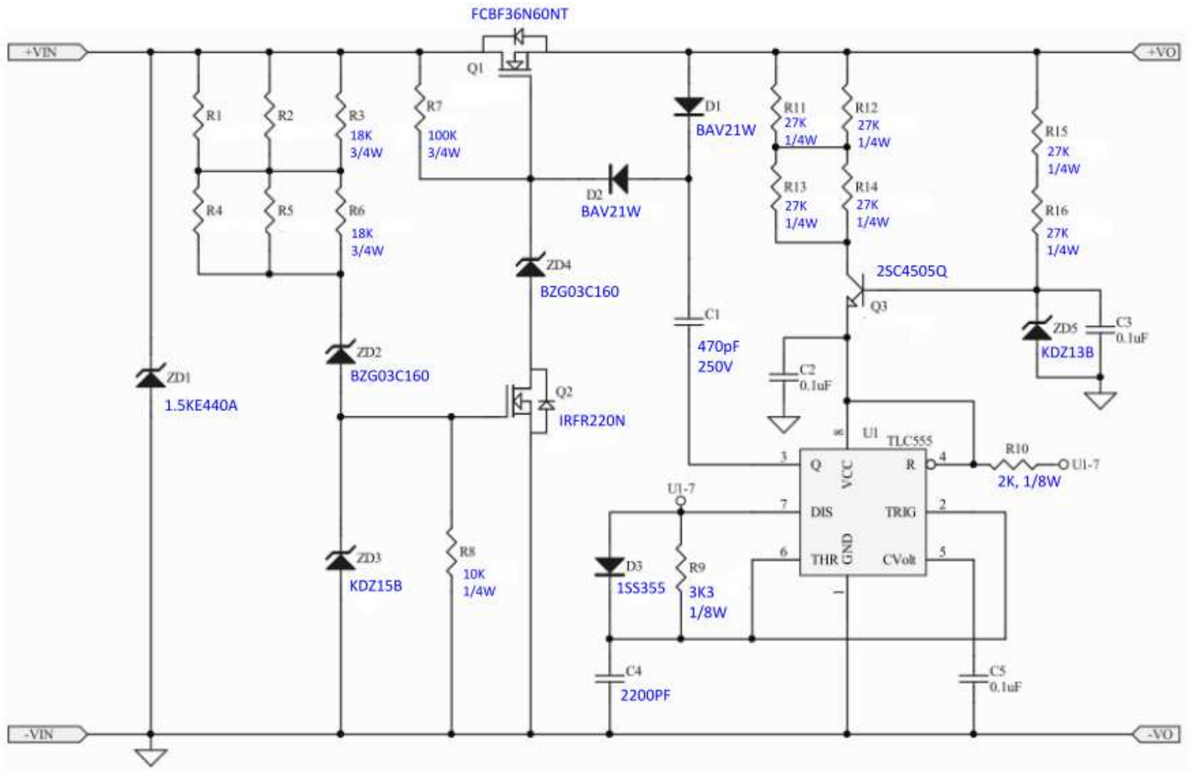
Vertical



Horizontal



7.3 Suggested Configuration for RIA12 Surge Test



8. Part Number

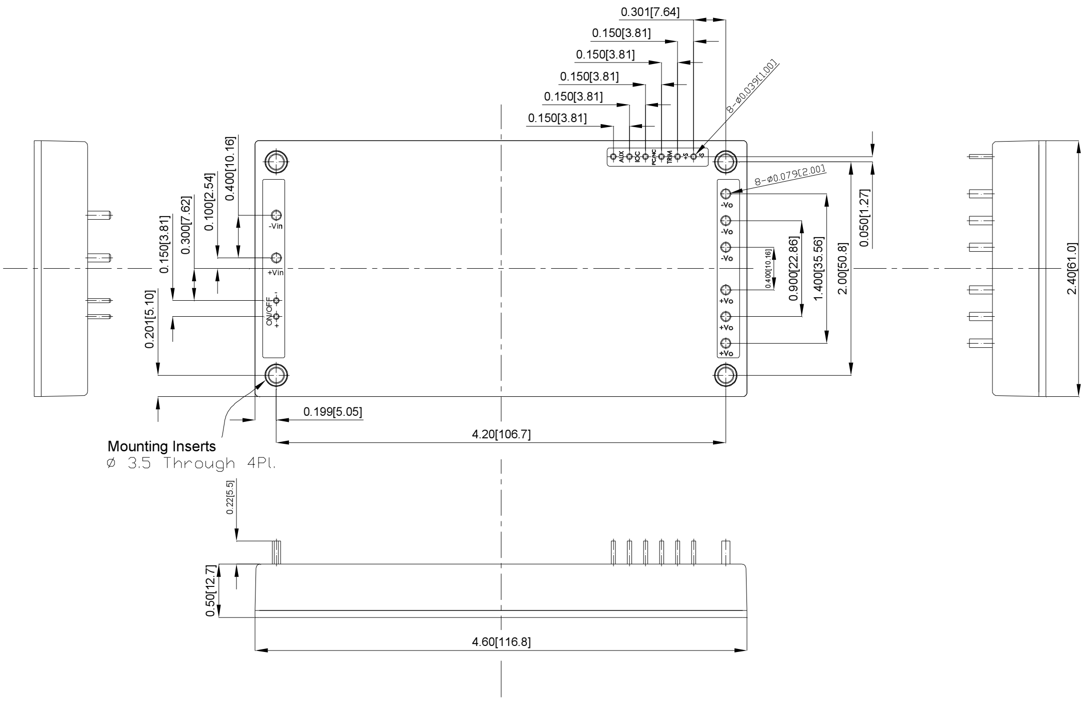
Format: CFB600W- II S OO L-Y

Parameter	Series	Nominal Input Voltage	Number of Outputs	Output Voltage	Remote ON/OFF Logic	Option
Symbol	CFB600W	II	X	OO	L	Y
Value	CFB600W	110: 110Volts	S: Single	12: 12 Volts 24: 24 Volts 28: 28 Volts 48: 48 Volts	None: Negative P: Positive	C0: Threaded Mounting Holes(M3*0.5)

9. Mechanical Specifications

9.1 Mechanical Outline Diagrams

All Dimensions in Inches[mm] Pin
Tolerance Inches:x.xx=±0.02 , x.xxx=±0.01 ±0.004
Millimeters:x.x=±0.5 , x.xx=±0.25 ±0.1



PIN CONNECTION

PIN NUMBER	CONNECTION
1	-V Input
2	+V Input
3	-On/Off
4	+On/Off
5~7	+V Output
8~10	-V Output
11	-Sense
12	+Sense
13	TRIM
14	PC
15	IOC
16	AUX

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