ISOLATED DC-DC CONVERTER
CFB750-300S SERIES
APPLICATION NOTE

Approved By:

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Contents

CFB750-300S Series
Application Note V15 December 2020

1. Introduction

The CFB750-300S Series is an industry standard half-brick DC-DC converter, providing up to 750W of output power @ single output voltages of 12, 15, 24, 28, 36, 48VDC. It has a high input voltage range of 200 to 425VDC (300VDC nominal) and reinforced with a 3000VAC isolation.

High efficiency up to 91%, allowing case operating temperature range of –40°C to 85°C. An optional heat sink is available to extend the full power range of the unit. Very low no load power consumption (10mA), an ideal solution for energy critical system applications.

The standard control functions include remote on/off (positive or negative) and 60-110% 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.

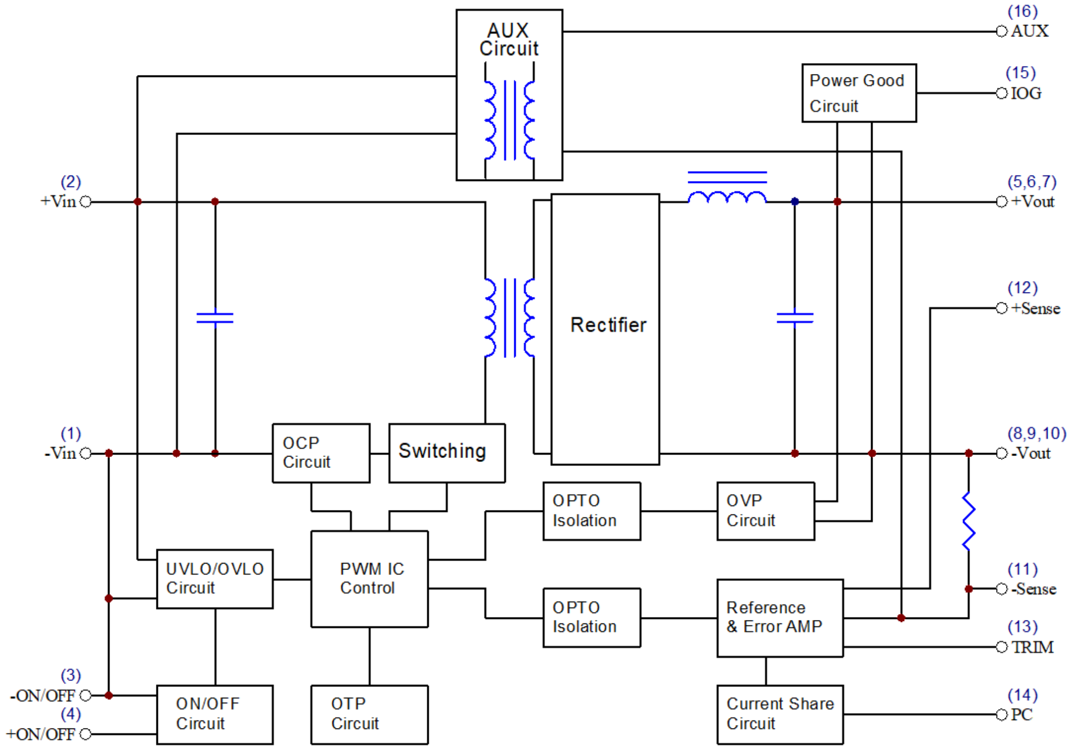
All models are highly suitable for distributed power architectures, telecommunications, servers, base station, battery operated equipment, and industrial applications.

2. DC-DC Converter Features

- 750W Isolated Output
- Efficiency to 91%
- Fixed Switching Frequency
- Low No Load Power Consumption
- Remote On/Off
- Input Under-Voltage Protection
- Over Temperature Protection
- Over Voltage/Current Protection
- Full Brick Size meet Industrial Standard
- Single Wire Parallel
- Safety Meets IEC/EN/UL 62368-1
- Fully Isolated 3000VAC

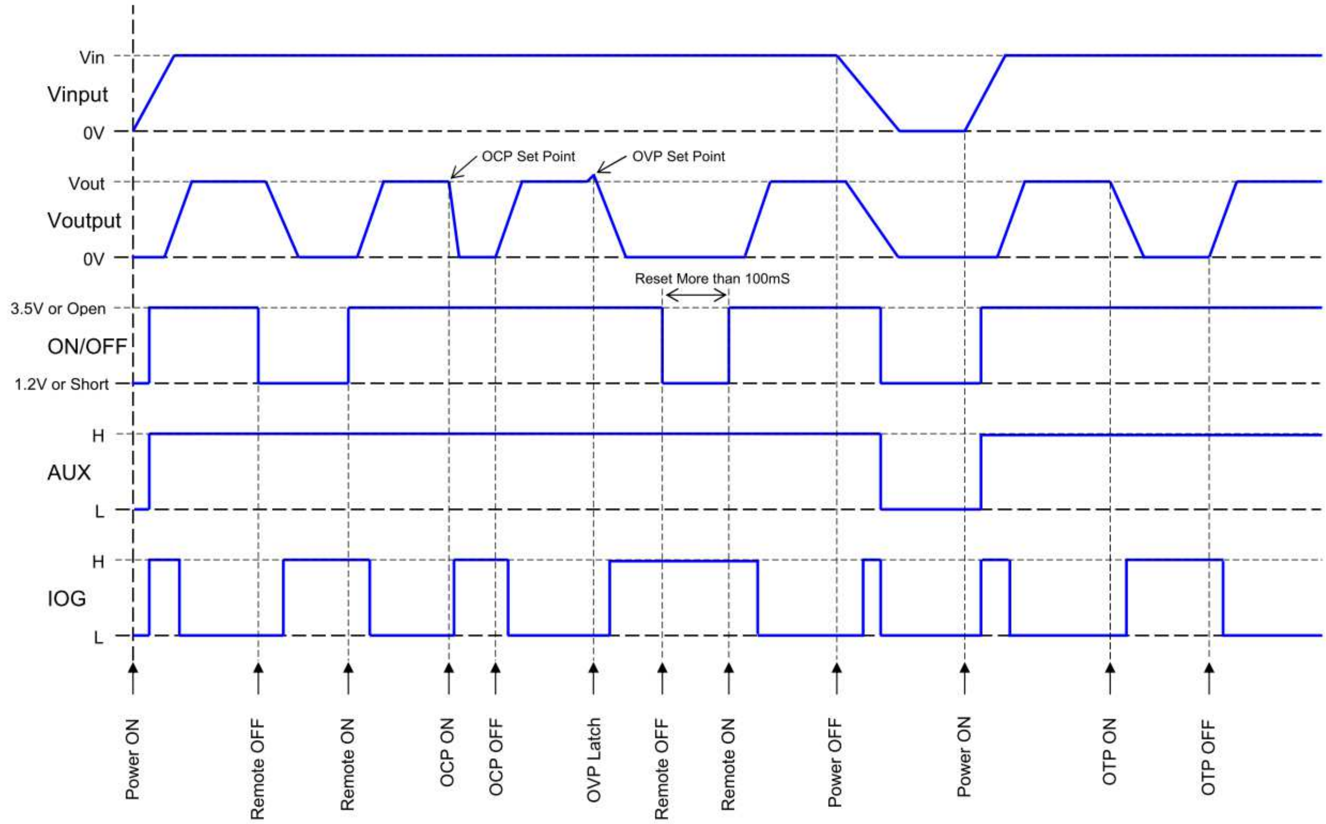
3. Function Block and Sequence Time Chart

3.1 Electrical Block Diagram



Electrical Block Diagram

3.2 Sequence Time Chart



Note:

1. On/Off Control, Positive Remote On/Off logic, Refer to –Vin pin
   Module on ……………………………. >3.5Vdc to 75Vdc or Open Circuit
   Module off ……………………………………….…………… 0 to <1.2Vdc
2. H Level: 7-13VDC

4. Technical Specifications

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

ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage						
Continuous		All	-0.3		425	V_{dc}
Transient	100ms	All			475	V_{dc}
Operating Case Temperature		All	-40		85	°C
Storage Temperature		All	-55		105	°C
Isolation Voltage	1 minute; input/output	All			3000	V_{ac}
	1 minute; input/case	All			2500	V_{ac}
	1 minute; output/case	All			500	V_{ac}

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		All	200	300	425	V_{dc}
Input Under Voltage Lockout						
Turn-On Voltage Threshold		All	185	190	195	V_{dc}
Turn-Off Voltage Threshold		All	175	180	185	V_{dc}
Lockout Hysteresis Voltage		All		10		V_{dc}
Input Over Voltage Protection						
Module-On Voltage		All		480		V_{dc}
Module -Off Voltage		All		500		V_{dc}
Maximum Input Current	100% Load, V_{in}=200V for All	All		4.3		A
No-Load Input Current		300S12		10		mA
		300S15		10		
		300S24		10		
		300S28		10		
		300S36		10		
		300S48		10		
Input Filter	Pi filter.	All				
Inrush Current (I^2t)	As per ETS300 132-2.	All			0.1	A^2s
Input Reflected Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz, **See 6.3**	All		60		mA

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	Vo=12V	11.88	12	12.12	V_{dc}
		Vo=15V	14.85	15	15.15	
		Vo=24V	23.76	24	24.24	
		Vo=28V	27.72	28	28.28	
		Vo=36V	35.64	36	36.36	
		Vo=48V	47.52	48	48.48	
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	Tc=-40°C to 85°C	All			±0.02	%/°C
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full load, 1000uF aluminun and 1.0uF ceramic capacitors.**See 6.12**	Vo=12V			300	mV
		Vo=15V			300	
		Vo=24V			600	
		Vo=28V			600	
		Vo=36V			650	
		Vo=48V			750	
RMS.		Vo=12V			150	mV
		Vo=15V			150	
		Vo=24V			300	
		Vo=28V			300	
		Vo=36V			300	
		Vo=48V			350	
Operating Output Current Range		Vo=12V	0		62.5	
		Vo=15V	0		50	A
		Vo=24V	0		31.2	
		Vo=28V	0		26.7	
		Vo=36V	0		20.8	
		Vo=48V	0		15.6	
Output DC Current Limit Inception	Continuous Current. Auto Recovery. **See 5.3**	All	105	115	125	%
Maximum Output Capacitance	Full load (resistive)	300S12	0		10000	uF
		300S15	0		10000	
		300S24	0		10000	
		300S28	0		10000	
		300S36	0		8000	
		300S48	0		8000	
Output Voltage Trim Range	P_{out}=max rated power, **See 6.10**	All	-40		+10	%
Output Over Voltage Protection	Limited Voltage, **See 5.4**	All	115	125	140	%

DYNAMIC CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Error Band	75% to 100% of I_{o_max} step load change d_i/d_t=0.1A/us (within 1% Vout nominal)	All			±5	%
Recovery Time		All			500	us
Turn-On Delay and Rise Time	Full load (Constant resistive load)					
Turn-On Delay Time, From On/Off Control	$V_{on/off}$ to 10%V_{o_set}	All		100		ms
Turn-On Delay Time, From Input	V_{in_min} to 10%V_{o_set}	All		600		ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All		40		ms

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	**Vin=300V, See 6.8**	300S12		89		
		300S15		89		%
		300S24		90		
		300S28		90		
		300S36		90		
		300S48		91		

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Isolation Voltage	1 minute; input/output	All			3000	V_{ac}
	1 minute; input/case,	All			2500	V_{ac}
	1 minute; output/case	All			500	V_{ac}
Isolation Resistance	Input/Output	All	10			MΩ
Isolation Capacitance	Input/Output	All		NC		uF
	Input/Case	All		NC		
	Output/Case	All		0.02		

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency	Pulse wide modulation (PWM), Fixed	All	170	200	230	KHz
On/Off Control, Positive Remote On/Off logic, Refer to –Vin pin.						
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	0		1.2	V
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.0uA	All	3.5 or Open Circuit		75	V

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
On/Off Control, Negative Remote On/Off logic, Refer to –Vin pin						
Logic High (Module Off)	$V_{on/off}$ at $I_{on/off}$=0.0uA	All	3.5 or Open Circuit		75	V
Logic Low (Module On)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	0		1.2	V
On/Off Current (for both remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0.0V	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic High, $V_{on/off}$=15V	All			30	uA
Off Converter Input Current	Shutdown input idle current	All		5	10	mA
Auxiliary Output Voltage		All	7	10	13	V
Auxiliary Output Current		All			20	mA
Over Temperature Shutdown	Aluminum baseplate temperature	All		95		°C
Over Temperature Recovery		All		75		°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		370		K hours
Weight		All		230		grams
Case Material	Plastic, DAP					
Baseplate Material	Aluminum					
Potting Material	UL 94V-0					
Pin Material	Base: Copper Plating: Nickel with Matte Tin					
Shock/Vibration	EN50155 / EN61373					
Humidity	95% RH max. Non Condensing					
Altitude	2000m Operating Altitude	12000m Transport Altitude				
Thermal Shock	MIL-STD-810F					
EMI	Meets EN55032	with external input filter, see 7.2				Class A
ESD	Meets IEC/EN61000-4-2	Air ± 8 kV, Contanct ± 4 kV				Perf. Criteria A
Radiated immunity	Meets IEC/EN61000-4-3	3 V/m				Perf. Criteria A
Fast Transient	Meets IEC/EN61000-4-4	± 1 kV, external input capacitor required, see 7.1				Perf. Criteria A
Surge	Meets IEC/EN61000-4-5 EN55024: Line to Earth ±4kV, Line to Line ±2kV, external circuit required, see 7.1					Perf. Criteria A
Conducted immunity	Meets IEC/EN61000-4-6	3Vrms				Perf. Criteria A
Power Frequency Magnetic Field Immunity	Meets IEC/EN61000-4-8	50/60Hz, 3A/m (r.m.s.)				Perf. Criteria A

5. Main Features and Functions

5.1 Operating Temperature Range

The CFB750-300S series converters can be operated within a wide case temperature range of -40°C to 85°C. Consideration must be given to the derating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from open full brick models is influenced by usual factors, such as:

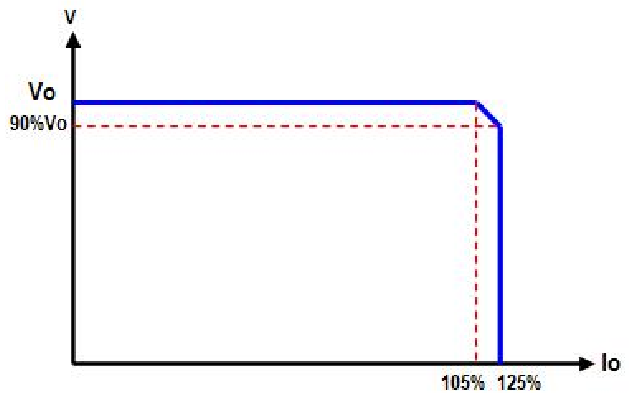
- Input voltage range
- Output load current
- Forced air or natural convection
- Heat sink optional

5.2 Output Voltage Adjustment

Section 6.10 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 +10% to –40%.

5.3 Over Current Protection

All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into Constant Current mode protection.



5.4 Output Over Voltage Protection

The output over voltage protection consists of circuitry that internally limits the output voltage. If more accurate output over voltage protection is required then an external circuit can be used via the remote on/off pin.

Note: Please note that device inside the power supply might fail when voltage more than rate output voltage is applied to output pin. This could happen when the customer tests the over voltage protection of unit.

5.5 Remote On/Off

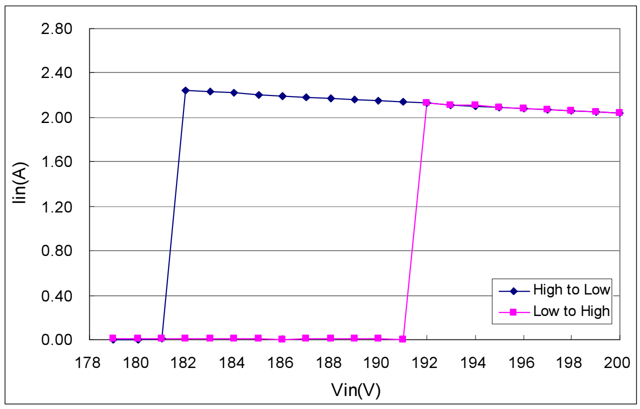
The CFB750-300S series allows the user to switch the module on and off electronically with the remote on/off feature. All models are available in “positive logic” and “negative logic” (optional) versions. The converter turns on if the remote on/off pin is high (>3.5Vdc to 75Vdc or open circuit). Setting the pin low (0 to <1.2Vdc) will turn the converter off. The signal level of the remote on/off input is defined with respect to ground. If not using the remote on/off pin, leave the pin open (converter will be on). Models with part number suffix “N” are the “negative logic” remote on/off version. The unit turns off if the remote on/off pin is high (>3.5Vdc to 75Vdc or open circuit). The converter turns on if the on/off pin input is low (0 to <1.2Vdc). Note that the converter is off by default. **See 6.14**

Logic State (Pin 2)	Negative Logic	Positive Logic
Logic Low – Switch Closed	Module on	Module off
Logic High – Switch Open	Module off	Module on

5.6 UVLO (Under Voltage Lock Out)

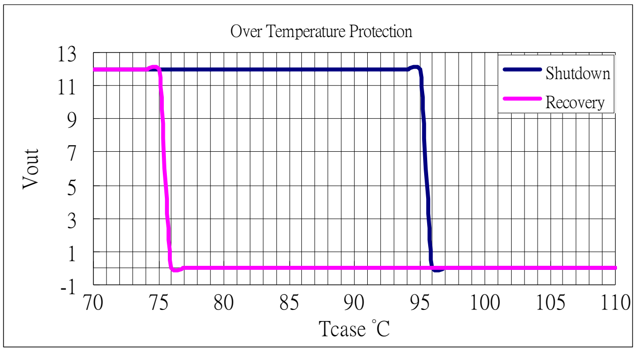
Input under voltage lockout is standard on the CFB750-300S unit. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

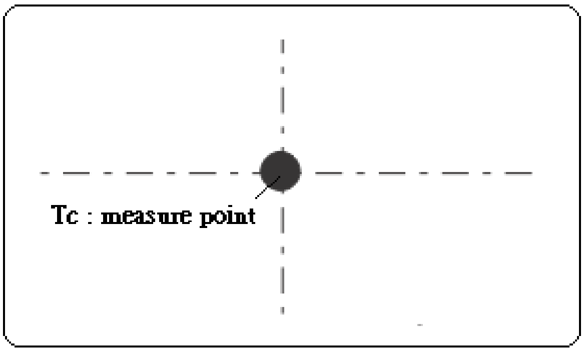
Iin Vs Vin

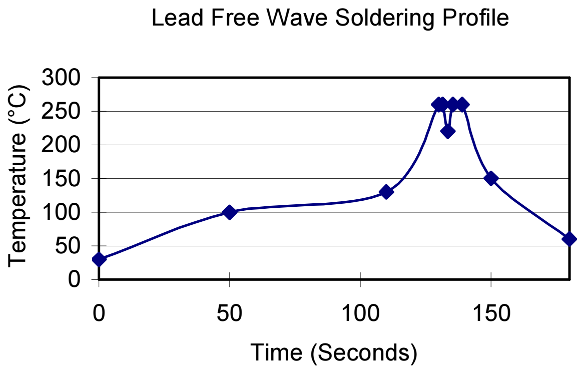


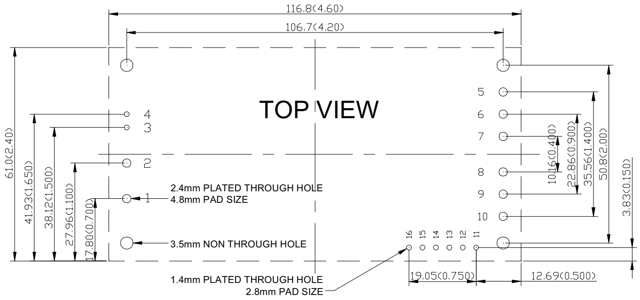
5.7 Over Temperature Protection

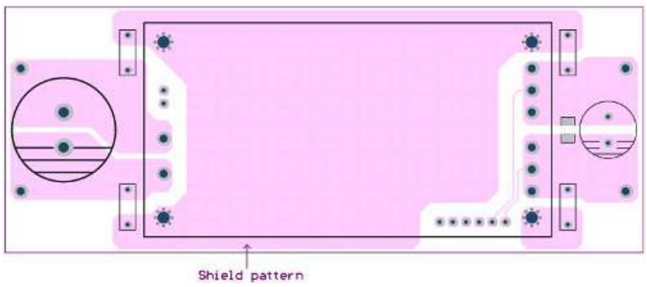
These modules have an over temperature protection circuit to safeguard against thermal damage. Shutdown occurs with the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below over temperature recovery threshold. Please measure case temperature of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











6. Applications

6.1 Recommend 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.

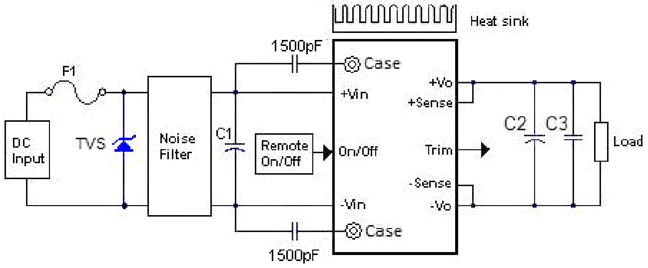
Clean the soldered side of the module with a brush, Prevent liquid from getting into the module. Do not clean by soaking the module into liquid. Do not allow solvent to come in contact with product labels or resin case as this may changed the color of the resin case or cause deletion of the letters printed 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.

6.2 Connection for Standard Use

The connection for standard use is shown below. An external input capacitor (C1) 330uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 1000uF aluminum and 1uF ceramic capacitor.

The CFB750-300S series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 10A 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).

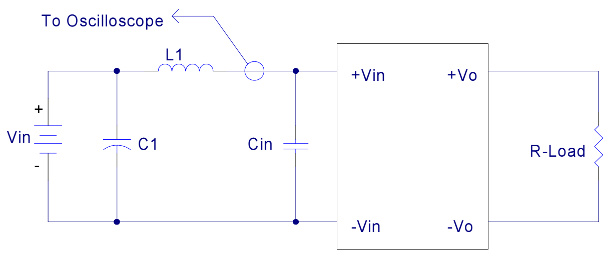


Symbol	Component	Reference
F1	Input fuse	**Section 7.1**
C1	External capacitor on input side	**Note**
C2, C3	External capacitor on the output side	**Section 6.12/6.13**
Noise Filter	External input noise filter	**Section 7.2**
Remote On/Off	External Remote On/Off control	**Section 6.16**
Trim	External 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: 330uF ESR<0.7ohm @100KHz
Cin: 330uF ESR<0.7ohm @100KHz

6.4 Convection Requirements for Cooling

To predict the approximate cooling needed for the quarter 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 85°C as measured at the center of the top of the case (thus verifying proper cooling).

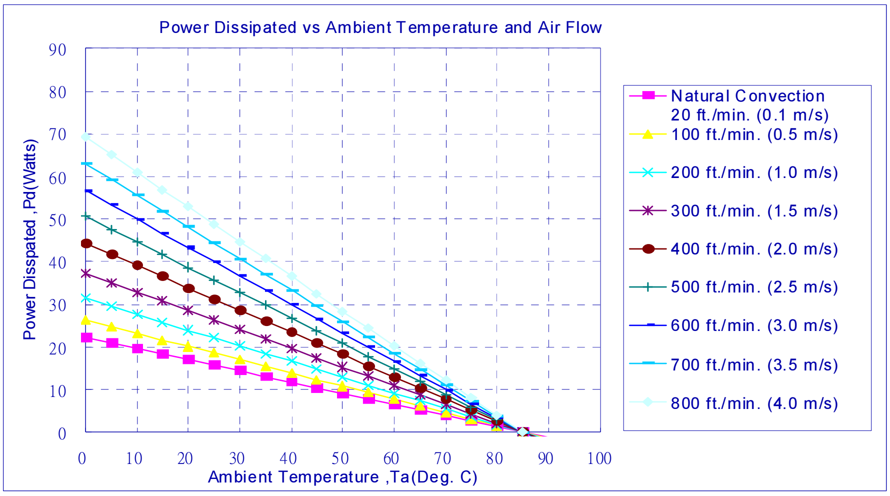
6.5 Thermal Considerations

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 example 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 Derating

The operating case temperature range of CFB750-300S series is -40°C to +85°C. When operating the CFB750-300S series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 85°C.

The following curve is the de-rating curve of CFB750-300S series without heat sink.



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

Example:

What is the minimum airflow necessary for a CFB750-300S48 operating at nominal line voltage, an output current of 11A, and a maximum ambient temperature of 25°C?

Solution:
Given:

V_{in}=300V_{dc}, Vo=48V_{dc}, I_o=10A

Determine Power dissipation (P_d):

$P_d = P_i - P_o = P_o(1-\eta)/\eta$

P_d =48V×10A×(1-0.91)/0.91=47.47Watts

Determine airflow:

Given: P_d =47.47W and T_a=25°C

Check *Power Derating* curve:

Minimum airflow= 800 ft./min.

Verify:

Maximum temperature rise is

ΔT = Pd × Rca=47.47W×1.23=58.38°C.

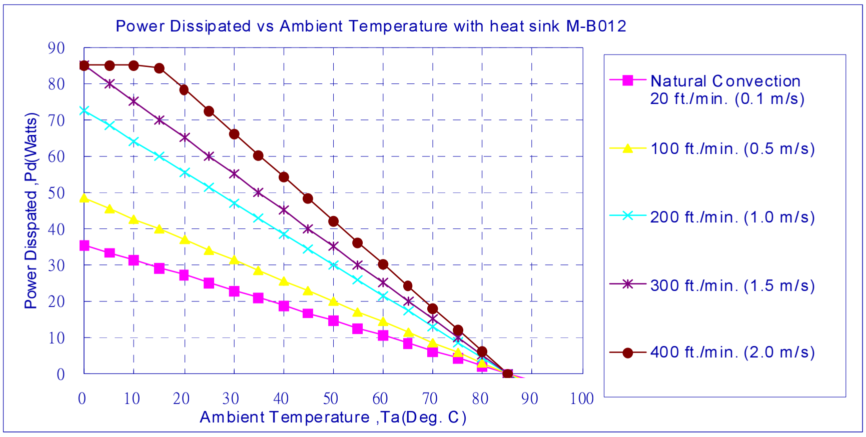
Maximum case temperature is

Tc=Ta+ΔT=83.38°C <85°C.

Where:

The Rca is thermal resistance from case to ambient environment.

Ta is ambient temperature and Tc is case temperature.



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

Example with heat sink FBL254 (M-B012):

What is the minimum airflow necessary for a CFB750-300S48 operating at nominal line voltage, an output current of 15.6A, and a maximum ambient temperature of 20℃?

Solution:

Given:

Vin=300Vdc, Vo=48Vdc, Io=15.6A

Determine Power dissipation (P_d):

Pd=Pi-Po=Po(1-η)/η

Pd=48×15.6×(1-0.91)/0.91=74.1Watts

Determine airflow:

Given: Pd=74.1W and Ta=20℃

Check above Power de-rating curve:

Minimum airflow= 400 ft./min

Verify:

Maximum temperature rise is $\Delta T = P_d \times R_{ca}$=74.1×0.83=61.5℃

Maximum case temperature is Tc=Ta+△T=81.5℃ <85℃

Where:

The Rca is thermal resistance from case to ambient environment.

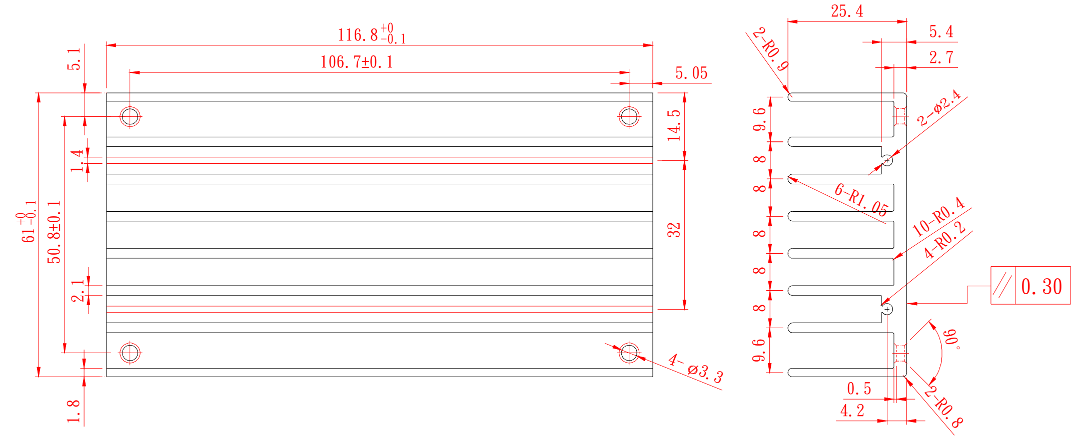
Ta is ambient temperature and Tc is case temperature.

6.7 Full Brick Heat Sinks:

Heat-sink FBL254 (M-B012)

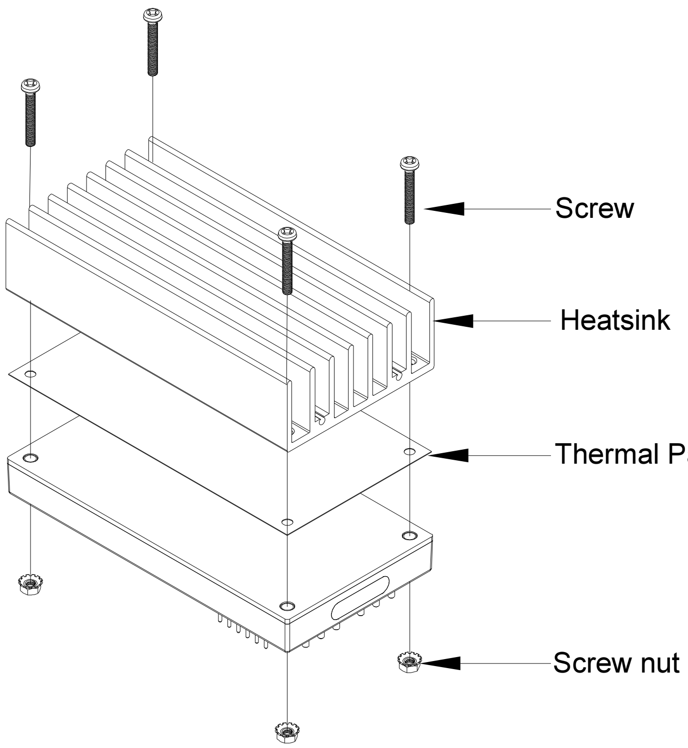
All Dimension In mm

Longitudinal Fins



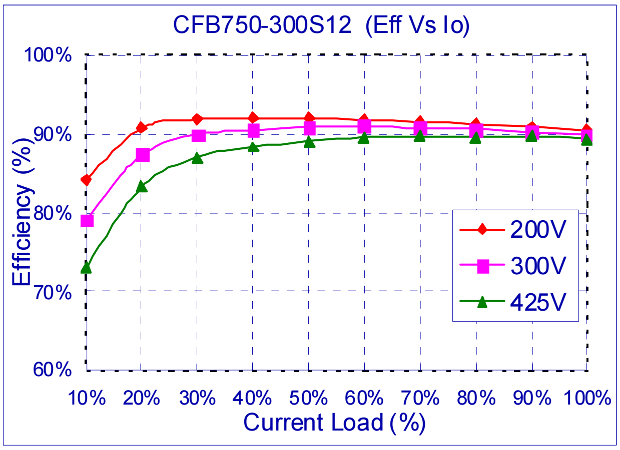
Heat Sink (Clear Mounting Inserts Φ3.3mm Through): 116.8*61*25.4 FBL254 (M-B012) G6620090204
Thermal PAD PF01: PMP-P400 60*115.8*0.23 (G6135041073)
Screw Nut K320N: M3*20L (G75A1300052) & NH+WOM3*P0.5N (G75A2440392)

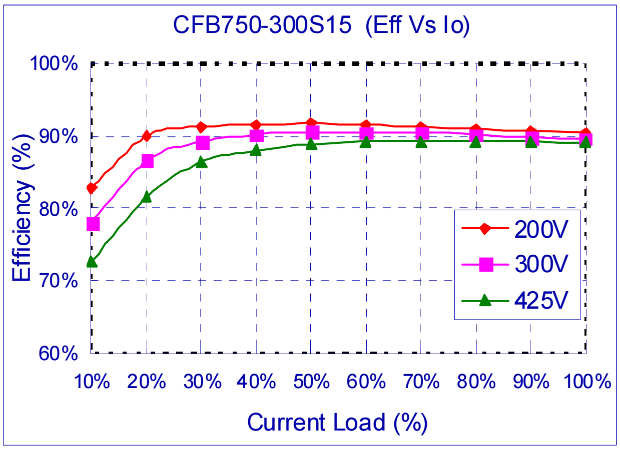
Full Brick Heat Sink Assembly

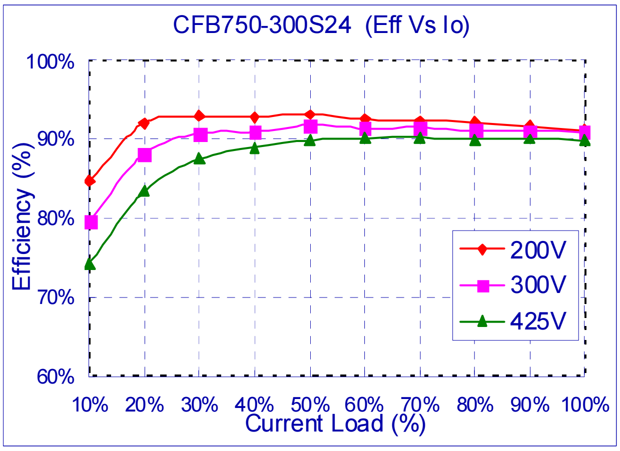


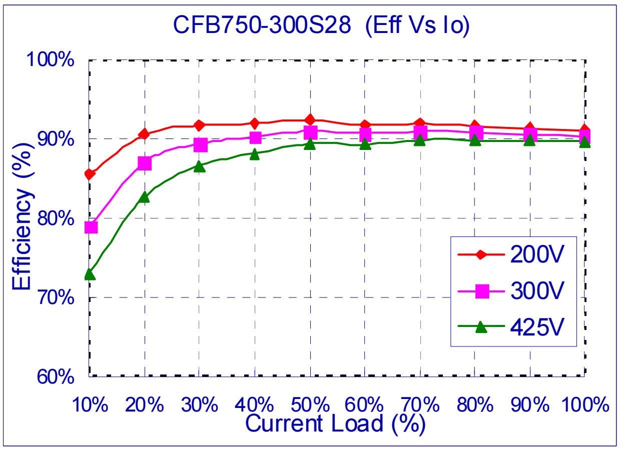
Heat Sink: FBL254 (M-B012)
Thermal PAD PF01: PMP-P400 60*115.8*0.25 (G6135041073)
Screw & Nut K320N:
M3*20L (G75A1300052) & NH+WOM3*P0.5N(G75A2440392)

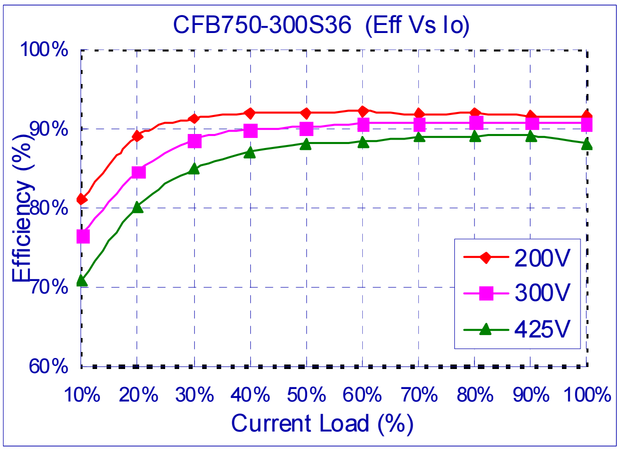
6.8 Efficiency VS. Load

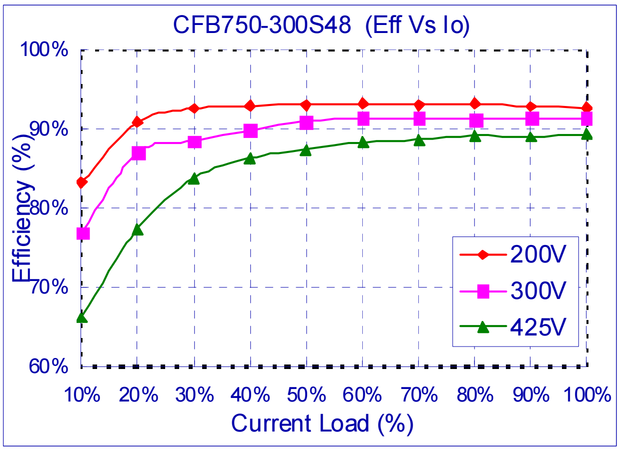












6.9 Test Set-Up

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:

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

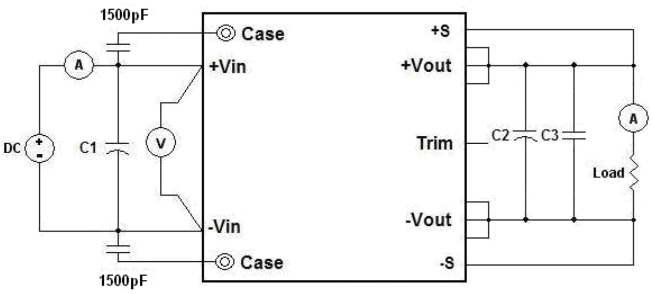
Where:

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.

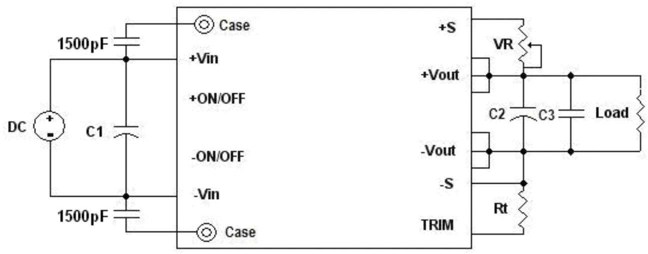


CFB750-300S Series Test Setup

C1: 330uF/450V ESR<0.7Ω
C2: 1000uF aluminum capacitor.
C3: 1uF/ 1210 ceramic capacitor

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, This is shown:



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

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

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

Rt, VR Unit: KΩ
Vo: Nominal Output Voltage
Recommend Rt=6.8KΩ

For example, to trim-up the output voltage of 24V module (CFB750-300S24) 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:

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

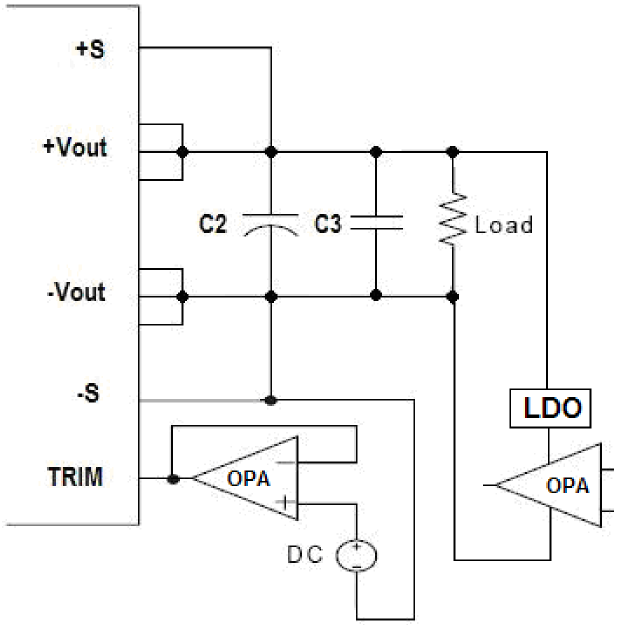
The typical value of R_{trim_up}

Trim up %	12V	15V	24V	28V	36V	48V
	R_{trim_up} (KΩ)					
1%	11.09	13.86	22.17	25.87	33.26	44.34
2%	11.31	14.14	22.63	26.40	33.94	45.26
3%	11.54	14.43	23.09	26.93	34.63	46.17
4%	11.77	14.71	23.54	27.47	35.31	47.09
5%	12.00	15.00	24.00	28.00	36.00	48.00
6%	12.23	15.29	24.46	28.53	36.69	48.91
7%	12.46	15.57	24.91	29.07	37.37	49.83
8%	12.69	15.86	25.37	29.60	38.06	50.74
9%	12.91	16.14	25.83	30.13	38.74	51.66
10%	13.14	16.43	26.29	30.67	39.43	52.57

The typical value of R_{trim_down}

Trim down %	12V	15V	24V	28V	36V	48V
	R_{trim_down} (KΩ)					
1%	10.63	13.29	21.26	24.80	31.89	42.51
2%	10.40	13.00	20.80	24.27	31.20	41.60
3%	10.17	12.71	20.34	23.73	30.51	40.69
4%	9.943	12.43	19.89	23.20	29.83	39.77
5%	9.714	12.14	19.43	22.67	29.14	38.86
6%	9.486	11.86	18.97	22.13	28.46	37.94
7%	9.257	11.57	18.51	21.60	27.77	37.03
8%	9.029	11.29	18.06	21.07	27.09	36.11
9%	8.800	11.00	17.60	20.53	26.40	35.20
10%	8.571	10.71	17.14	20.00	25.71	34.29
11%	8.343	10.43	16.69	19.47	25.03	33.37
12%	8.114	10.14	16.23	18.93	24.34	32.46
13%	7.886	9.857	15.77	18.40	23.66	31.54
14%	7.657	9.571	15.31	17.87	22.97	30.63
15%	7.429	9.286	14.86	17.33	22.29	29.71
16%	7.200	9.000	14.40	16.80	21.60	28.80
17%	6.971	8.714	13.94	16.27	20.91	27.89
18%	6.743	8.429	13.49	15.73	20.23	26.97
19%	6.514	8.143	13.03	15.20	19.54	26.06
20%	6.286	7.857	12.57	14.67	18.86	25.14
21%	6.057	7.571	12.11	14.13	18.17	24.23
22%	5.829	7.286	11.66	13.60	17.49	23.31
23%	5.600	7.000	11.20	13.07	16.80	22.40
24%	5.371	6.714	10.74	12.53	16.11	21.49
25%	5.143	6.429	10.29	12.00	15.43	20.57
26%	4.914	6.143	9.829	11.47	14.74	19.66
27%	4.686	5.857	9.371	10.93	14.06	18.74
28%	4.457	5.571	8.914	10.40	13.37	17.83
29%	4.229	5.286	8.457	9.867	12.69	16.91
30%	4.000	5.000	8.000	9.333	12.00	16.00
31%	3.771	4.714	7.543	8.800	11.31	15.09
32%	3.543	4.429	7.086	8.267	10.63	14.17
33%	3.314	4.143	6.629	7.733	9.943	13.26
34%	3.086	3.857	6.171	7.200	9.257	12.34
35%	2.857	3.571	5.714	6.667	8.571	11.43
36%	2.629	3.286	5.257	6.133	7.886	10.51
37%	2.400	3.000	4.800	5.600	7.200	9.600
38%	2.171	2.714	4.343	5.067	6.514	8.686
39%	1.943	2.429	3.886	4.533	5.829	7.771
40%	1.714	2.143	3.429	4.000	5.143	6.857

The output voltage can also be adjustment by using external DC voltage, This is shown:



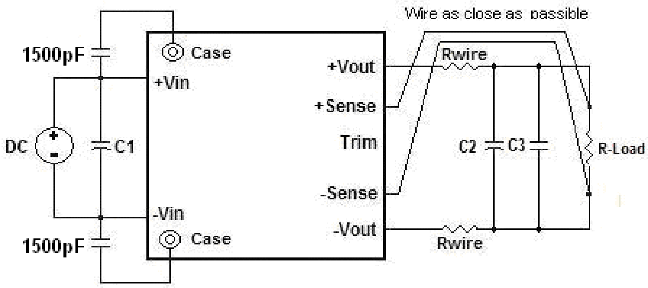
*Output Voltage = TRIM Terminal Voltage * Nominal Output Voltage*

6.11 Output Remote Sensing

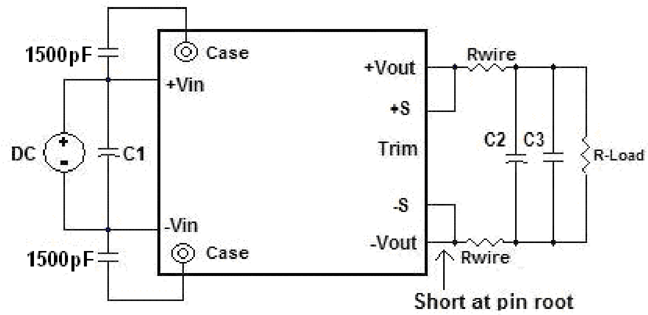
The CFB750-300S series converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the CFB750-300S 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.

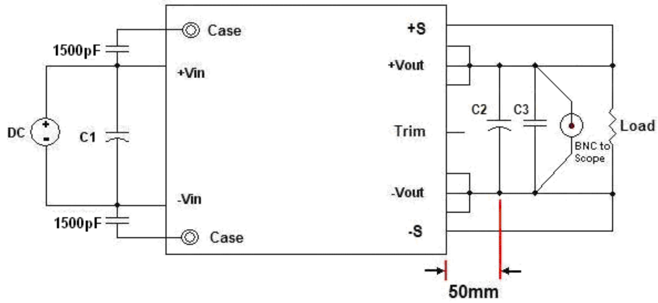


If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module. Wire between +Sense and +Vout and between -Sense and –Vout as short as possible. Loop wiring should be avoided. The converter might become unstable by noise coming from poor wiring. This is shown in the schematic below.



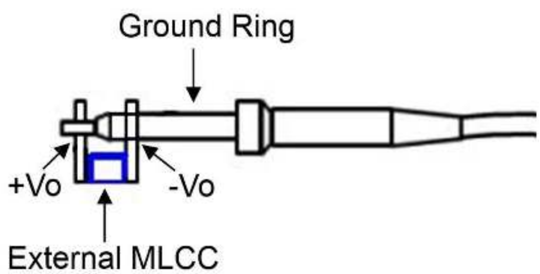
Note: Although the output voltage can be varied (increased or decreased) by both remote sense and trim, the maximum variation for the output voltage is the larger of the two values not the sum of the values. The output power delivered by the module is defined as the voltage at the output terminals multiplied 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 1000uF aluminum 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.

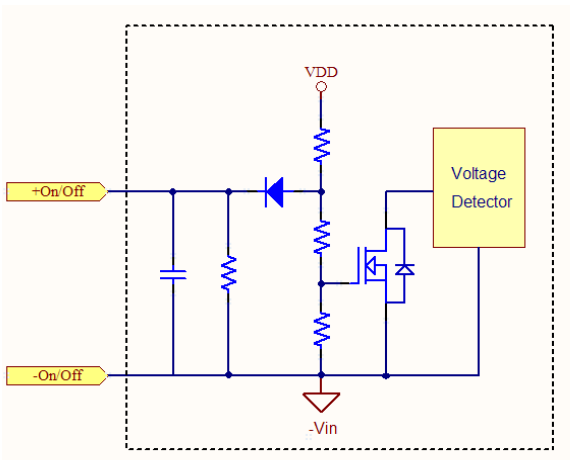


6.13 Output Capacitance

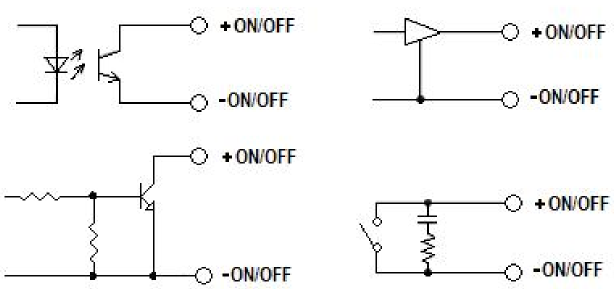
The CFB750-300S series converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load (<100mm). PCB design emphasizes low resistance and inductance tracks in consideration of high current 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 Remote On/Off Circuit

The converter remote On/Off circuit built-in on input side. The ground pin of input side remote On/Off circuit is –Vin pin. **Refer to 5.5** for more details. Connection examples see below.



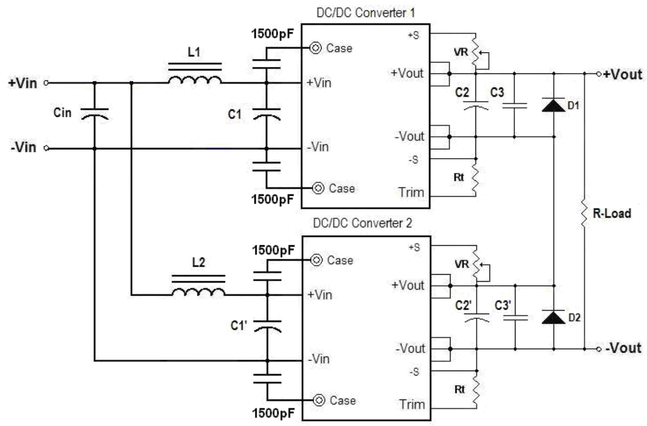
External connection examples see below.



Remote On/Off Connection Example

6.15 Series Operation

Series operation is possible by connecting the outputs two or more units. Connection is shown in below. The output current in series connection should be lower than the lowest rate current in each power module.



Simple Series Operation Connect Circuit

L1, L2: 1.0uH

Cin, C1, C1': 330uF/450V ESR<0.7Ω

C2, C2': 1000uF

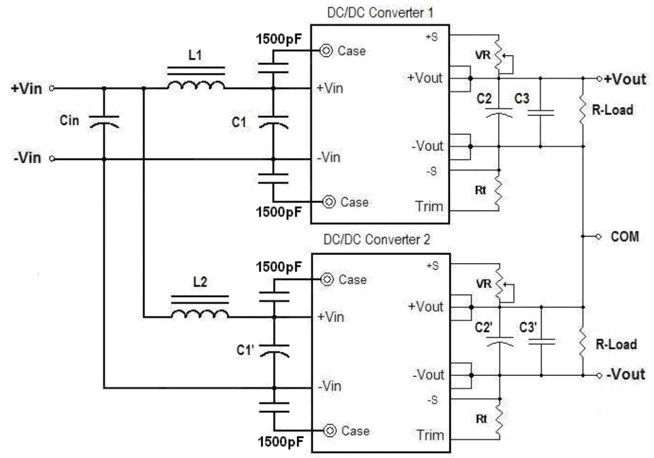
C3, C3': 1uF MLCC

Note:

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

2. Recommend Schottky diode (D1, D2) be connected across the output of each series connected converter, so that if one converter shuts down for any reason, then the output stage won't be thermally overstressed. Without this external diode, the output stage of the shut-down converter could carry the load current provided by the other series converters, with its MOSFETs conducting through the body diodes. The MOSFETs could then be overstressed and fail. The external diode should be capable of handling the full load current for as long as the application is expected to run with any unit shut down.

Series for ±output operation is possible by connecting the outputs two units, as shown in the schematic below.



Simple ±Output Operation Connect Circuit

L1, L2: 1.0uH
Cin, C1, C1’: 330uF/450V ESR<0.7Ω
C2, C2’: 1000uF
C3, C3’: 1uF MLCC

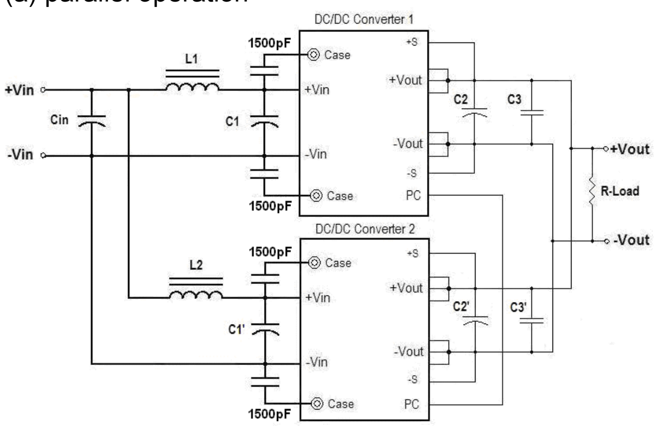
Note:

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

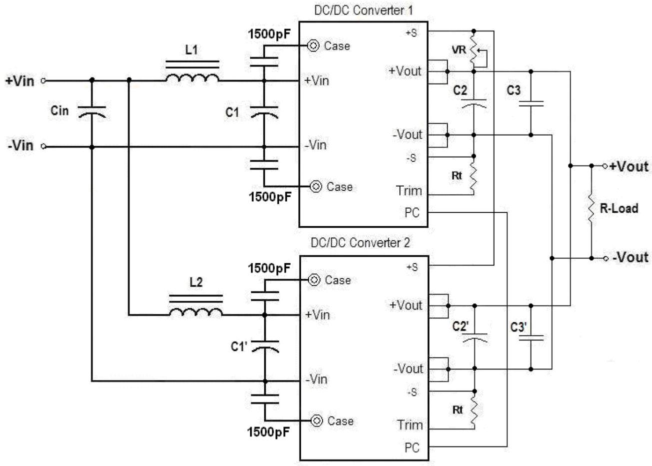
6.16 Parallel/Redundant Operation

The CFB750-300S 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 CFB750-300S 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.

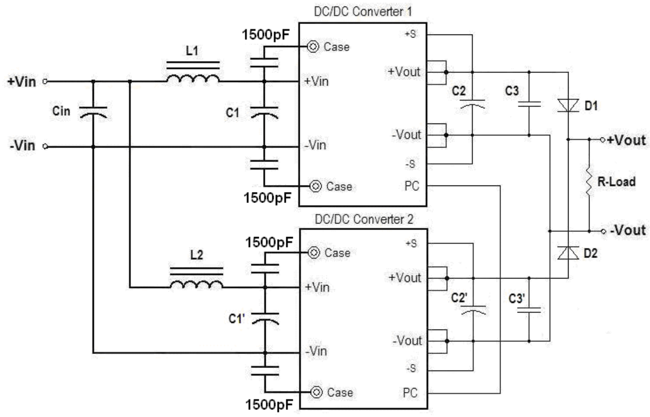
(a) parallel operation



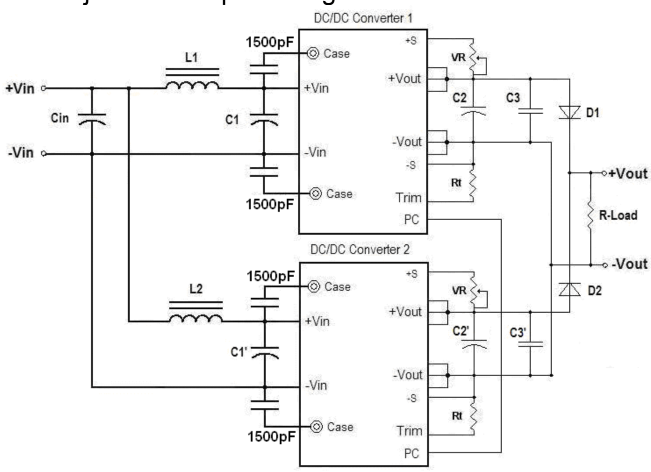
(b) Parallel operation with programmed and adjustable output



(c) N+1 redundant connection



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



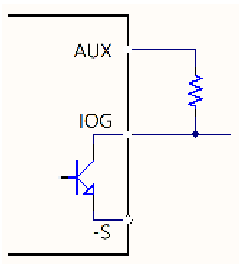
L1, L2: 1.0uH
Cin, C1, C1’: 330uF/450V ESR<0.7Ω
C2, C2’: 1000uF
C3, C3’: 1uF MLCC

Note:

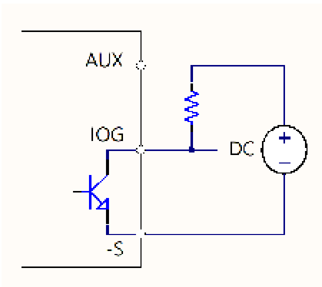
If the impedance of input line is high, Cin, C1 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃

6.17 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 ow when the converter is normally operating and HIGH when the converter is disabled or when the converter is abnormally operating.

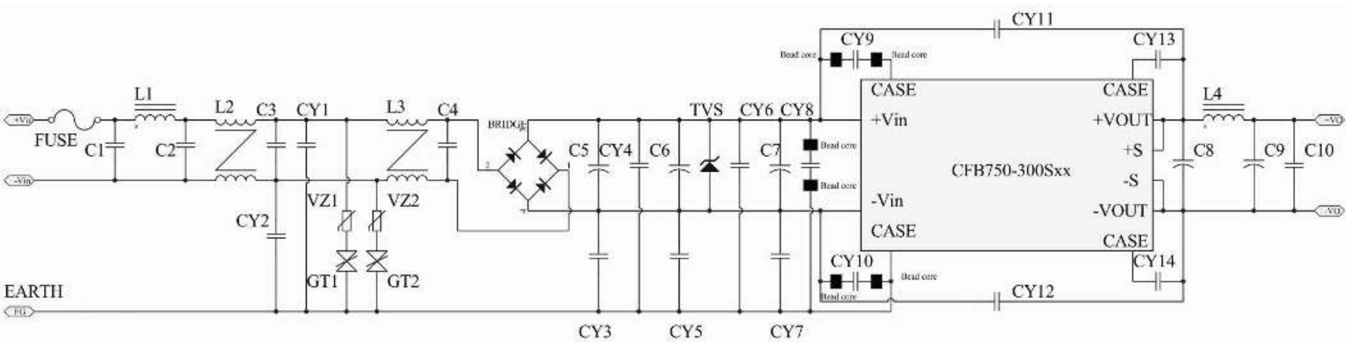
6.18 Auxiliary Power for Output Signal

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

7. Safety & EMC

7.1 Input Fusing and Safety Considerations

The CFB750-300S series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 10A 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).



The external circuit is required if CFB750-300SXX series has to meet EN61000-4-4, EN61000-4-5.
The CFB750-300SXX recommended components are shown below.
C5, C6, C7: 330uF/450V aluminum capacitor (Nippon Chemi-Con KMR series).
VZ1, VZ2: TVR10471KSV TKS
GT1, GT2: B5G3000 BENCENT

7.2 AC Input EMC Considerations

EMI Test standard: EN55022/EN55032 Class A Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load
(1) EMI and conducted noise meet EN55022/EN55032 Class A:

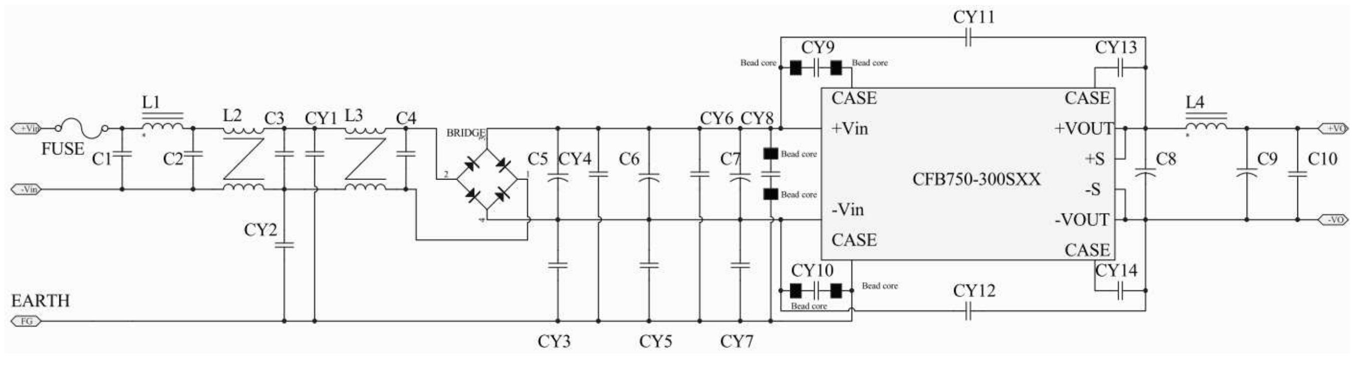


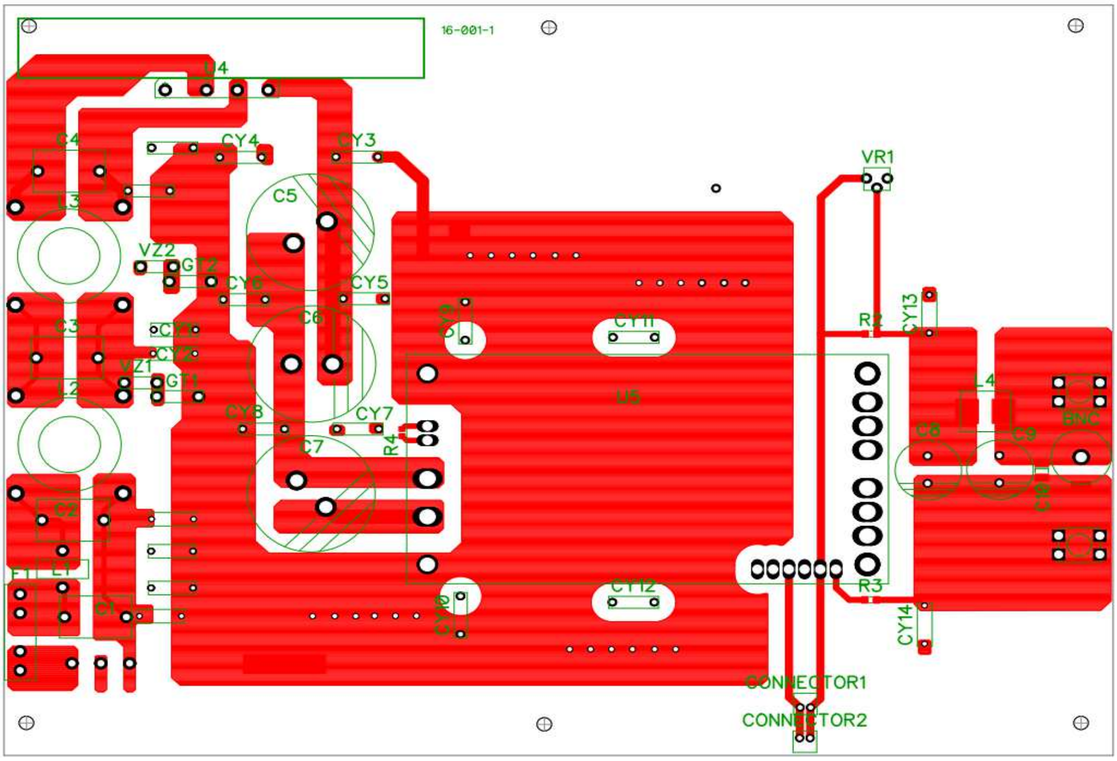
Figure1 Connection circuit for conducted EMI Class A testing

(2) EMI and conducted noise meet EN55022/EN55032 Class A specifications:

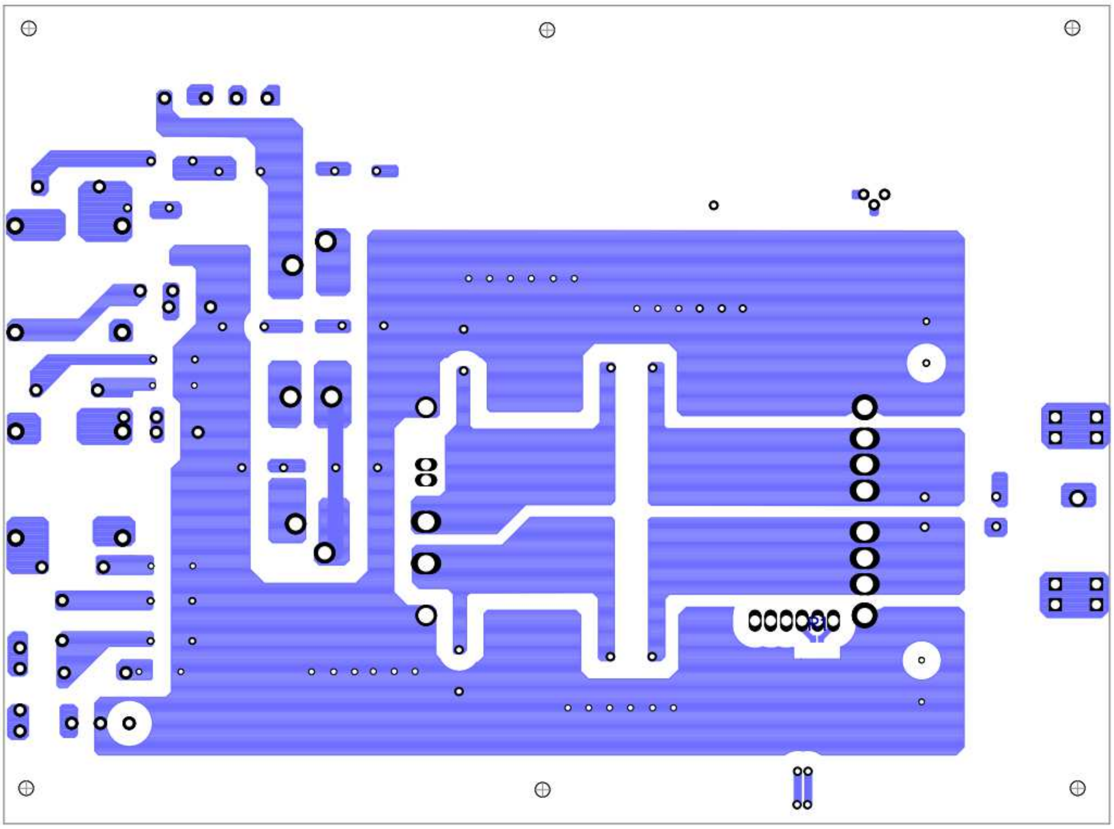
	Model Number					
	CFB750-300S12	CFB750-300S15	CFB750-300S24	CFB750-300S28	CFB750-300S36	CFB750-300S48
C1	0.68uF					
C2						
C3						
C4						
C5	330uF					
C6						
C7						
C8	820uF					
C9						
C10	1uF					
CY1	2200pF					
CY2						
CY5	330pF					
CY6	100pF					
CY7	220pF					
CY8	100pF					
CY9	2200pF					
CY10						
CY11	150 pF	NC				
CY12	100 pF	NC				
CY13	0.022uF					
CY14						
L1	Short					
L2	4.2mH					
L3	4.2mH					
L4	Short					
Bead Core	CY8, CY9, CY10					

Note:

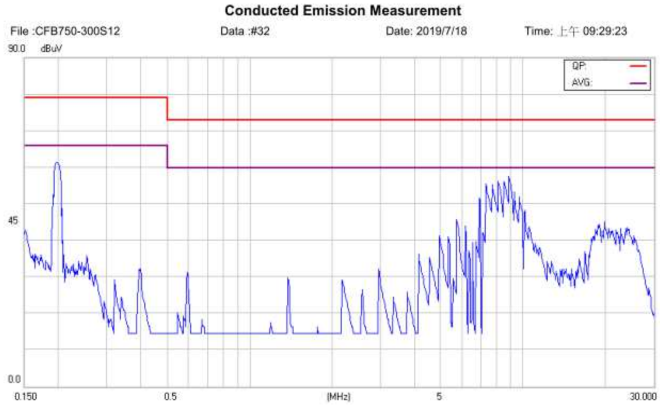
C1, C2, C3, C4 X2 capacitors, C5, C6, C7, C8, C9 aluminum capacitors, CY1, CY2, CY5, CY6, CY8, CY9, CY10, CY11, CY12, C10, ceramic capacitors, CY13, CY14 X2 capacitors
C1, C2, C3, C4: 0.68uF/305VAC (FARATRONIC MKP62 Series C42Q2684M6HC000) or equivalent.
C5, C6, C7: 330uF/450V (NIPPON CHEMI-CON KMR Series EKMR451VSN331MR35S) or equivalent.
C8, C9: 820uF/63V (Rubycon ZLH Series 63ZLH820MEFC16X25) or equivalent.
CY1, CY2, CY5, CY6, CY7, CY8, CY9, CY10, CY11, CY12:
100pF (CD Series TDK) or equivalent.
150pF (CD Series TDK) or equivalent.
220pF (CD Series TDK) or equivalent.
330pF (CD Series TDK) or equivalent.
2200pF (CD Series TDK) or equivalent.
C10: 1uF/100V (TDK CGA Series CGA8N2X7R2A105K230KA) or equivalent.
CY13, CY14: 0.022uF/275VAC MPX Series CARLI or equivalent.
L2, L3: 4.2mH (VAKOS T25*15*13 R8K Series φ0.8mm/20T) or equivalent.
Bead Core: BRI 4*1.5*2 CHILISIN for CY8, BRH3.5*3.2*1.2mm CHILISIN for CY9, CY10



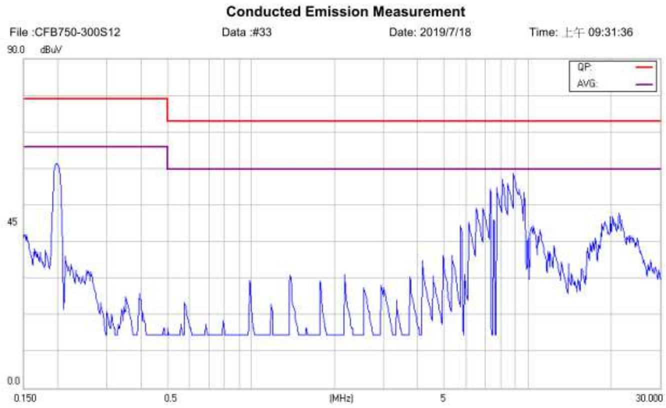
EMI test board top side



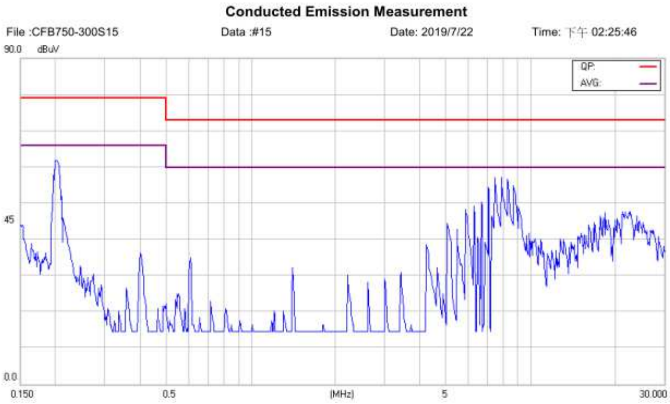
EMI test board bottom side



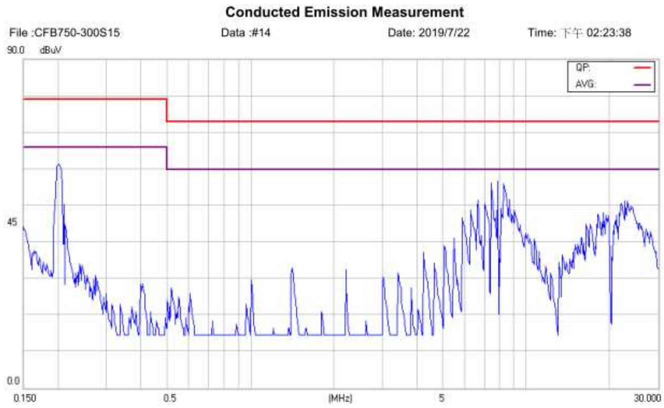
Conducted Class A of CFB750-300S12 Line



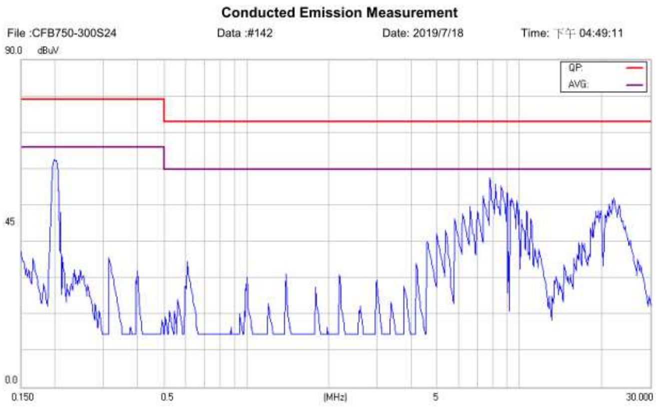
Conducted Class A of CFB750-300S12 Nature



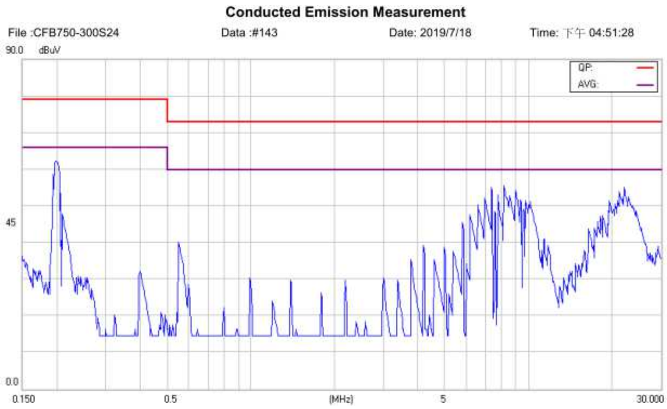
Conducted Class A of CFB750-300S15 Line



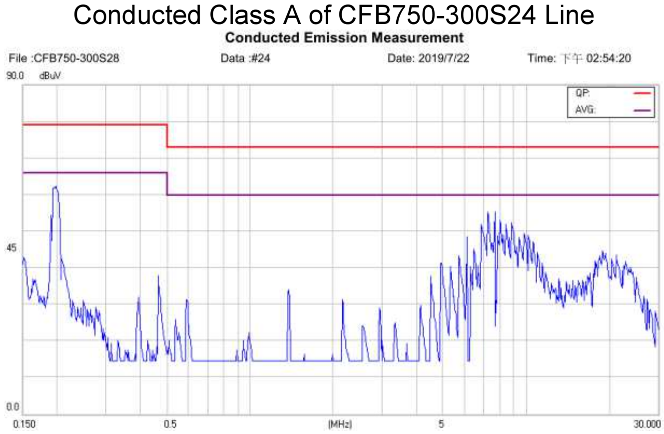
Conducted Class A of CFB750-300S15 Nature



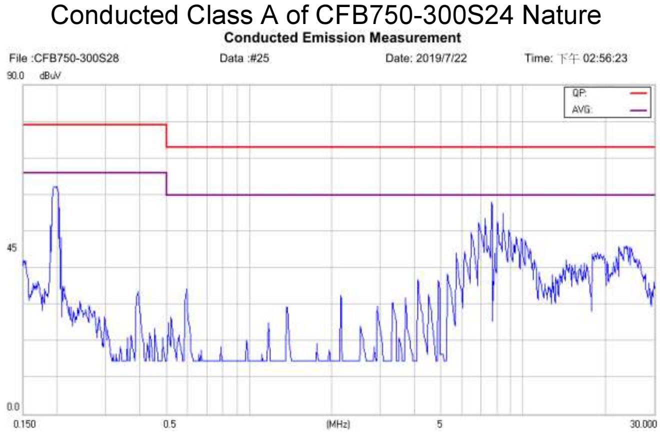
Conducted Class A of CFB750-300S24 Line



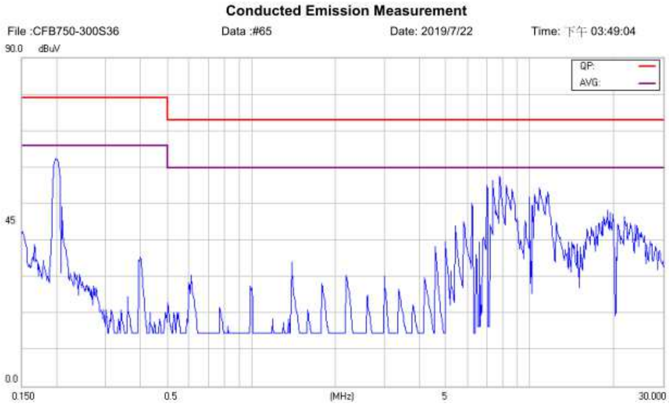
Conducted Class A of CFB750-300S24 Nature



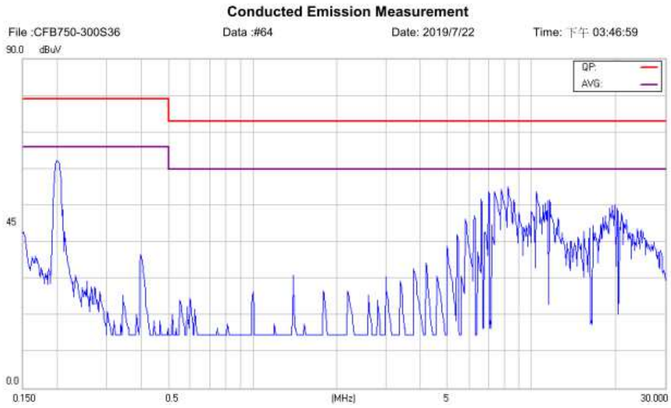
Conducted Class A of CFB750-300S28 Line



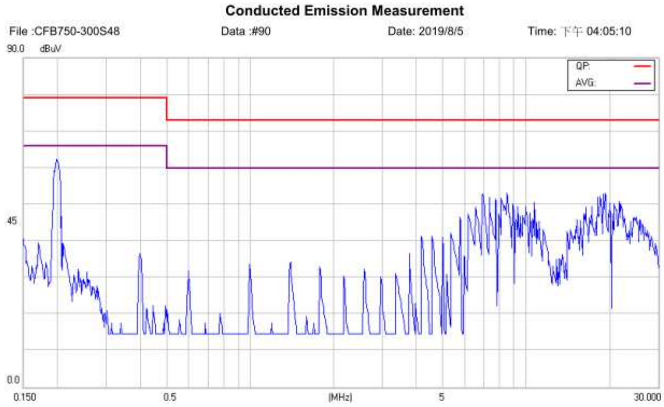
Conducted Class A of CFB750-300S28 Nature



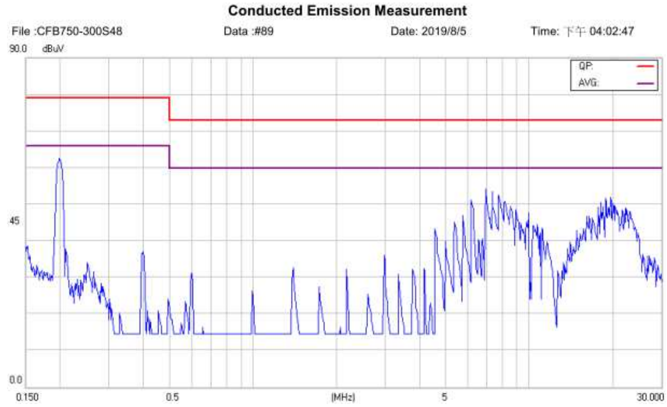
Conducted Class A of CFB750-300S36 Line



Conducted Class A of CFB750-300S36 Nature



Conducted Class A of CFB750-300S48 Line



Conducted Class A of CFB750-300S48 Nature

7.3 DC Input EMC Considerations

EMI Test standard: EN55022/EN55032 Class A Conducted Emission

Test Condition: Input Voltage: Nominal, Output Load: Full Load

(1) EMI and conducted noise meet EN55022/EN55032 Class A:

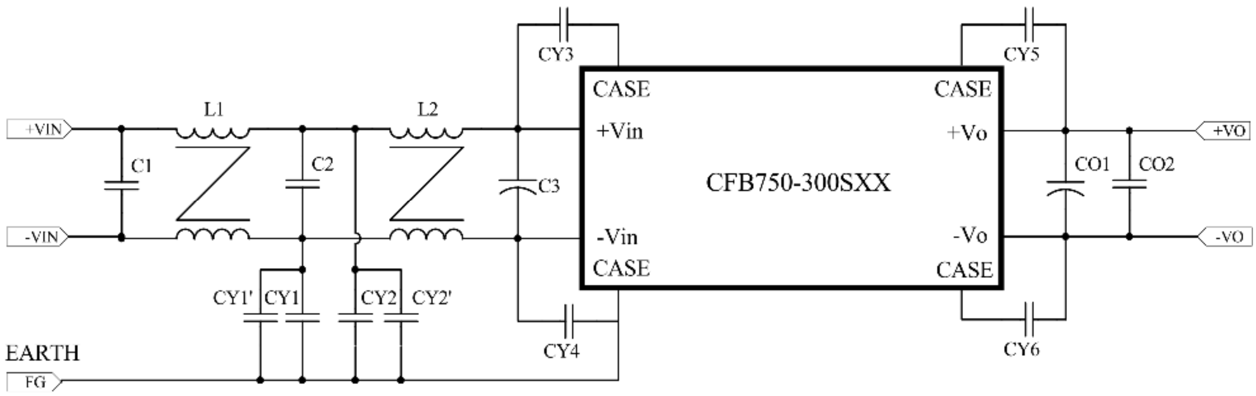


Figure2 Connection circuit for conducted EMI Class A testing

(1) EMI and conducted noise meet EN55022/EN55032 Class A specifications:

	Model Number					
	CFB750-300S12	**CFB750-300S15**	**CFB750-300S24**	**CFB750-300S28**	**CFB750-300S36**	**CFB750-300S48**
C1	0.68uF					
C2	0.68uF					
C3	150uF					
CO1	820uF					
CO2	1uF					
CY1	2200pF					
CY1’	470pF					
CY2	2200pF					
CY2’	470pF					
CY3	2200pF					
CY4	2200pF					
CY5	0.022uF					
CY6	0.022uF					
L1	4.2mH					
L2	4.2mH					

Note:

C1, C2, CY5, CY6: X2 capacitors, C3, Co1: aluminum capacitors, CY1, CY1’, CY2, CY2’, CY3, CY4, Co2 ceramic capacitors

C3: 150uF/450V (NIPPON CHEMI-CON KXG Series EKXG451ELL151MM45S) or equivalent.

Co1: 820uF/63V (Rubycon ZLH Series 63ZLH820MEFC16X25) or equivalent.

CY1, CY1’, CY2, CY2, CY3, CY4:

2200pF CD Series TDK or equivalent.

470pF CD Series TDK or equivalent.

Co2: 1uF/100V (TDK CGA Series CGA8N2X7R2A105K230KA) or equivalent.

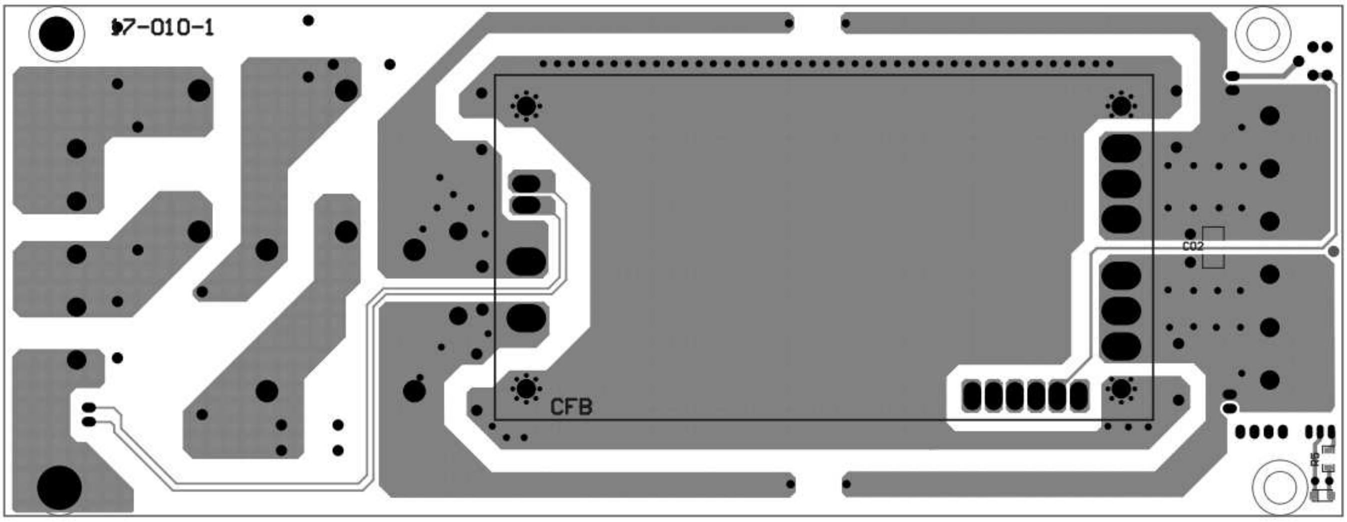
C1, C2, CY5, CY6:

0.68uF/305VAC MKP Series HJC or equivalent.

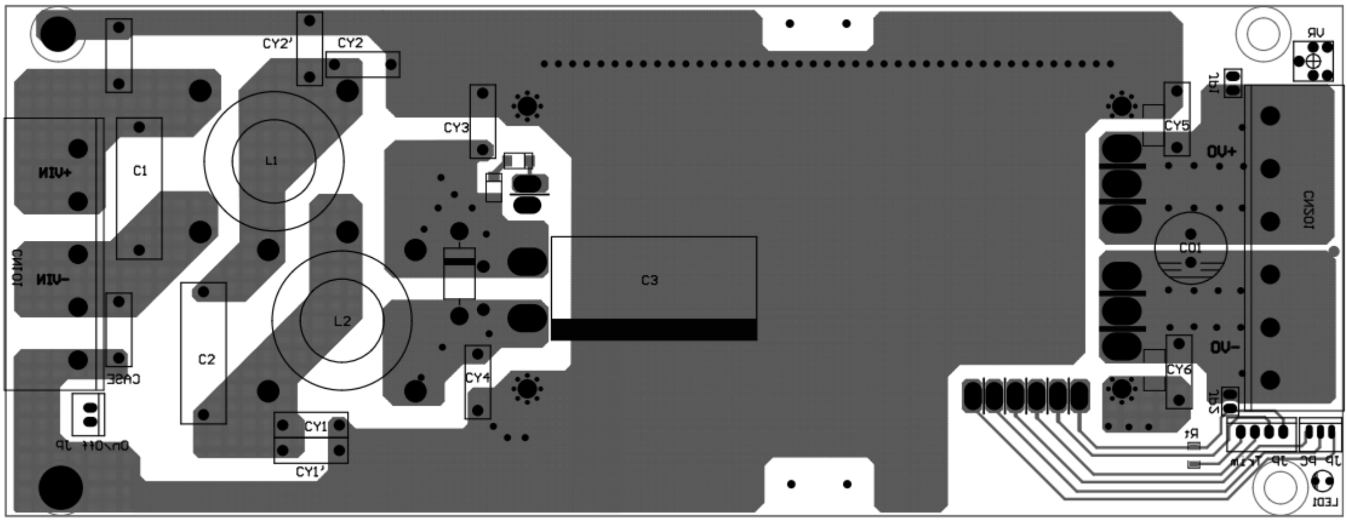
0.022uF/275VAC MPX Series CARLI or equivalent.

L1, L2:

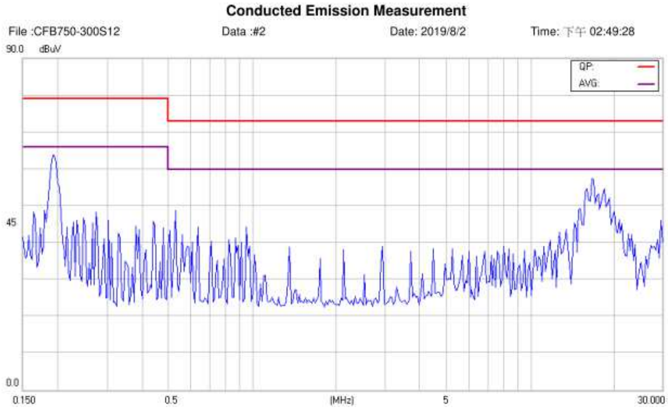
4.2mH (VAKOS T25*15*13 R8K Series φ0.8mm/20T) or equivalent.



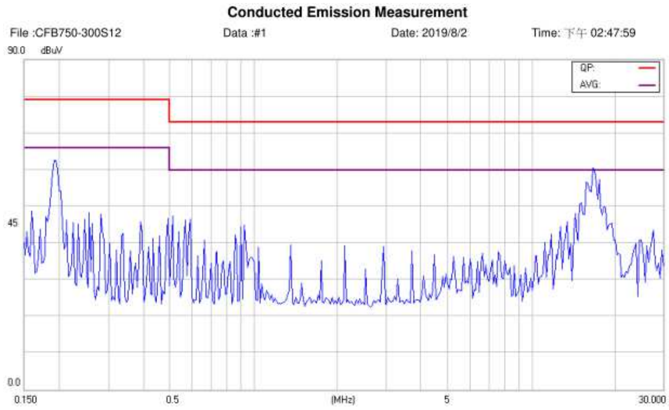
EMI test board top side



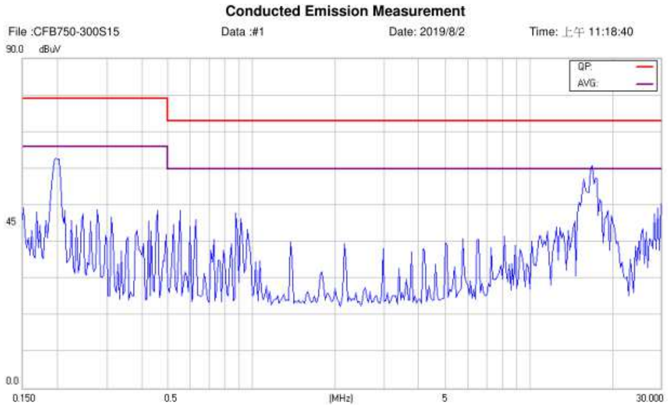
EMI test board bottom side



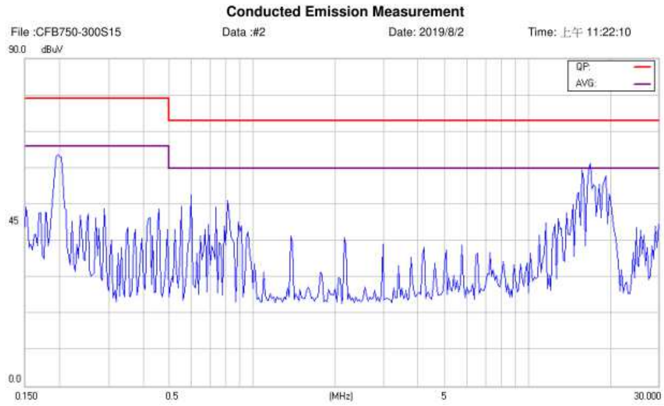
Conducted Class A of CFB750-300S12 Line



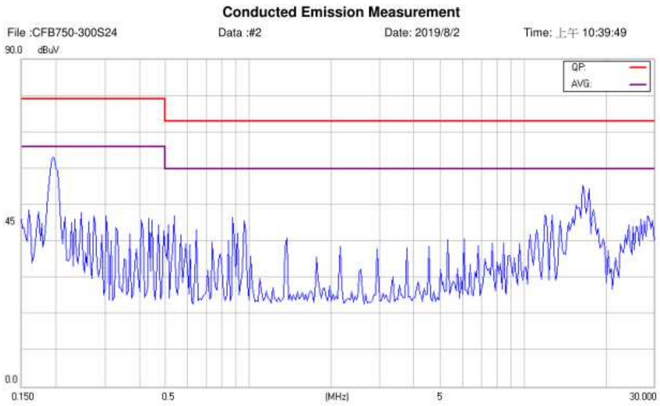
Conducted Class A of CFB750-300S12 Nature



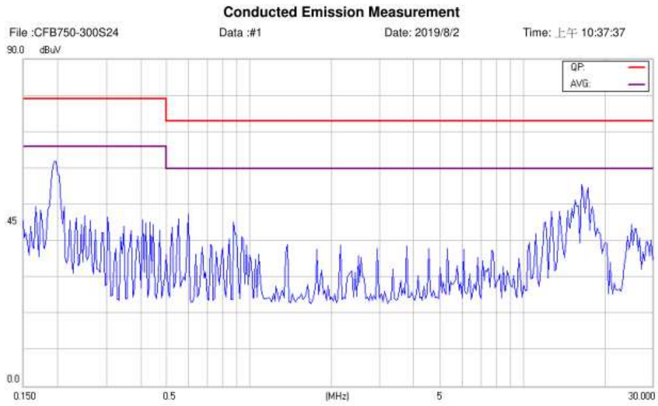
Conducted Class A of CFB750-300S15 Line



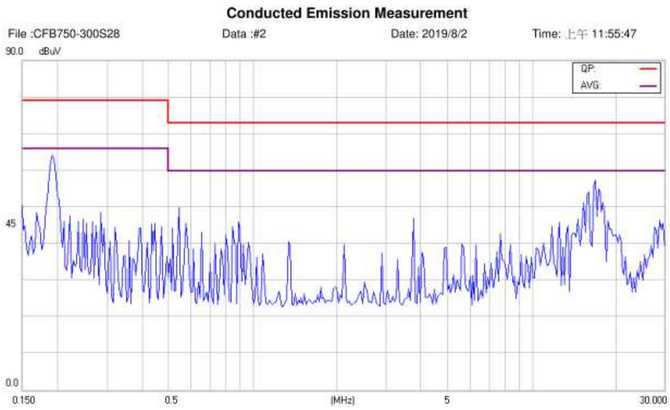
Conducted Class A of CFB750-300S15 Nature



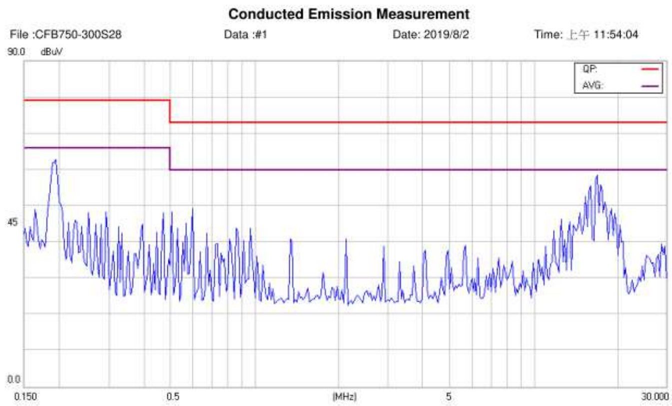
Conducted Class A of CFB750-300S24 Line



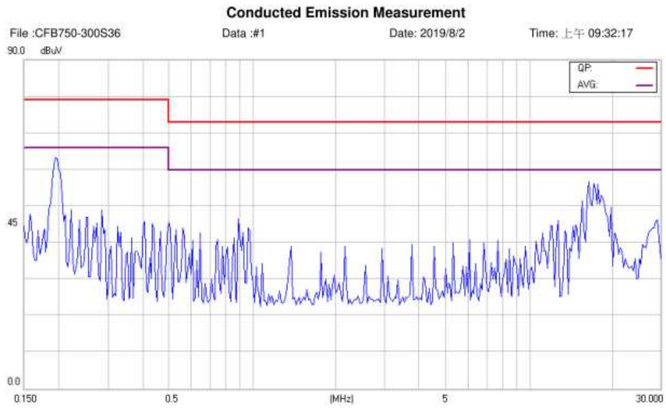
Conducted Class A of CFB750-300S24 Nature



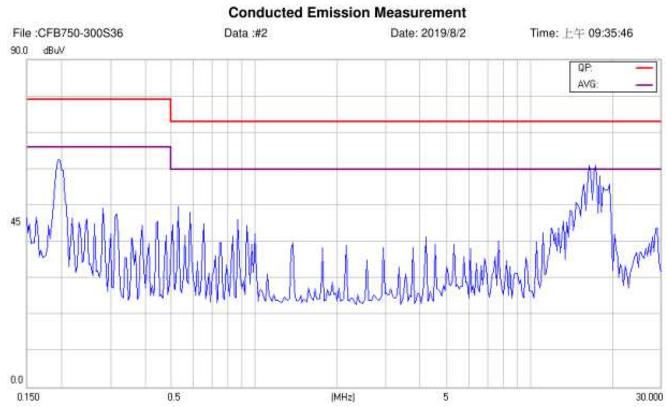
Conducted Class A of CFB750-300S28 Line



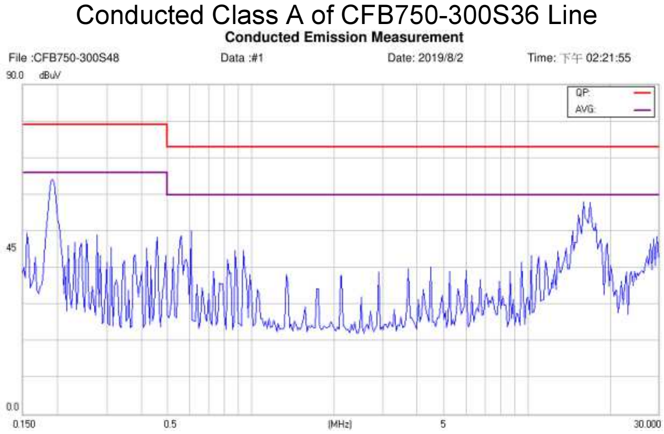
Conducted Class A of CFB750-300S28 Nature



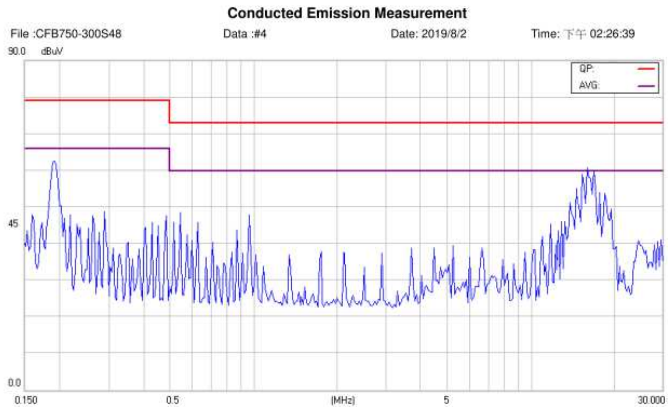
Conducted Class A of CFB750-300S36 Line



Conducted Class A of CFB750-300S36 Nature



Conducted Class A of CFB750-300S48 Line



Conducted Class A of CFB750-300S48 Nature

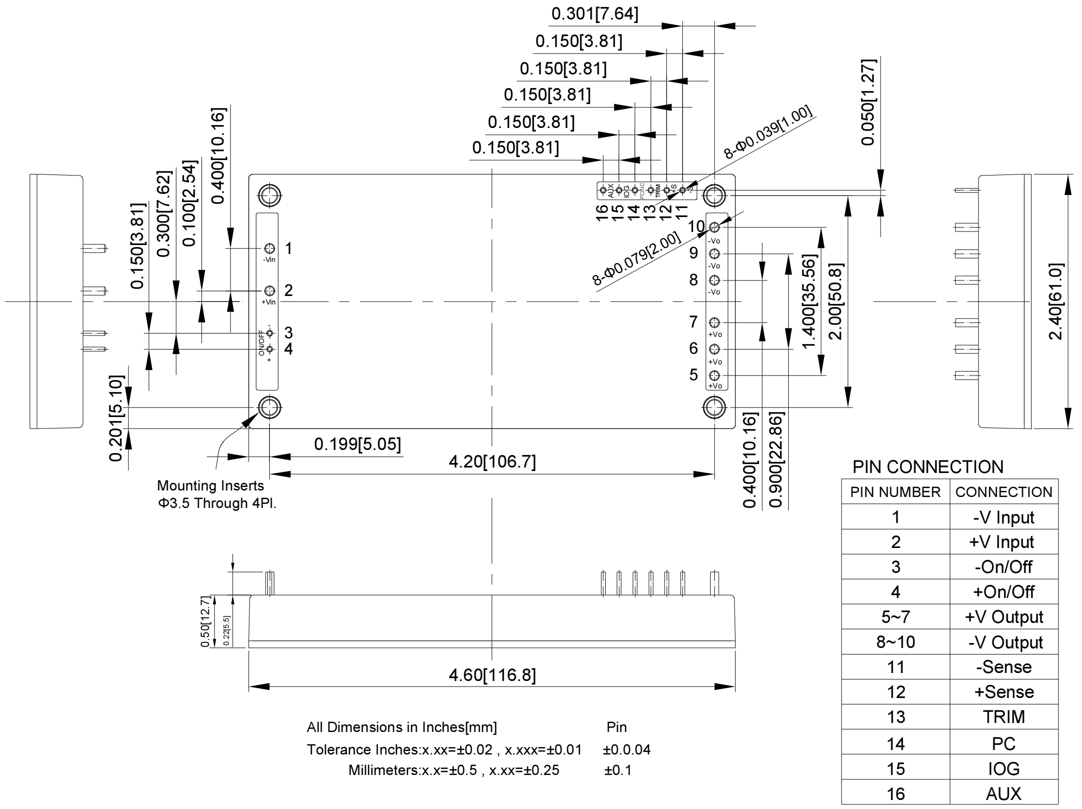
8. Part Number

Format: CFB750– II O XX L

Parameter	Series	Nominal Input Voltage	Number of Outputs	Output Voltage	Remote On/Off Logic
Symbol	CFB	II	O	XX	L
Value	CFB750-	300: 300 Volts	S: Single	12: 12 Volts 15: 15 Volts 24: 24 Volts 28: 28 Volts 36: 36 Volts 48: 48 Volts	None: Positive N: Negative

9. Mechanical Specifications

9.1 Mechanical Outline Diagrams



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	IOG
16	AUX

CFB750-300S Mechanical Outline Diagram

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