ISOLATED DC-DC CONVERTER
CQB150W-110SXX SERIES
APPLICATION NOTE

Approved By:

<table>
<tr><td>Department</td><td>Approved By</td><td>Checked By</td><td>Written By</td></tr>
<tr><td rowspan="2">Research and Development Department</td><td rowspan="2">Enoch</td><td>Astray</td><td rowspan="2">Astray</td></tr>
<tr><td>Jacky</td></tr>
<tr><td>Quality Assurance Department</td><td>Ryan</td><td>Benny</td><td></td></tr>
</table>

Contents

CQB150W-110SXX Series
Application Note V12 July 2019

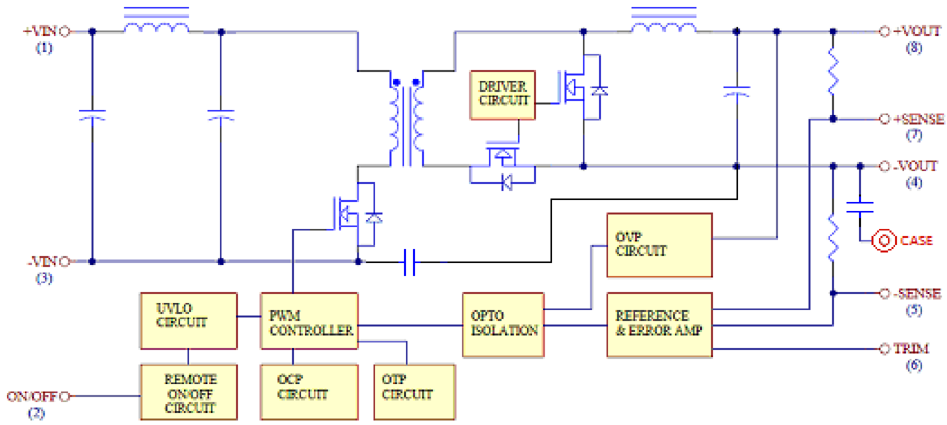
1. Introduction

The CQB150W-110SXX series offers 150 watts of output power with high power density in an industry standard quarter-brick package. The CQB150W-110SXX series has wide (4:1) input voltage ranges of 43-160VDC and provides a precisely regulated output. This series has features such as high efficiency, 3000VDC isolation and a case operating temperature range of –40°C to 105°C. The modules are fully protected against input UVLO (under voltage lock out), output short circuit, output over voltage and over temperature conditions. Furthermore, the standard control functions include remote on/off and output voltage trimming. All models are highly suited to railway, telecommunications, distributed power architectures, battery operated equipment, industrial, and mobile equipment applications.

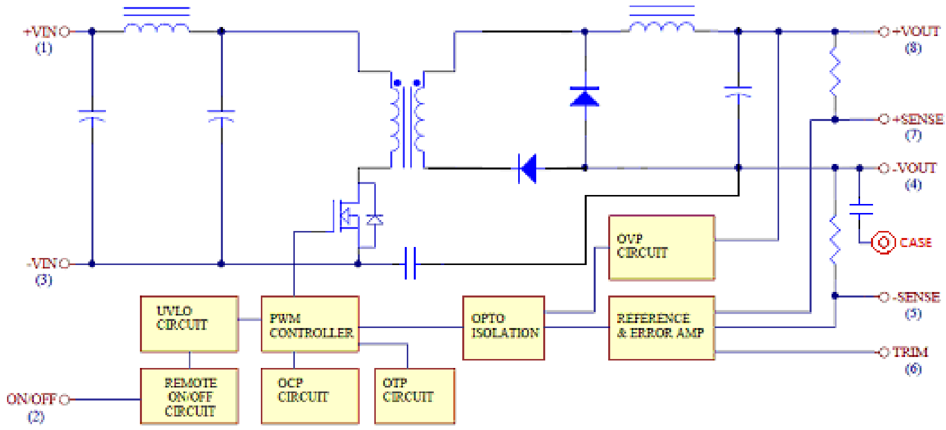
2. DC-DC Converter Features

- 99W-150W Isolated Output
- Efficiency up to 92%
- Fixed Switching Frequency
- 4:1 Input Range
- Regulated Outputs
- Remote On/Off
- Low No Load Power Consumption
- Over Temperature Protection
- Over Voltage/Current Protection
- Continuous Short Circuit Protection
- Quarter Brick Size meet industrial standard
- UL60950-1 2nd (Basic Insulation) Approval (Except 3.3&15Vout)
- Meets EN50155 with External Circuits
- Fire & Smoke Meets EN45545-2
- 3000m Operating Altitude
- CB Test Certificate IEC60950-1 (Except 3.3&15Vout)

3. Electrical Block Diagram



Electrical Block Diagram for 3.3Vout, 5Vout, 12Vout and 15Vout



Electrical Block Diagram for other modules

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		160	V_{dc}
Transient	100ms	All			200	V_{dc}
Operating Case Temperature		All	-40		105	°C
Storage Temperature		All	-55		125	°C
Isolation Voltage	1 minute; input/output,	All			3000	V_{dc}
	1 minute; input/case,	All			2250	V_{dc}
	1 minute; output/case	All			500	V_{ac}

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	40.5	41.5	42.5	V_{dc}
Turn-Off Voltage Threshold		All	37	38	39	V_{dc}
Lockout Hysteresis Voltage		All		3.5		V_{dc}
Maximum Input Current	100% Load, V_{in}=110V for All	All		1.5		A
No-Load Input Current		110S3V3		10		mA
		110S05		10		
		110S12		10		
		110S15		10		
		110S24		10		
		110S28		10		
		110S48		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		30		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=3.3V	3.267	3.3	3.333	V_{dc}
		Vo=5.0V	4.95	5	5.05	
		Vo=12V	11.88	12	12.12	
		Vo=15V	14.85	15	15.15	
		Vo=24V	23.76	24	24.24	
		Vo=28V	27.72	28	28.28	
		Vo=48V	47.52	48	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			±0.2	%
Line Regulation	V_{in}=low line to high line	All			±0.2	%
Temperature Coefficient	TC=-40°C to 105°C	All			±0.02	%/°C
Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Full load, 10uF tantalum and 1uF ceramic capacitors (for Vo=48V: Full Load 10uF aluminum and 1uF ceramic capacitors). **See 6.12**	Vo= 3.3V Vo=5.0V Vo=12V Vo=15V Vo=24V Vo=28V Vo=48V			100 100 150 150 280 280 480	mV
RMS.		Vo= 3.3V Vo=5.0V Vo=12V Vo=15V Vo=24V Vo=28V Vo=48V			40 40 60 60 100 100 200	mV
Operating Output Current Range		Vo= 3.3V Vo=5.0V Vo=12V Vo=15V Vo=24V Vo=28V Vo=48V	0 0 0 0 0 0 0		30 30 12.5 10 6.3 5.4 3.2	A
Output DC Current Limit Inception	Hiccup Mode. Auto Recovery. **See 5.3**	All	110	125	160	%
Maximum Output Capacitance	Full load (resistive)	110S3V3 110S05 110S12 110S15 110S24 110S28 110S48	0 0 0 0 0 0 0		30000 30000 12500 10000 6300 5400 1000	uF
Output Voltage Trim Range	P_{out}=max rated power, **See 6.10**	110S3V3 110S15	-20		+10	%
		Others	-10		+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			250	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		30		ms
Turn-On Delay Time, From Input	V_{in_min} to 10%V_{o_set}	All		30		ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All		30		ms

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=110V **See 6.8**	110S3V3		89		%
		110S05		91		
		110S12		92		
		110S15		91		
		110S24		89		
		110S28		89		
		110S48		90.5		

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Isolation Voltage	1 minute; input/output	All			3000	V_{dc}
	1 minute; input/case,	All			2250	V_{dc}
	1 minute; output/case	All			500	V_{ac}
Isolation Resistance	Input / Output	All	100			MΩ
Isolation Capacitance	Input / Output	All		1500		pF
	Input/Case	All		NC		
	Output/Case	110S3V3		470		
		110S05		470		
		110S12		10000		
		110S15		10000		
		110S24		3000		
		110S28		3000		
		110S48		10000		

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency	Pulse wide modulation (PWM), Fixed	All	270	300	330	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		160	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		160	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
Output Voltage Trim Range	P_{out}=max rated power	All	-10		+10	%
Output Over Voltage Protection		All	115	125	140	%
Over Temperature Shutdown	Aluminum base plate temperature	All		110		°C
Over Temperature Recovery		All		100		°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	110S3V3 110S05 110S12 Others		875 720 720 840		K hours
Weight		All		68		grams
Case Material	Plastic, DAP					
Base plate 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	3000m Operating Altitude, 12000m Transport Altitude					
Thermal Shock	MIL-STD-810F					
EMI	Meets EN55011, EN55032 & EN50155 with external input filter, see 7.2					Class A
ESD	EN61000-4-2 Level 3: Air ±8kV, Contact ±6Kv					Perf. Criteria A
Radiated immunity	EN61000-4-3 Level 3: 80~1000MHz, 20V/m					Perf. Criteria A
Fast Transient	EN61000-4-4 Level 3: On power input port, ±2kV, external input capacitor required, see 7.1					Perf. Criteria A
Surge	EN61000-4-5 Level 4: Line to earth, ±4kV, Line to line, ±2kV					Perf. Criteria A
Conducted immunity	EN61000-4-6 Level 3: 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

Immunity to Environmental Conditions.

Phenomenon	EN50155; 2005 Reference Clause(s)	Reference Standard	Test Conditions	Result
Cooling Test	EN 50155 section 12.2.3 Column 4, Class TX	EN 60068-2-1	Temperature: -40℃ Dwell time: 2 hrs/ cycle	Pass
Dry Heat Test	EN 50155 section 12.2.4 Column 4, Class TX	EN 60068-2-2	Temperature: 85℃ Duration: 6 hrs/ 10min	Pass
Damp Heat test, Cyclic	EN 50155 section 12.2.5	EN 60068-2-30	Temperature: 25℃ - 55℃ Humidity: 90% RH Duration: 48 hrs	Pass
Vibration Test	EN 50155 section 12.2.11	EN 61373	Temperature: 25℃ +/- 10℃ Humidity: 50% +/-25% RH Duration: 10 mins	Pass
Increased Vibration Test	EN 50155 section 12.2.11	EN 61373	Temperature: 25℃ +/-10℃ Humidity: 50% +/-25% RH Duration: 5 hrs	Pass
Shock Test	EN 50155 section 12.2.11	EN 61373	Temperature: 25℃ +/-10℃ Humidity: 50% +/-25% RH Duration: 30mS x18	Pass
Low Temperature Storage Test	EN 50155 section 12.2.3 Column 4, Class TX	EN 60068-2-1	Temperature: -40℃ Dwell time: 16 hrs	Pass

EN45545-2 Fire & Smoke Test Conditions.

Item		Standard	Hazard Level
R22	Oxygen Index Test	EN 45545-2: 2013 EN ISO 4589-2: 2006	HL1, HL2, HL3
	Smoke Density Test	EN 45545-2: 2013 EN ISO 5659-2: 2013	HL1, HL2
	Smoke Toxicity Test	EN 45545-2: 2013 NF X70-100: 2006	HL1, HL2, HL3
R23	Oxygen Index Test	EN 45545-2: 2013 EN ISO 4589-2: 2006	HL1, HL2, HL3
	Smoke Density Test	EN 45545-2: 2013 EN ISO 5659-2: 2013	HL1, HL2, HL3
	Smoke Toxicity Test	EN 45545-2: 2013 NF X70-100: 2006	HL1, HL2, HL3
R24	Oxygen Index Test	EN45545-2: 2013 EN ISO 4589-2	HL1, HL2, HL3
R26	Vertical Flame Test	EN 45545-2: 2013 EN 60695-11-10: 2013	HL1, HL2, HL3

5. Main Features and Functions

5.1 Operating Temperature Range

The CQB150W-110SXX series converters can be operated within a wide case temperature range of -40°C to 105°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 quarter brick models is influenced by usual factors, such as:

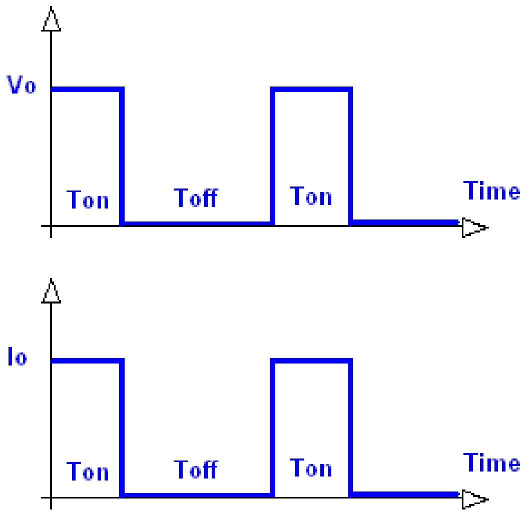
- Input voltage range
- Output load current
- Forced air or natural convection
- Heat sink optional

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 3.3Vout is adjustable within the range of +10% to –20%, the other models is +10% to -10%.

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 hiccup 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

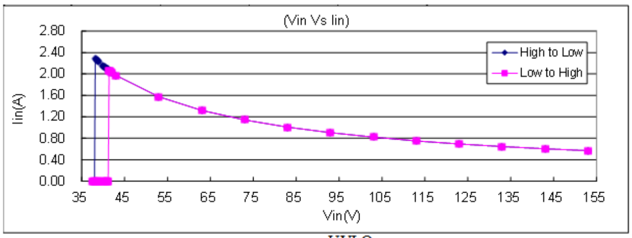
The CQB150W-110SXX series allows the user to switch the module on and off electronically with the remote On/Off feature. All models are available in "positive logic" and "negative logic" (optional) versions. The converter turns on if the remote On/Off pin is high (>3.5Vdc to 160Vdc or open circuit). 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 160Vdc 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 CQB150W-110SXX 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.

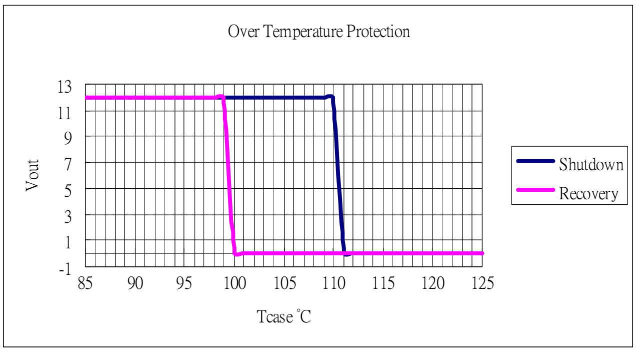
CQB150W-110SXX
Iin Vs Vin

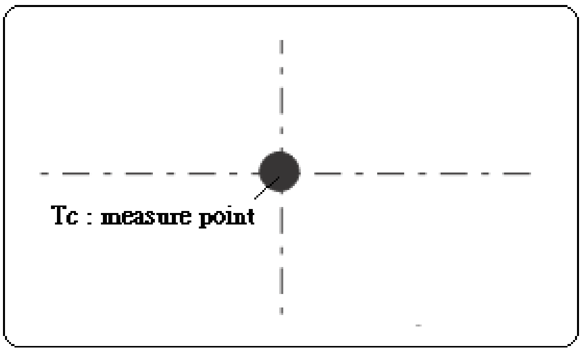


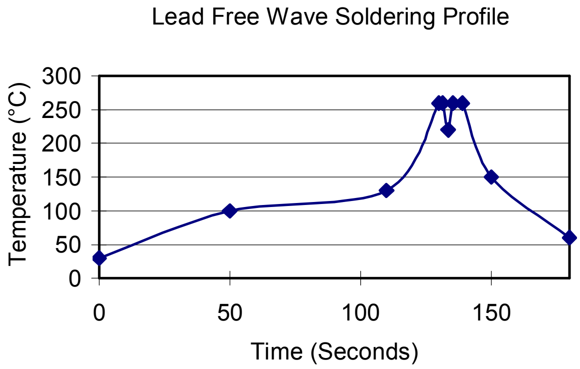
UVLO

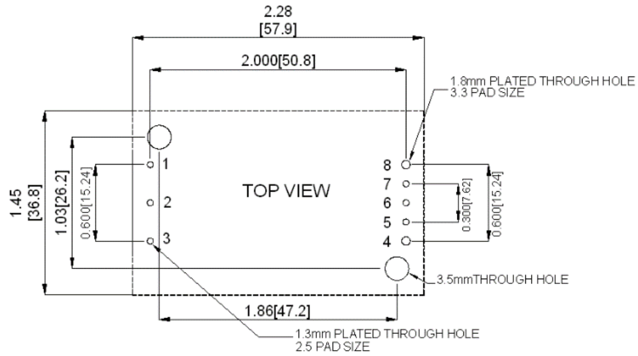
5.7 Over Temperature Protection

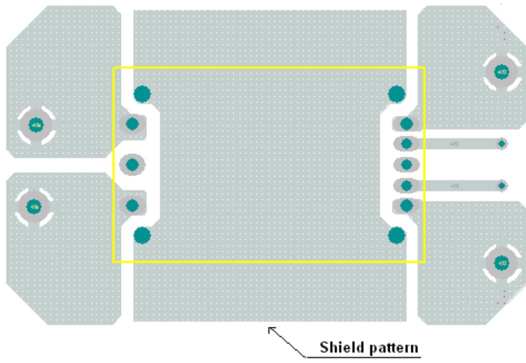
These modules have an over temperature protection circuit to safeguard against thermal damage. Shutdown occurs with the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below over temperature recovery threshold. Please measure case temperature of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











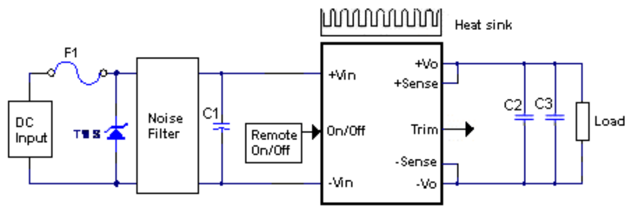
6. Applications

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. 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) 220uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 10uF aluminum and 1uF ceramic capacitors for 48Vout, and 10uF tantalum and 1uF ceramic capacitors for other models.

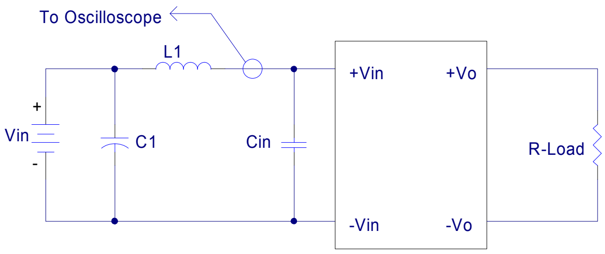


Symbol	Component	Reference
F1, TVS	Input fuse, TVS	**Section 7.1**
C1	External capacitor on input side	**Note**
C2,C3	External capacitor on the output side	**Section 6.12/6.13**
Noise Filter	External input noise filter	**Section 7.2**
Remote On/Off	External Remote On/Off control	**Section 6.14**
Trim	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<0.075ohm @100KHz
Cin: 220uF ESR<0.07ohm @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 105°C as measured at the center of the top of the case (thus verifying proper cooling).

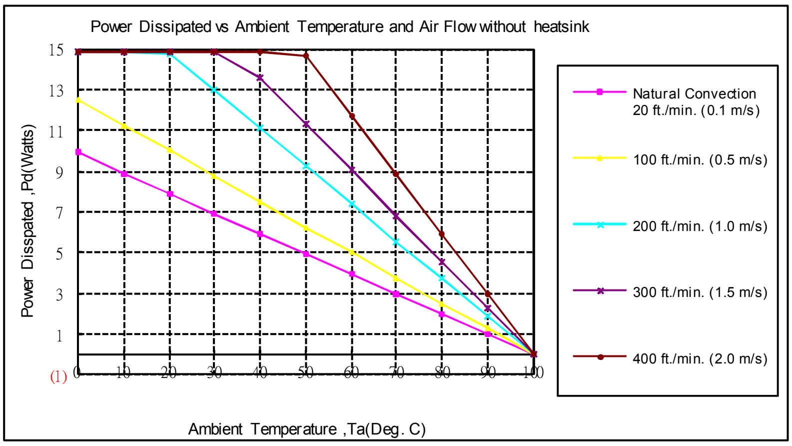
6.5 Thermal Considerations

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 CQB150W-110SXX series is -40°C to +105°C. When operating the CQB150W-110SXX series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 105°C.

The following curve is the de-rating curve of CQB150W-110SXX series without heat sink.



AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	10.1 ℃/W
100 ft./min. (0.5m/s)	8.0 ℃/W
200 ft./min. (1.0m/s)	5.4 ℃/W
300 ft./min. (1.5m/s)	4.4 ℃/W
400 ft./min. (2.0m/s)	3.4 ℃/W

Example:

What is the minimum airflow necessary for a CQB150W-110S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 50°C?

Solution:

Given:

V_{in}=110V_{dc}, Vo=12V_{dc}, I_o=12.5A

Determine Power dissipation (P_d):

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

P_d =12V×12.5A×(1-0.91)/0.91=14.84Watts

Determine airflow:

Given: P_d =14.84W and T_a=50°C

Check *Power Derating* curve:

Minimum airflow= 400 ft./min.

Verify:

Maximum temperature rise is

ΔT = Pd × Rca=14.84W×3.4=50.46°C

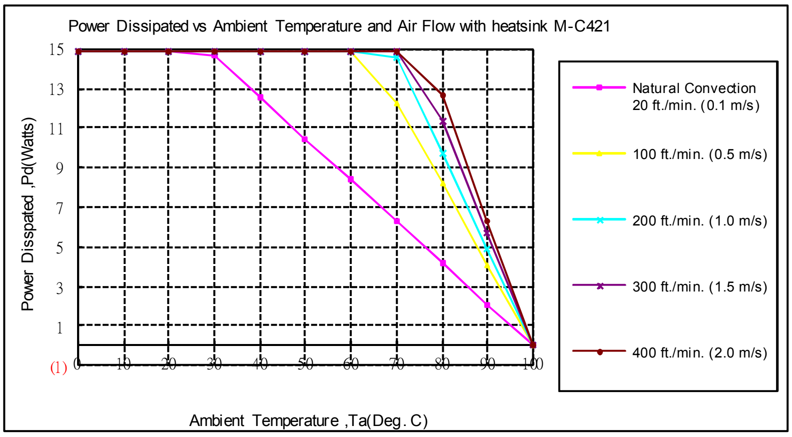
Maximum case temperature is

Tc=Ta+ΔT=100.46°C<105°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)	4.78 ℃/W
100 ft./min. (0.5m/s)	2.44 ℃/W
200 ft./min. (1.0m/s)	2.06 ℃/W
300 ft./min. (1.5m/s)	1.76 ℃/W
400 ft./min. (2.0m/s)	1.58 ℃/W

Example with heat sink QBT210 (M-C421):

What is the minimum airflow necessary for a CQB150W-110S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 60℃?

Solution:

Given:

Vin=110Vdc, Vo=12Vdc, Io=12.5A

Determine Power dissipation (P_d):

Pd=Pi-Po=Po(1-η)/η

Pd=12.0×12.5×(1-0.91)/0.91=14.84Watts

Determine airflow:

Given: Pd=14.84W and Ta=60℃

Check above Power de-rating curve:

Minimum airflow= 100 ft./min

Verify:

Maximum temperature rise is $\triangle T = P_d \times R_{ca}$=14.84×2.44=36.21℃

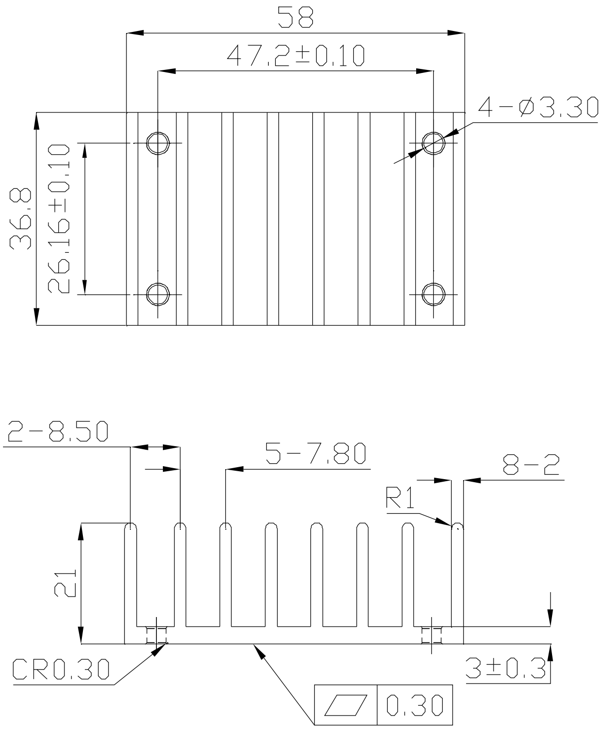
Maximum case temperature is Tc=Ta+△T=96.21℃<105℃

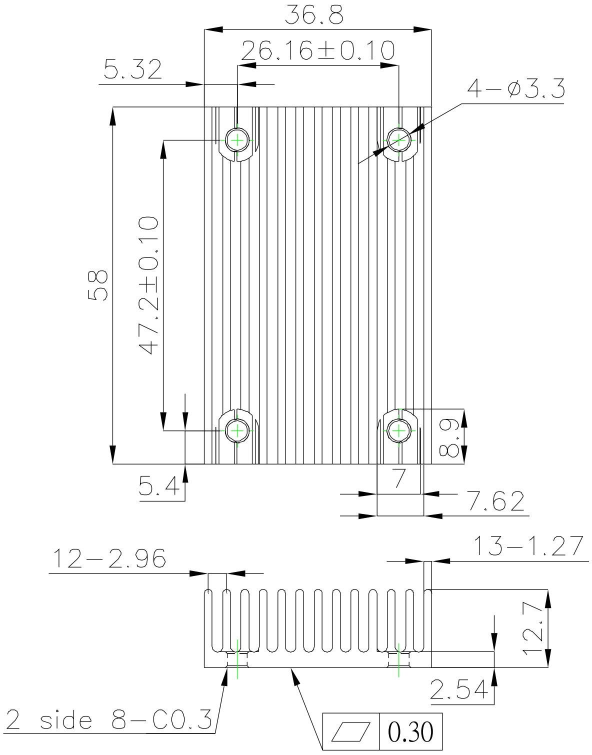
Where:

The Rca is thermal resistance from case to ambient environment.

Ta is ambient temperature and Tc is case temperature.

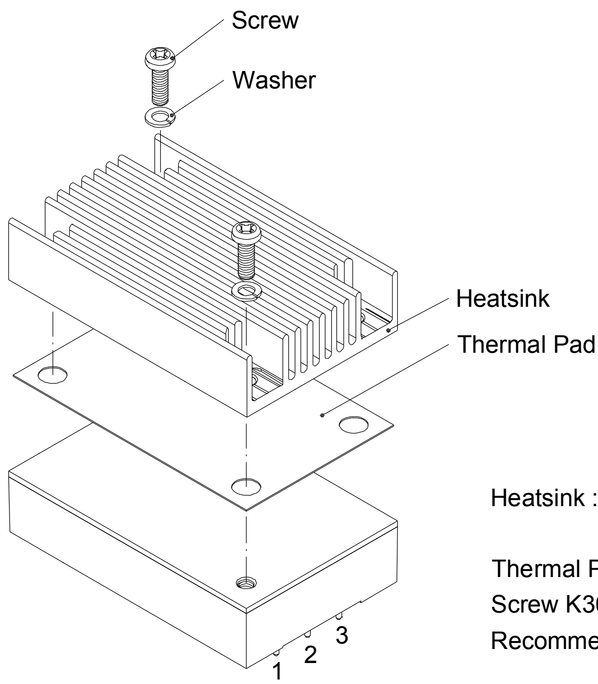
6.7 Quarter Brick Heat Sinks:





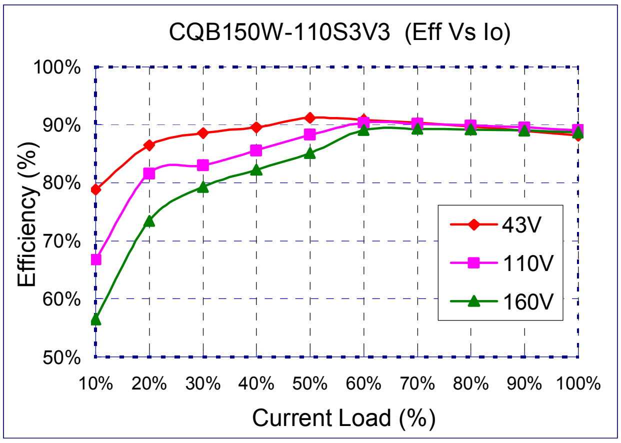
All Dimensions in mm

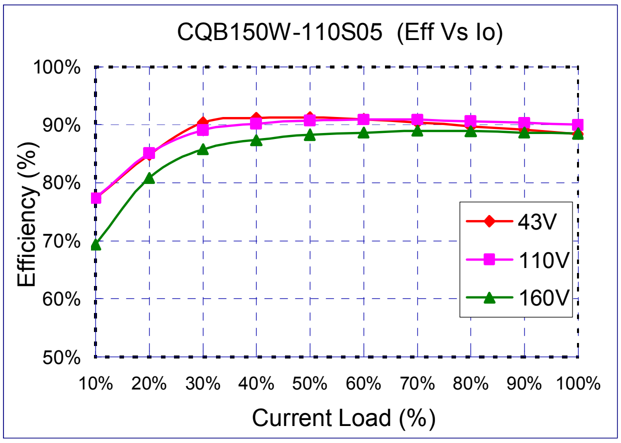
QBT210 (M-C421): G6620510201 Transverse Heat Sink	QBL127 (M-C448): G6620570202 Longitudinal Heat Sink
Rca: 4.78°C/W (typ.), At natural convection	Rca: 5.61°C/W (typ.), At natural convection
2.44°C/W (typ.), At 100LFM	4.01°C/W (typ.), At 100LFM
2.06°C/W (typ.), At 200LFM	3.39°C/W (typ.), At 200LFM
1.76°C/W (typ.), At 300LFM	2.86°C/W (typ.), At 300LFM
1.58°C/W (typ.), At 400LFM	2.49°C/W (typ.), At 400LFM

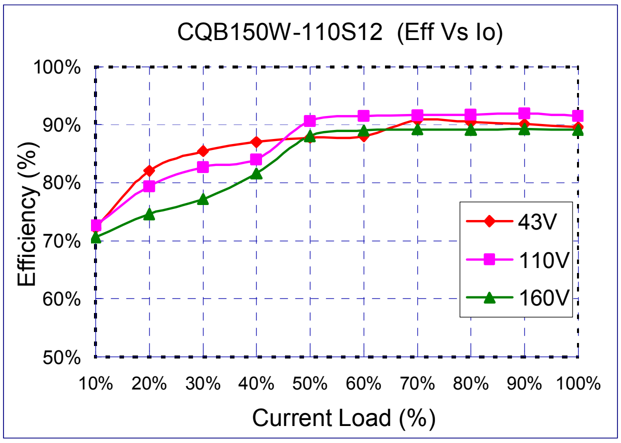


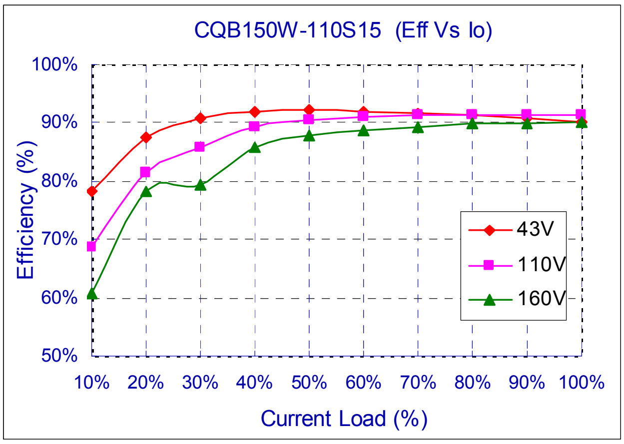
Heatsink : QBL127 (M-C448)
QBT210 (M-C421)
Thermal Pad PQ01: SZ35.8x56.9x0.25mm
Screw K308W: SMP+SW M3x8L
Recommended torque 3 Kgf-cm

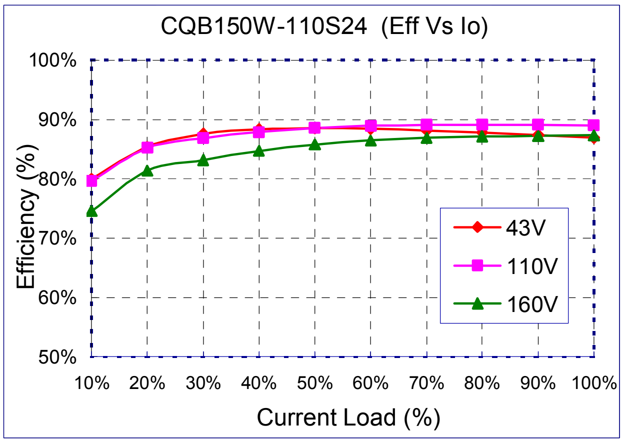
6.8 Efficiency VS. Load

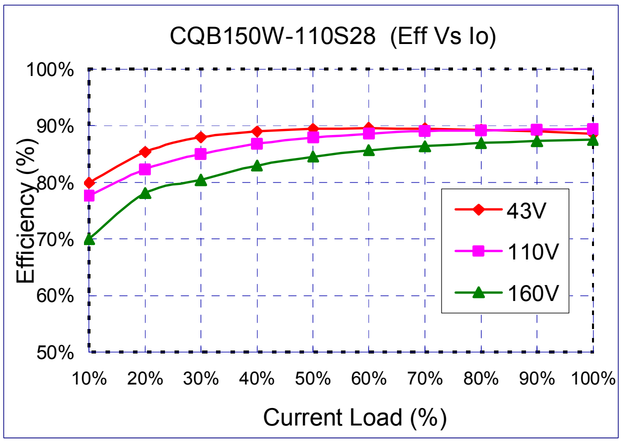


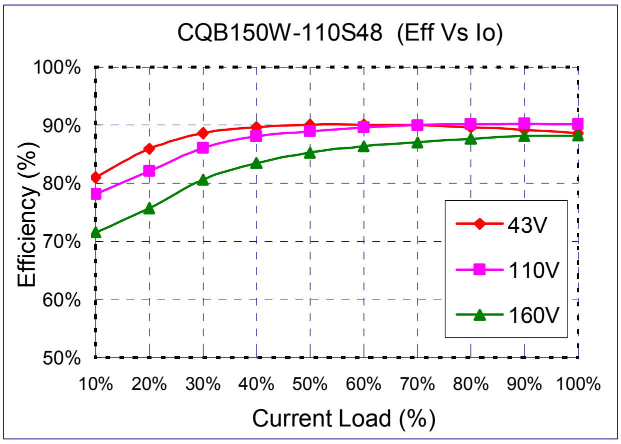












CQB150W-110S48 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
43V
110V
160V

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:

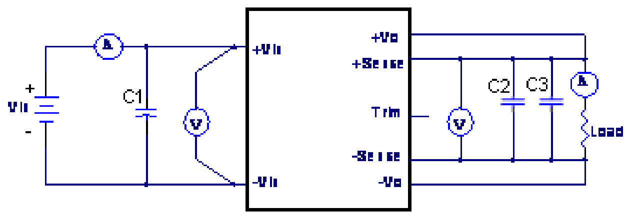
$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

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.

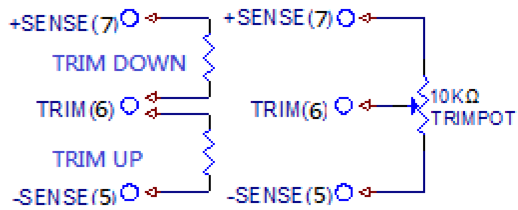


CQB150W-110SXX Series Test Setup

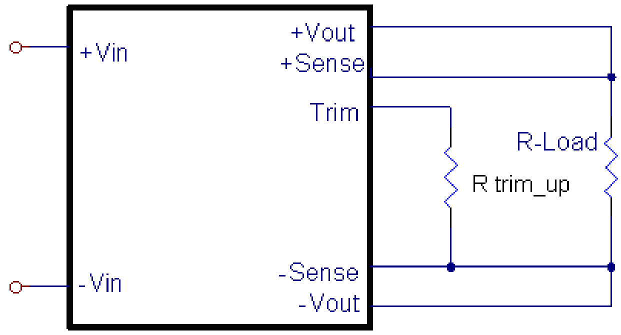
C1: 220uF/200V ESR<0.035Ω
C2: 1uF/1210 ceramic capacitor
C3: 10uF aluminum capacitor for 48Vout.
10uF tantalum capacitor for others.

6.10 Output Voltage Adjustment

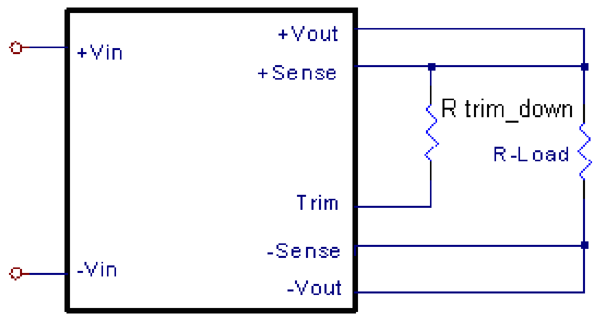
Output may be externally trimmed (±10%, except 3.3Vout is +10%, -20%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



In order to trim the voltage up or down, one needs to connect the trim resistor either between the trim pin and -Sense for trim-up or between trim pin and +Sense for trim-down. The output voltage trim range is ±10%. This is shown:



Trim-up Voltage Setup



Trim-down Voltage Setup

V_{out}(V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	V_r (V)	V_f (V)
3.3V	3	5.1	0	1.24	0
5V	2.32	3.3	0	2.5	0
12V	9.1	51	5.1	2.5	0.46
15V	12	36	8.25	2.5	0.46
24V	20	100	7.5	2.5	0.46
28V	23.7	150	6.2	2.5	0.46
48V	36	270	5.1	2.5	0.46

Trim Resistor Values

The value of R_{trim_up} defined as:

For Vo=5V Rtrim_up decision:

$$R_{trim\_up} = \frac{R_1 V_r}{Vo - V_{o\_nom}} - R_2 \quad (K\Omega)$$

For others Rtrim_up decision:

$$R_{trim\_up} = \left(\frac{R_1(V_r - V_f(\frac{R_2}{R_2+R_3}))}{V_O - V_{o\_nom}}\right) - \frac{R_2R_3}{R_2+R_3} \ (K\Omega)$$

Where:

R_{trim_up} is the external resistor in KΩ.

V_{o_nom} is the nominal output voltage.

V_o is the desired output voltage.

R1,R2, R3 and V_r are internal components.

For example, to trim-up the output voltage of 12V module(CQB150W-110S12) by 5% to 12.6V, R_{trim_up} is calculated as follows:

$V_o - V_{o\_nom}$ = 12.6 – 12 = 0.6V
R1 = 9.1 KΩ, R2 = 51 KΩ, R3 = 5.1KΩ,
V_r= 2.5 V, V_f=0.46 V

$$R_{trim\_up} = \frac{18.944}{0.6} - 4.636 = 26.94\ (K\Omega)$$

The value of R_{trim_down} defined as:

$$R_{trim\_down} = \frac{R_1 \times (V_o - V_r)}{V_{o\_nom} - V_o} - R_2 \ (K\Omega)$$

Where:

R_{trim_down} is the external resistor in KΩ.

V_{o_nom} is the nominal output voltage.

V_o is the desired output voltage.

R1,R2, R3 and V_r are internal components.

For example: to trim-down the output voltage of 12V module(CQB150W-110S12) by 5% to 11.4V, R_{trim_down} is calculated as follows:

$V_{o\_nom} - V_o$ = 12 – 11.4 = 0.6 V
R1 = 9.1 KΩ, R2 = 51 KΩ, V_r= 2.5 V

$$R_{trim\_down} = \frac{9.1 \times (11.4 - 2.5)}{0.6} - 51 = 83.98\ (K\Omega)$$

The typical value of R_{trim_up}

Trim up (%)	3.3V	5V	12V	15V	24V	28V	48V
	R_{trim_up} (KΩ)						
1%	107.6	112.7	153.2	163.3	165.7	168.3	148.6
2%	51.26	54.70	74.30	78.32	79.36	81.16	71.81
3%	32.48	35.37	47.99	49.98	50.58	52.12	46.21
4%	23.08	25.70	34.83	35.80	36.19	37.60	33.40
5%	17.45	19.90	26.94	27.30	27.56	28.86	25.72
6%	13.69	16.03	21.68	21.63	21.80	23.08	20.60
7%	11.00	13.27	17.92	17.58	17.69	18.93	16.94
8%	8.99	11.20	15.10	14.55	14.61	15.82	14.20
9%	7.43	9.589	12.91	12.18	12.21	13.40	12.07
10%	6.17	8.300	11.15	10.29	10.29	11.47	10.36

The typical value of R_{trim_down}

Trim down (%)	5V	12V	24V	28V	48V
	R_{trim_down} (KΩ)				
1%	110.4	660.3	1671	1984	3106
2%	52.38	300.1	775.8	905.5	1400
3%	33.05	180.0	477.2	545.8	831.5
4%	23.38	120.0	327.9	365.9	547.1
5%	17.58	83.98	238.3	258.0	376.5
6%	13.71	59.97	178.6	186.0	262.8
7%	10.95	42.82	136.0	134.6	181.5
8%	8.880	29.95	104.0	96.10	120.6
9%	7.269	19.95	79.07	66.12	73.17
10%	5.980	11.94	59.17	42.14	35.25

he 3.3Vout & 15Vout typical value of R_{trim_down}

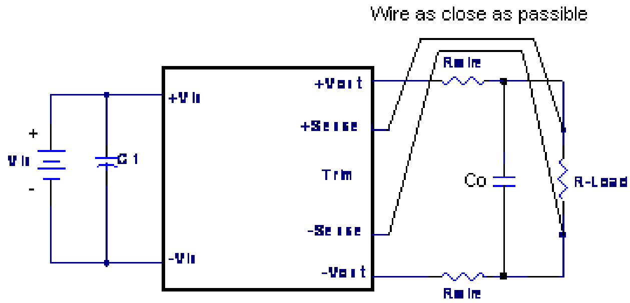
Trim down (%)	3.3V	15V	Trim down (%)	3.3V	15V
	R_{trim_down} (KΩ)			R_{trim_down} (KΩ)	
1%	148.2	952.0	11%	8.67	42.91
2%	77.22	452.0	12%	7.30	35.33
3%	50.58	285.3	13%	6.13	28.92
4%	36.61	202.0	14%	5.13	23.43
5%	28.02	152.0	15%	4.26	18.67
6%	22.19	118.6	16%	3.50	14.50
7%	17.99	94.86	17%	2.82	10.82
8%	14.81	77.00	18%	2.22	7.56
9%	12.32	63.11	19%	1.68	4.63
10%	10.32	52.00	20%	1.20	2.00

6.11 Output Remote Sensing

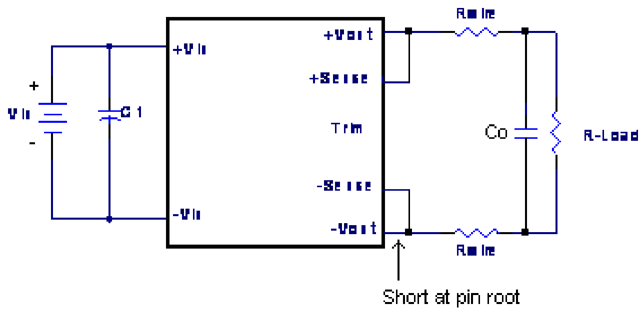
The CQB150W-110SXX series converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the CQB150W-110SXX 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)] ≦ 10% of $V_{o\_nominal}$; (Except 3.3 &15Vout is 20%)

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.

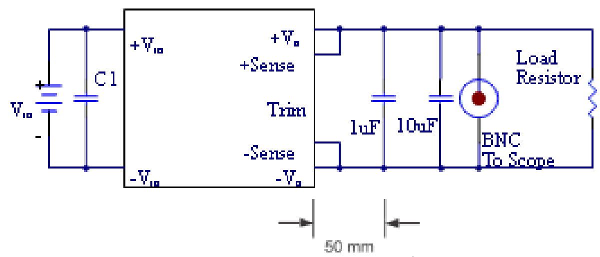


If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module. Wire between +Sense and +Vout and between -Sense and –Vout as short as possible.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

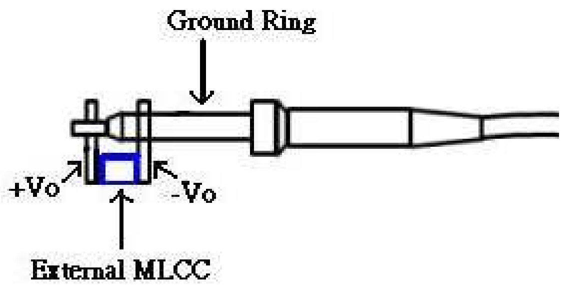
6.12 Output Ripple and Noise



Output ripple and noise measured with 10uF aluminum and 1uF ceramic capacitors across output for 48Vout and with 10uF tantalum and 1uF ceramic capacitors for others. 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.

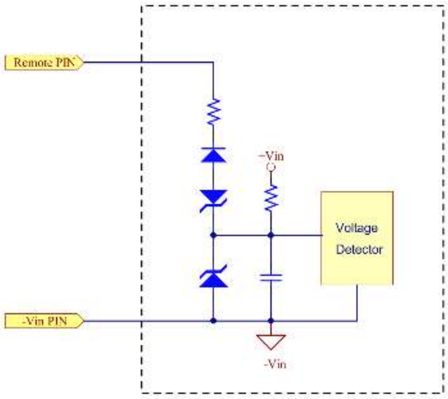


6.13 Output Capacitance

The CQB150W-110SXX 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.

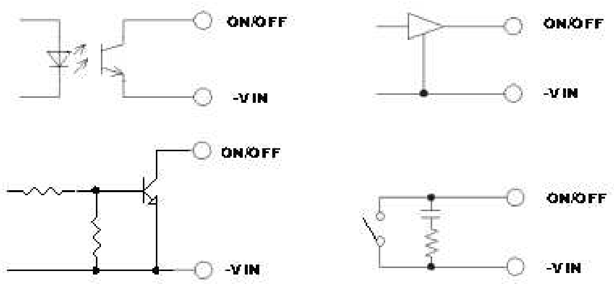
6.14 Remote On/Off Circuit

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.



Inside Remote On/Off Circuit Schematic

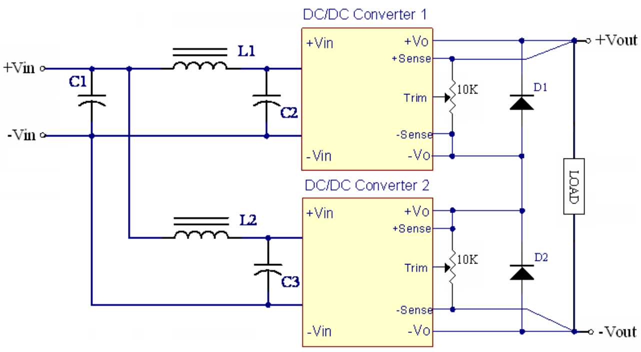
External connection examples see below.



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

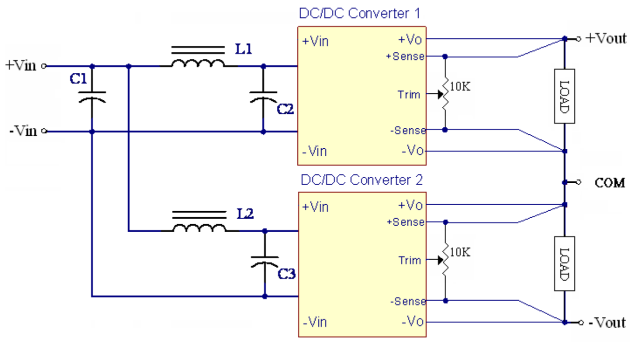
C1, C2, C3: 220uF/200V ESR<0.07Ω

Note:

1. If the impedance of input line is high, C1, C2, C3 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

C1, C2, C3: 220uF/200V ESR<0.07Ω

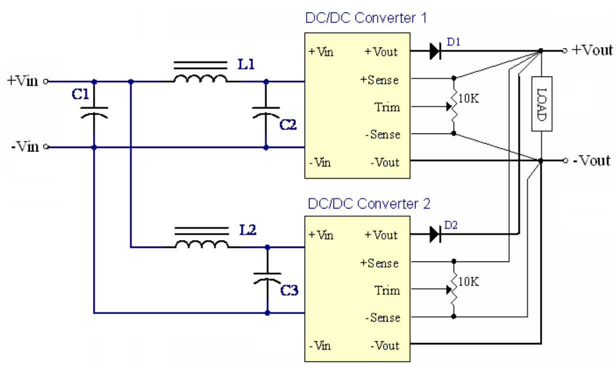
Note:

If the impedance of input line is high, C1, C2, C3 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 CQB150W-110SXX series parallel operation is **not** possible.

Parallel for redundancy operation is possible by connecting the units as shown in the schematic below. The current of each converter become unbalance by a slight difference of the output voltage. Make sure that the output voltage of units of equal value and the output current from each power supply does not exceed the rate current. Suggest use an external potentiometer to adjust output voltage from each power supply.



Simple Redundant Operation Connect Circuit

L1, L2: 1.0uH

C1, C2, C3: 220uF/200V ESR<0.07Ω

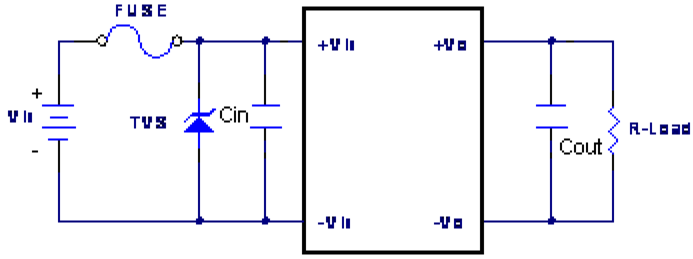
Note:

If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃.

7. Safety & EMC

7.1 Input Fusing and Safety Considerations

The CQB150W-110SXX series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 6A time delay 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 input capacitor (Cin) is required if CQB150W-110SXX series has to meet EN61000-4-4, EN61000-4-5. The CQB150W-110SXX recommended an aluminum capacitor (220uF/200V) to connect parallel.

7.2 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 EN55011/EN55032/EN50155 Class A:

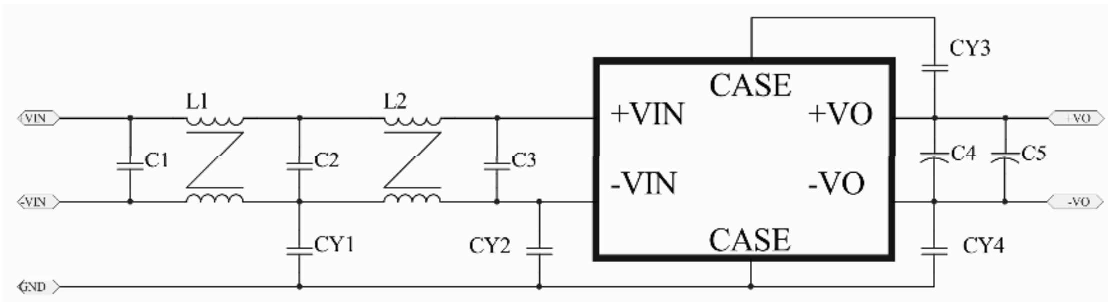


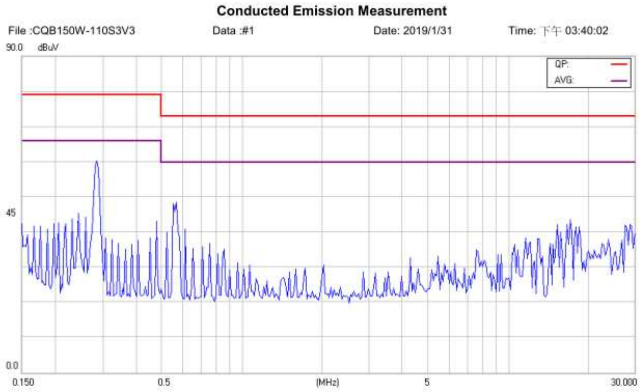
Figure1 Connection circuit for conducted EMI Class A testing

Model No.	C1	C2	C3	C4	C5	CY1	CY2
CQB150W-110SXX	220uF/200V	220uF/200V	220uF/200V	10uF/50V	1uF/50V	1000pF	2200pF
	CY3	CY4	L1	L2			
	4700pF	3300pF	5.5mH	5.5mH			

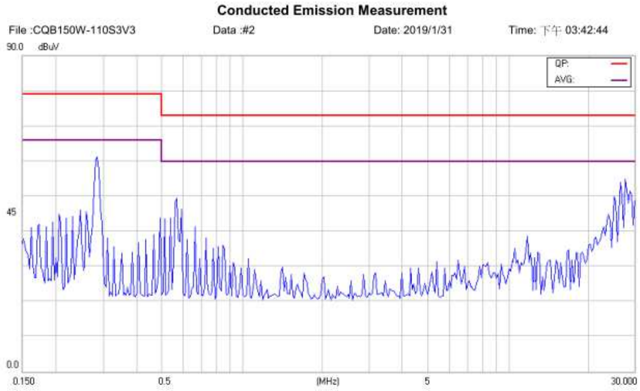
Note: C1, C2, C3 are RUBYCON YXF series aluminum capacitors, C4 is tantalum capacitor, C5 is ceramic capacitor, CY1, CY2, CY3, CY4 are MURATA Y1 capacitors or equivalent, L1, L2 are 5.5mH (URT24-05055H) BULL WILL or equivalent.

CQB150W-110S3V3

Line

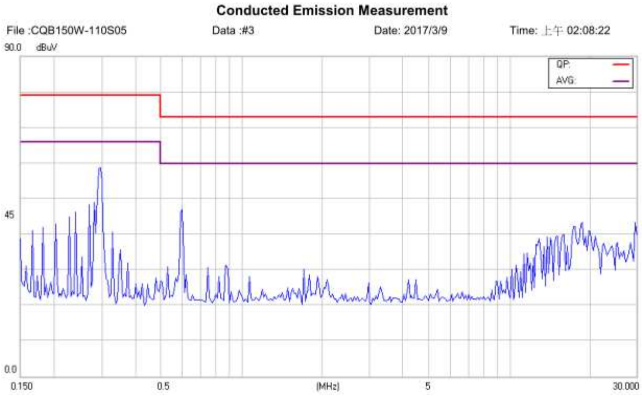


Neutral

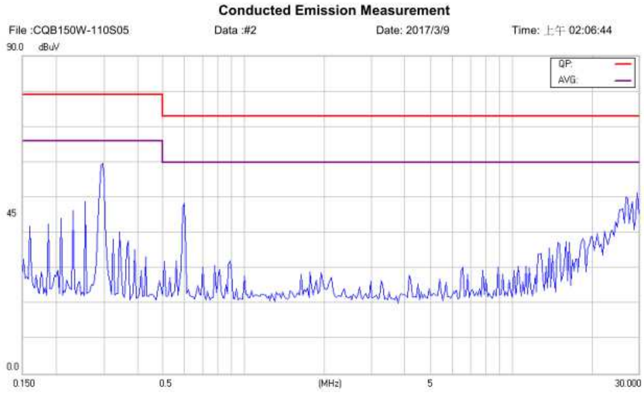


CQB150W-110S05

Line

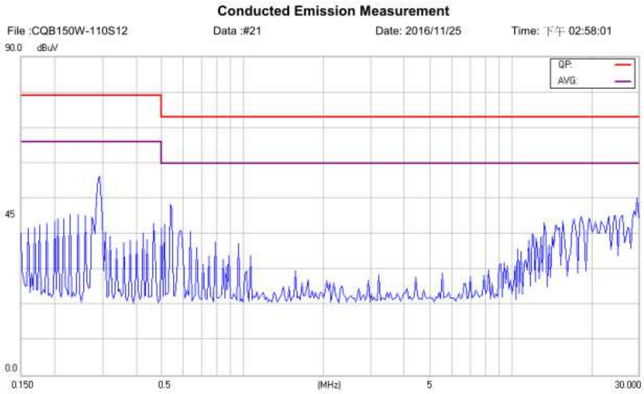


Neutral

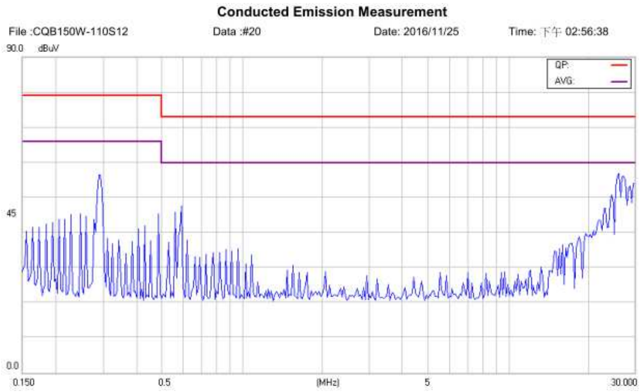


CQB150W-110S12

Line

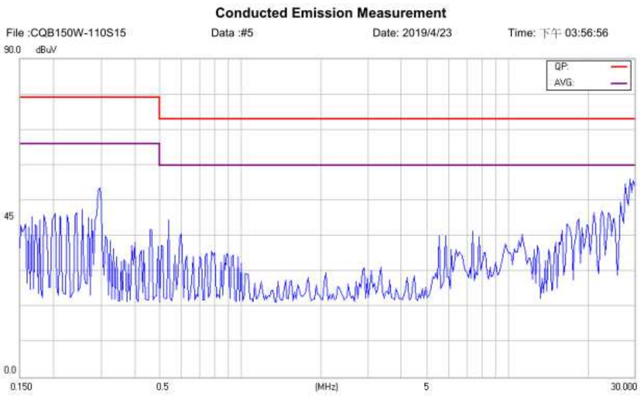


Neutral

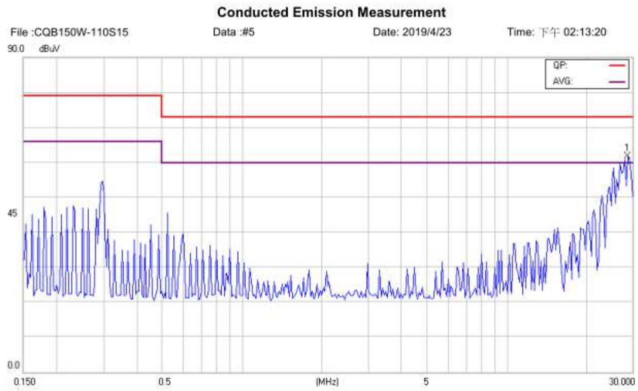


CQB150W-110S15

Line

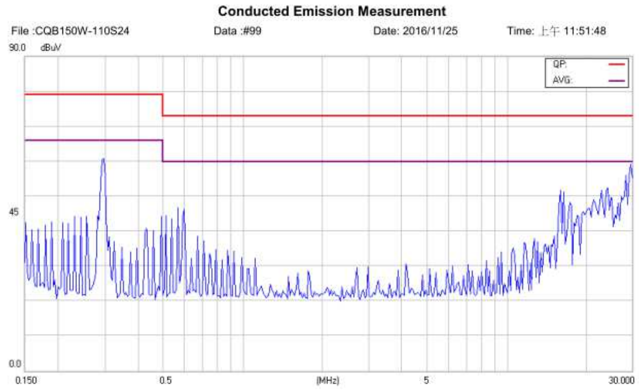


Neutral

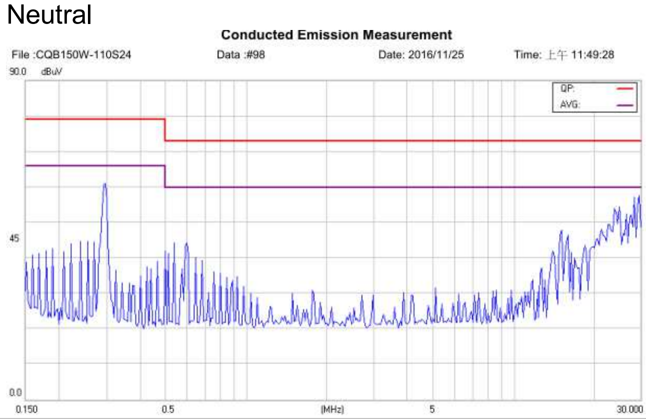


CQB150W-110S24

Line

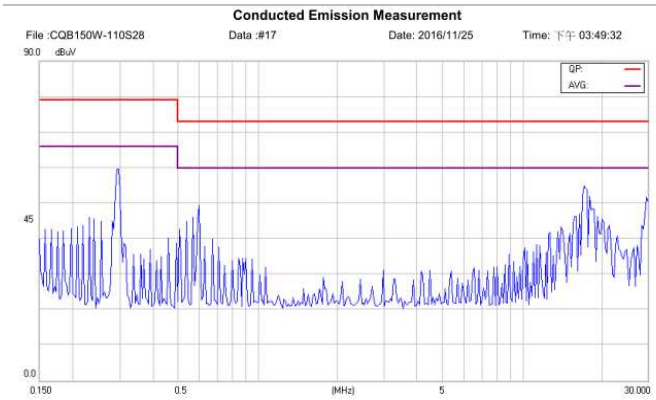


Neutral

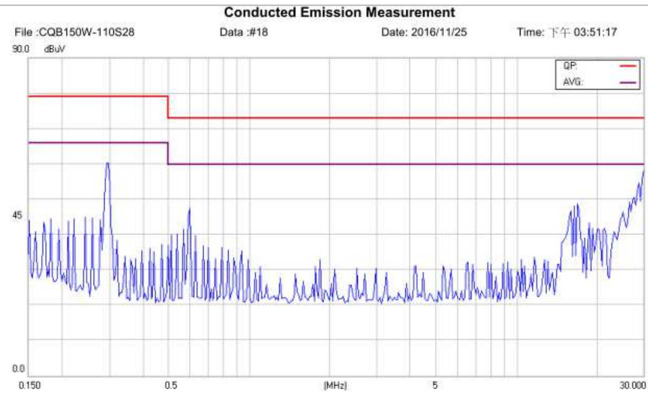


CQB150W-110S28

Line

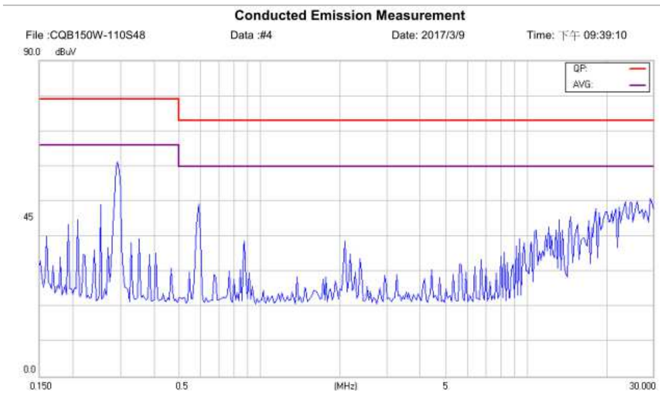


Neutral

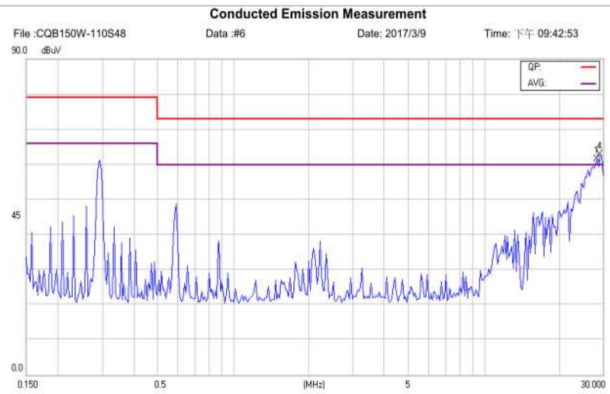


CQB150W-110S48

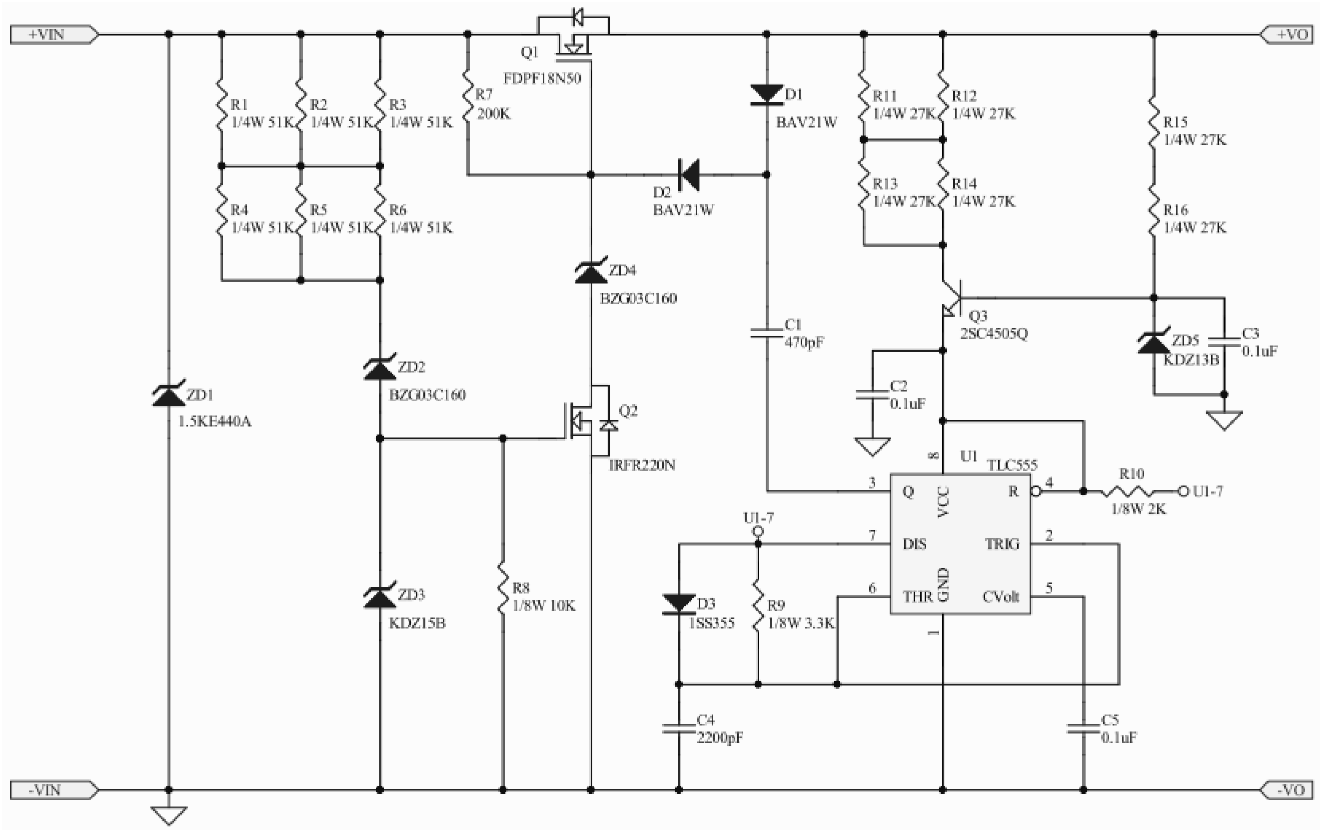
Line



Neutral



7.3 Suggested Configuration for RIA12 Surge Test



8. Part Number

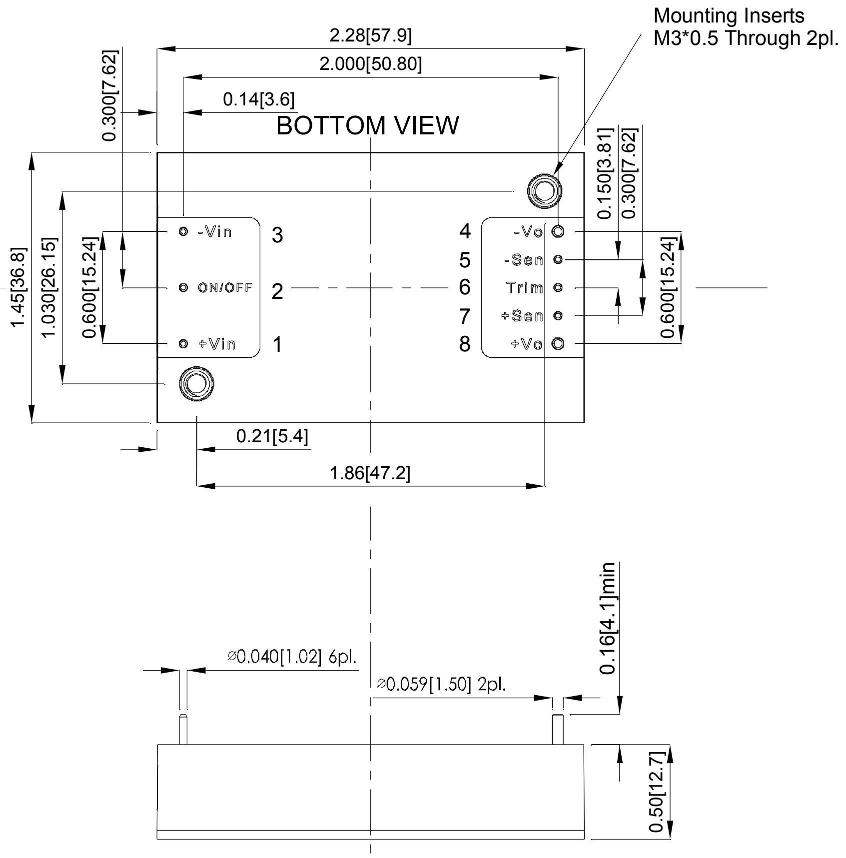
Format: CQB150W – II OXX L-Y

Parameter	Series	Nominal Input Voltage	Number of Outputs	Output Voltage	Remote On/Off Logic	Mounting Inserts
Symbol	CQB150W-	II	O	XX	L	Y (Option)
Value	CQB150W-	110: 110 Volts	S: Single	3V3: 3.3 Volts 05: 5.0 Volts 12: 12 Volts 15: 15 Volts 24: 24 Volts 28: 28 Volts 48: 48 Volts	None: Positive N: Negative	C: Clear Mounting Insert(3.2mm DIA.)

9. Mechanical Specifications

9.1 Mechanical Outline Diagrams

All Dimensions In Inches(mm)
Tolerances Inches: X.XX= ±0.02 , X.XXX= ±0.010
Millimeters: X.X= ±0.5 , X.XX=±0.25



CQB150W-110SXX Mechanical Outline Diagram

PIN CONNECTION	
PIN	Function
1	+V Input
2	On/Off
3	-V Input
4	-V Output
5	-Sense
6	Trim
7	+Sense
8	+V Output

CINCON ELECTRONICS CO., LTD.

Headquarters:

14F, No.306, Sec.4, Hsin Yi Rd.
Taipei, Taiwan
Tel: 886-2-27086210
Fax: 886-2-27029852
E-mail: support@cincon.com.tw
Web Site: http://www.cincon.com

Factory:

No. 8-1, Fu Kung Rd.
Fu Hsing Industrial Park
Fu Hsing Hsiang,
ChangHua Hsien, Taiwan
Tel: 886-4-7690261
Fax: 886-4-7698031

Cincon North America:

1655Mesa Verde Ave. Ste 180
Ventura, CA93003
Tel: 805-639-3350
Fax: 805-639-4101
E-mail: info@cincon.com