ISOLATED DC-DC CONVERTER
CQB50W12 SERIES
APPLICATION NOTE

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1. Introduction

The CQB50W12 series of DC-DC converters offers 30-50 watts of output power @ single output voltages of 5, 12, 24, 48VDC with industry standard quarter-brick. It has a wide (12:1) input voltage range of 14 to 160VDC (72VDC nominal) and 3000VDC basic isolation.

Compliant with EN50155, EN45545, EN50121-3-2. High efficiency up to 89%, allowing case operating temperature range of –40°C to 100°C. An optional heat sink is available to extend the full power range of the unit. Very low no load power consumption (5mA), an ideal solution for energy critical systems.

The standard control functions include remote on/off (positive or negative) and +10%, -20% adjustable output voltage.

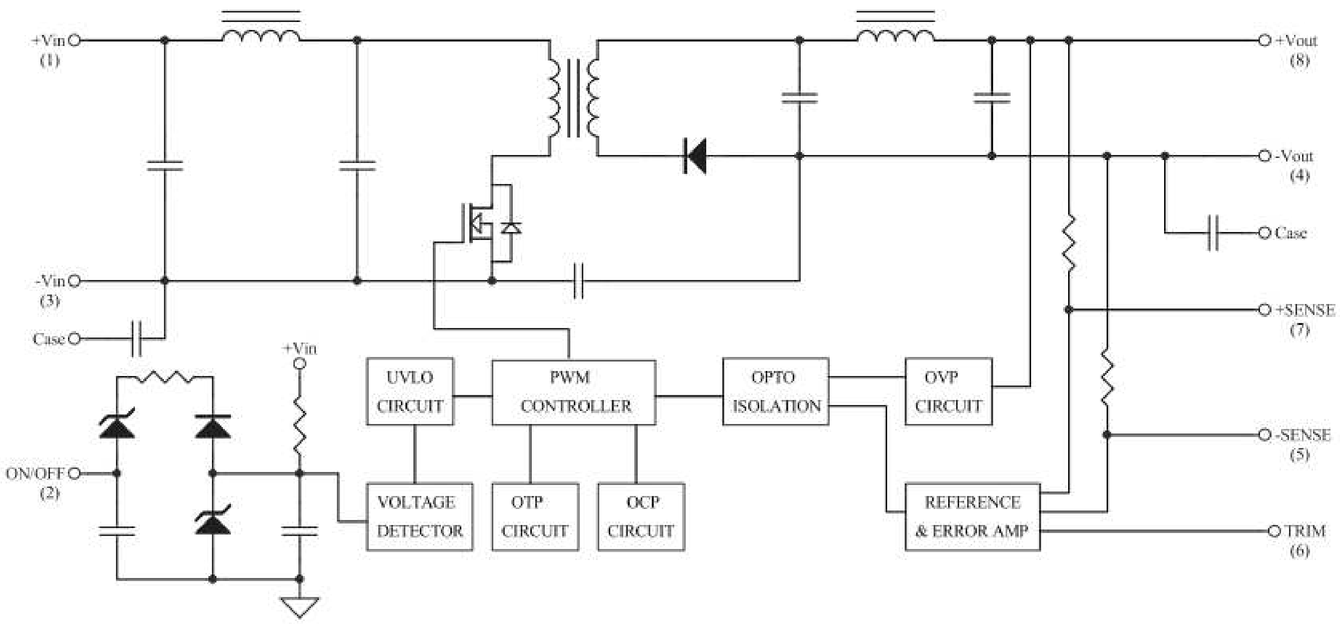
Fully protected against input UVLO (under voltage lock out), output over-current, output over-voltage and over-temperature and continuous short circuit conditions.

CQB50W12 series is designed primarily for common railway applications of 24V, 36V, 48V, 72V, 96V, 110V nominal voltage and also suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. DC-DC Converter Features

- 30-50W Isolated Output
- Efficiency to 89%
- Fixed Switching Frequency
- 12:1 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
- CB Test Certificate IEC60950-1
- Meet EN50155 with External Circuits
- Shock & Vibration Meet EN 50155 (EN 61373)
- Fire & Smoke Meet EN45545-2
- 5000m Operating Altitude

3. Electrical Block Diagram



Electrical Block Diagram

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		100	°C
Storage Temperature		All	-55		125	°C
Isolation Voltage	1 minute; input/output	All			3000	V_{dc}
	1 minute; input/case	All			2500	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	14	72	160	V_{dc}
Input Under Voltage Lockout						
Turn-On Voltage Threshold		All	14.2	14.6	15	V_{dc}
Turn-Off Voltage Threshold		All	11.6	12.0	12.4	V_{dc}
Lockout Hysteresis Voltage		All		2.6		V_{dc}
Maximum Input Current	100% Load, V_{in}=14V	All		4.6		A
No-Load Input Current		Vo=5.0V		5		mA
		Vo=12V		5		
		Vo=24V		5		
		Vo=48V		8		
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=5.0V	4.95	5	5.05	V_{dc}
		Vo=12V	11.88	12	12.12	
		Vo=24V	23.76	24	24.24	
		Vo=48V	47.52	48	48.48	
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 100°C	All			±0.02	%/°C
Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Full load, 22uF aluminum solid cpaacitor and 1.0uF ceramic capacitors **See 6.13**	All			100	mV
RMS.		All			40	mV

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Output Current Range		Vo=5.0V Vo=12V Vo=24V Vo=48V	0 0 0 0		6 4.2 2.1 1.05	A
Output DC Current Limit Inception	Hiccup Mode. Auto Recovery. **See 5.3**	All	110	180	220	%
Maximum Output Capacitance	Full load (resistive)	Vo=5.0V Vo=12V Vo=24V Vo=48V	0 0 0 0		10000 6800 3300 680	uF
Output Voltage Trim Range	P_{out}=max rated power, **See 6.11**	All	-20		+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		15		ms
Turn-On Delay Time, From Input	V_{in_min} to 10%V_{o_set}	All		15		ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All		10		ms

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=72V **See 6.8**	Vo=5.0V Vo=12V Vo=24V Vo=48V		83 87 89 88		%
	Vin=110V **See 6.8**	Vo=5.0V Vo=12V Vo=24V Vo=48V		81 86 87 85		%

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			2500	V_{dc}
	1 minute; output/case	All			500	V_{ac}
Isolation Resistance	Input/Output	All	200			MΩ
Isolation Capacitance	Input/Output	All		1000		pF
	Input/Case	All		1500		pF
	Output/Case	All		10000		pF

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency	Pulse wide modulation (PWM), Fixed	All	215	240	265	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
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	4.0 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		0.4	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		3	5	mA
Over Temperature Shutdown	Aluminum baseplate 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	All		780		K hours
Weight		All		61.5		grams
Case Material	Plastic, DAP					
Baseplate Material	Aluminum					
Potting Material	UL 94V-0					
Pin Material	Base: Copper Plating: Nickel with Matte Tin					
Shock/Vibration	MIL-STD-810F / EN61373					
Humidity	95% RH max. Non Condensing					
Altitude	5000m Operating Altitude, 12000m Transport Altitude					
Thermal Shock	MIL-STD-810F					
Fire & Smoke	Meets EN45545-2					
EMI	Meets EN55011, EN55022 & EN50155 with external input filter, **see 7.2** EN55032					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, **see 6.18**					Perf. Criteria B
Supply Change Over	EN50155 Class C2:During a supply break of 30 ms, **see 6.18**					Perf. Criteria B

5. Main Features and Functions

5.1 Operating Temperature Range

The CQB50W12 series converters can be operated within a wide case temperature range of -40°C to 100°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:

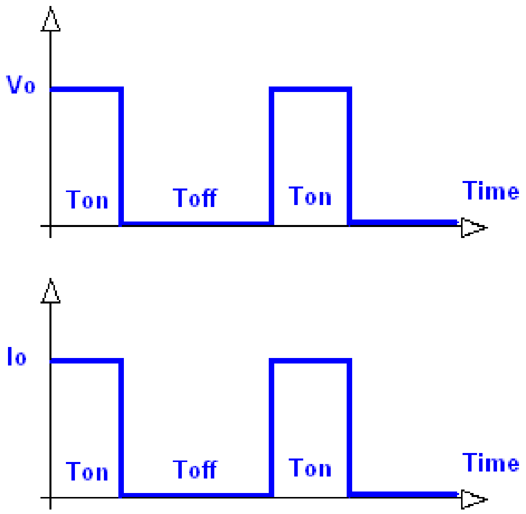
- Input voltage range
- Output load current
- Forced air or natural convection
- Heat sink optional

5.2 Output Voltage Adjustment

Section 6.11 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 –20%.

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

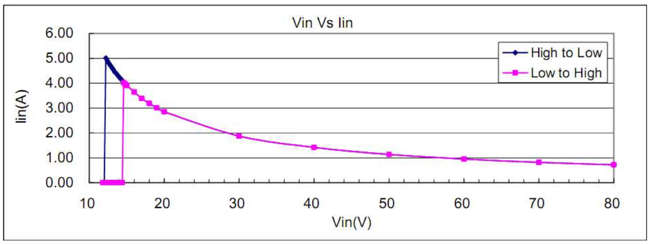
The CQB50W12 series allows the user to switch the module on and off electronically with the remote on/off feature. All models are available in “positive logic” and “negative logic” (optional) versions. The converter turns on if the remote on/off pin is high (>3.5Vdc to 160Vdc or open circuit). Setting 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 (>4.0Vdc 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 6.15**

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)

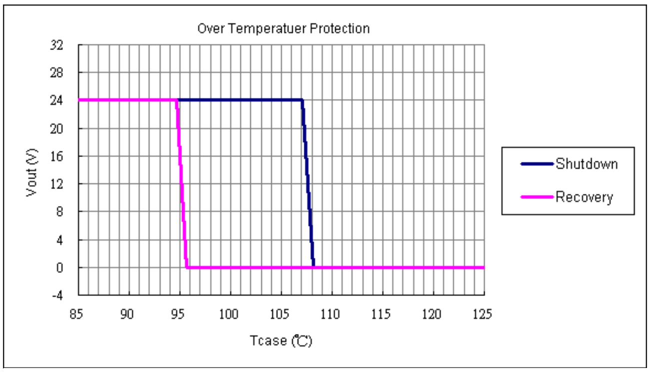
Input under voltage lockout is standard on the CQB50W12 series unit. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

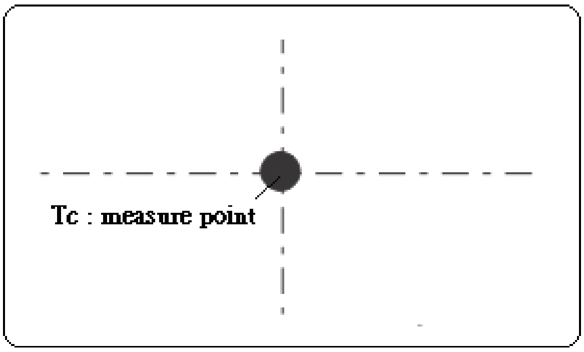
Vin Vs Iin



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.

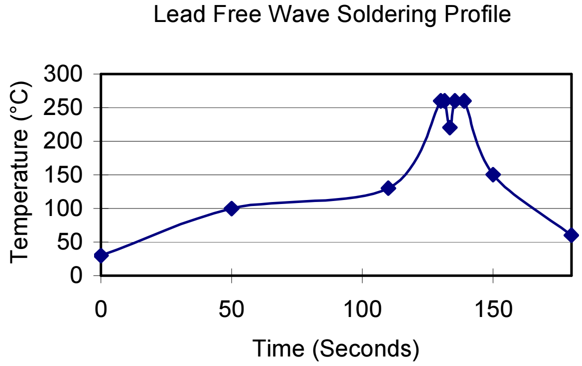


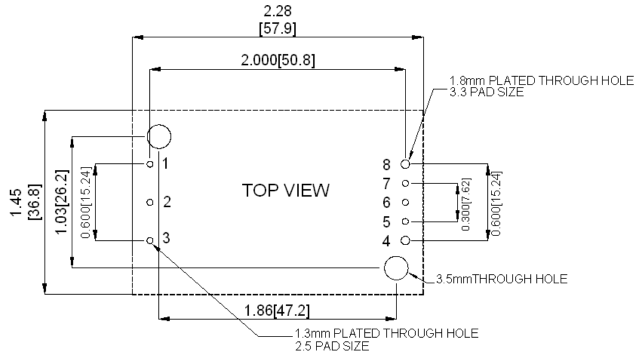


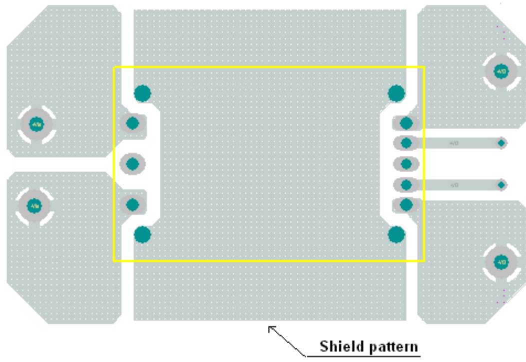
6. Applications

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. The recommended soldering profile and PCB layout are shown below.

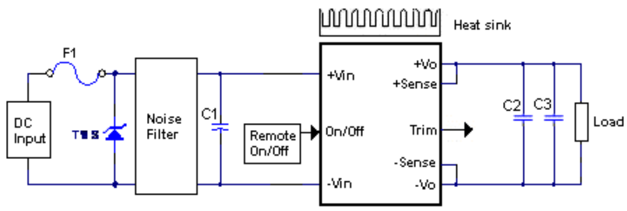






6.2 Connection for standard use

The connection for standard use is shown below. An external input capacitor (C1) 68uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 22uF aluminum solid and 1uF ceramic capacitor for all models.

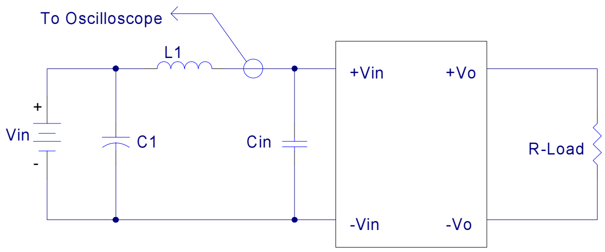


Symbol	Component	Reference
F1, TVS	Input fuse, TVS	**Section 7.1**
C1	External capacitor on input side	**Note**
C2,C3	External capacitor on the output side	**Section 6.13/6.14**
Noise Filter	External input noise filter	**Section 7.2**
Remote On/Off	External remote on/off control	**Section 6.15**
Trim	External output voltage adjustment	**Section 6.11**
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: 68uF ESR<0.7ohm @100KHz
Cin: 68uF 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 100°C as measured at the center of the top of the case (thus verifying proper cooling).

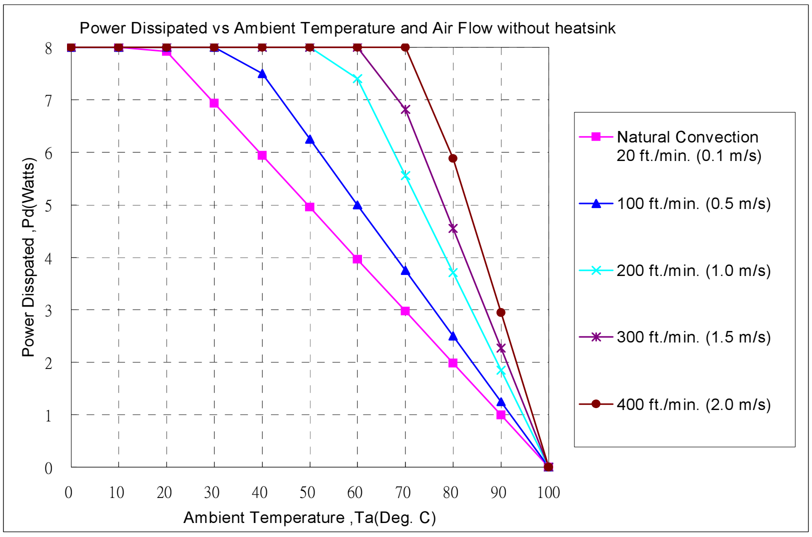
6.5 Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The 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 CQB50W12 series is -40°C to +100°C. When operating the CQB50W12 series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 100°C.

The following curve is the de-rating curve of CQB50W12 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 CQB50W12-72S12 operating at nominal line voltage, an output current of 4.2A, and a maximum ambient temperature of 40°C?

Solution:
Given:

V_{in}=72V_{dc}, Vo=12V_{dc}, I_o=4.2A

Determine Power dissipation (P_d):

P_d =P_i-P_o=P_o(1-η)/η

P_d =12V×4.2A×(1-0.87)/0.87=7.53Watts

Determine airflow:

Given: P_d =7.53W and T_a=40°C

Check *Power Derating* curve:

Minimum airflow= 200 ft./min.

Verify:

Maximum temperature rise is

ΔT = Pd × Rca=7.53W×5.4=40.67°C.

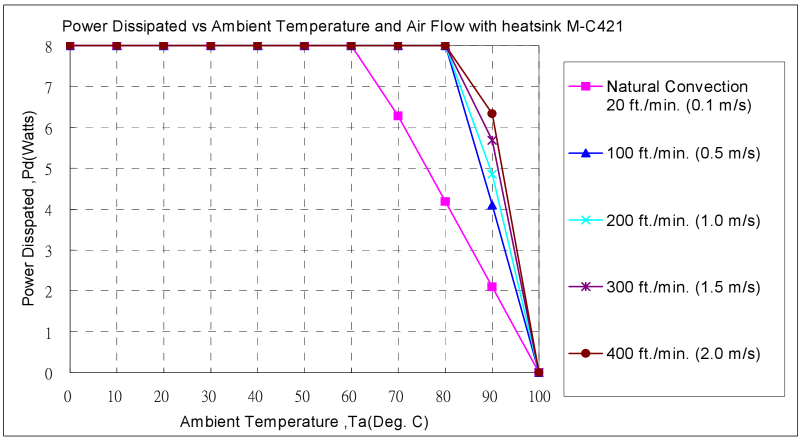
Maximum case temperature is

Tc=Ta+ΔT=80.67°C <100°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 M-C421):

What is the minimum airflow necessary for a CQB50W12-72S12 operating at nominal line voltage, an output urrent of 4.2A, and a maximum ambient temperature of 80℃?

Solution:

Given:

Vin=72Vdc, Vo=12Vdc, Io=4.2A

Determine Power dissipation (P_d):

Pd=Pi-Po=Po(1-η)/η

Pd=12×4.2×(1-0.87)/0.87=7.53Watts

Determine airflow:

Given: Pd=7.53W and Ta=80℃

Check above Power de-rating curve:

Minimum airflow= 100 ft./min

Verify:

Maximum temperature rise is $\triangle T = P_d \times R_{ca}$=7.53×2.44=18.37℃

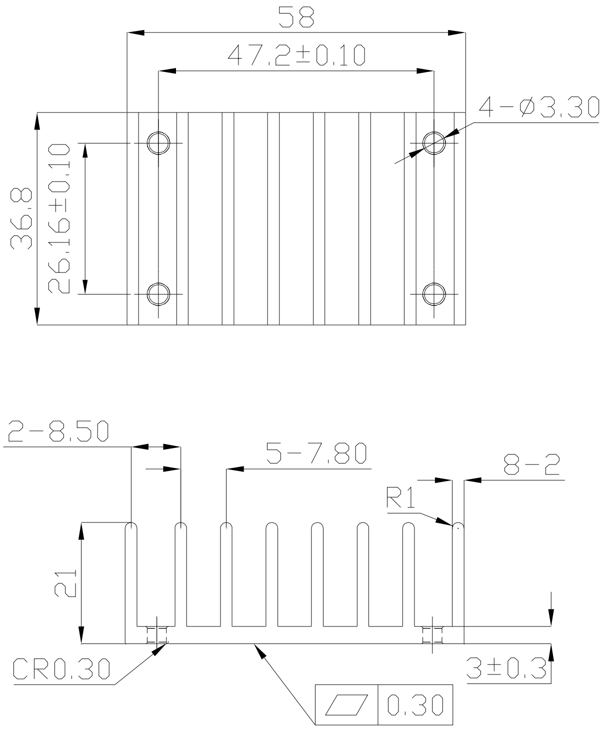
Maximum case temperature is Tc=Ta+△T=98.37℃ <100℃

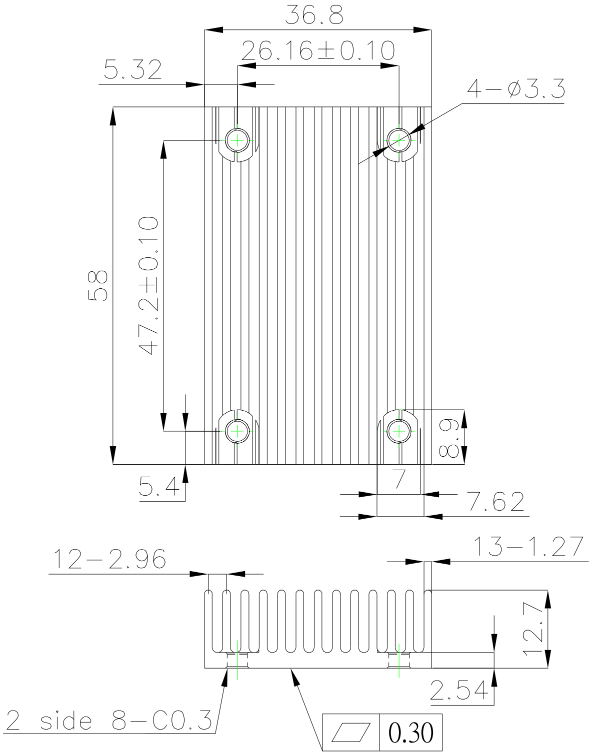
Where:

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:





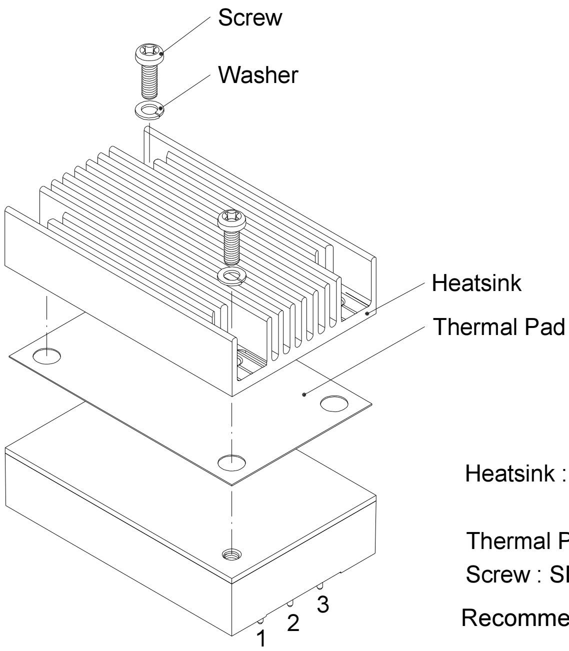
All Dimensions in mm

M-C421 (G6620510201)
Transverse Heat Sink

Rca: 4.78°C/W (typ.), At natural convection
2.44°C/W (typ.), At 100LFM
2.06°C/W (typ.), At 200LFM
1.76°C/W (typ.), At 300LFM
1.58°C/W (typ.), At 400LFM

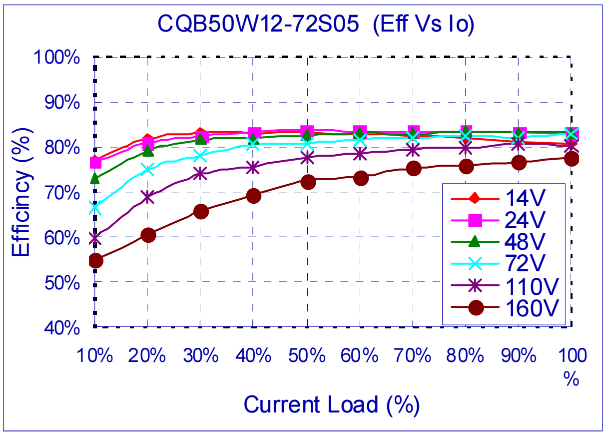
M-C448 (G6620570202)
Longitudinal Heat Sink

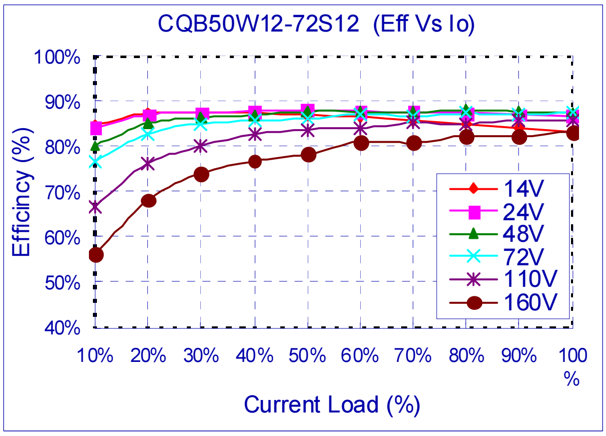
Rca: 5.61°C/W (typ.), At natural convection
4.01°C/W (typ.), At 100LFM
3.39°C/W (typ.), At 200LFM
2.86°C/W (typ.), At 300LFM
2.49°C/W (typ.), At 400LFM

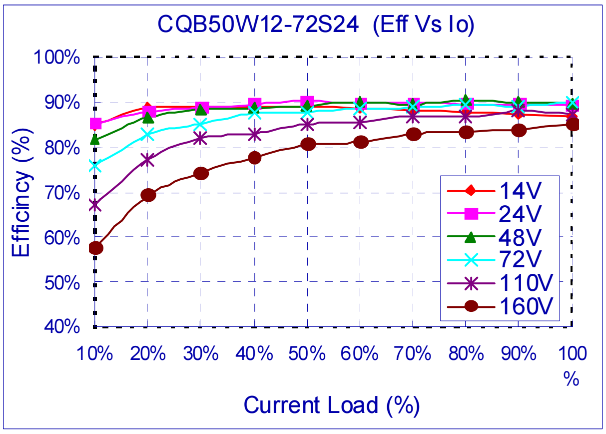


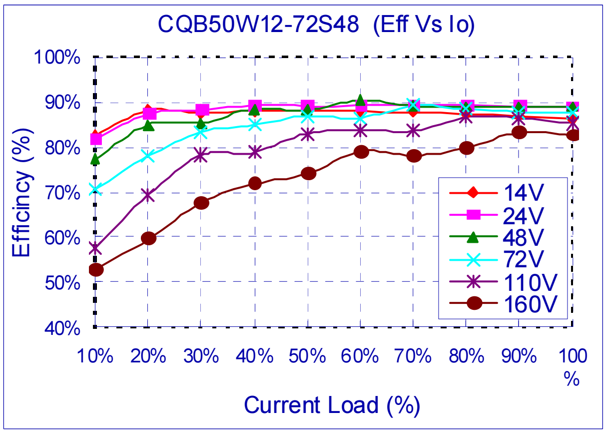
Heatsink : M-C448
M-C421
Thermal Pad : SZ35.8x56.9x0.25mm
Screw : SMP+SW M3x8L
Recommended torque 3 Kgf-cm

6.8 Efficiency VS. Load

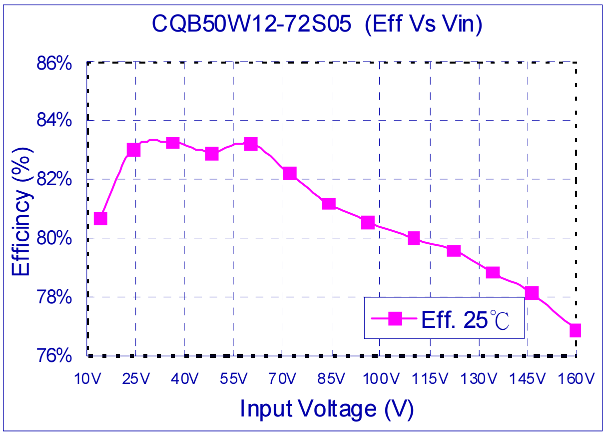


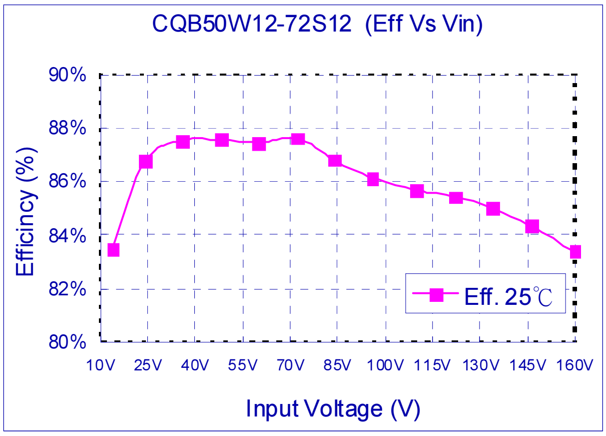


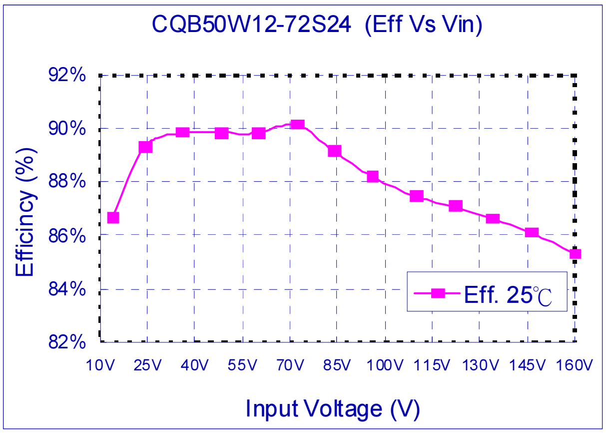


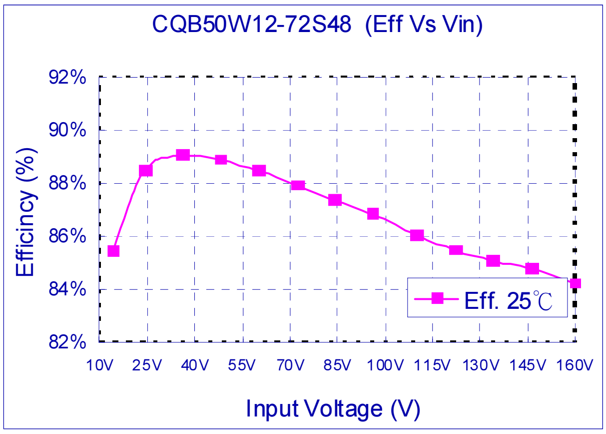


6.9 Efficiency VS. Vin









6.10 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:

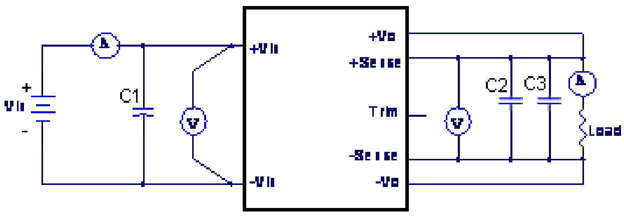
$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

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.

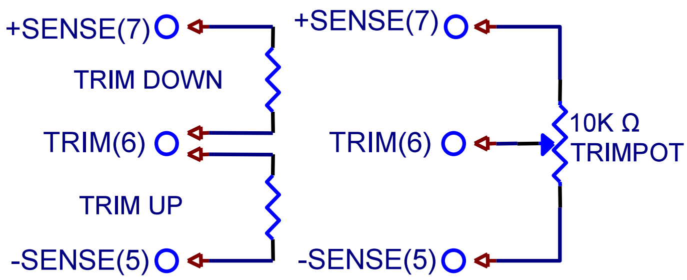


CQB50W12 Series Test Setup

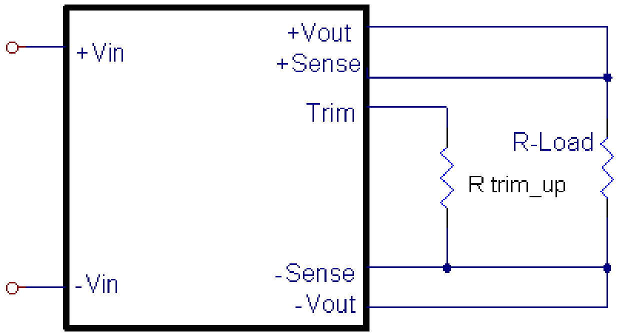
C1: 68uF/200V ESR<0.7Ω
C2: 1uF/ 1206 ceramic capacitor
C3: 22uF aluminum solid capacitor.

6.11 Output Voltage Adjustment

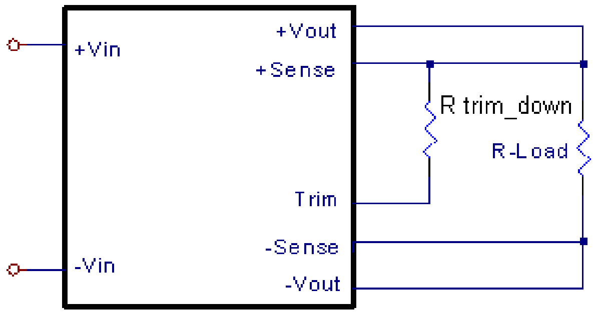
Output may be externally trimmed (-20% to +10%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



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 -20% to +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)
5V	3	6.8	2.4	1.24	0.5
12V	9.1	24	5.1	2.5	0.5
24V	20	68	7.5	2.5	0.5
48V	36	82	5.1	2.5	0.5

Trim Resistor Values

The value of R_{trim_up} defined as:

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

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 (CQB50W12-72S12) 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 = 24 KΩ , R3 = 5.1KΩ ,
V_r= 2.5 V, V_f=0.5 V

$$R_{trim\_up} = \frac{18.997}{0.6} - 4.206 = 27.45\,(K\Omega)$$

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 (CQB50W12-72S12) 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

$$R_{trim\_down} = \frac{9.1 \times (11.4 - 2.5)}{0.6} - 24 = 110.98 \;\; (K\Omega)$$

The typical value of R_{trim_up}

Trim up %	5V	12V	24V	48V
	R_{trim_up} (KΩ)			
1%	50.45	154.1	164.0	147.3
2%	24.34	74.95	78.64	71.29
3%	15.63	48.56	50.18	45.93
4%	11.28	35.37	35.94	33.24
5%	8.67	27.45	27.40	25.63
6%	6.93	22.17	21.71	20.56
7%	5.69	18.41	17.64	16.94
8%	4.75	15.58	14.59	14.22
9%	4.03	13.38	12.22	12.10
10%	3.45	11.62	10.32	10.41

The typical value of R_{trim_down}

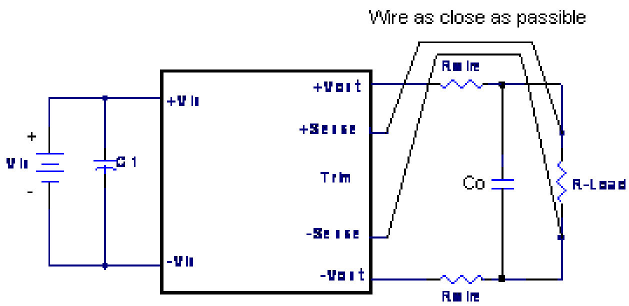
Trim down %	5V	12V	24V	48V
	R_{trim_down} (KΩ)			
1%	215.8	687.3	1703	3294
2%	103.0	327.1	807.8	1588
3%	65.40	207.0	509.2	1019
4%	46.60	147.0	359.9	735.1
5%	35.32	110.9	270.3	564.5
6%	27.80	86.96	210.6	450.7
7%	22.43	69.81	167.9	369.5
8%	18.40	56.95	135.9	308.5
9%	15.27	46.94	111.0	261.1
10%	12.76	38.94	91.16	223.2
11%	10.71	32.39	74.87	192.2
12%	9.00	26.93	61.30	166.3
13%	7.55	22.31	49.82	144.5
14%	6.31	18.35	39.97	125.7
15%	5.24	14.92	31.44	109.5
16%	4.30	11.92	23.97	95.28
17%	3.47	9.277	17.39	82.73
18%	2.73	6.923	11.53	71.58
19%	2.07	4.817	6.298	61.60
20%	1.48	2.921	1.583	52.62

6.12 Output Remote Sensing

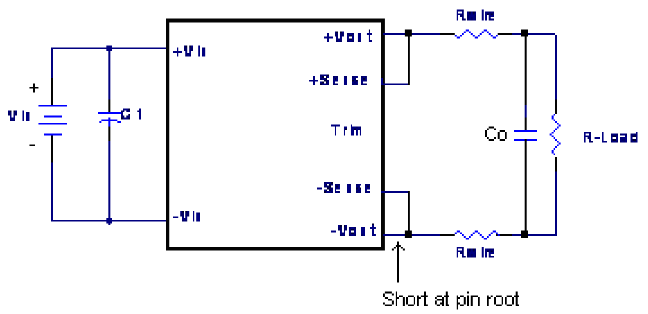
The CQB50W12 series converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the CQB50W12 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.

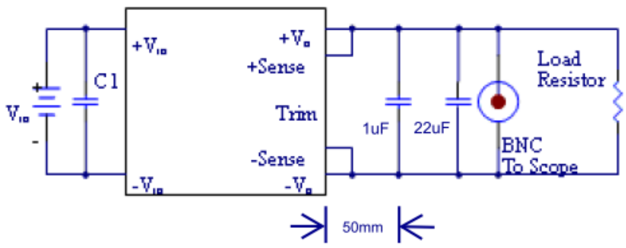


If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module. Wire between +Sense and +Vout and between -Sense and –Vout as short as possible.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

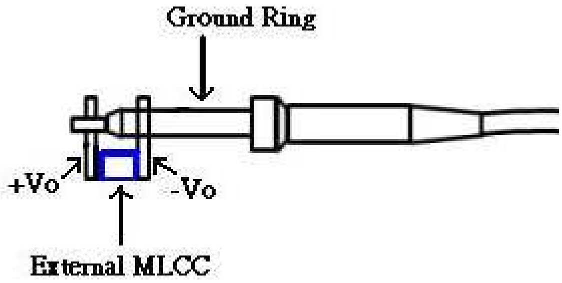
6.13 Output Ripple and Noise



Output ripple and noise measured with 22uF aluminum solid 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.

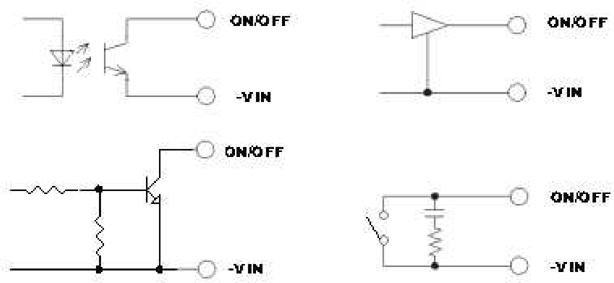


6.14 Output Capacitance

The CQB50W12 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.

6.15 Remote On/Off circuit

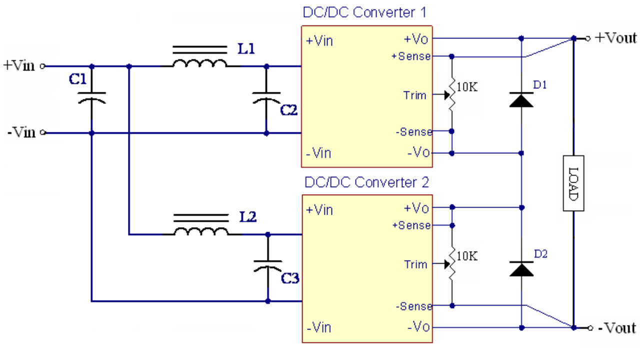
The converter remote On/Off circuit built-in on input side. The ground pin of input side Remote On/Off circuit is –Vin pin. **Refer to 5.5** for more details. Connection examples see below.



Remote On/Off Connection Example

6.16 Series operation

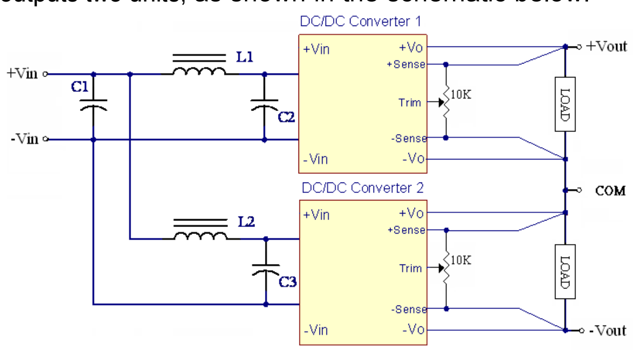
Series operation is possible by connecting the outputs two or more units. Connection is shown in below. The output current in series connection should be lower than the lowest rate current in each power module.



Simple Series Operation Connect Circuit

L1, L2: 1.0uH
C1, C2, C3: 68uF/200V ESR<0.7Ω
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.

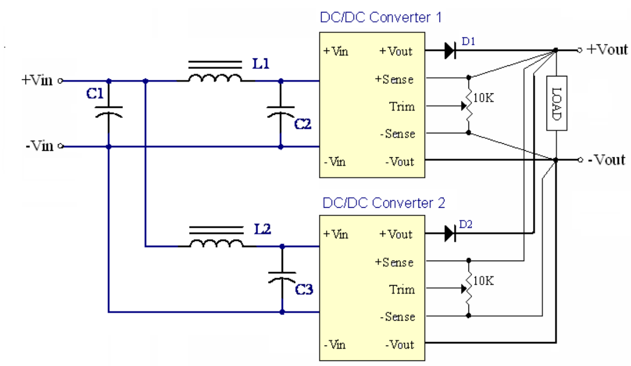


Simple ±Output Operation Connect Circuit

L1, L2: 1.0uH
C1, C2, C3: 68uF/200V ESR<0.7Ω
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 ℃

6.17 Parallel/Redundant operation

The CQB50W12 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.

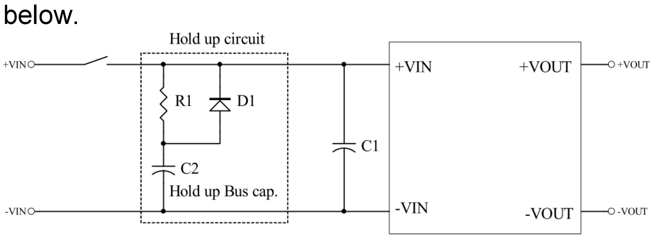


Simple Redundant Operation Connect Circuit

L1, L2: 1.0uH
C1, C2, C3: 68uF/200V ESR<0.7Ω
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 ℃

6.18 Hold up Time

Hold up time is defined as the duration of time that DC/DC converter output will remain active following a loss of input power. To meet power supply interruptions, an external circuit is required, shown below.



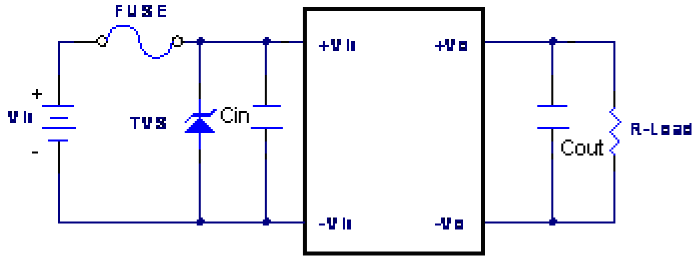
D1:200V/10A
R1:100Ω/10W
C1: 68uF/200V ESR<0.7Ω

C2	24Vin	36Vin	48Vin
Hold up time for 10ms	3300uF	1100uF	600uF
Hold up time for 30ms	9400uF	3300uF	1700uF
C2	72Vin	96Vin	110Vin
Hold up time for 10ms	250uF	150uF	120uF
Hold up time for 30ms	730uF	410uF	330uF

7. Safety & EMC

7.1 Input Fusing and Safety Considerations

The CQB50W12 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 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).

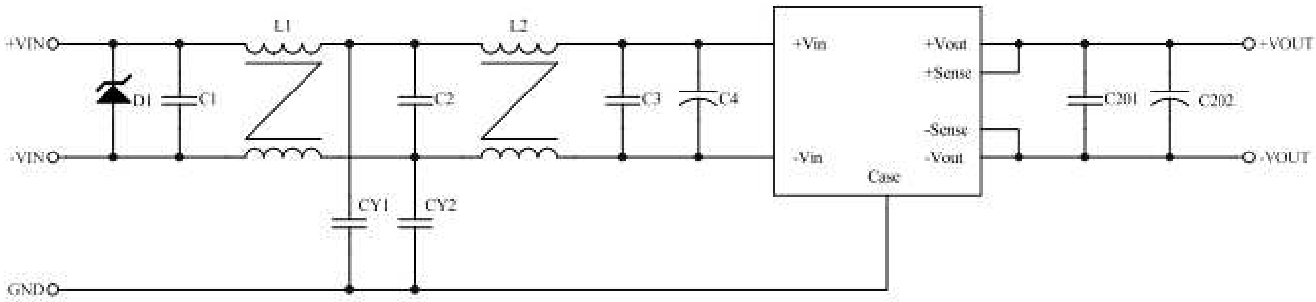


The external TVS & input capacitor (Cin) is required if CQB50W12 series has to meet EN61000-4-4, EN61000-4-5. The CQB50W12 series recommended a TVS (Littelfuse 1.5KE180A) & aluminum capacitor (82uF/200V) to connect parallel.

7.2 EMC Considerations

EMI Test standard: EN50121-3-2 Conducted & Radiated Emission
Test Condition: Input Voltage: 110Vdc, Output Load: Full Load

(1) EMI meet EN55011 / EN55022 / EN50121-3-2:2006

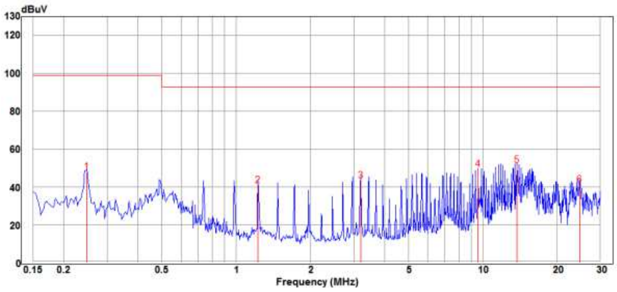


C1,C2,C3	C4	C201	C202	CY1,CY2	D1	L1,L2
1uF/250V 1812 Ceramic Cap.	82uF/250V KXJ Series Aluminum Cap.	1uF/100V 1206 Ceramic Cap.	22uF/100V Solid Aluminum Cap.	1500pF	1.5KE180A	URT24-050055H 5.5mH

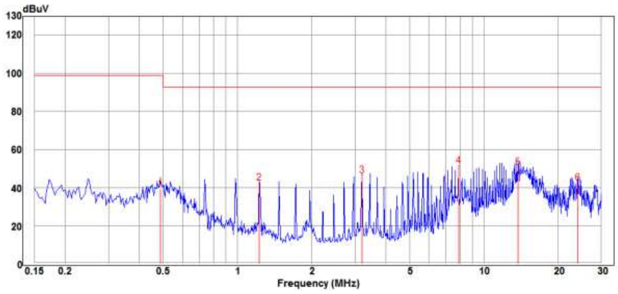
Note: C4 UNITED CHEMI-CON KXJ series or equivalent, CY1, CY2 MURATA Y1 capacitors or equivalent, L1, L2 BULL WILL URT24-05055H or equivalent

Conducted Emission:

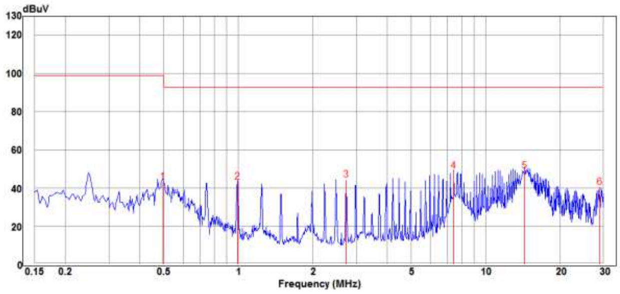
CQB50W12-72S05
Line



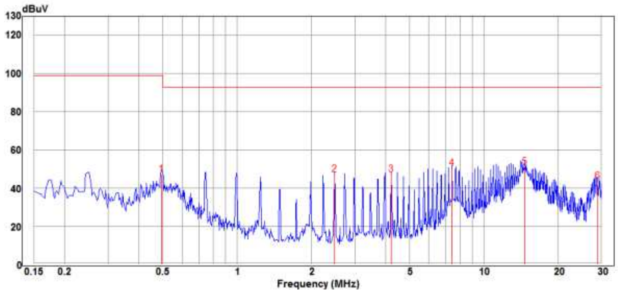
CQB50W12-72S05
Neutral



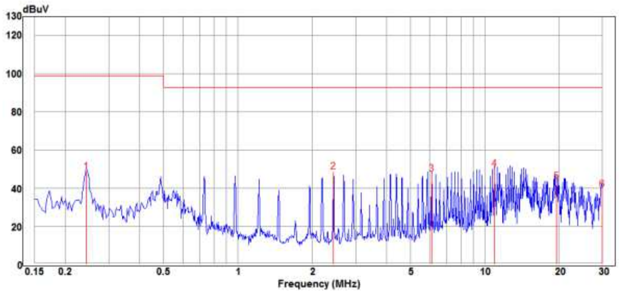
CQB50W12-72S12
Line



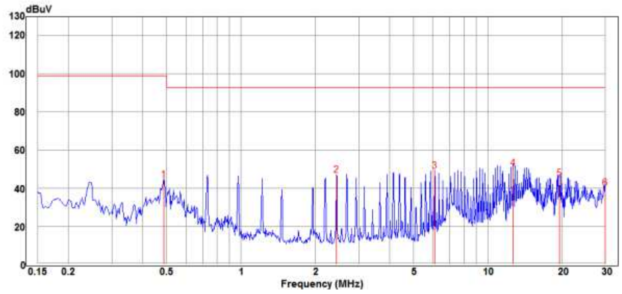
CQB50W12-72S12
Neutral



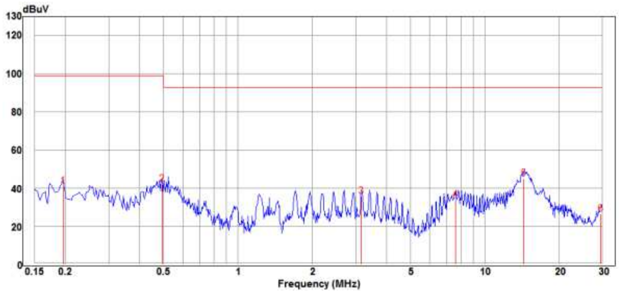
CQB50W12-72S24
Line



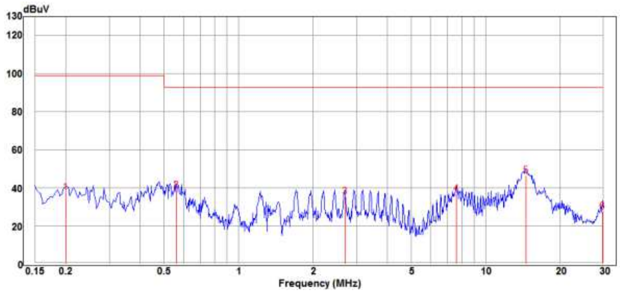
CQB50W12-72S24
Neutral



CQB50W12-72S48
Line

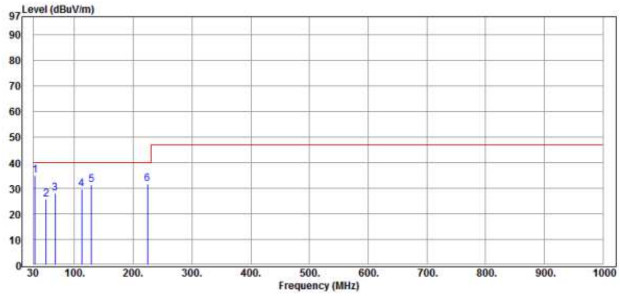


CQB50W12-72S48
Neutral

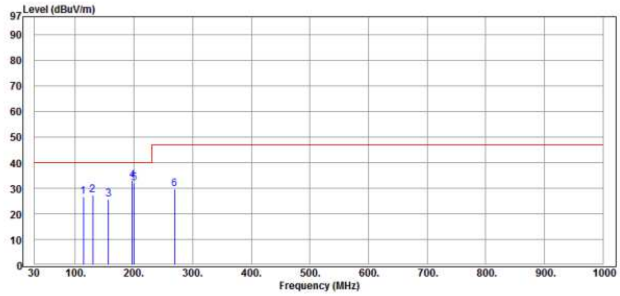


Radiated Emission:

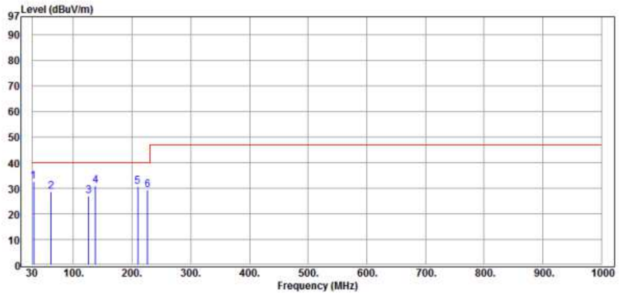
CQB50W12-72S05
Vertical



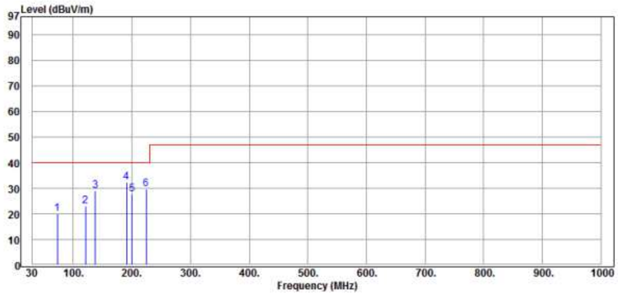
CQB50W12-72S05
Horizontal



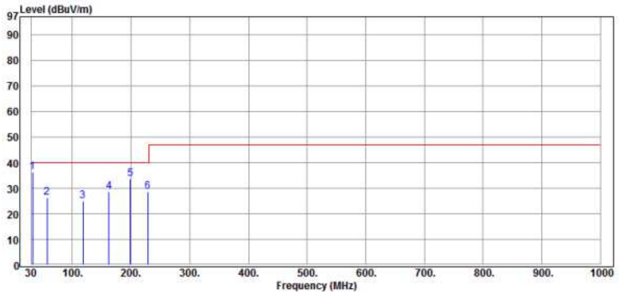
CQB50W12-72S12
Vertical



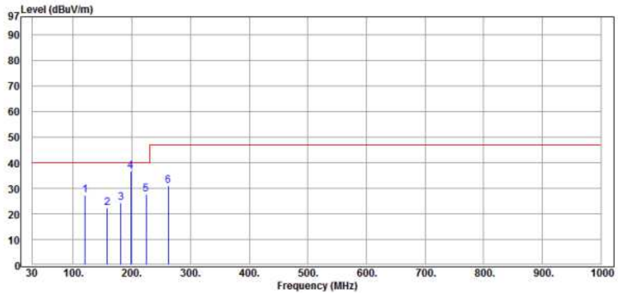
CQB50W12-72S12
Horizontal



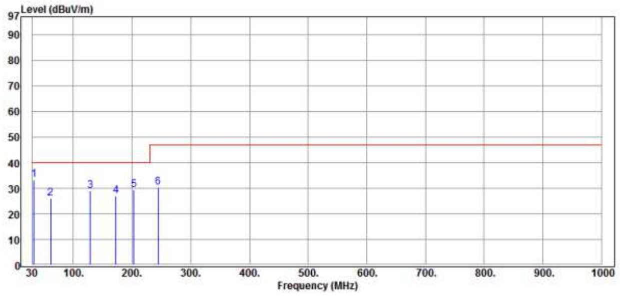
CQB50W12-72S24
Vertical



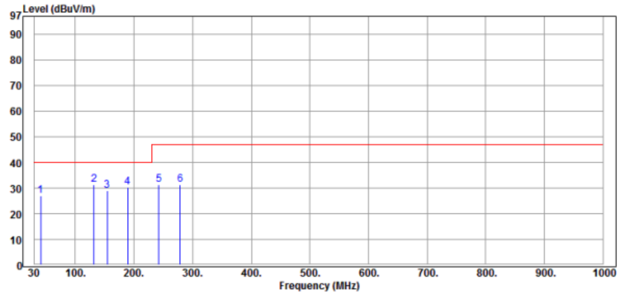
CQB50W12-72S24
Horizontal



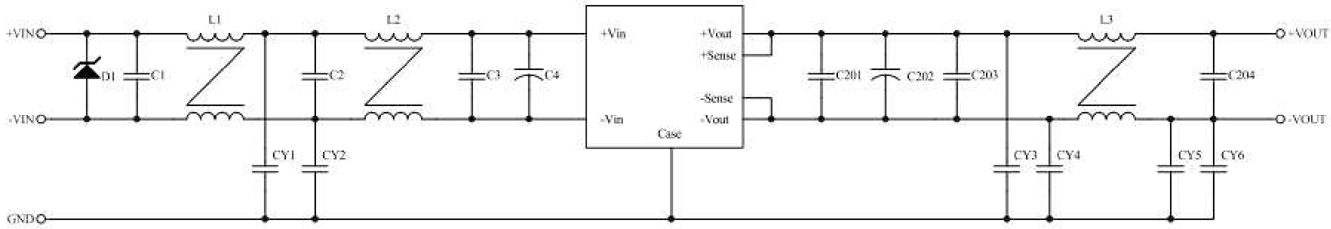
CQB50W12-72S48
Vertical



CQB50W12-72S48
Horizontal



(2) EMI meet EN50121-3-2:2015

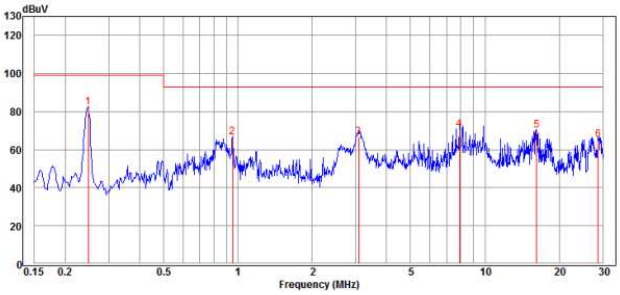


C1,C2,C3	C4	C201	C202	C203,C204	CY1,CY2	CY3,CY4,CY5,CY6
1uF/250V 1812 Ceramic Cap.	82uF/250V KXJ Series Aluminum Cap.	1uF/100V 1206 Ceramic Cap.	22uF/100V Solid Aluminum Cap.	2.2uF/100V 1210 Ceramic Cap.	1500pF	0.047uF/1KV 1812 Ceramic Cap.
D1	L1,L2	L3				
1.5KE180A	URT24-050055H 5.5mH	Core P/N: CM15*10*4.5 Winding: 1.0mm*2 / 4Turns 0.4mH				

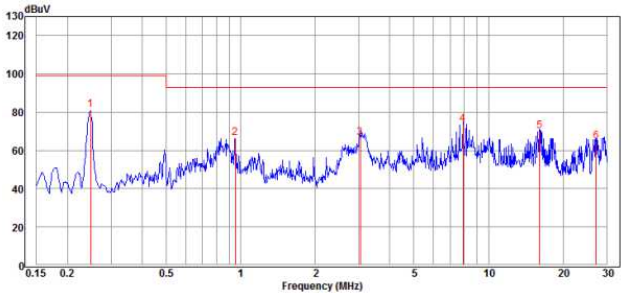
Note: C4 UNITED CHEMI-CON KXJ series or equivalent, CY1, CY2 MURATA Y1 capacitors or equivalent,
L1, L2 BULL WILL URT24-05055H or equivalent

Output Conducted Emission:

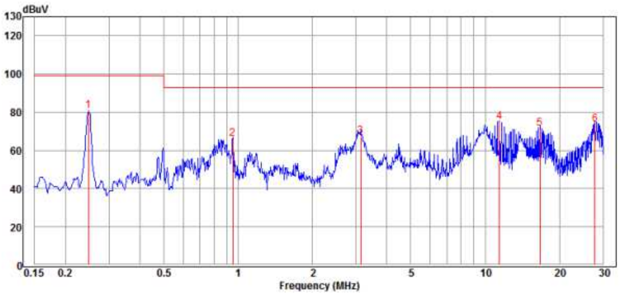
CQB50W12-72S05
Pos



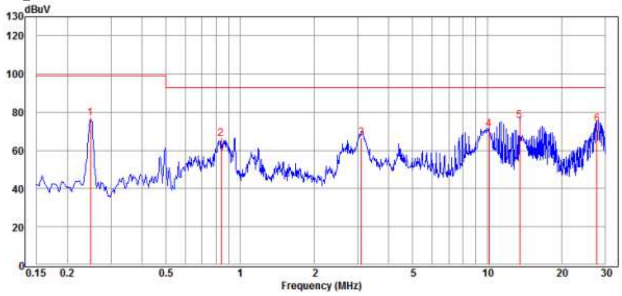
CQB50W12-72S05
Neg



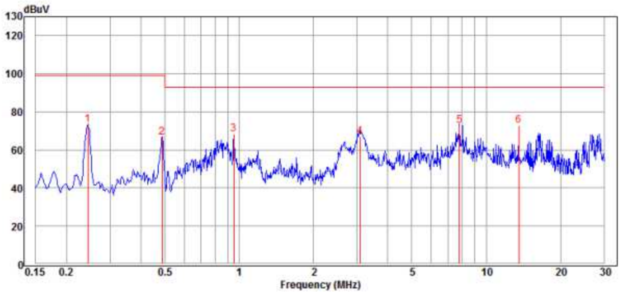
CQB50W12-72S12
Pos



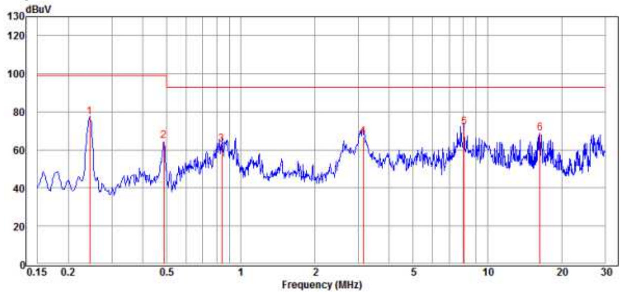
CQB50W12-72S12
Neg



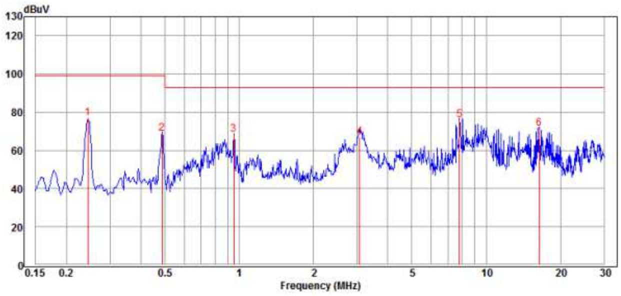
CQB50W12-72S24
Pos



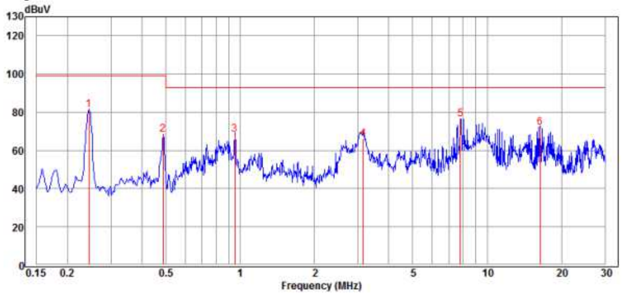
CQB50W12-72S24
Neg



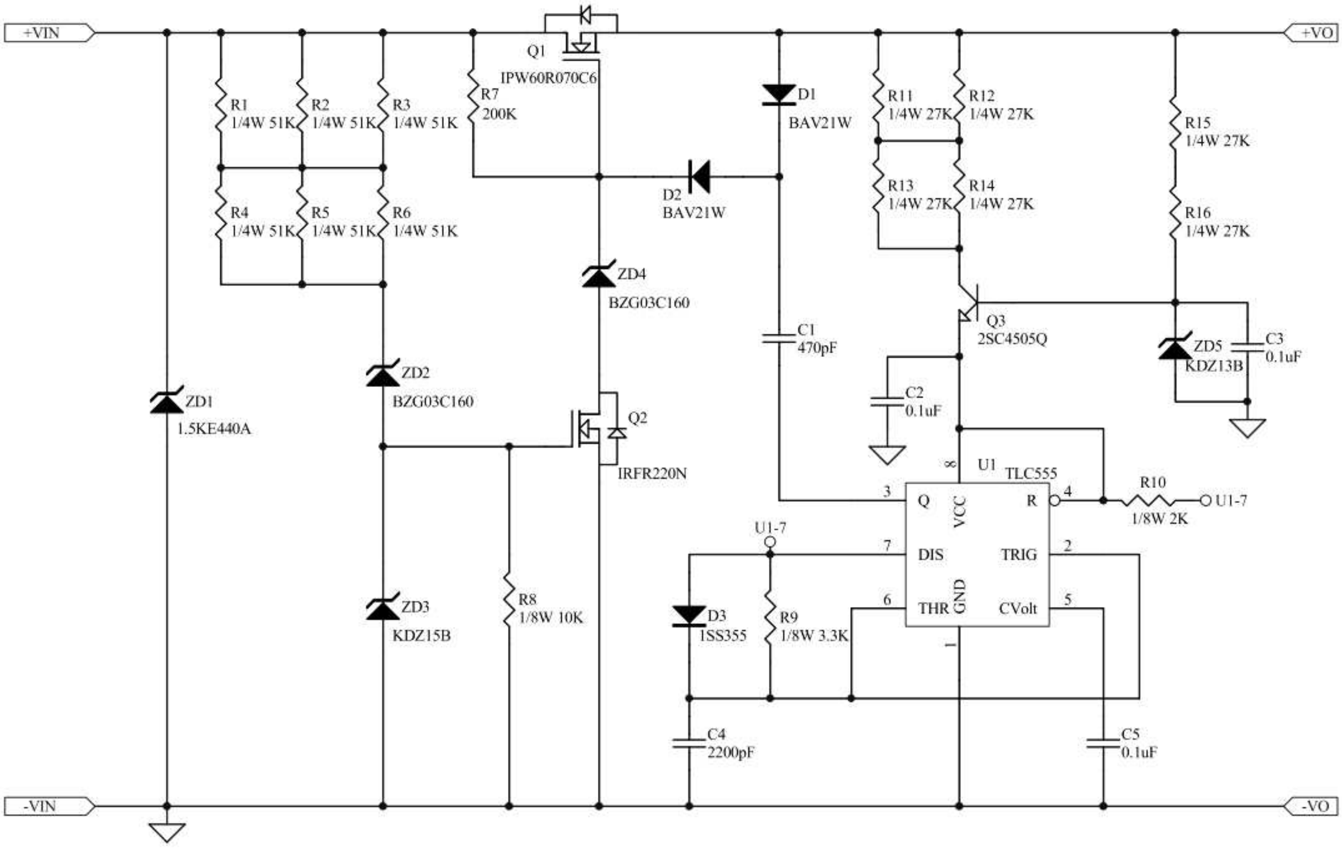
CQB50W12-72S48
Pos



CQB50W12-72S48
Neg



7.3 Suggested Configuration for RIA12 Surge Test



Note: Q1 suggest use Infineon IPW60R070C6 or equivalent, and provide good heat dissipation conditions

8. Part Number

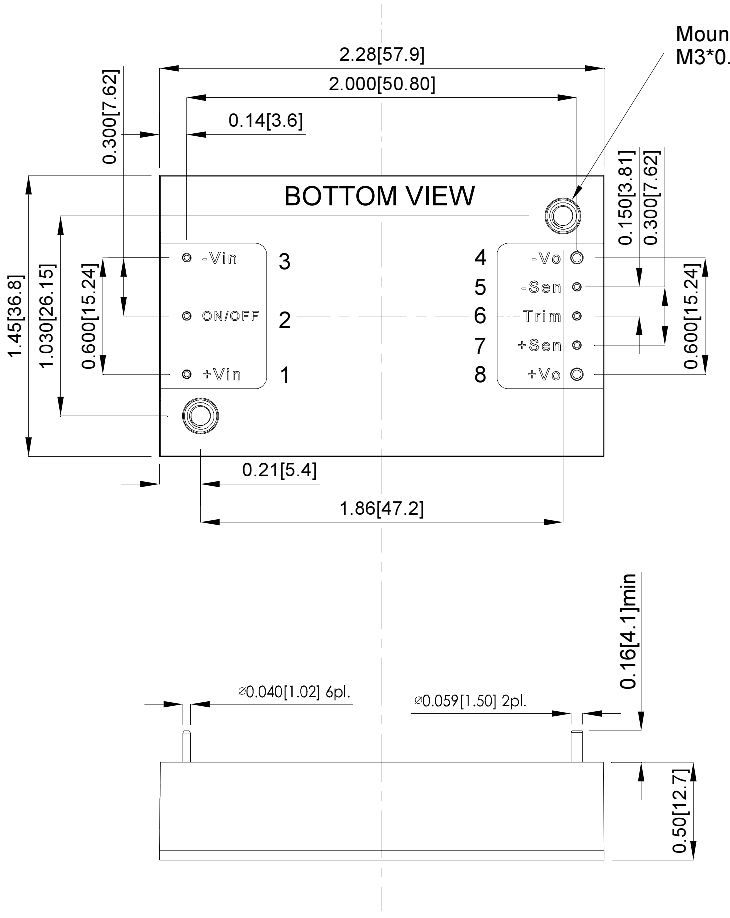
Format: CQB50W12 – II O XX L-Y

Parameter	Series	Nominal Input Voltage	Number of Outputs	Output Voltage	Remote On/Off Logic	Mounting Inserts
Symbol	CQB50W12	II	O	XX	L	Y (Option)
Value	CQB50W12	72: 72 Volts	S: Single	05: 5.0 Volts 12: 12 Volts 24: 24 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



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

CQB50W12-72SXX Mechanical Outline Diagram

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