



# CQB150W14 Series Application Note V10

## ISOLATED DC-DC CONVERTER CQB150W14 SERIES APPLICATION NOTE



**Approved By:**

Department	Approved By	Checked By	Written By
Research and Development Department	Jacky	Astray	Elsie
Design Quality Department	Benny	JoJo	



# CQB150W14 Series Application Note V10

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## 1. Introduction

The CQB150W14 series of DC-DC converters offers 150 watts of output power @ single output voltages of 5, 12, 15, 24, 28, 54VDC with industry standard quarter-brick. It has a ultrawide (14:1) input voltage range of 12 to 160VDC (72VDC nominal) and 3000VAC reinforced isolation.

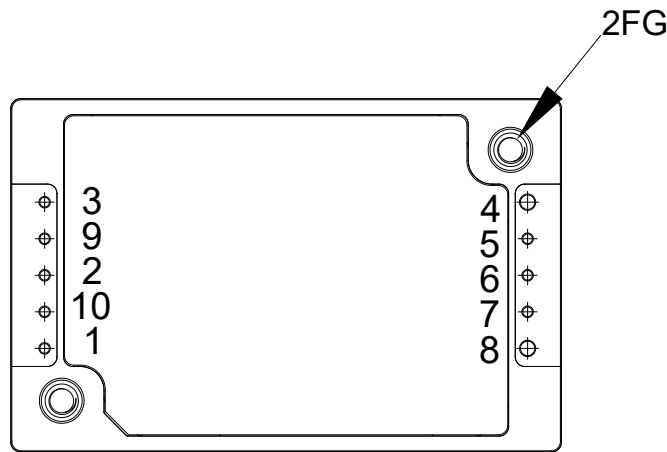
Compliant with EN50155, EN45545, EN50121-3-2. High efficiency up to 90.5%, allowing case operating temperature range of -40°C to 105°C. An optional heat sink is available to extend the full power range of the unit. Very low no load power consumption (25mA), an ideal solution for energy critical systems.

The standard control functions include remote on/off (positive or negative) and +15% to -20% (except for 54Vout +10% to -20%) adjustable output voltage.

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

CQB150W14 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. Pin Function Description



No	Label	Function	Description	Reference
1	+Vin	+V Input	Positive Supply Input	<b>Section 7.1/7.2/ 7.3</b>
2	ON/OFF	On/Off	External Remote On/Off Control	<b>Section 6.5</b>
3	-Vin	-V Input	Negative Supply Input	<b>Section 7.1/7.2/7.3</b>
4	-Vo	-V Output	Negative Power Output	<b>Section 7.4/7.5</b>
5	-Sen	-Sense	Negative Output Remote Sense	<b>Section 6.6</b>
6	Trim	Trim	External Output Voltage Adjustment	<b>Section 6.7</b>
7	+Sen	+Sense	Positive Output Remote Sense	<b>Section 6.6</b>
8	+Vo	+V Output	Positive Power Output	<b>Section 7.4/7.5</b>
9	Bus	Bus	Pre-Regulator Voltage Output (Option)	<b>Section 7.2</b>
10	UVLO	UVLO	External UVLO Function (Option)	<b>Section 6.1</b>
--	--	Mounting Insert	Mounting Insert (FG)	<b>Section 9.5/10.2</b>

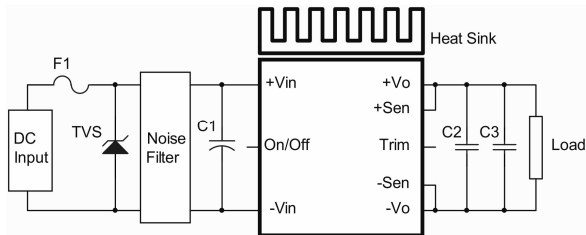
Note: Base plate can be connected to FG through M3 threaded mounting insert. Recommended torque 3Kgf-cm.



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## 3. Connection for Standard Use

The connection for standard use is shown below. An external input capacitor (C1) 470uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 10uF polymer tantalum and 1uF ceramic capacitors for all models.



Symbol	Component	Reference
F1, TVS	Input fuse, TVS	<b>Section 10.1</b>
C1	External capacitor on the input side	<b>Note</b> <b>Section 7.2</b>
C2, C3	External capacitor on the output side	<b>Section 7.4/7.5</b>
Noise Filter	External input noise filter	<b>Section 10.2</b>
Remote On/Off	External Remote On/Off control	<b>Section 6.5</b>
Trim	External output voltage adjustment	<b>Section 6.7</b>
Heat sink	External heat sink	<b>Section 9.2/9.3/9.4/9.5</b>
+Sense/-Sense	--	<b>Section 6.6</b>

### Note:

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

## 4. 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:

$$\eta = \frac{V_o \times I_o}{V_{in} \times I_{in}} \times 100\%$$

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:

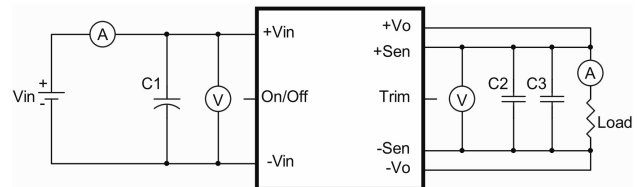
$V_{FL}$  is the output voltage at full load  
 $V_{NL}$  is the output voltage at no load

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 80% full load



CQB150W14 Series Test Setup

C1: 470uF/200V ESR<0.04Ω

C2: 1uF/1210 ceramic capacitor

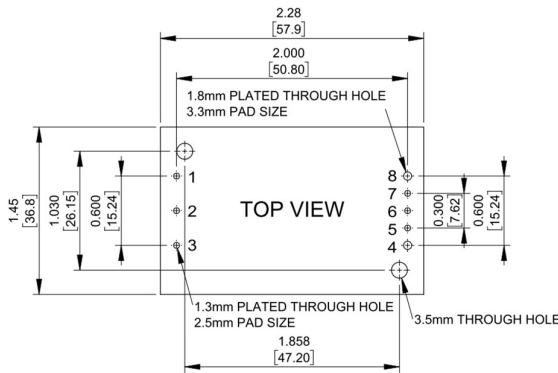
C3: 10uF polymer tantalum capacitor (ESR≤0.05Ω)



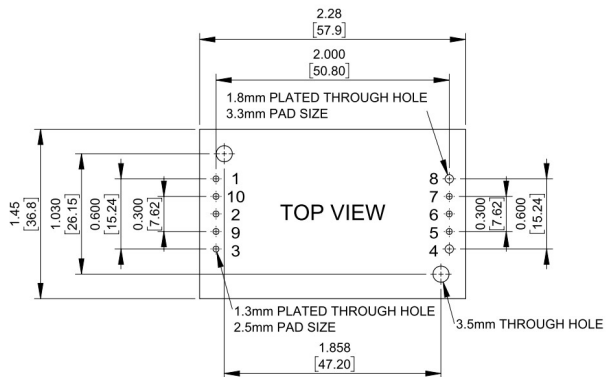
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## 5. Recommend Layout, PCB Footprint and Soldering Information

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.



Standard Module

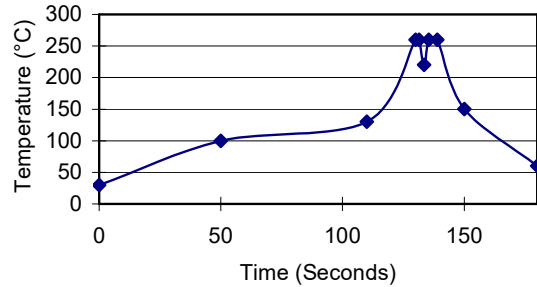


Option -B Module

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 change 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°C for up to 5 seconds (less than 50W). Furthermore, the recommended soldering profile is shown below, and PCB layout is referring to **Section 10.2**.

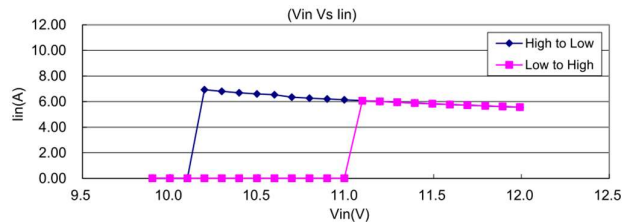
Lead Free Wave Soldering Profile



## 6. Features and Functions

### 6.1 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the CQB150W14 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.

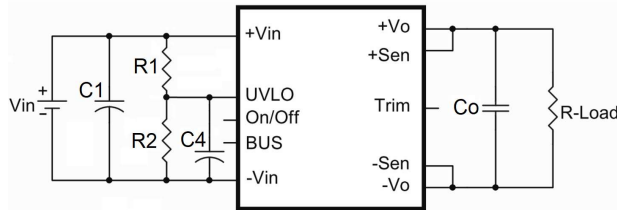


And the CQB150W14 series has an adjustable under voltage lockout which will shut down the converter according to following settings.

Nom. Input Voltage (VDC)	24	36	48	72	110
Turn Off Threshold (VDC)	13.8 ±0.75	20.8 ±0.75	28.0 ±1.0	42.5 ±1.5	53.0 ±3.0
Turn On Threshold (VDC)	14.8 ±0.75	21.8 ±0.75	29.0 ±1.0	43.5 ±1.5	54.0 ±3.0
R1 Resistor (KΩ) (UVLO to +Vin)	Open	Open	Open	Open	240
R2 Resistor (KΩ) (UVLO to -Vin)	18.84	6.1	3.64	2.0	1.18



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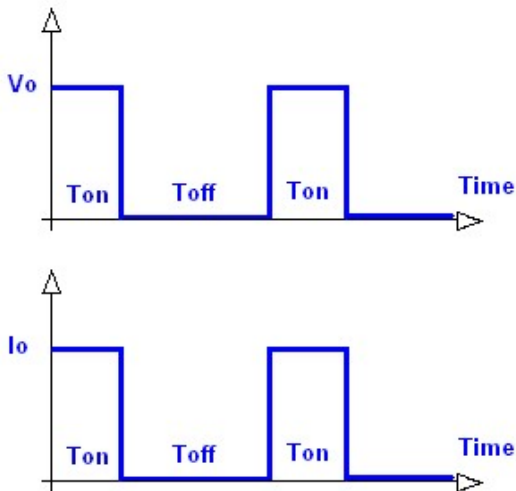
C1: 470uF/200V ESR<0.04Ω  
C4: 0.01uF/50V ceramic capacitor

**Note:**

If need to configure UVLO turn off threshold to 10Vdc, please make sure the output power is no more than 80% full load, even though the 11V operating is short duration. And the module operating between input 12Vdc to 16Vdc, please make sure the output power is no more than 80% full load.

### 6.2 Over Current/Short Circuit 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.



### 6.3 Output Over Voltage Protection

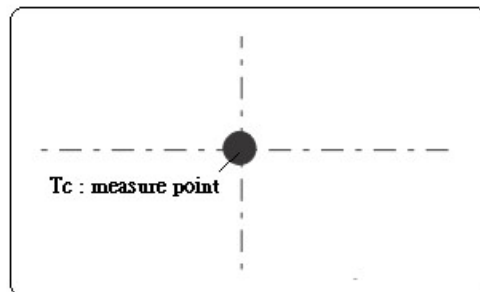
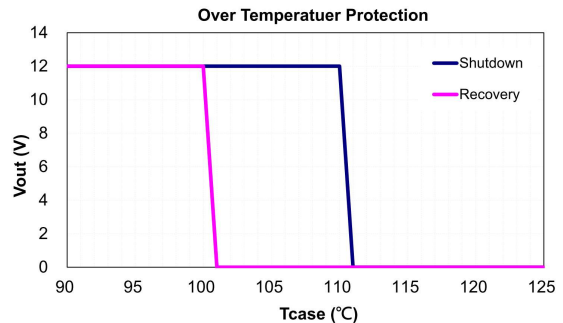
The output over voltage protection consists of circuitry that internally limits the output voltage. If more accurate output over voltage protection is required, then an external circuit can be used via the remote on/off pin.

**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. OVP can be tested by using the TRIM UP function. Consult us for more information.

### 6.4 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.





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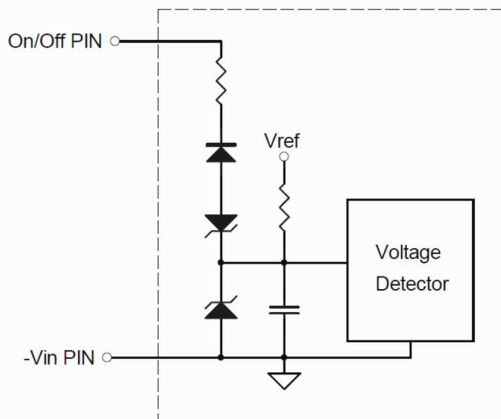
## 6.5 Remote On/Off

The CQB150W14 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).

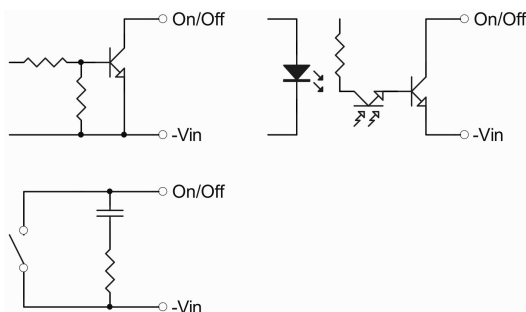
Models with part number suffix “N” are the “negative logic” remote On/Off version. The unit turns off if the remote On/Off pin is high (>3.5Vdc to 160Vdc or open circuit). The converter turns on if the On/Off pin input is low (0 to <1.2Vdc). Note that the converter is off by default.

Logic State (Pin 2)	Negative Logic	Positive Logic
Logic Low	Module on	Module off
Logic High	Module off	Module on

The converter remote On/Off circuit built-in on input side. The ground pin of input side Remote On/Off circuit is -Vin pin. Inside connection sees below.



Connection examples see below.



Remote On/Off Connection Example

## 6.6 Output Remote Sensing

The CQB150W14 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 CQB150W14 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:

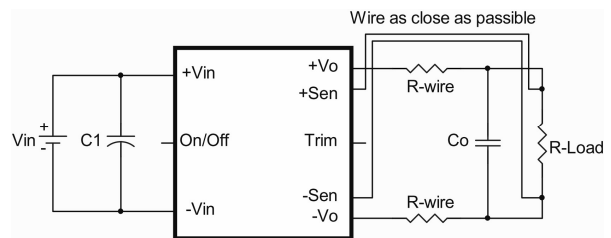
For  $V_o=54V$

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

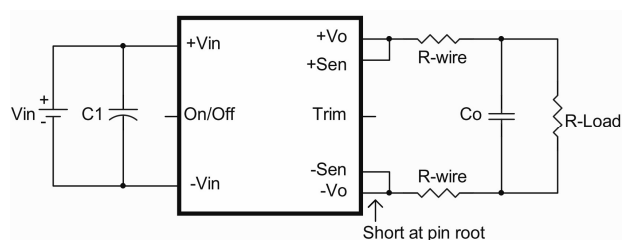
For Others

$$[(+V_{out}) - (-V_{out})] - [(+Sense) - (-Sense)] \leq 15\% \text{ of } V_{o\_nominal}$$

When remote sense is in use, the sense should be connected by twisted-pair wire or shield wire. If the sensing patterns short, heavy current flows and the pattern may be damaged. Output voltage might become unstable because 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







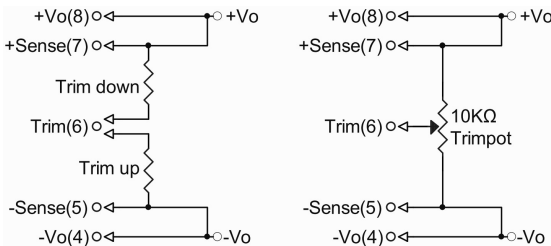
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## Note:

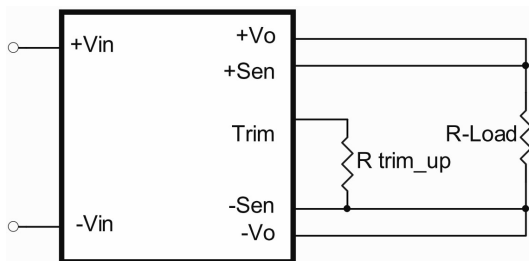
Although the output voltage can be varied (increased or decreased) by both remote sense and trim, the maximum variation for the output voltage is the larger of the two values not the sum of the values. The output power delivered by the module is defined as the voltage at the output terminals multiplied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

## 6.7 Output Voltage Adjustment

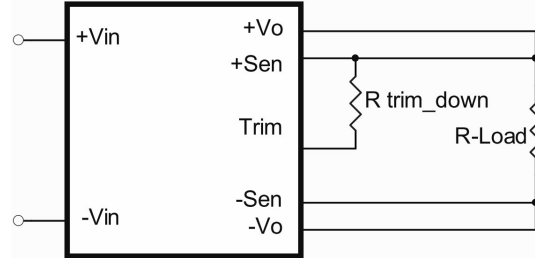
Output may be externally trimmed (+15% to -20%, except 54Vout is +10% to -20%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



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 +15% to -20%, except 54Vout, it is +10% to -20%. This is shown:



Trim-up Voltage Setup



Trim-down Voltage Setup

The value of  $R_{trim\_up}$  defined as:

$$R_{trim\_up} = \left[ \frac{V_r \times R1 \times (R2 + R3)}{R2 \times (V_o - V_{o,nom})} \right] - R_t \text{ (K}\Omega\text{)}$$

Where:

$R_{trim\_up}$  is the external resistor in K $\Omega$ .

$V_{o,nom}$  is the nominal output voltage.

$V_o$  is the desired output voltage.

$R1, R2, R3, R_t$  and  $V_r$  are internal to the unit and are defined in Table 1.

Table 1 – Trim up and Trim down Resistor Values

Model Number	Output Voltage(V)	R1 (K $\Omega$ )	R2 (K $\Omega$ )	R3 (K $\Omega$ )	Rt (K $\Omega$ )	Vr (V)
CQB150W14-72S05	5.0	6.2	2.37	1	8.2	1.24
CQB150W14-72S12	12.0	6.8	2.37	2.2	10	2.5
CQB150W14-72S15	15.0	9.1	2.32	2.49	12	2.5
CQB150W14-72S24	24.0	15	2.43	5.9	20	2.5
CQB150W14-72S28	28.0	15.4	2.49	10	23.2	2.5
CQB150W14-72S54	54.0	36	2.43	14	51	2.5

For example, to trim-up the output voltage of 12V module (CQB150W14-75S12) by 15% to 13.8V,  $R_{trim\_up}$  is calculated as follows:

$$R1=6.8K\Omega, R2=2.37K\Omega, R3=2.2K\Omega, R_t=10K\Omega, V_r=2.5V, V_o=13.8V, V_{o,nom}=12V$$

$$R_{trim\_up} =$$

$$\left[ \frac{2.5 \times 6.8 \times (2.37 + 2.2)}{2.37 \times (13.8 - 12)} \right] - 10 = 8.2 \text{ (K}\Omega\text{)}$$





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The typical value of  $R_{trim\_up}$

Trim up (%)	5V	12V	15V	24V	28V	54V
	$R_{trim\_up}$ (K $\Omega$ )					
1%	210.44	263.17	302.45	515.62	666.51	1075
2%	101.12	126.59	145.22	247.81	321.65	512.44
3%	64.68	81.06	92.82	158.54	206.70	324.63
4%	46.46	58.29	66.61	113.91	149.23	230.72
5%	35.53	44.63	50.89	87.12	114.74	174.38
6%	28.24	35.53	40.41	69.27	91.75	136.81
7%	23.03	29.02	32.92	56.52	75.33	109.98
8%	19.13	24.15	27.31	46.95	63.01	89.86
9%	16.09	20.35	22.94	39.51	53.43	74.21
10%	13.66	17.32	19.44	33.56	45.77	61.69
11%	11.68	14.83	16.59	28.69	39.50	
12%	10.02	12.76	14.20	24.64	34.28	
13%	8.62	11.01	12.19	21.20	29.85	
14%	7.42	9.51	10.46	18.26	26.06	
15%	6.38	8.21	8.96	15.71	22.78	

The typical value of  $R_{trim\_down}$

Trim down (%)	5V	12V	15V	24V	28V	54V
	$R_{trim\_down}$ (K $\Omega$ )					
1%	387.84	389.67	573.80	929.51	811.80	2382.14
2%	186.72	186.43	276.35	447.25	386.60	1147.57
3%	119.68	118.69	177.20	286.50	244.87	736.05
4%	86.16	84.82	127.62	206.13	174.00	530.28
5%	66.05	64.49	97.88	157.90	131.48	406.83
6%	52.64	50.94	78.05	125.75	103.13	324.52
7%	43.06	41.27	63.89	102.79	82.89	265.73
8%	35.88	34.01	53.26	85.56	67.70	221.64
9%	30.29	28.36	45.00	72.17	55.89	187.35
10%	25.82	23.85	38.39	61.45	46.44	159.91
11%	22.17	20.15	32.98	52.68	38.71	137.47
12%	19.12	17.07	28.47	45.38	32.27	118.76
13%	16.54	14.47	24.66	39.19	26.82	102.93
14%	14.33	12.23	21.39	33.89	22.14	89.37
15%	12.42	10.30	18.56	29.30	18.09	77.61
16%	10.74	8.60	16.08	25.28	14.55	67.32
17%	9.26	7.11	13.89	21.74	11.42	58.24
18%	7.95	5.78	11.95	18.58	8.64	50.17
19%	6.77	4.59	10.21	15.76	6.16	42.95
20%	5.71	3.52	8.64	13.23	3.92	36.46

The value of  $R_{trim\_down}$  defined as:

$$R_{trim\_down} = R1 \times \left[ \frac{V_r \times R1}{R2 \times (V_{o,nom} - V_o)} - 1 \right] - R_t \text{ (K}\Omega\text{)}$$

Where:

$R_{trim\_down}$  is the external resistor in K $\Omega$ .

$V_{o,nom}$  is the nominal output voltage.

$V_o$  is the desired output voltage.

$R1, R2, R3, R_t$  and  $V_r$  are internal to the unit and are defined in Table 1.

For example: to trim-down the output voltage of 12V module (CQB150W14-72S12) by 20% to 9.6V,  $R_{trim\_down}$  is calculated as follows:

$$R1=6.8K\Omega, R2=2.37K\Omega, R3=2.2K\Omega, R_t=10K\Omega, V_r=2.5V, V_o=9.6V, V_{o,nom}=12V$$

$$R_{tri\_down} = 6.8 \times \left[ \frac{2.5 \times 6.8}{2.37 \times (12 - 9.6)} - 1 \right] - 10 = 3.52 \text{ (K}\Omega\text{)}$$

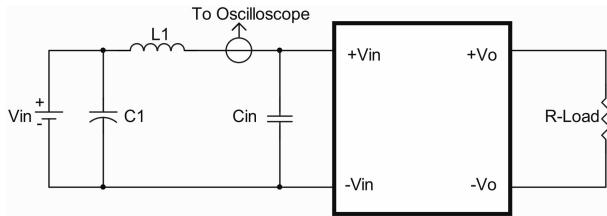
## 7. Input/Output Considerations

### 7.1 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 ( $C_{in}$ ) should be placed close to the converter input pins to decouple 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).



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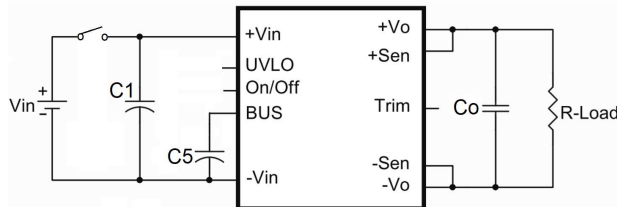


L1: 12uH  
C1: 220uF/200V ESR<0.047Ω  
Cin: 470uF/200V ESR<0.04Ω

## 7.2 Hold Up Time

Hold up time is defined as the duration of time that the DC/DC converter output will remain active following a loss of input power. The BUS pin is for hold up time function. It is designed to work with an external circuit comprises C5. When input power supply is interrupt, the CQB150W14-72S series use the energy stored in C5 to support operation.

A typical configuration shows as below.



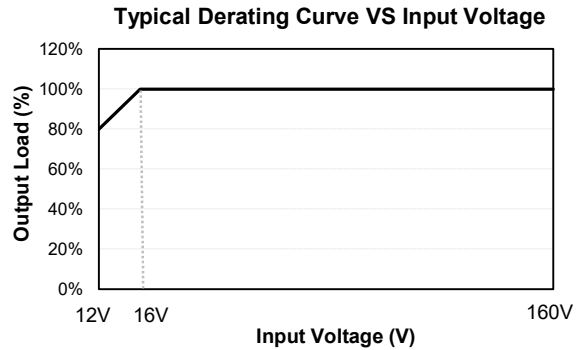
C1: 470uF/200V ESR<0.04Ω

If hold up time function is not needed, please remove the component(C5). This function provides energy that maintains the DC-DC converter in operation for 10mS and 30mS hold up time. The capacity (C1 & C5) in the application is recommended as below.

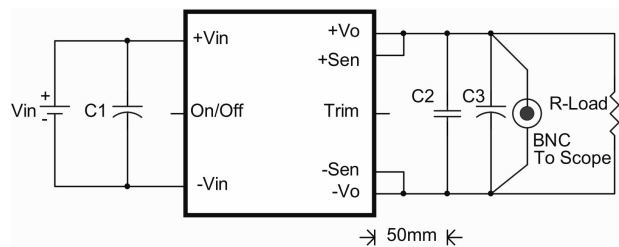
Vin		C1/C5					
		24V	36V	48V	72V	96V	110V
For 10 mS	C1	470uF					
	C5	20000uF	11000uF	10000uF	6800uF	2700uF	1000uF
For 30 mS	C1	470uF					
	C5	50000uF	28000uF	26000uF	24000uF	20000uF	16000uF

## 7.3 Input Derating Curve

CQB150W14 series has Derating by Input Voltage is required shown below.



## 7.4 Output Ripple and Noise



C1: 470uF/200V ESR<0.04Ω  
C2: 1uF/1210 ceramic capacitor  
C3: 10uF polymer tantalum capacitor (ESR ≤ 0.05Ω)

Output ripple and noise measured with 10uF polymer tantalum capacitor and 1uF ceramic capacitors across output. A 20 MHz bandwidth oscilloscope is normally used for the measurement.

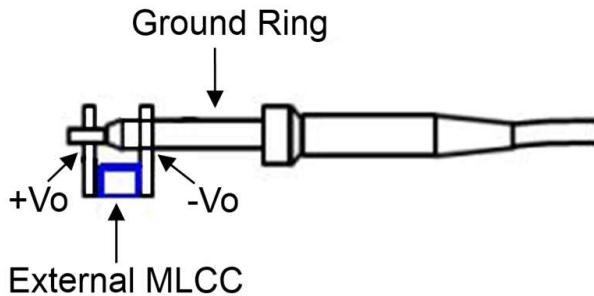
The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.





# CQB150W14 Series Application Note V10

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.



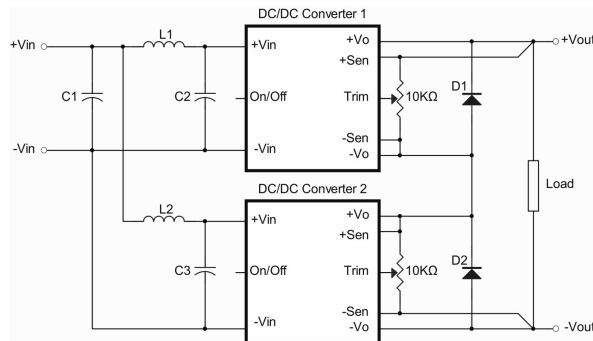
## 7.5 Output Capacitance

The CQB150W14 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 specifications.

## 8. Series and Parallel Operation

### 8.1 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

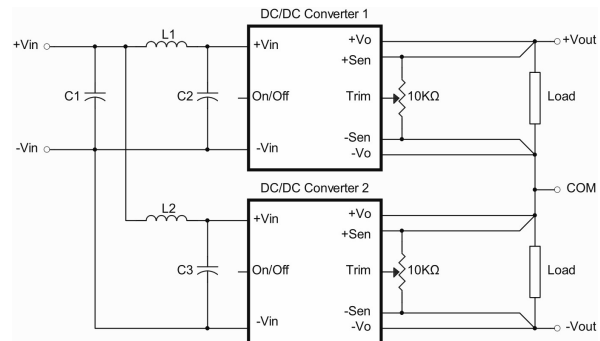
L1, L2: 1.0uH

C1, C2, C3: 470uF/200V ESR<0.04Ω

### 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°C.
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: 470uF/200V ESR<0.04Ω

### 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°C.

### 8.2 Parallel Operation

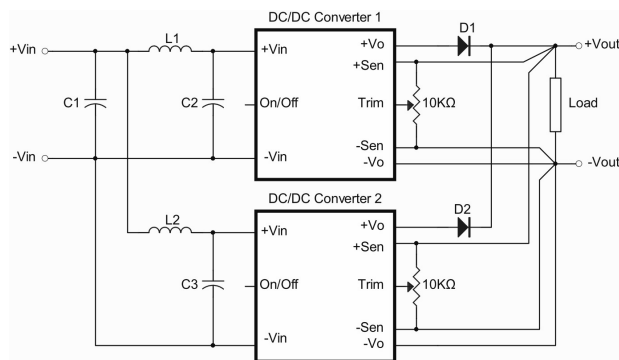
The CQB150W14 series parallel operation is not possible.



# CQB150W14 Series Application Note V10

### 8.3 Redundant Operation

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: 470uF/200V ESR<0.04Ω

**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°C.



# CQB150W14 Series Application Note V10

## 9. Thermal Design

### 9.1 Operating Temperature Range

The CQB150W14 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

### 9.2 Convection Requirements for Cooling

To predict the approximate cooling needed for the quarter brick module, refer to the power derating curves in **section 9.4**. 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).

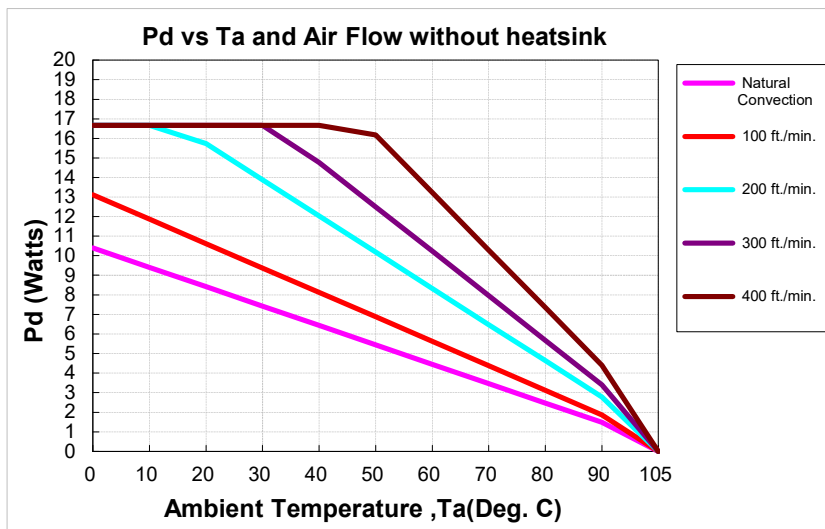
### 9.3 Thermal Considerations

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 9.4**. The power output of the module should not be allowed to exceed rated power ( $V_{o\_set} \times I_{o\_max}$ ).

### 9.4 Power Derating

The operating case temperature range of CQB150W14 series is -40°C to +105°C. When operating the CQB150W14 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 CQB150W14 series without heat sink.



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



# CQB150W14 Series Application Note V10

**Example:**

What is the minimum airflow necessary for a CQB150W14-72S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 40°C?

**Solution:**

**Given:**  $V_{in}=72V_{dc}$ ,  $V_o=12V_{dc}$ ,  $I_o=12.5A$

**Determine Power dissipation ( $P_d$ ):**  $P_d=P_i-P_o=P_o(1-\eta)/\eta$ ,  $P_d=12 \times 12.5 \times (1-0.9)/0.9=16.67Watts$

**Determine airflow:** Given:  $P_d=16.67W$  and  $T_a=40^\circ C$

**Check Power Derating curve:** Minimum airflow=400 ft./min.

**Verify:**

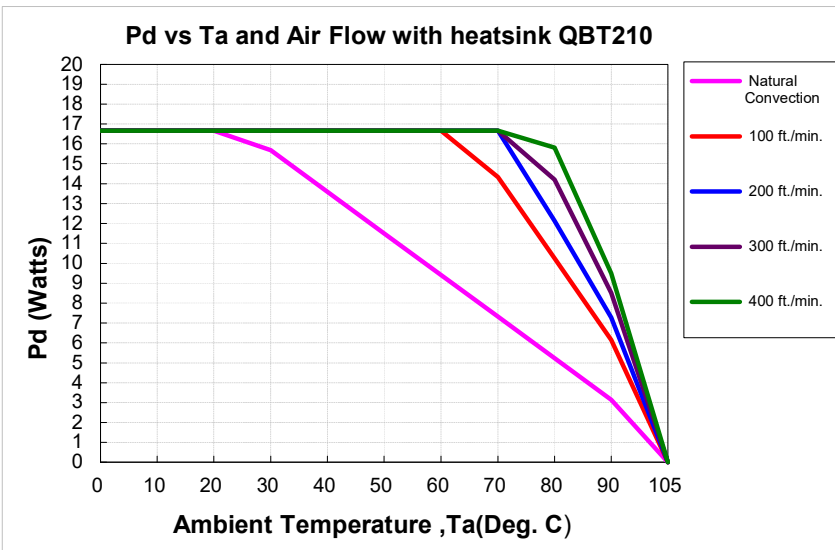
Maximum temperature rise is  $\Delta T = P_d \times R_{ca} = 16.67 \times 3.4 = 56.678^\circ C$

Maximum case temperature is  $T_c = T_a + \Delta T = 96.678^\circ C < 105^\circ C$

**Where:**

The  $R_{ca}$  is thermal resistance from case to ambient environment.

$T_a$  is ambient temperature and  $T_c$  is case temperature.



AIR FLOW RATE	TYPICAL $R_{ca}$
Natural Convection 20ft./min. (0.1m/s)	4.78 °C/W
100 ft./min. (0.5m/s)	2.44 °C/W
200 ft./min. (1.0m/s)	2.06 °C/W
300 ft./min. (1.5m/s)	1.76 °C/W
400 ft./min. (2.0m/s)	1.58 °C/W

**Example with heat sink QBT210 (M-C421):**

What is the minimum airflow necessary for a CQB150W14-72S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 60°C?

**Solution:**

**Given:**  $V_{in}=72V_{dc}$ ,  $V_o=12V_{dc}$ ,  $I_o=12.5A$

**Determine Power dissipation ( $P_d$ ):**  $P_d= P_i-P_o=P_o(1-\eta)/\eta$ ,  $P_d=12 \times 12.5 \times (1-0.9)/0.9=16.67Watts$

**Determine airflow:** Given:  $P_d=16.67W$  and  $T_a=60^\circ C$

**Check above Power de-rating curve:** Minimum airflow=100 ft./min

**Verify:**

Maximum temperature rise is  $\Delta T = P_d \times R_{ca} = 16.67 \times 2.44 = 40.675^\circ C$

Maximum case temperature is  $T_c = T_a + \Delta T = 100.675^\circ C < 105^\circ C$

**Where:**

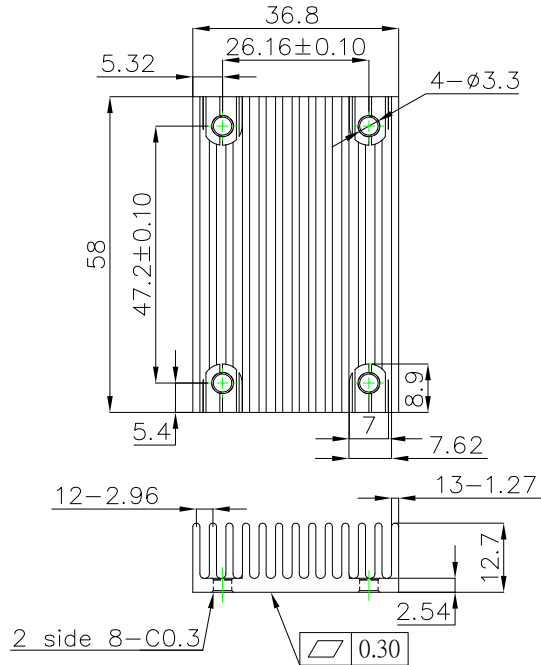
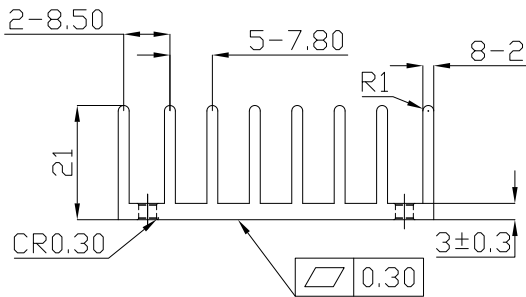
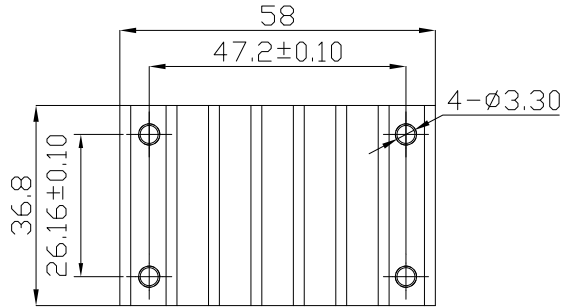
The  $R_{ca}$  is thermal resistance from case to ambient environment.

$T_a$  is ambient temperature and  $T_c$  is case temperature.



# CQB150W14 Series Application Note V10

## 9.5 Quarter Brick Heat Sinks



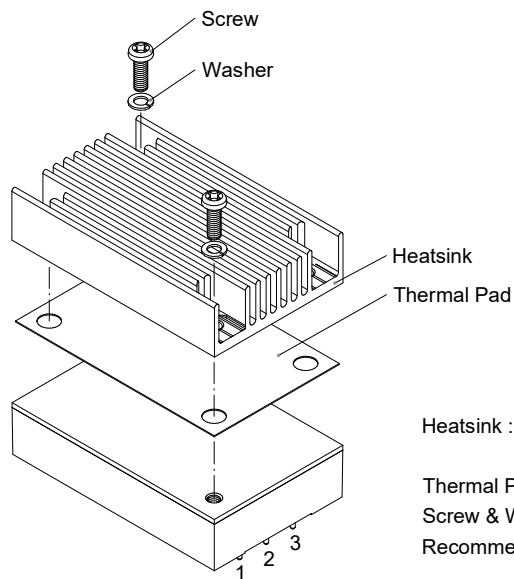
All Dimensions in mm

### QBT210 (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

### QBL127 (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 : QBL127 (M-C448)  
QBT210 (M-C421)  
Thermal Pad PQ01: SZ35.8x56.9x0.25mm  
Screw & Washer K308W: M3x8L & WS3.2N  
Recommended torque 3-5 Kgf-cm



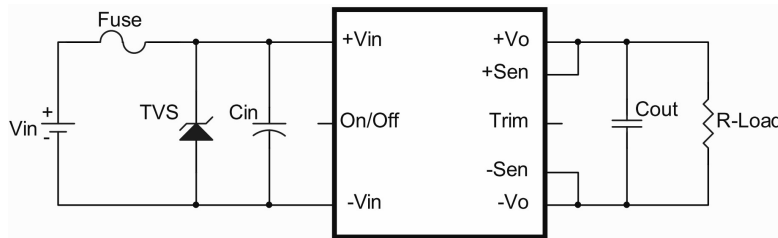


# CQB150W14 Series Application Note V10

## 10. Safety & EMC

### 10.1 Input Fusing and Safety Considerations

The CQB150W14 series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 20A time delay fuse for 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) and transient voltage suppressor diode (TVS) are required if CQB150W14 series has to meet EN61000-4-4, EN61000-4-5.

The Cin recommended a 470uF/200V (Nippon Chemi-Con KY series) aluminum capacitor. And the TVS recommended a SMCJ180A transient voltage suppressor.

### 10.2 EMC Considerations

EMI Test standard: EN55032 Class A / EN50121-3-2:2016 Conducted & Radiated Emission  
Test Condition: Input Voltage: 110Vdc, Output Load: Full Load

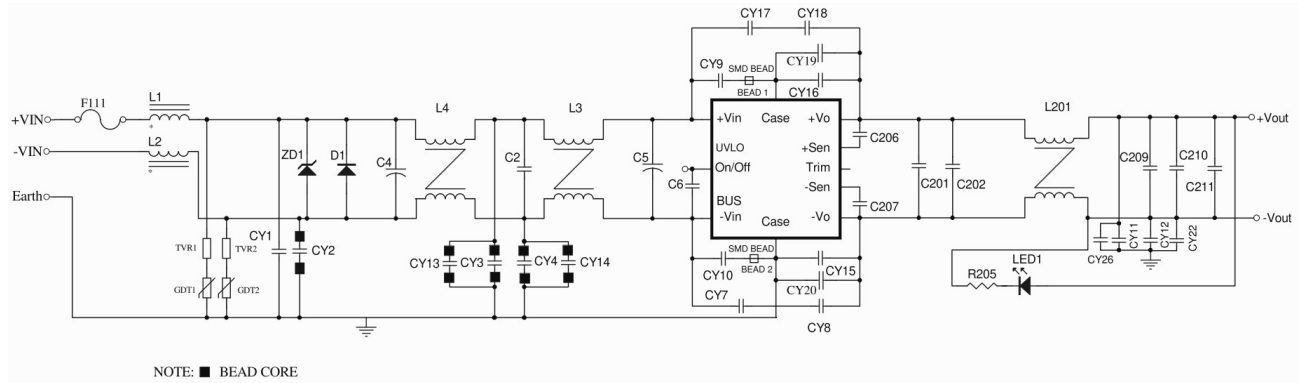


Figure1 Connection circuit





## CQB150W14 Series Application Note V10

### Components value:

Model Name	Model Number					
	72S05	72S12	72S15	72S24	72S28	72S54
C2,C211	1uF/250V SMD					
C4, C5	330uF/200V, Aluminum cap.					
C6	100pF/250V					
C201 C210,	22uF/25V SMD 1812			6.8uF/50V SMD 1812		4.7uF/100V SMD 1812
C202, C209	10uF/25V SMD 1210			10uF/50V SMD 1210		10uF/100V SMD 1210
CY1	100pF/Y1					
CY2	220pF/Y1	100pF/Y1	220pF/Y1	100pF/Y1		
CY3, CY4, CY13,CY14	2200pF/Y1					
CY7,CY8, CY17,CY18	Y2 CAP. SMD 2211 2200pF/250VAC					
CY9, CY10	Y2 CAP. SMD 2211 2200pF/250VAC					
CY19, CY20 CY11,CY12	0.022uF X2 cap					
CY16 ,CY15	NC					4700pF/Y1
CY22	NC					0.022uF X2 cap
CY26	NC	0.022uF X2 cap	NC			0.022uF X2 cap
BEAD1 BEAD2	BPH403022R5-400T					
TVR1,TVR2	TVR10471KIC7AV TKS					
GDT1,GDT2	2RK2500M-5-SS YAGEO					
L1,L2	SMD 1365 1.3uH	SMD 1365 2uH	SMD 1365 1.3uH	SMD 1365 2uH		
L3	0.7mm*3/10T 4.6mH TMC20-12.5-12-C(P)					
L4	0.8mm*3/10T 0.8mH R22/14/8-C MA120					
L201	0.8mm*4/4T 0.52mH SYG1HN 181306P or equivalent					0.7mm*1/20T 13mH SYG1HN 181306P or equivalent
F1	FUSE SMD 10.1x3.1x3.1mm 20A 250V CONQUER					
ZD1	SMCJ180A, LITTELFUSE					
D1	STTH8R03DJF-TR, ST					
LED1	MS-PT3216ZGSC STONE					
R205	100K					
C206,C207	0R 0805 SMD					
USING IN CY3, CY4, CY13, CY14 PIN	SN030 T2.8*1.7*1.2 SM BEAD CORE					
USING IN CY2 PIN (for 28Vout)	SN030 T2.8*1.7*1.2 SM BEAD CORE					



# CQB150W14 Series Application Note V10

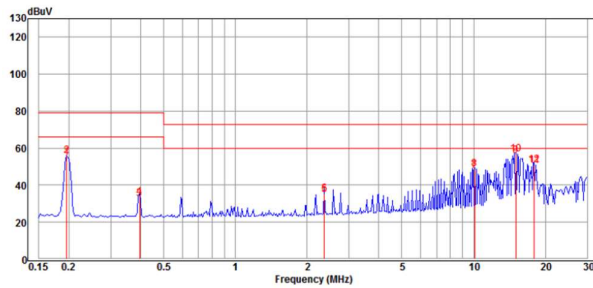
## Note:

- L1,L2: POWER INDUCTOR SMD 1365 7443551200,7443551130 WURTH or equivalent.
- C2, C201,C210,C211: 1812 X7R ceramic.
- C202, C209: 1210 X5R/X7R/X7S ceramic.
- C205,C206: 0805 CHIP RESISTOR SMD
- C6: 1206 X7R ceramic.
- C4, C5: Suscon aluminum capacitor or equivalent.
- CY1,CY2,CY3,CY4,CY13,CY14,CY15,CY16 : TDK Y1 capacitor or equivalent.
- CY11,CY12,CY19,CY20,CY22,CY26: MKP-223K0275AB1101 HUA JUNG X2 capacitor or equivalent.
- CY7,CY8,CY17,CY18,CY23,CY24: Y2 CAP. SMD 2211 2200pF/250VAC HOLY STONE or equivalent.

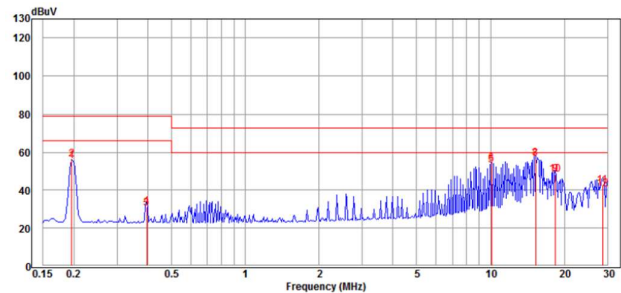
## Conducted Emission (Input):

CQB150W14-72S05

Line

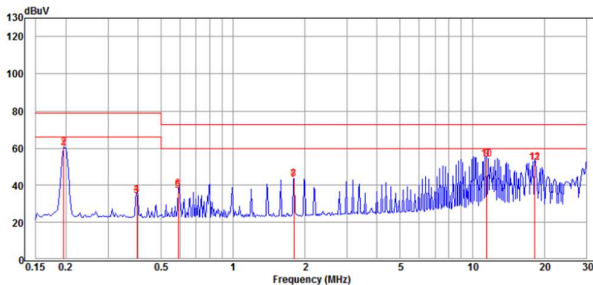


Neutral

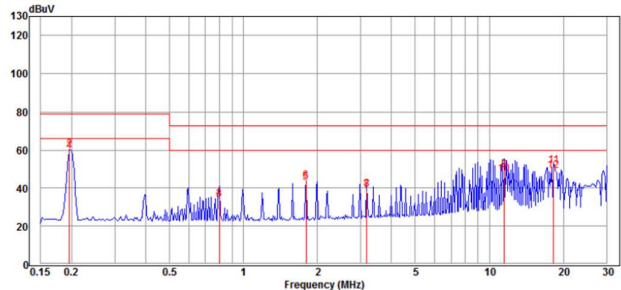


CQB150W14-72S12

Line

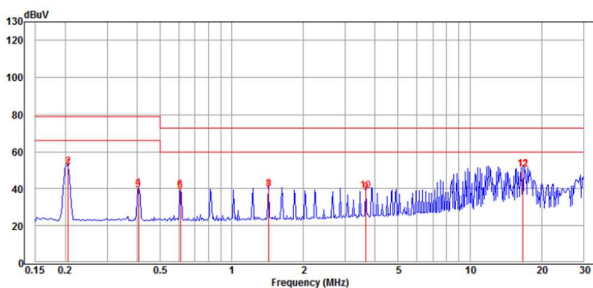


Neutral

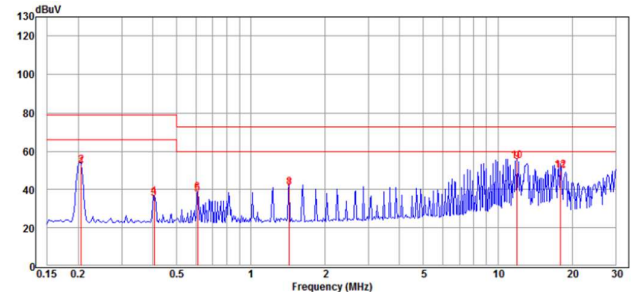


CQB150W14-72S15

Line



Neutral

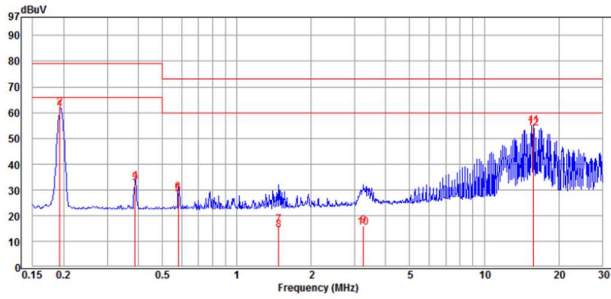




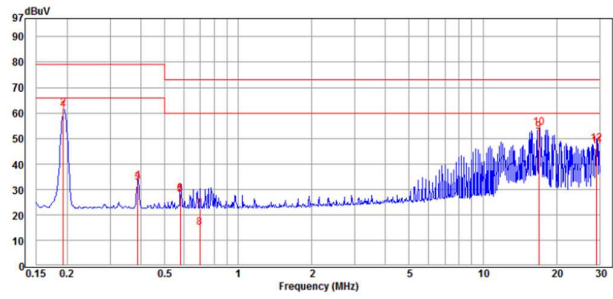
# CQB150W14 Series Application Note V10

CQB150W14-72S24

Line

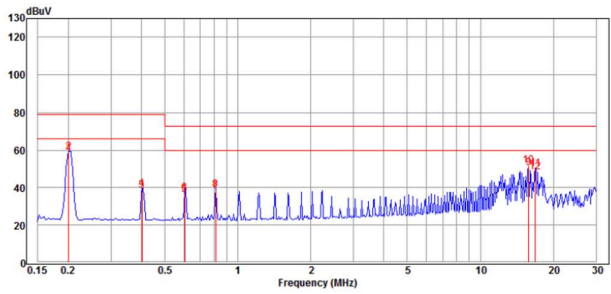


Neutral

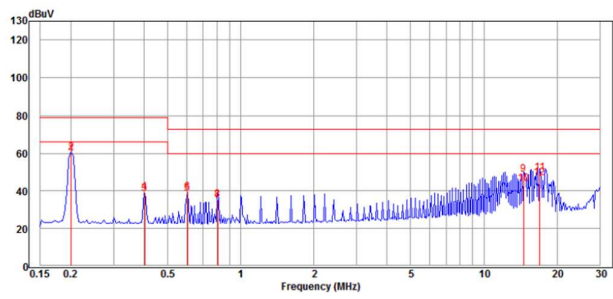


CQB150W14-72S28

Line

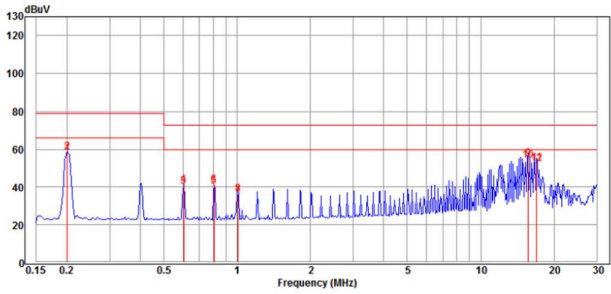


Neutral

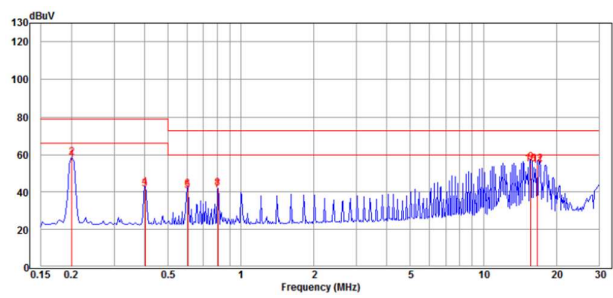


CQB150W14-72S54

Line



Neutral



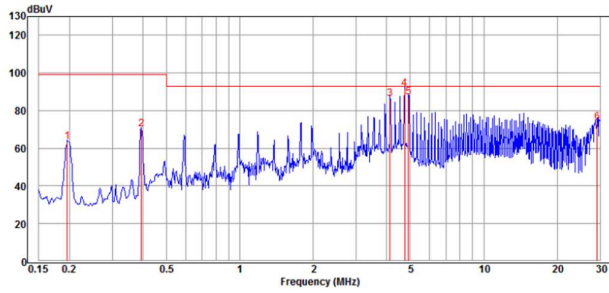


# CQB150W14 Series Application Note V10

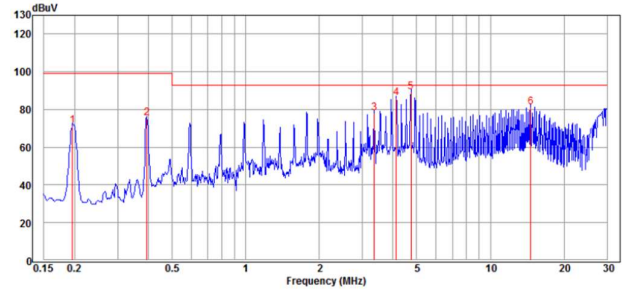
## Conducted Emission (Output):

CQB150W14-72S05

Positive

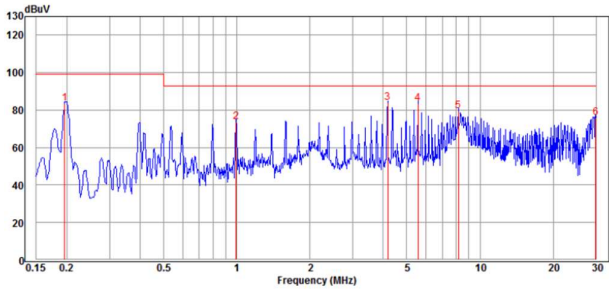


Negative

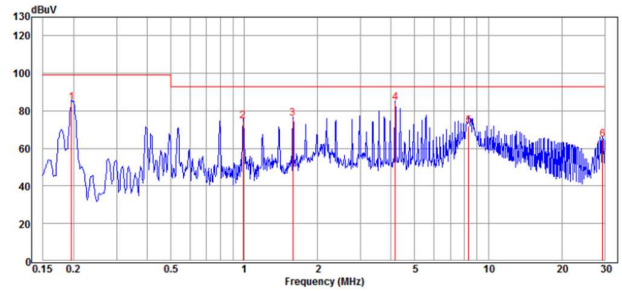


CQB150W14-72S12

Positive

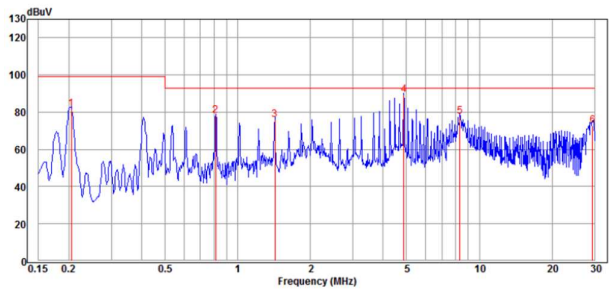


Negative

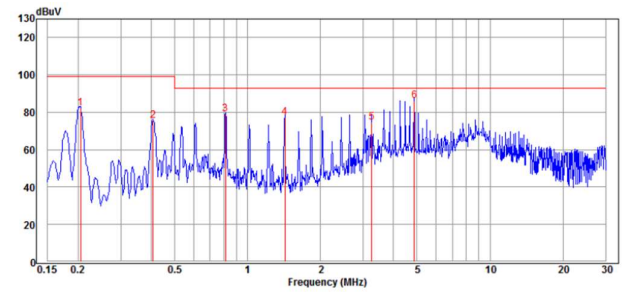


CQB150W14-72S15

Positive

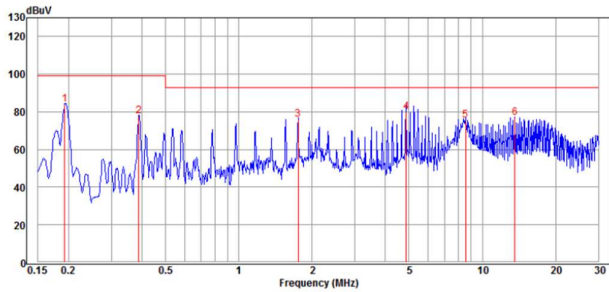


Negative

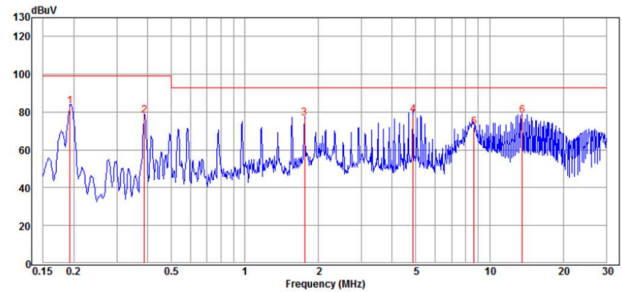


CQB150W14-72S24

Positive



Negative



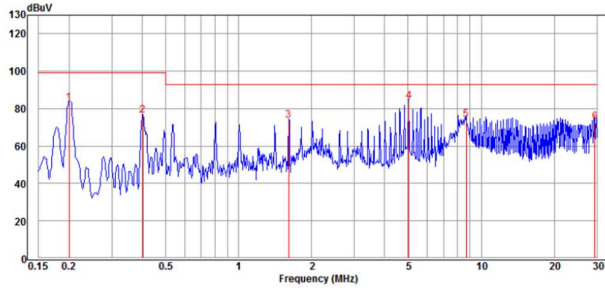




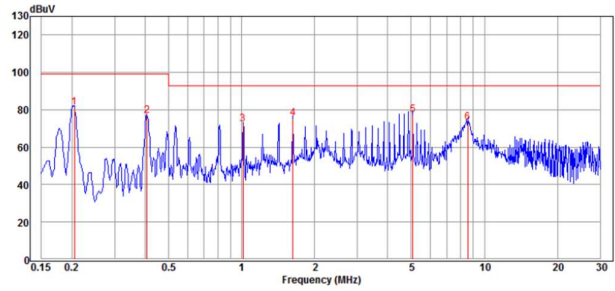
# CQB150W14 Series Application Note V10

CQB150W14-72S28

Positive

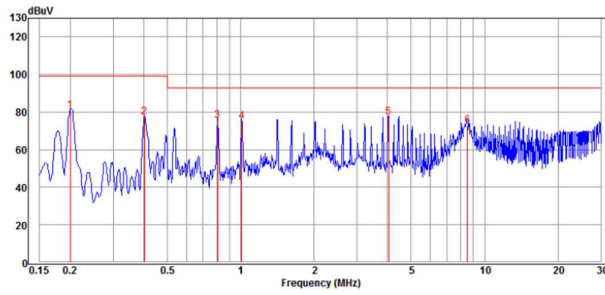


Negative

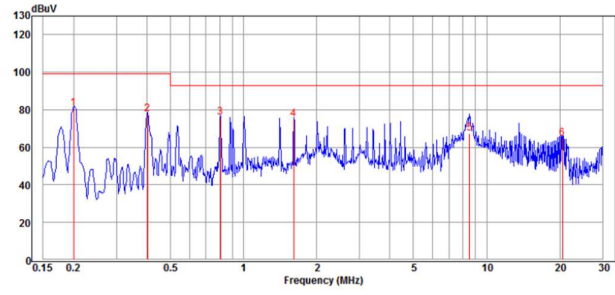


CQB150W14-72S54

Positive



Negative





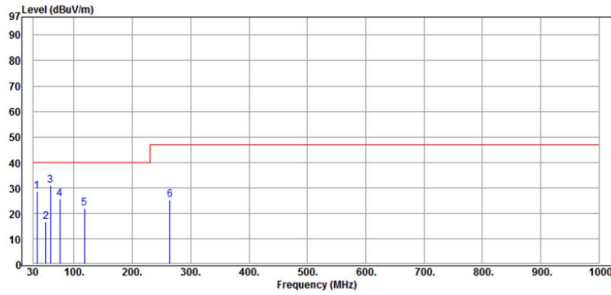


# CQB150W14 Series Application Note V10

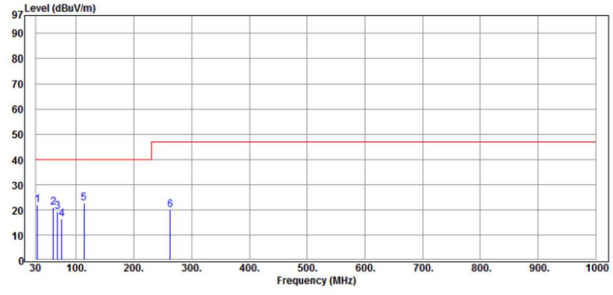
## Radiated Emission:

CQB150W14-72S05

Vertical

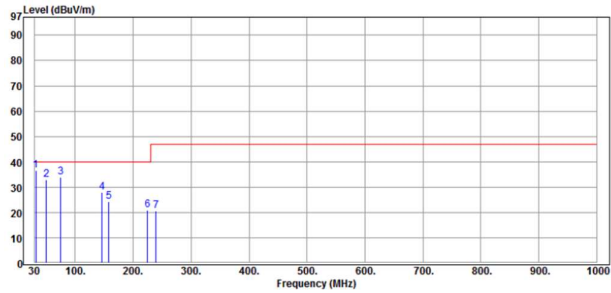


Horizontal

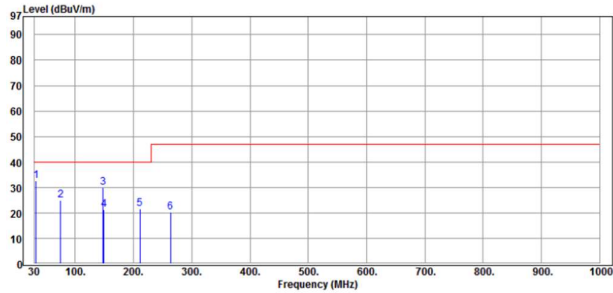


CQB150W14-72S12

Vertical

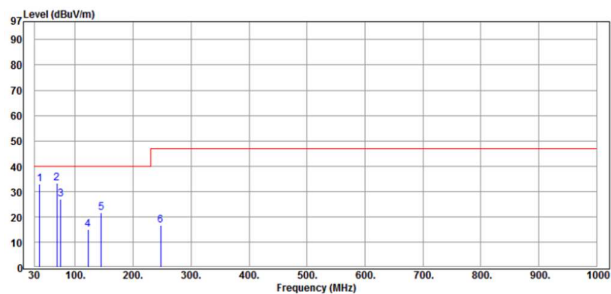


Horizontal

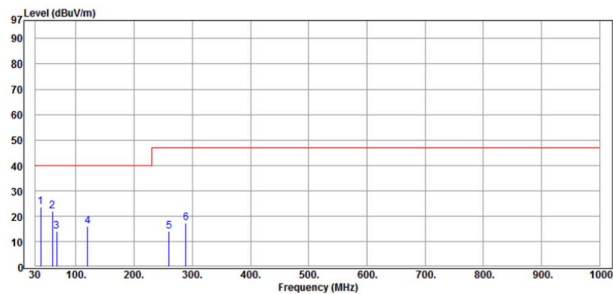


CQB150W14-72S15

Vertical

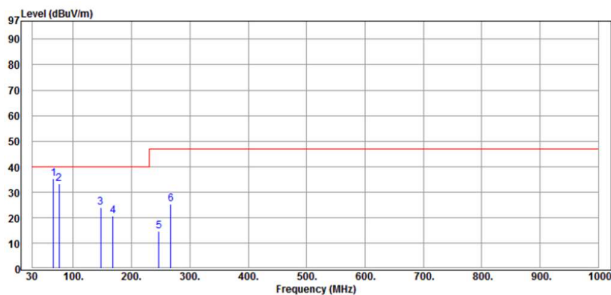


Horizontal

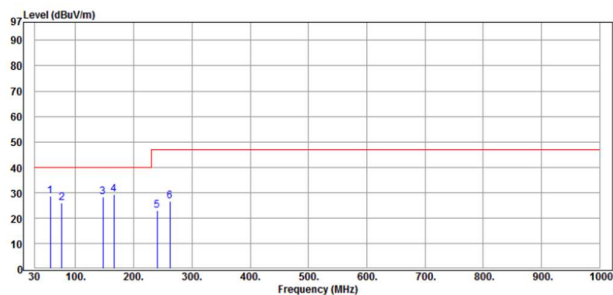


CQB150W14-72S24

Vertical



Horizontal

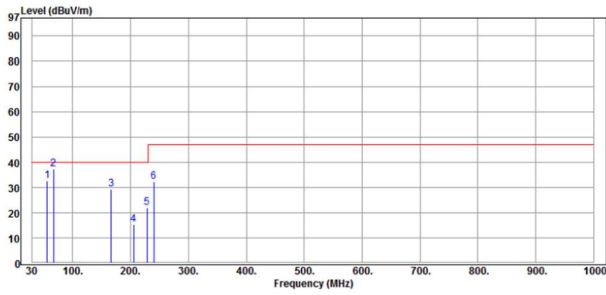




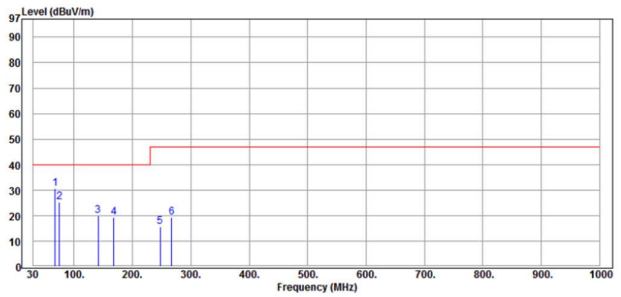
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CQB150W14-72S28

**Vertical**

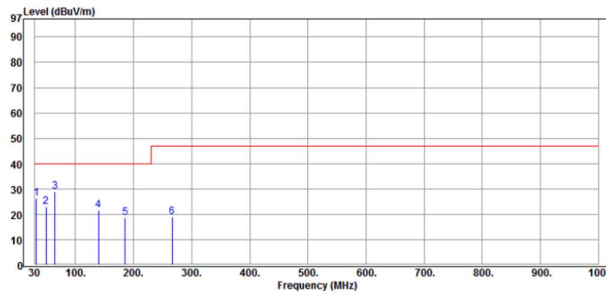


**Horizontal**

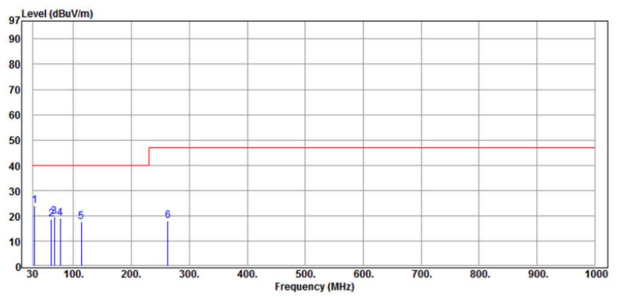


CQB150W14-72S54

**Vertical**



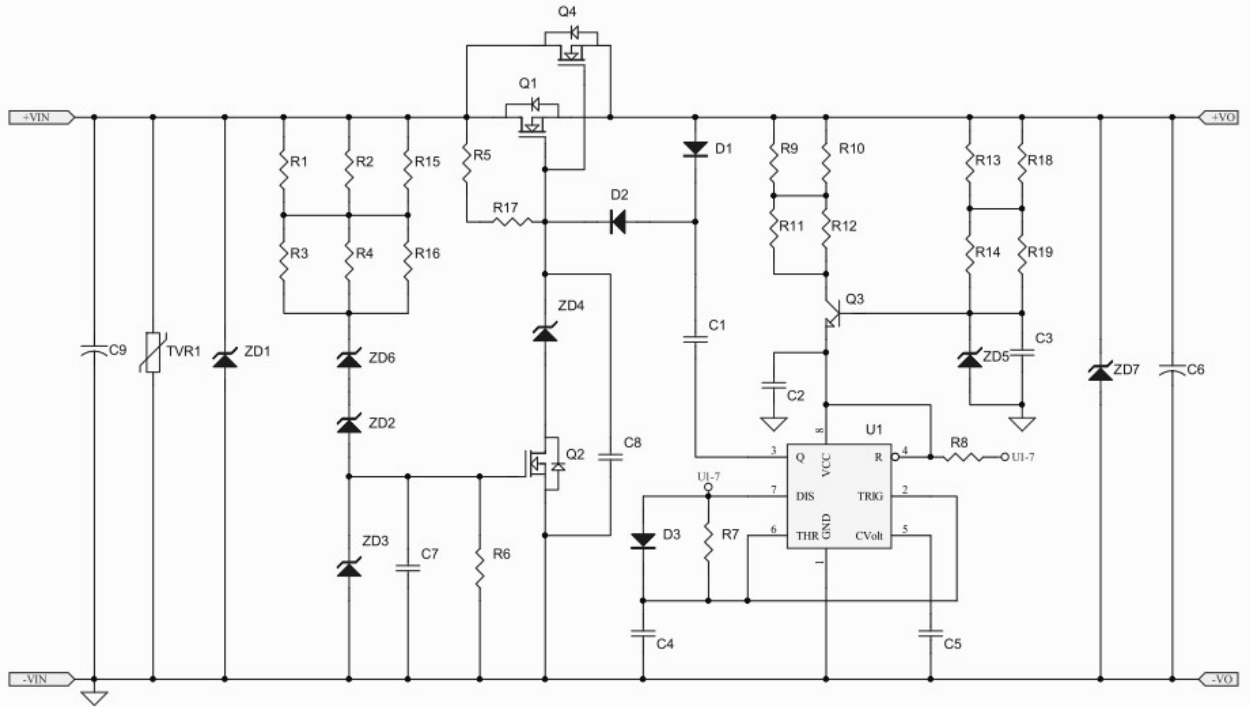
**Horizontal**





# CQB150W14 Series Application Note V10

## ,10.3 Suggested Configuration for RIA12 Surge Test



### 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: [sales@cincon.com.tw](mailto:sales@cincon.com.tw)  
Web Site: <https://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](mailto:info@cincon.com)