ISOLATED DC-DC CONVERTER
CQB150W8 SERIES
APPLICATION NOTE

Approved By:

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Contents

1. Introduction

The CQB150W8 series of DC-DC converters offers 150 watts of output power at single output voltages of 5, 12, 15, 24, 28, 48, 54VDC with industry standard quarter-brick. It has an ultrawide (8:1) input voltage range of 9 to 75VDC (36VDC nominal) and 3000VAC reinforced isolation.

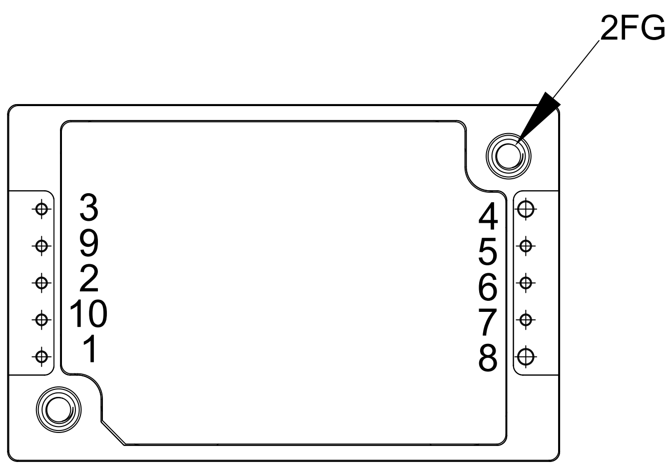
Compliant with EN 50155, EN 45545, EN 50121-3-2. High efficiency up to 91%, allowing case operating temperature range of -40℃ to 105℃. An optional heat sink is available to extend the full power range of the unit. Very low no load power consumption (35mA), an ideal solution for energy critical systems.

The standard control functions include remote **on/off** (positive or negative) and +15% to -20% (except for 54V_{out} +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.

CQB150W8 series is designed primarily for common railway applications of 24V, 36V, 48V nominal voltage and also suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. Pin Function Description

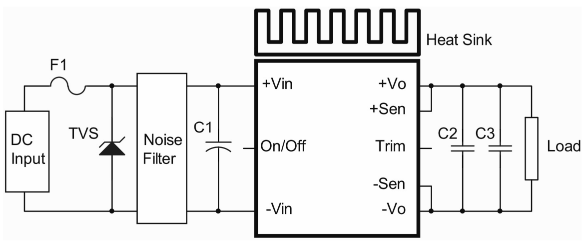


No	Label	Function	Description	Reference
1	+Vin	+V Input	Positive Supply Input	**Section 7.1/7.2/ 7.3**
2	ON/OFF	On/Off	External Remote On/Off Control	**Section 6.5**
3	-Vin	-V Input	Negative Supply Input	**Section 7.1/7.2/7.3**
4	-Vo	-V Output	Negative Power Output	**Section 7.4/7.5**
5	-Sen	-Sense	Negative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

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

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	**Section 10.1**
C1	External capacitor on the input side	**Note Section 7.2**
C2, C3	External capacitor on the output side	**Section 7.4/7.5**
Noise Filter	External input noise filter	**Section 10.2**
Remote On/Off	External remote **on/off** control	**Section 6.5**
Trim	External output voltage adjustment	**Section 6.7**
Heat Sink	External heat sink	**Section 9.2/9.3/9.4/9.5**
+Sense/-Sense	--	**Section 6.6**

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 and ensure the ESR is lower than 100mΩ when ambient temperature becomes lower than -20℃.

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:

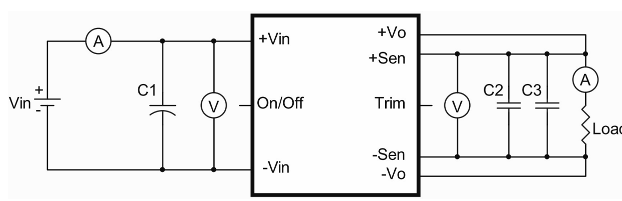
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at no load

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

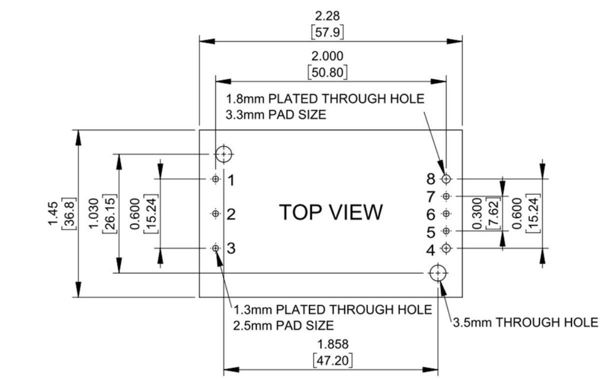


CQB150W8 Series Test Setup

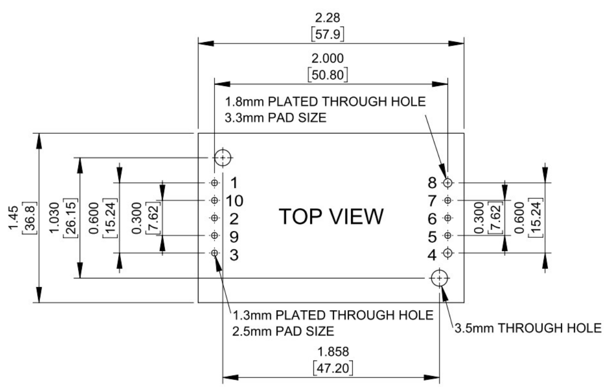
C1: 470uF/100V ESR<0.04Ω
C2: 1uF/1210 ceramic capacitor
C3: 10uF polymer tantalum capacitor (ESR≦0.05Ω)

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.



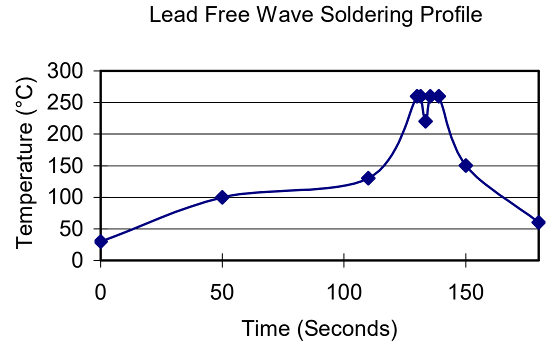
Standard Module



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.

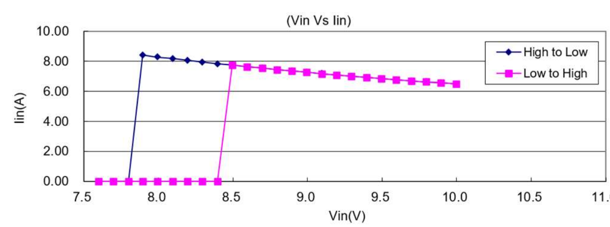
The suggested soldering iron is 450℃ for up to 5 seconds (less than 50W). Furthermore, the recommended soldering profile is shown below, and PCB layout is referring to **section 10.2.**



6. Features and Functions

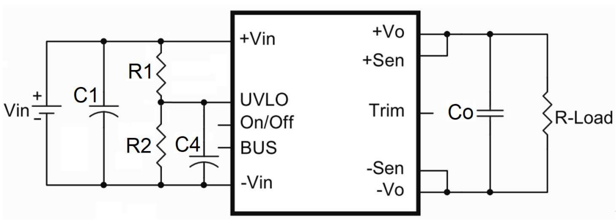
6.1 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the CQB150W8 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 CQB150W8 series has an adjustable under voltage lockout which will shut down the converter according to following settings.

Nom. Input Voltage (VDC)	24	36	48
Turn Off Threshold (VDC)	13.8 ±0.75	20.8 ±0.75	28.0 ±1.0
Turn On Threshold (VDC)	14.8 ±0.75	21.8 ±0.75	29.0 ±1.0
R1 Resistor (KΩ) (UVLO to +Vin)	Open	Open	Open
R2 Resistor (KΩ) (UVLO to -Vin)	6.4	2.95	1.9



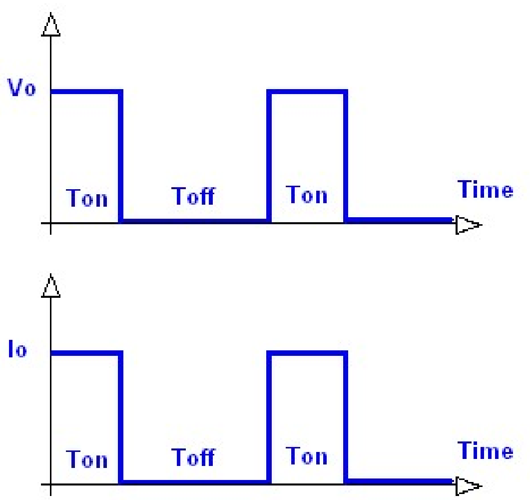
C1: 470uF/100V ESR<0.04Ω
C4: 0.01uF/50V ceramic capacitor

Note:

If need to configure UVLO turn off threshold to 8.0Vdc, please make sure the output power is no more than 80% full load, even though the 8.5V operating is short duration.
And the module operating between input 9Vdc to 12Vdc, 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

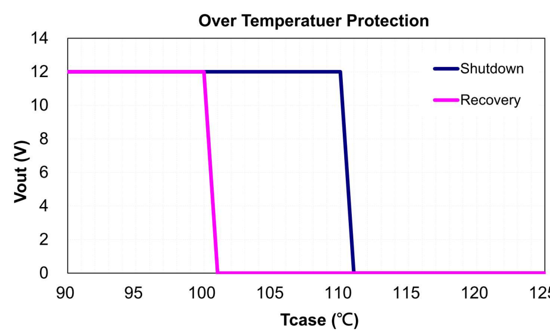
The output over voltage protection consists of circuitry that internally limits the output voltage. If more accurate output over voltage protection is required, then an external circuit can be used via the remote **on/off** pin.

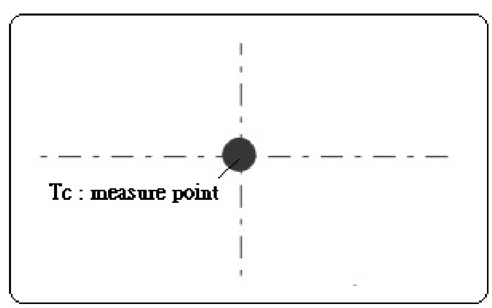
Note:

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.



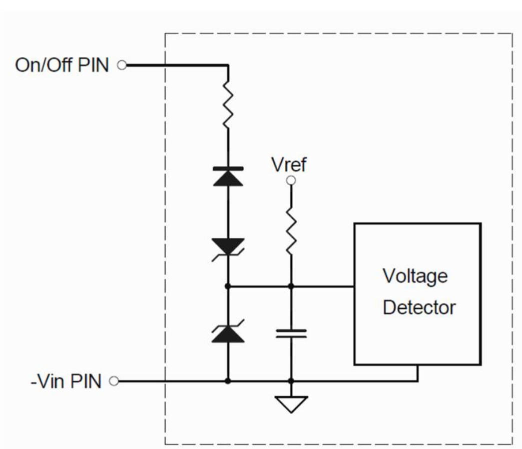


6.5 Remote On/Off

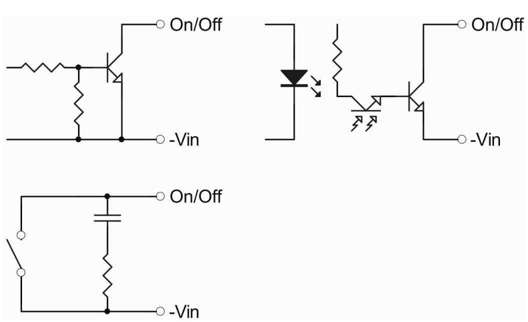
The CQB150W8 series allows the user to switch the module on and off electronically with the remote **on/off** feature. All models are available in “positive logic” and “negative logic” (optional) versions. The converter turns on if the remote **on/off** pin is high (>3.5Vdc to 75Vdc or open circuit). Setting the pin low (0 to<1.2Vdc) will turn the converter off. The signal level of the remote **on/off** input is defined with respect to ground.
If not using the remote **on/off** pin, leave the pin open (converter will be on).
Models with part number suffix “N” are the “negative logic” remote **on/off** version. The unit turns off if the remote **on/off** pin is high (>3.5Vdc to 75Vdc or open circuit). The converter turns on if the **on/off** pin input is low (0 to<1.2Vdc). Note that the converter is off by default.

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 $-V_{in}$ pin. Inside connection sees below.



Connection examples see below.



Remote On/Off Connection Example

6.6 Output Remote Sensing

The CQB150W8 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 CQB150W8 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:

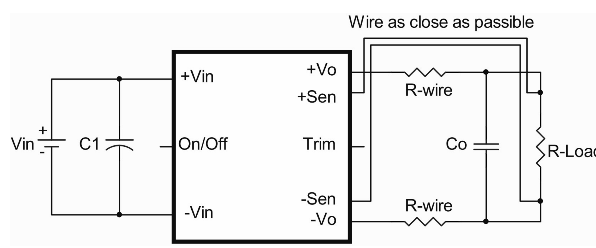
For Vo=54V

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

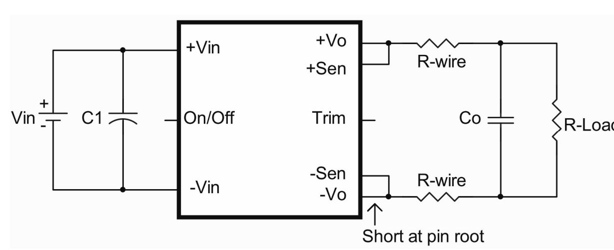
For Others

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

When remote sense is in use, the sense should be connected by twisted-pair wire or shield wire. If the sensing patterns short, heave 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 $+V_{out}$ pin at the module and the -Sense pin should be connected to the $-V_{out}$ pin at the module. Wire between +Sense and $+V_{out}$ and between -Sense and $-V_{out}$ 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

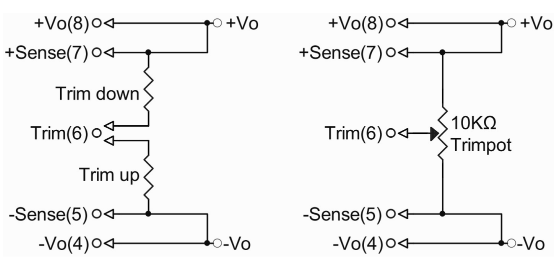


Note:

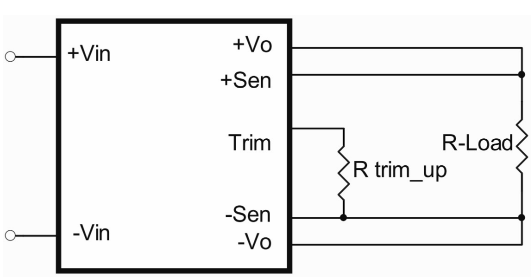
Although the output voltage can be varied (increased or decreased) by both remote sense and trim, the maximum variation for the output voltage is the larger of the two values not the sum of the values. The output power delivered by the module is defined as the voltage at the output terminals multiplied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

6.7 Output Voltage Adjustment

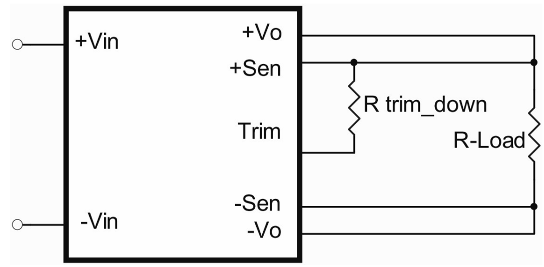
Output may be externally trimmed (+15% to -20%, except $54V_{out}$ is +10% to -20%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



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 $54V_{out}$, it is +10% to -20%. This is shown:



Trim-up Voltage Setup



Trim-down Voltage Setup

The value of R_{trim_up} defined as:

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

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, Rt and Vr 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 (KΩ)	R2 (KΩ)	R3 (KΩ)	Rt (KΩ)	Vr (V)
CQB150W8-36S05	5.0	6.2	2.37	1	8.2	1.24
CQB150W8-36S12	12.0	6.8	2.37	2.2	10	2.5
CQB150W8-36S15	15.0	9.1	2.32	2.49	12	2.5
CQB150W8-36S24	24.0	15	2.43	5.9	20	2.5
CQB150W8-36S28	28.0	15.4	2.49	10	23.2	2.5
CQB150W8-36S48	48.0	28.7	2.4	15	43.2	2.5
CQB150W8-36S54	54.0	36	2.43	14	51	2.5

For example, to trim-up the output voltage of 12V module (CQB150W8-36S12) by 15% to 13.8V, R_{trim_up} is calculated as follows:

R1=6.8KΩ, R2=2.37KΩ, R3=2.2KΩ, Rt=10KΩ, Vr=2.5V, V_o=13.8V, $V_{o,\ nom}$=12V

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

The typical value of R_{trim_up}

Trim up (%)	5V	12V	15V	24V
	R_{trim_up} (KΩ)			
1%	210.44	263.17	302.45	515.62
2%	101.12	126.59	145.22	247.81
3%	64.68	81.06	92.82	158.54
4%	46.46	58.29	66.61	113.91
5%	35.53	44.63	50.89	87.12
6%	28.24	35.53	40.41	69.27
7%	23.03	29.02	32.92	56.52
8%	19.13	24.15	27.31	46.95
9%	16.09	20.35	22.94	39.51
10%	13.66	17.32	19.44	33.56
11%	11.68	14.83	16.59	28.69
12%	10.02	12.76	14.20	24.64
13%	8.62	11.01	12.19	21.20
14%	7.42	9.51	10.46	18.26
15%	6.38	8.21	8.96	15.71

Trim up (%)	28V	48V	54V
	R_{trim_up} (KΩ)		
1%	666.51	1040.52	1075
2%	321.65	498.66	512.44
3%	206.70	324.63	324.63
4%	149.23	227.73	230.72
5%	114.74	173.54	174.38
6%	91.75	137.42	136.81
7%	75.33	111.62	109.98
8%	63.01	92.27	89.86
9%	53.43	77.21	74.21
10%	45.77	65.17	61.69
11%	39.50	55.32	
12%	34.28	47.11	
13%	29.85	40.16	
14%	26.06	34.21	
15%	22.78	29.05	

The value of R_{trim_down} defined as:

$$R_{trim_{down}} = R1 \times \left[\frac{V_r \times R1}{R2 \times (V_{o,nom} - V_o)} - 1 \right] - Rt\ (K\Omega)$$

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, Rt and Vr are internal to the unit and are defined in Table 1

For example: to trim-down the output voltage of 12V module (CQB150W8-36S12) by 20% to 9.6V, R_{trim_down} is calculated as follows:

R1=6.8KΩ, R2=2.37KΩ, R3=2.2KΩ, Rt=10KΩ, Vr=2.5V, Vo=9.6V, Vo, nom=12V

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

The typical value of R_{trim_down}

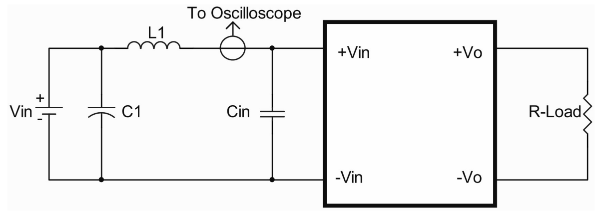
Trim down (%)	5V	12V	15V	24V
	R_{trim_down} (KΩ)			
1%	387.84	389.67	573.80	929.51
2%	186.72	186.43	276.35	447.25
3%	119.68	118.69	177.20	286.50
4%	86.16	84.82	127.62	206.13
5%	66.05	64.49	97.88	157.90
6%	52.64	50.94	78.05	125.75
7%	43.06	41.27	63.89	102.79
8%	35.88	34.01	53.26	85.56
9%	30.29	28.36	45.00	72.17
10%	25.82	23.85	38.39	61.45
11%	22.17	20.15	32.98	52.68
12%	19.12	17.07	28.47	45.38
13%	16.54	14.47	24.66	39.19
14%	14.33	12.23	21.39	33.89
15%	12.42	10.30	18.56	29.30
16%	10.74	8.60	16.08	25.28
17%	9.26	7.11	13.89	21.74
18%	7.95	5.78	11.95	18.58
19%	6.77	4.59	10.21	15.76
20%	5.71	3.52	8.64	13.23

Trim down (%)	28V	48V	54V
	R_{trim_down} (KΩ)		
1%	811.80	1715.62	2382.14
2%	386.60	821.86	1147.57
3%	244.87	523.94	736.05
4%	174.00	374.98	530.28
5%	131.48	285.6	406.83
6%	103.13	226.02	324.52
7%	82.89	183.46	265.73
8%	67.70	151.54	221.64
9%	55.89	126.71	187.35
10%	46.44	106.85	159.91
11%	38.71	90.6	137.47
12%	32.27	77.06	118.76
13%	26.82	65.6	102.93
14%	22.14	55.78	89.37
15%	18.09	47.27	77.61
16%	14.55	39.82	67.32
17%	11.42	33.25	58.24
18%	8.64	27.41	50.17
19%	6.16	22.18	42.95
20%	3.92	17.48	36.46

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 (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).

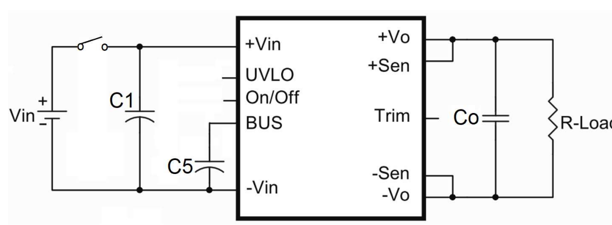


L1: 12uH
C1: 470uF/100V ESR<0.04Ω
Cin: Two pcs 470uF/100V ESR<0.04Ω aluminum capacitor in parallel

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 CQB150W8-36S series use the energy stored in C5 to support operation.

A typical configuration shows as below.



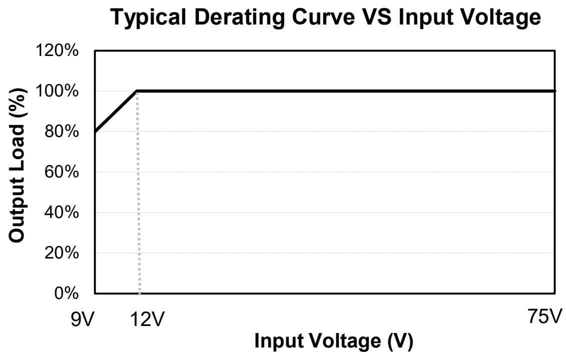
C1: 470uF/200V ESR<0.04Ω

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.

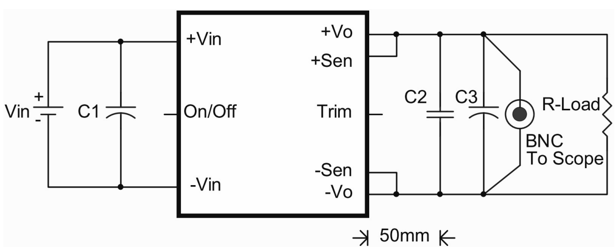
C1/C5 \ V_{in}		24V	36V	48V
For 10 mS	**C1**	470uF		
	C5	15000uF	10000uF	10000uF
For 30 mS	**C1**	470uF		
	C5	36600uF	22200uF	22200uF

7.3 Input Derating Curve

CQB150W8 series has Derating by Input Voltage is required shown below.



7.4 Output Ripple and Noise



C1: 470uF/100V ESR<0.04Ω

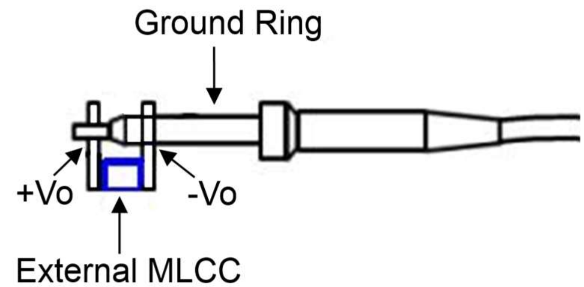
C2: 1uF/1210 ceramic capacitor

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.

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 -V_{out} terminal while the tip contacts the +V_{out} terminal. This makes the shortest possible connection across the output terminals.



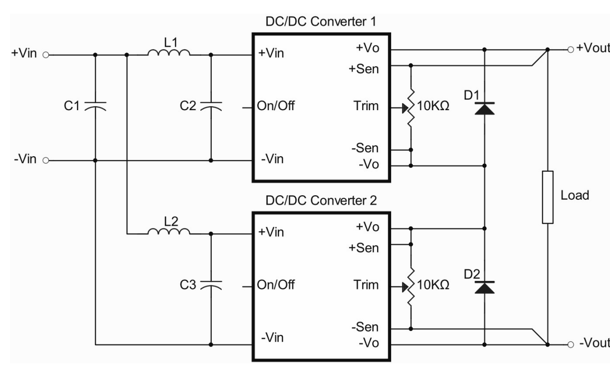
7.5 Output Capacitance

The CQB150W8 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

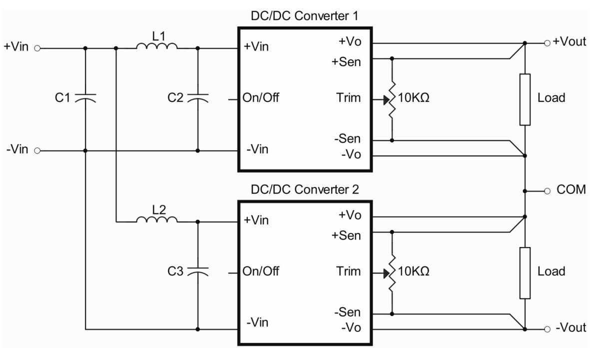
L1, L2: 1.0uH

C1, C2, C3: 470uF/100V 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℃.
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/100V ESR<0.04Ω

Note:

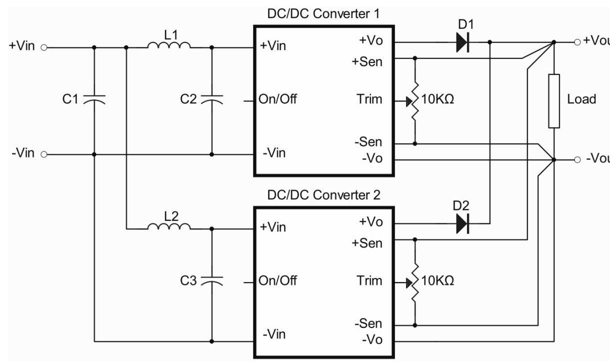
If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20℃.

8.2 Parallel Operation

The CQB150W8 series parallel operation is not possible.

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/100V 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℃.

9. Thermal Design

9.1 Operating Temperature Range

The CQB150W8 series converters can be operated within a wide case temperature range of -40℃ to 105℃. 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

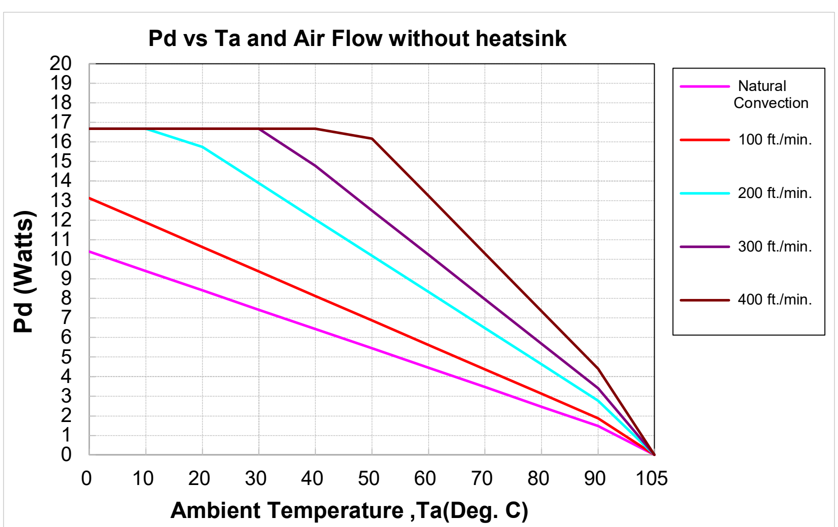
To predict the approximate cooling needed for the quarter brick module, refer to the power derating curves in **section 9.4**. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed 105℃ 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} x $I_{o\_max.}$).

9.4 Power Derating

The operating case temperature range of CQB150W8 series is -40℃ to +105℃. When operating the CQB150W8 series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 105℃.
The following curve is the de-rating curve of CQB150W8 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 CQB150W8-36S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 40℃?

Solution:

Given: V_{in}=36V_{dc}, V_o=12V_{dc}, I_o=12.5A

Determine power dissipation (P_d): $P_d=P_i-P_o=P_o(1-\eta)/\eta$, $P_d=12\times12.5\times(1-0.9)/0.9=16.67$Watts

Determine airflow: Given: P_d=16.67W and T_a=40℃

Check power derating curve: Minimum airflow=400ft./min.

Verify:

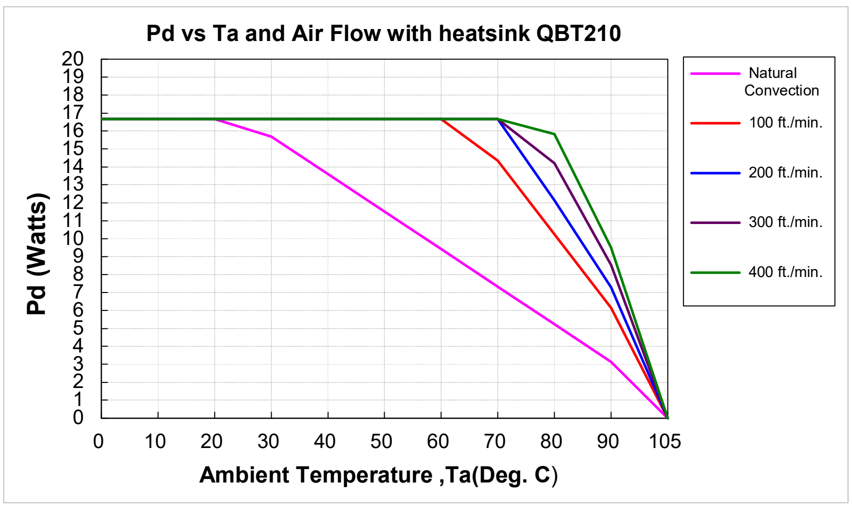
Maximum temperature rise is $\Delta T=P_d\times R_{ca}=16.67\times3.4=56.678$℃

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

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 CQB150W8-36S12 operating at nominal line voltage, an output current of 12.5A, and a maximum ambient temperature of 60℃?

Solution:

Given: V_{in}=36Vdc, V_o=12Vdc, Io=12.5A

Determine power dissipation (P_d): $P_d= P_i-P_o=P_o(1-\eta)/\eta$, $P_d=12\times12.5\times(1-0.9)/0.9=16.67$Watts

Determine airflow: Given: P_d=16.67W and T_a=60℃

Check above power derating curve: Minimum airflow=100ft./min

Verify:

Maximum temperature rise is $\Delta T= P_d \times R_{ca}=16.67\times2.44=40.675$℃

Maximum case temperature is $T_c= T_a +\Delta T=100.675$℃<105℃

Where:

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

T_a is ambient temperature and T_c is case temperature

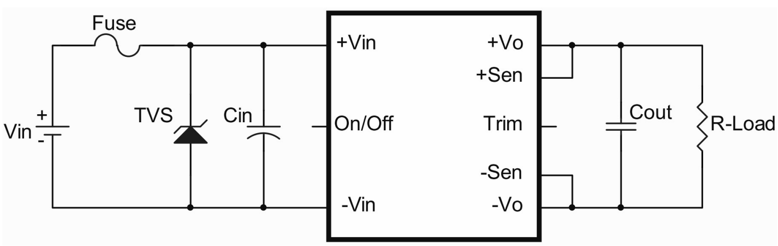
9.5 Quarter Brick Heat Sinks

Heat sinks assembly **[refer to Datasheet-Thermal]**

10. Safety & EMC

10.1 Input Fusing and Safety Considerations

The CQB150W8 series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 24A 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 CQB150W8 series has to meet EN 61000-4-4, EN 61000-4-5.

The Cin recommended a 470uF/100V (Nippon Chemi-Con KY series) aluminum capacitor. And the TVS recommended a SMDJ78A transient voltage suppressor.

10.2 EMC Considerations

EMI Test standard: EN 55032 Class A/EN 50121-3-2:2016 Conducted & Radiated Emission
Test Condition: Input Voltage: 36Vdc, Output Load: Full Load

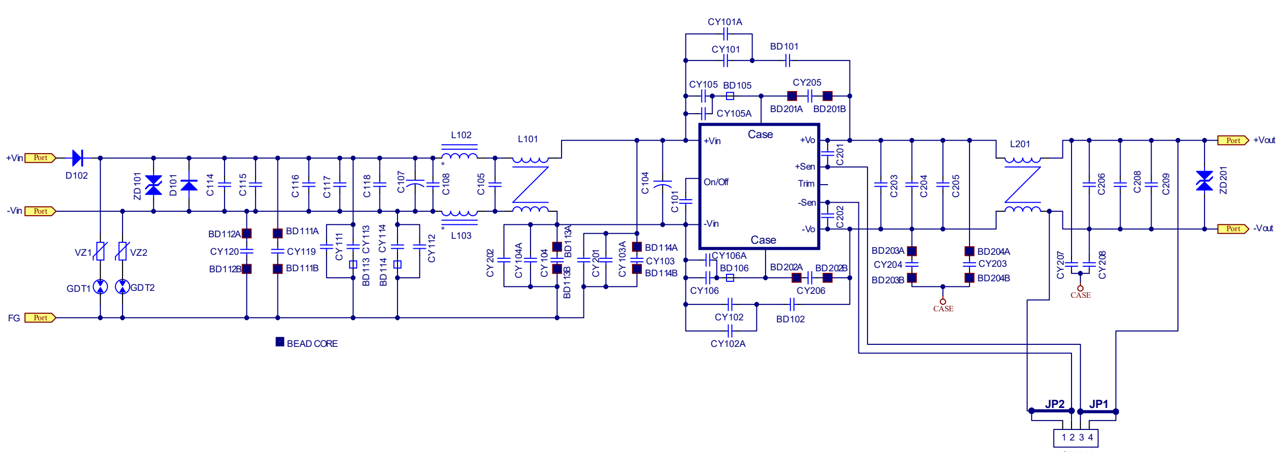


Figure1 Connection Circuit

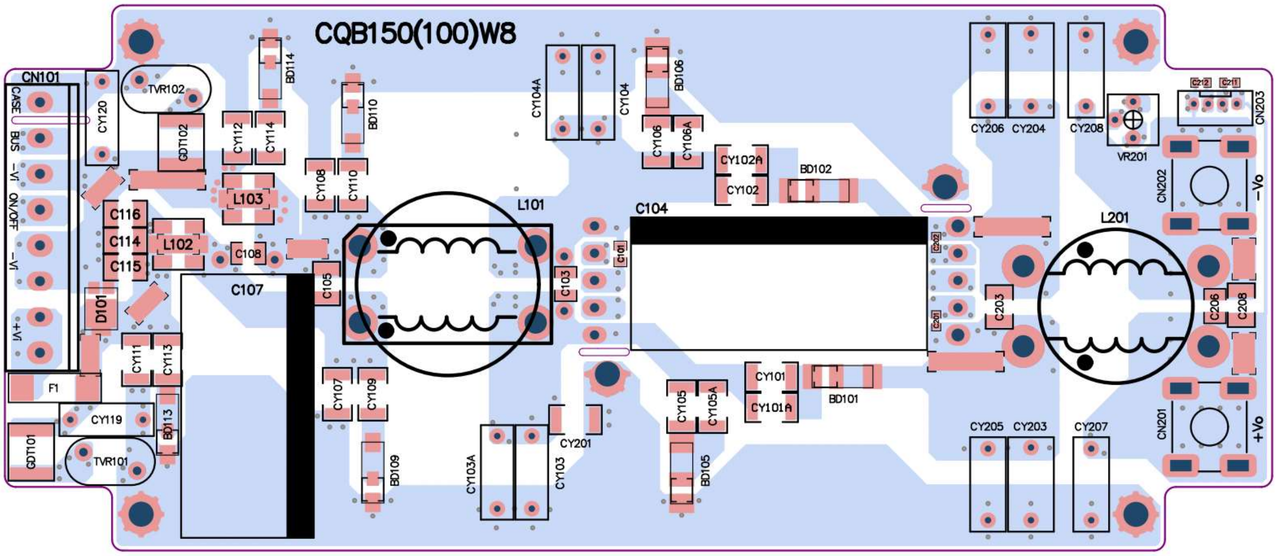


Figure2 PCB Layout Top View

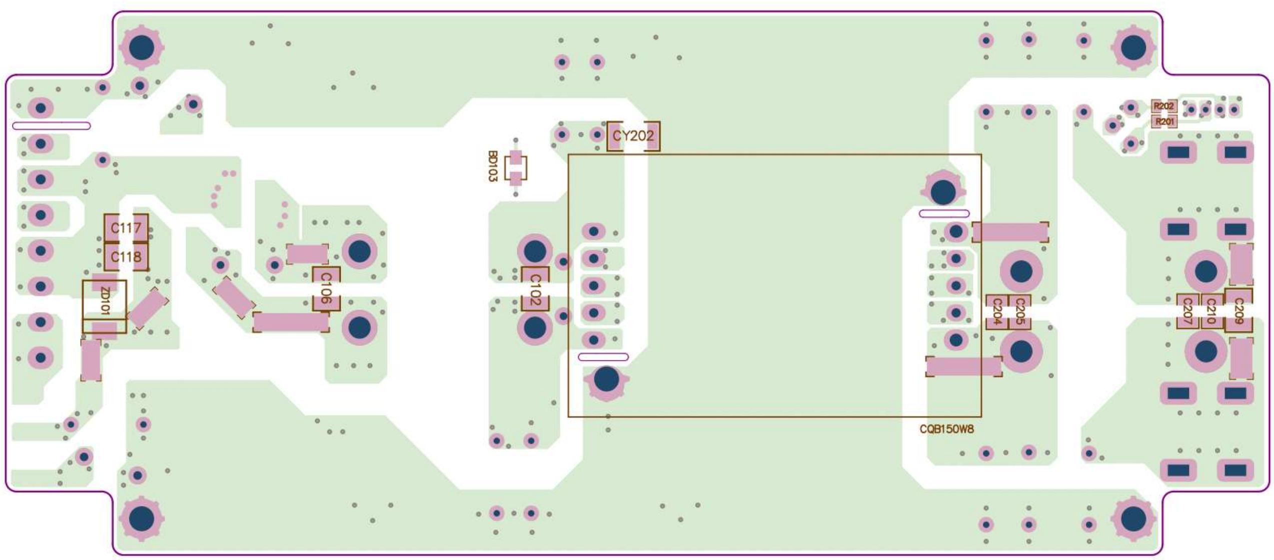


Figure3 PCB Layout Bottom View

CQB150W8 Series
Application Note December 2024 V11

Components value:

<table>
<tr><td></td><td colspan="7">Model Number</td></tr>
<tr><td>DC/DC</td><td>36S05</td><td>36S12</td><td>36S15</td><td>36S24</td><td>36S28</td><td>36S48</td><td>36S54</td></tr>
<tr><td>C101</td><td colspan="7">0.1uF/100V</td></tr>
<tr><td>C105</td><td colspan="7">4.7uF/100V X7R</td></tr>
<tr><td>C108</td><td>NC</td><td>2.2uF/100V</td><td colspan="3">NC</td><td colspan="2">2.2uF/100V</td></tr>
<tr><td>C114</td><td colspan="5">4.7uF/100V X7R</td><td colspan="2">2.2uF/100V</td></tr>
<tr><td>C115</td><td colspan="3" rowspan="2">4.7uF
100V X7R</td><td colspan="2" rowspan="2">NC</td><td colspan="2">NC</td></tr>
<tr><td>C116</td><td colspan="2">4.7uF/100V X7R</td></tr>
<tr><td>C117, C118</td><td>NC</td><td>4.7uF
100V X7R</td><td colspan="5">NC</td></tr>
<tr><td>C104, C107</td><td colspan="7">470uF/100V SUSCON</td></tr>
<tr><td>C203, C208, C209</td><td>33uF/16V</td><td colspan="2">22uF/25V</td><td colspan="2">6.8uF/50V</td><td colspan="2">4.7uF/100V</td></tr>
<tr><td>C204, C205, C206</td><td>47uF/6.3V</td><td colspan="2">22uF/25V</td><td colspan="2">10uF/50V</td><td colspan="2">2.2uF/100V</td></tr>
<tr><td>CY107, CY108
CY113, CY114</td><td colspan="3">NC</td><td colspan="4">560pF</td></tr>
<tr><td>CY119</td><td>220pF</td><td>470pF</td><td>100pF</td><td colspan="2">100pF</td><td>100pF</td><td>100pF</td></tr>
<tr><td>CY120</td><td>680pF</td><td>1500pF</td><td>680pF</td><td colspan="2">470pF</td><td>470pF</td><td>330pF</td></tr>
<tr><td>CY103, CY104</td><td colspan="7">4700pF</td></tr>
<tr><td>CY103A, CY104A</td><td colspan="5">NC</td><td colspan="2">4700pF</td></tr>
<tr><td>CY101, CY101A, CY102
CY102A, CY105, CY106</td><td colspan="7">2200pF</td></tr>
<tr><td>CY105A, CY106A</td><td colspan="3">2200pF</td><td colspan="2">NC</td><td colspan="2">2200pF</td></tr>
<tr><td>CY201, CY202</td><td>NC</td><td>2200pF</td><td colspan="5">NC</td></tr>
<tr><td>CY203, CY204</td><td colspan="5">4700pF</td><td colspan="2">0.01uF</td></tr>
<tr><td>CY205, CY206</td><td colspan="2">NC</td><td colspan="5">3300pF</td></tr>
<tr><td>CY207, CY208</td><td>4700pF</td><td colspan="4">0.01uF</td><td colspan="2">0.022uF</td></tr>
<tr><td>BD103</td><td colspan="7">BPH323023W5-400T-NB</td></tr>
<tr><td>BD111A, BD111B
BD112A, BD112B</td><td colspan="3">A8H035030015</td><td colspan="4">A6B T4.1*1.5*2</td></tr>
<tr><td>BD113A, BD113B
BD114A, BD114B
BD201A, BD201B
BD202A, BD202B
BD203A, BD203B
BD204A, BD204B</td><td colspan="7">A6B T4.1*1.5*2</td></tr>
<tr><td>L101</td><td colspan="7">0.7mmx3x10T 5.7mH</td></tr>
<tr><td>L102, L103</td><td colspan="2">6.8uH</td><td colspan="5">SHORT</td></tr>
<tr><td>L201</td><td>0.8mm*4/4
T 0.52mH</td><td colspan="4">0.8mm*2/8T 2mH</td><td colspan="2">0.55mm*2/13T 5.45mH</td></tr>
<tr><td>BD101, BD102</td><td colspan="7">BPH853025WR5-101T-NB</td></tr>
<tr><td>BD105, BD106</td><td>Short</td><td>742792510
WURTH</td><td>Short</td><td colspan="2">BPH853025WR5-101T-
NB</td><td colspan="2">Short</td></tr>
</table>

	Model Number						
DC/DC	36S05	36S12	36S15	36S24	36S28	36S48	36S54
BD113, BD114	NC	NC	NC	BPH853025WR5-101T-NB			
D101	SMPD20150L-C						
D102	STPS30170DJF-TR						
ZD101, ZD201	SMDJ78A						
VZ1, VZ2	TVR10471KIC7AV						
GDT1, GDT2	2RK2500M-5-SS						

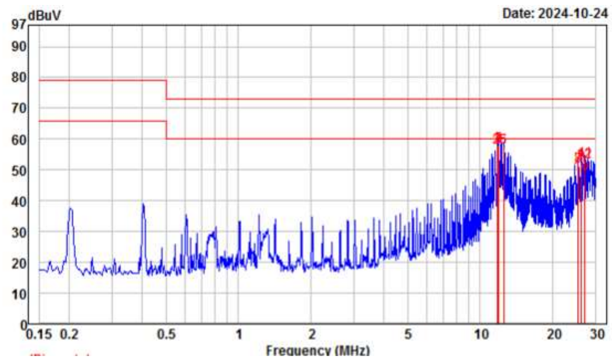
Note:

BD101, BD102, BD113, BD114: BPH853025WR5-101T-NB TAI-TECH or equivalent
BD103: BPH323023W5-400T-NB or equivalent
BD105, BD106: BPH853025WR5-101T-NB TAI-TECH or equivalent for 24V,28V_{out}, 742792510 Wurth or equivalent for 12V_{out} others short
BD111A, BD111B, BD112A, BD112B: A8H035030015 EROCORE or equivalent for 5V,12V,15V_{out}, others A6B T 4*1.5*2 KING CORE or equivalent
BD113A, BD113B, BD114A, BD114B, BD201A, BD201B, BD202A, BD202B, BD203A, BD203B, BD204A, BD204B: A6B T 4*1.5*2 KING CORE or equivalent
C105, C114, C115, C116, C117, C118, C203, C208, C209: SMD CAP X7R 1812 or equivalent
C104, C107: 470uF/100V ALUMINUM CAP SUSCON SDN series or equivalent
C108, C204, C205, C206: SMD CAP X7R 1210 or equivalent
CY103, CY103A, CY104, CY104A, CY119, CY120, CY205, CY206: Y1 CAP DIP TDK or equivalent
CY203, CY204: Y1 CAP DIP TDK for 5V,12V,15V,24V,28V_{out},others X2 CAP HJC MKP series 223K0275AB1101 or equivalent
CY207, CY208: Y1 CAP DIP TDK for 5V_{out}, others X2 CAP HJC MKP series 223K0275AB1101 or equivalent
CY101, CY102, CY101A, CY102A, CY105, CY105A, CY106, CY106A: SMD Y2 CAP 2211 or equivalent
CY107,CY108,CY113,CY114: SMD CAP X7R 1808 or equivalent
VZ1, VZ2: TVR10471KIC7AV TKS or equivalent
GDT1, GDT2: 2RK2500M-5-SS YAGEO or equivalent
D101: SMPD20150L-C SECOS or equivalent
D102: STPS30170DJF-TR ST or equivalent
ZD101, ZD201: SMDJ78A Littlefuse or equivalent
L101: TMC20-12.5-12-C(P) NANOCRYSTALLINE TECH MOUNT or equivalent
L102, L103: 6.8uH SMD or equivalent
L201: SYG1HN 181306P BJ-SHOUYE or equivalent
CN101: TERMINAL BLOCK UL 5.0mm EK500V-08P 300V 20A DINLE or equivalent
CN201, CN202: P-831N DINKLE or equivalent
CN203: WAFER DIP AC-DC Nylon UL 94V-0 P110I-04 180° 2.0mm 4PIN KP or equivalent
MINI JUMPER HMJ20-02O-95BS 2.0mm TKP or equivalent: UISNG IN CN203

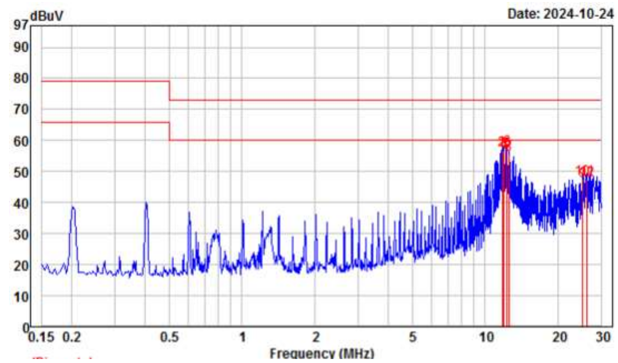
Conducted Emission (Input):

CQB150W8-36S05

Line

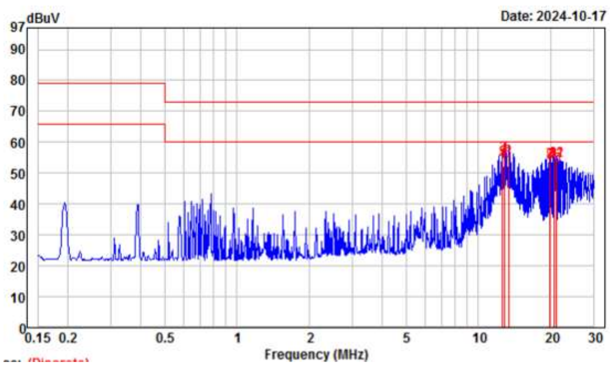


Neutral



CQB150W8-36S12

Line



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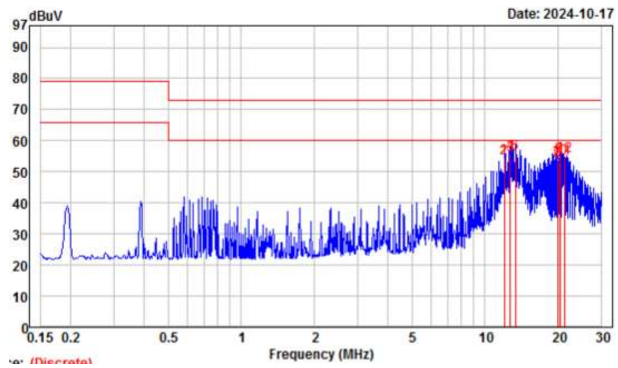
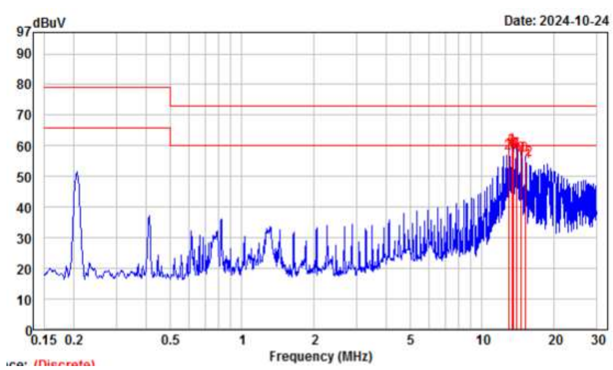
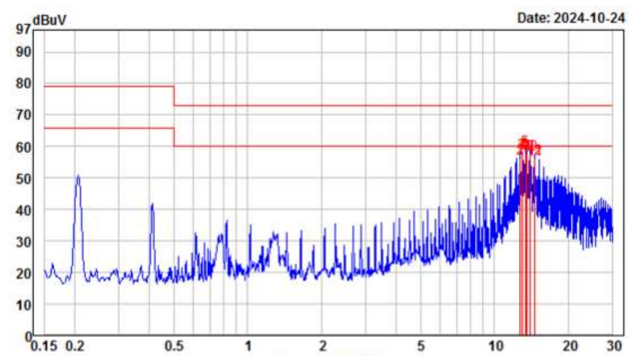


CQB150W8-36S15

Line

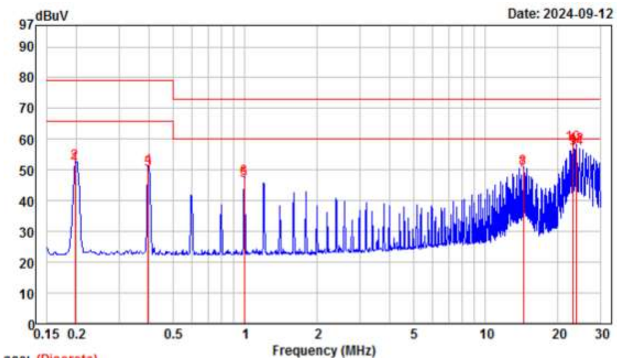


Neutral

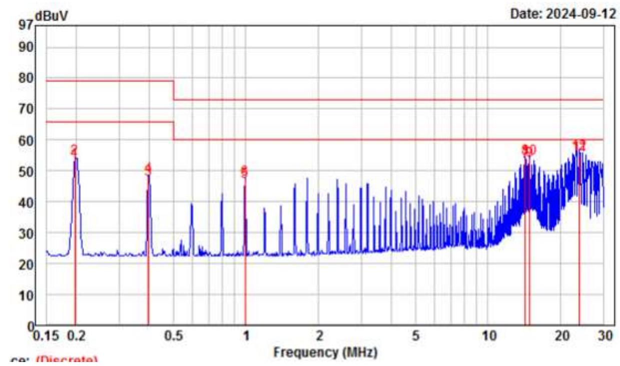


CQB150W8-36S24

Line

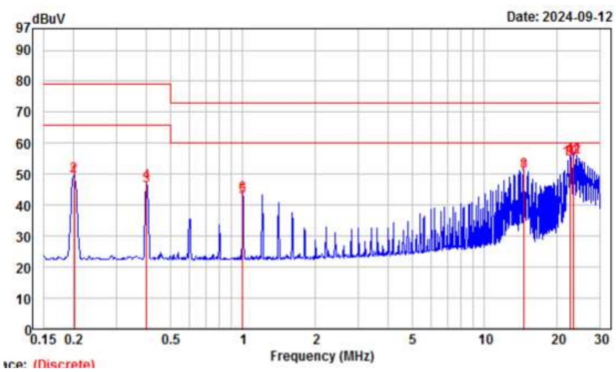


Neutral

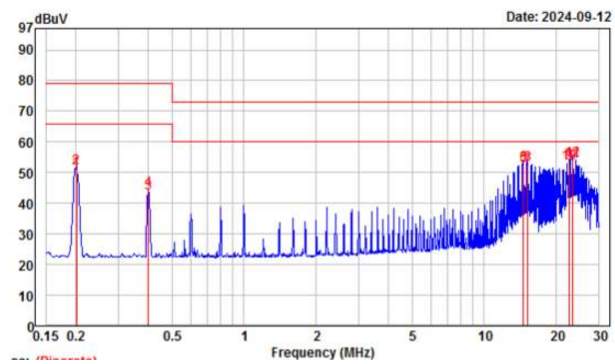


CQB150W8-36S28

Line

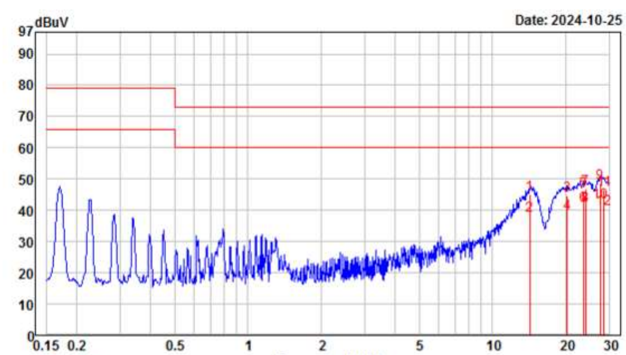


Neutral

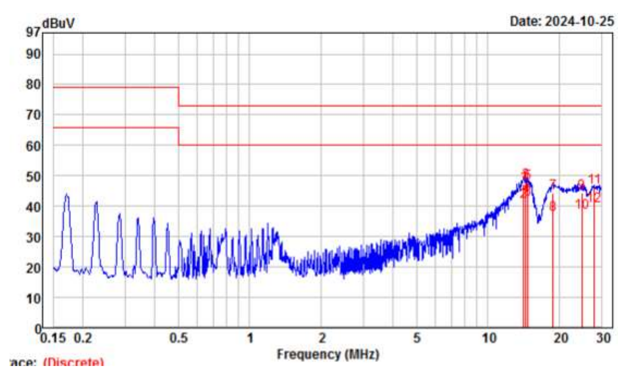


CQB150W8-36S48

Line

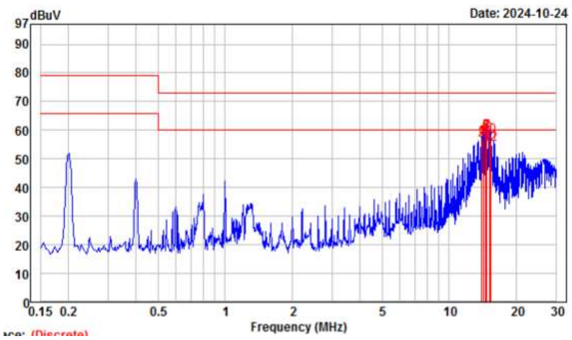


Neutral

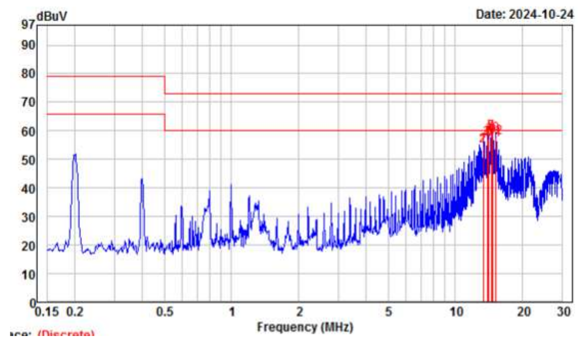


CQB150W8-36S54

Line



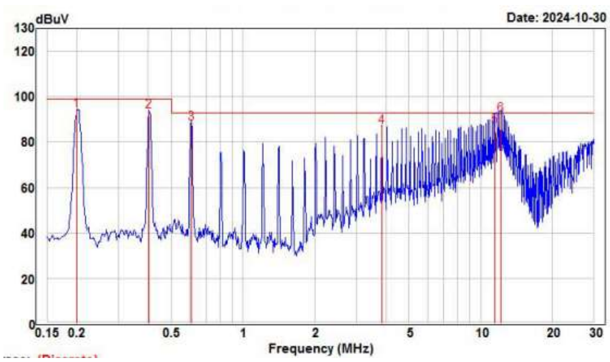
Neutral



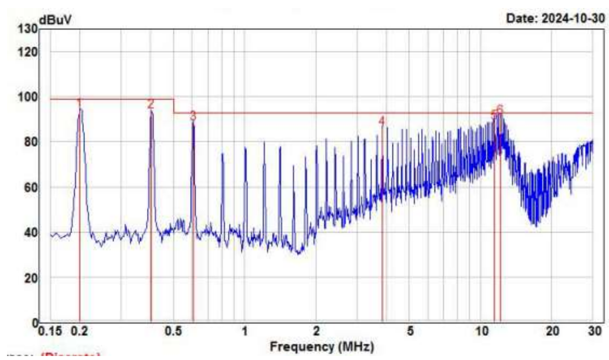
Conducted Emission (Output):

CQB150W8-36S05

Positive

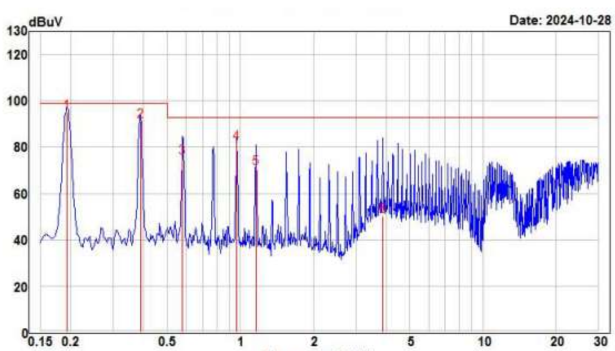


Negative



CQB150W8-36S12

Positive



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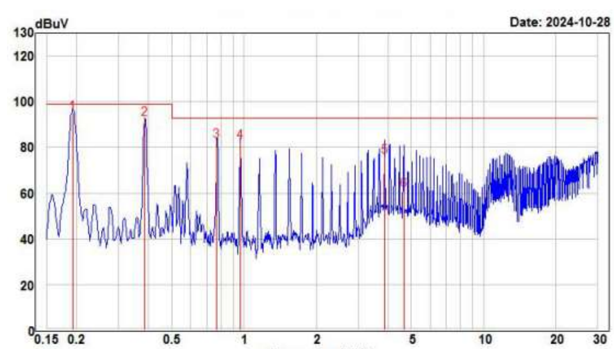

CQB150W8-36S15

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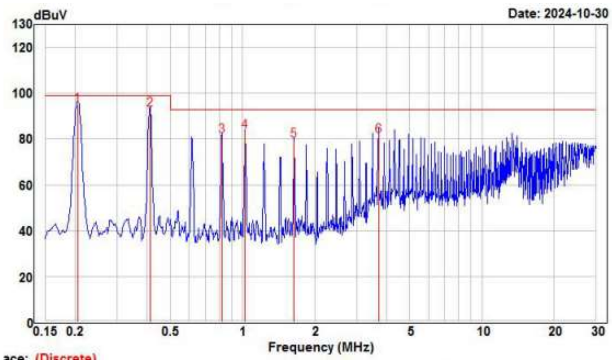

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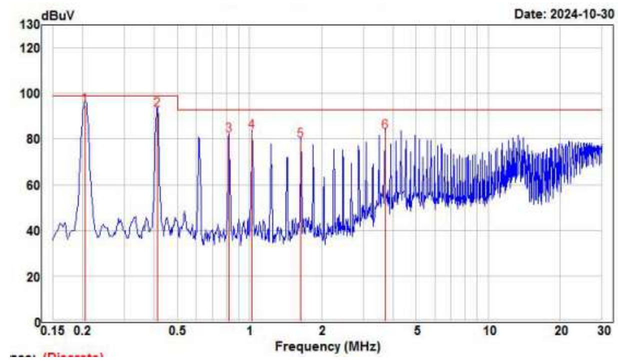

CQB150W8-36S24

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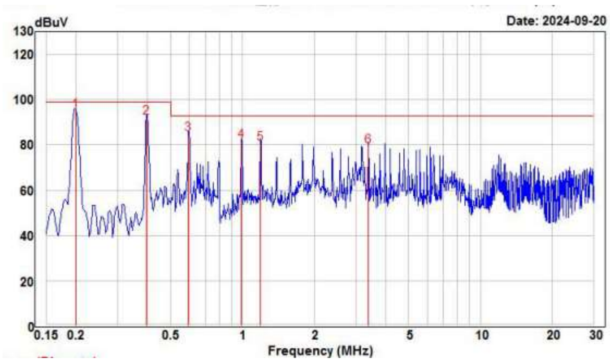

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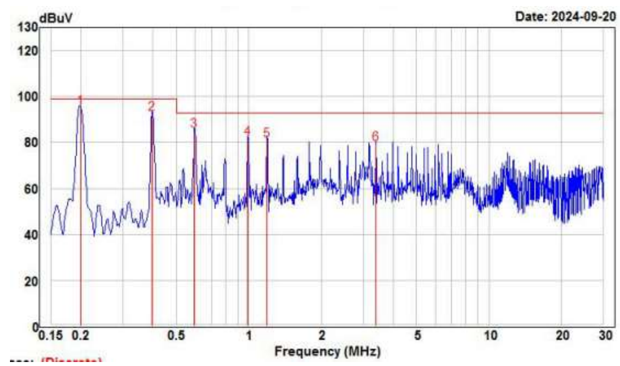

CQB150W8-36S28

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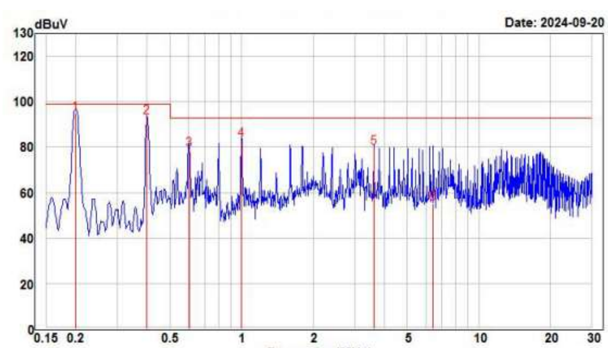

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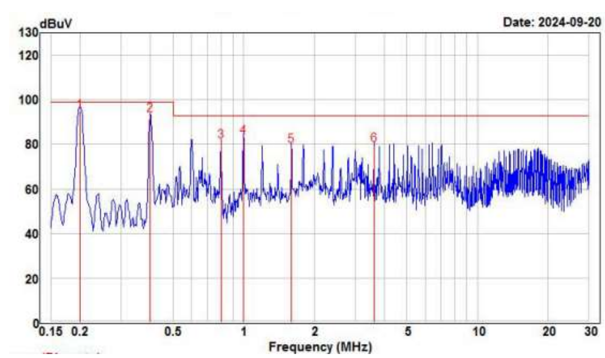

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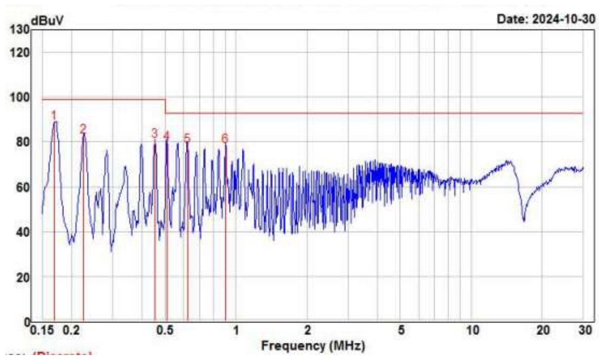

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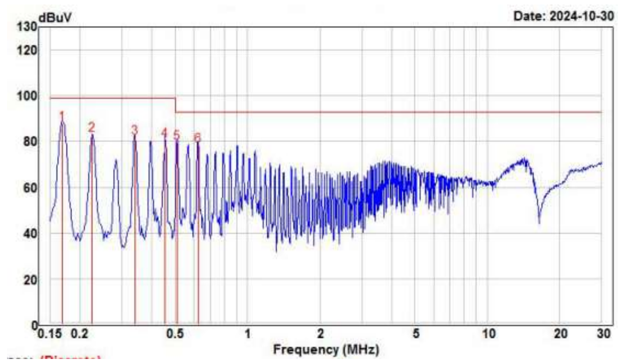

CQB150W8-36S54

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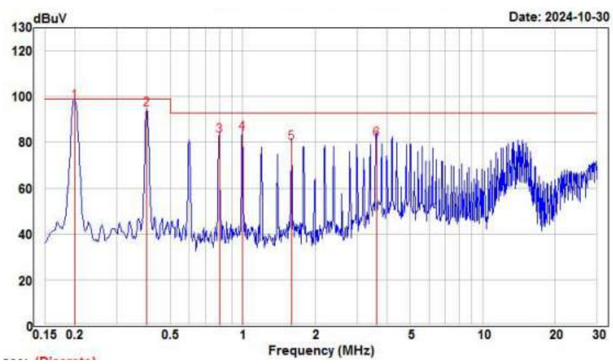

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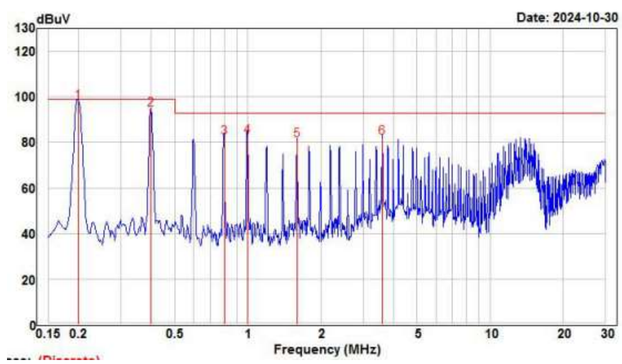
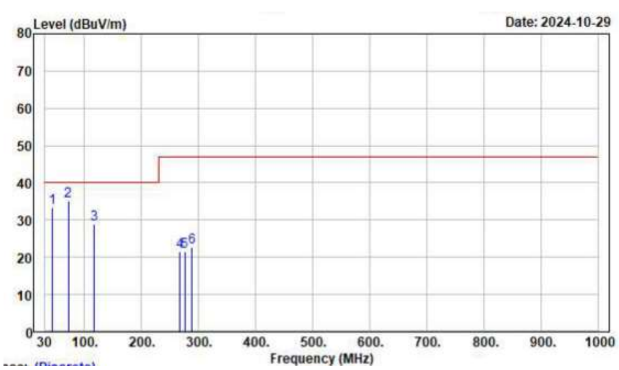


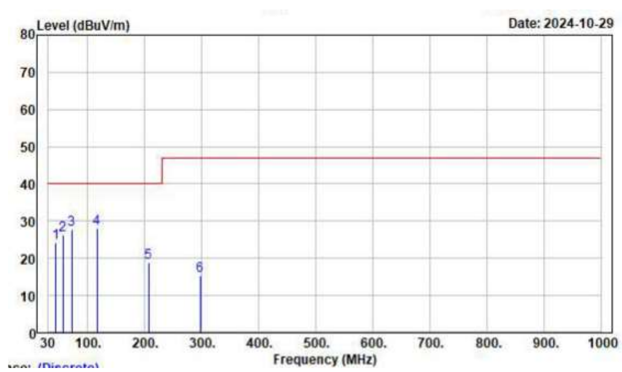
Radiated Emission:

CQB150W8-36S05

Vertical

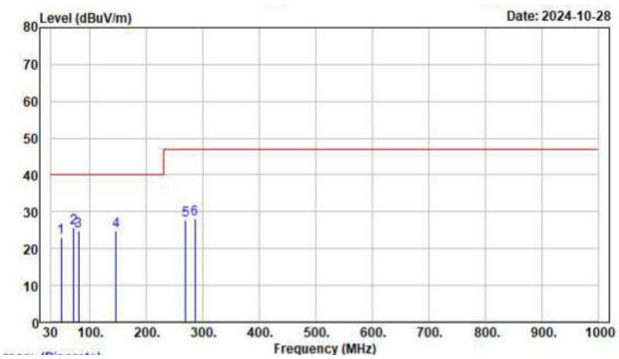


Horizontal



CQB150W8-36S12

Vertical



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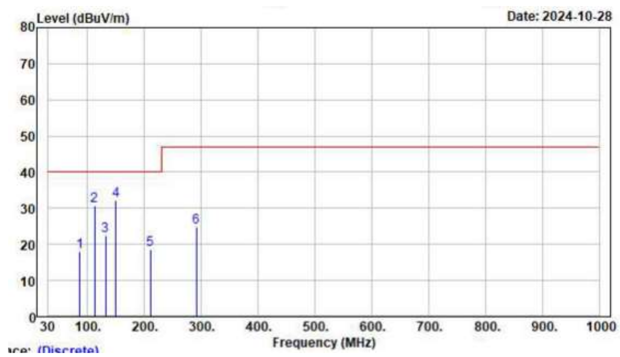
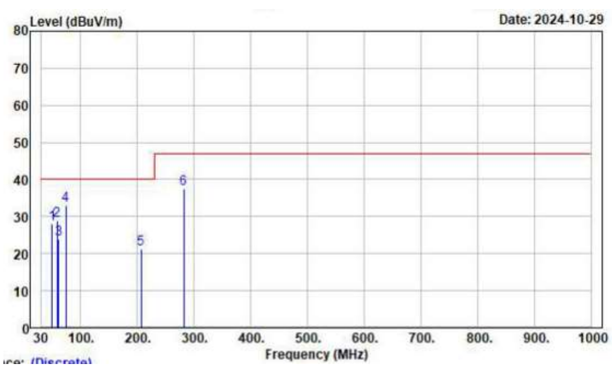


CQB150W8-36S15

Vertical



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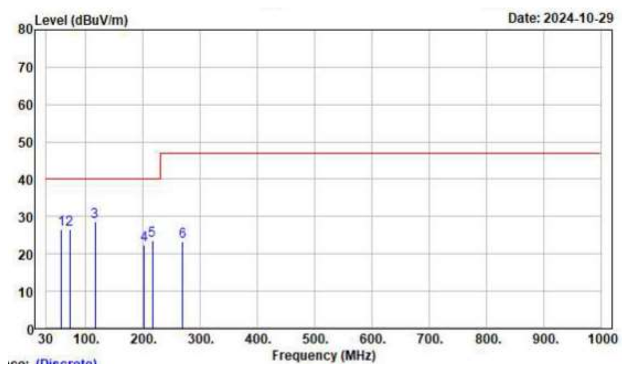
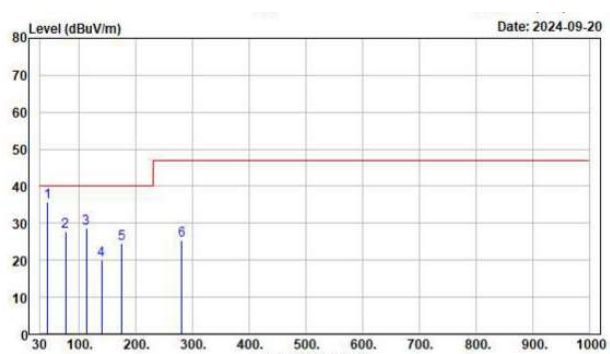
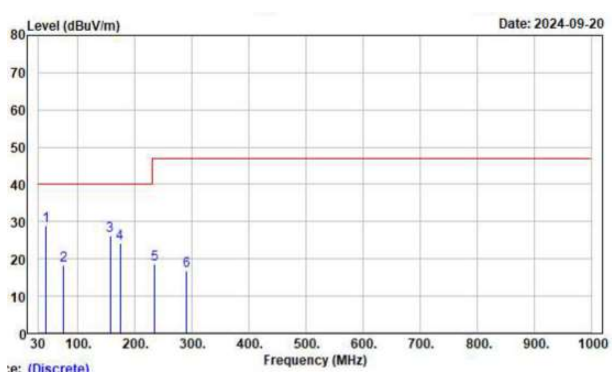


CQB150W8-36S24

Vertical

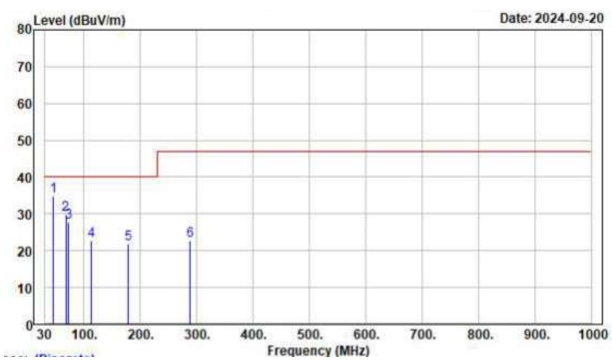


Horizontal



CQB150W8-36S28

Vertical



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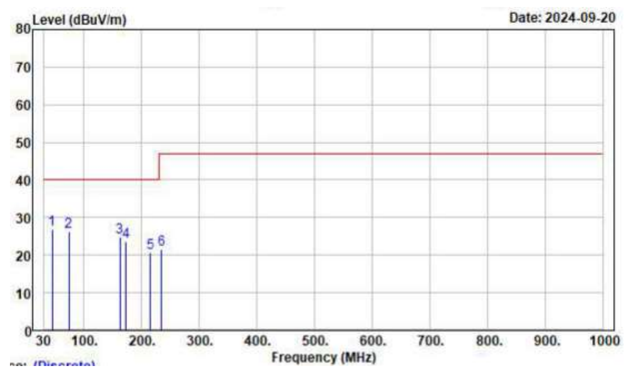
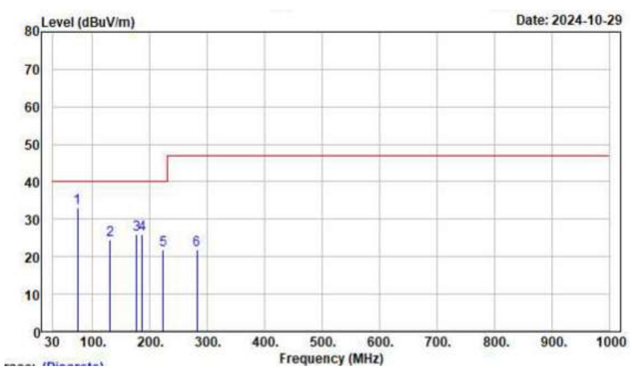


CQB150W8-36S48

Vertical



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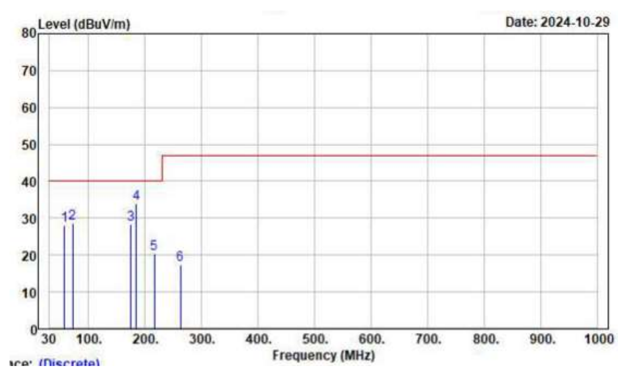
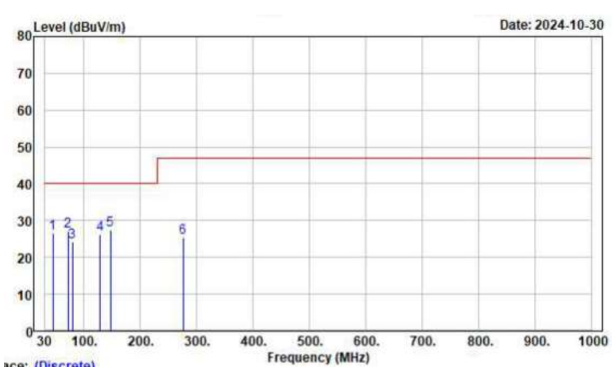
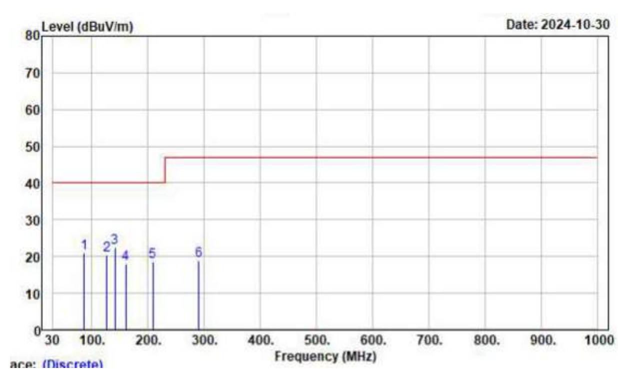


CQB150W8-36S54

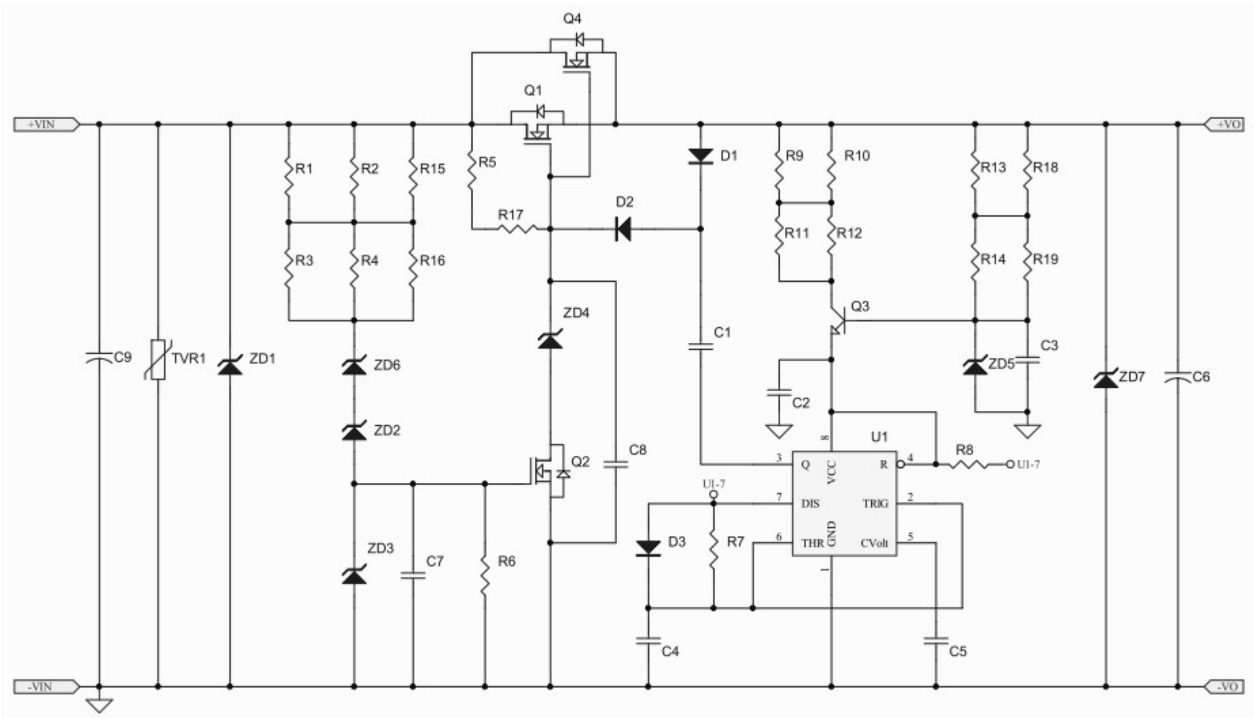
Vertical



Horizontal



10.3 Suggested Configuration for RIA12 Surge Test



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