



EC2SBW-H Series Application Note V10

ISOLATED DC-DC CONVERTER EC2SBW-H SERIES APPLICATION NOTE



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1. Introduction

The EC2SBW-H series of DC-DC converters offers 10 watts of output power @ output voltages of 3.3, 5, 12, 15, ± 12 , ± 15 VDC with industry 1.0"x1.0"x0.4" package. It has a wide (4:1) input voltage range of 9 to 36VDC (24VDC nominal), 18 to 74VDC (48VDC nominal) and 3000VDC isolation.

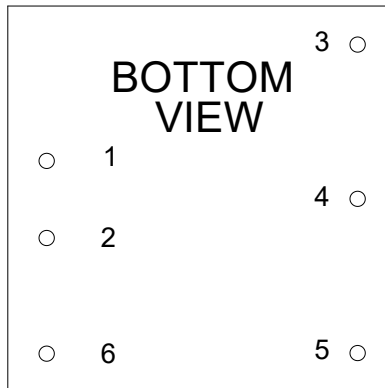
High efficiency up to 89.5%, allowing case operating temperature range of -40°C to 105°C . Very low no load power consumption (10mA), an ideal solution for energy critical systems.

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

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

EC2SBW-H series is designed suitable for distributed power architectures, telecommunications, battery operated equipment, industrial and mobile equipment application.

2. Pin Function Description



Single Output

No	Label	Function	Description	Reference
1	+Vin	+V Input	Positive Supply Input	Section 7.1
2	-Vin	-V Input	Negative Supply Input	Section 7.1
3	+Vout	+V Output	Positive Power Output	Section 7.2/7.3
4	Trim	Trim	External Output Voltage Adjustment	Section 6.5
5	-Vout	-V Output	Negative Power Output	Section 7.2/7.3
6	Remote	Remote On/Off	External Remote On/Off Control	Section 6.4

Dual Output

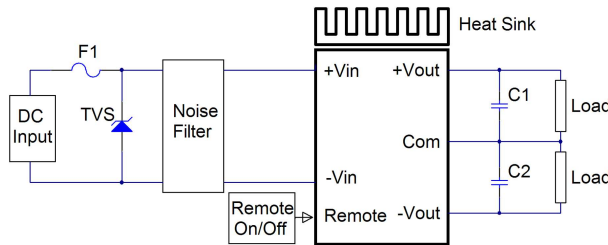
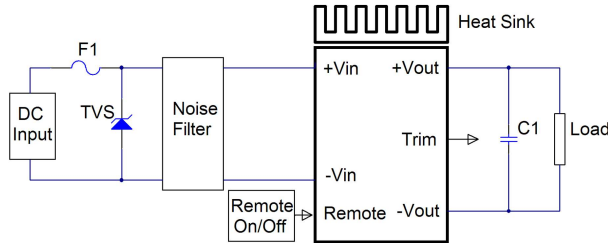
No	Label	Function	Description	Reference
1	+Vin	+V Input	Positive Supply Input	Section 7.1
2	-Vin	-V Input	Negative Supply Input	Section 7.1
3	+Vout	+V Output	Positive Power Output	Section 7.2/7.3
4	Com	Common	Common Power Output	Section 7.2/7.3
5	-Vout	-V Output	Negative Power Output	Section 7.2/7.3
6	Remote	Remote On/Off	External Remote On/Off Control	Section 6.4



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3. Connection for Standard Use

The connection for standard use is shown below. External output capacitors (C1, C2) are recommended to reduce output ripple and noise, 1uF ceramic capacitor for all models.



Symbol	Component	Reference
F1, TVS	Input fuse, TVS	Section 9.1
C1, C2	External capacitor on the output side	Section 7.3
Noise Filter	External input noise filter	Section 9.2
Remote On/Off	External remote on/off control	Section 6.4
Trim	External output voltage adjustment	Section 6.5
Heat sink	External heat sink	Section 8.1/8.2/8.3/8.4/8.5

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

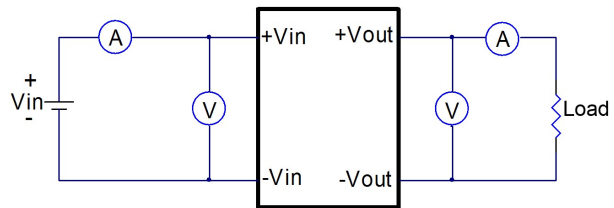
The value of line regulation is defined as:

$$Line\ reg. = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

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 full load



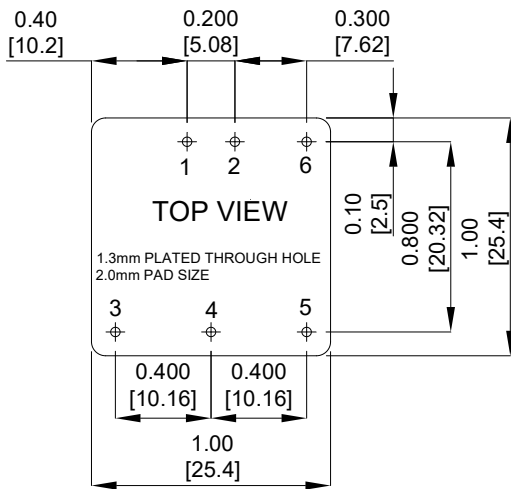
EC2SBW-H Series Test Setup



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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. The recommended footprints and soldering profiles are shown below.

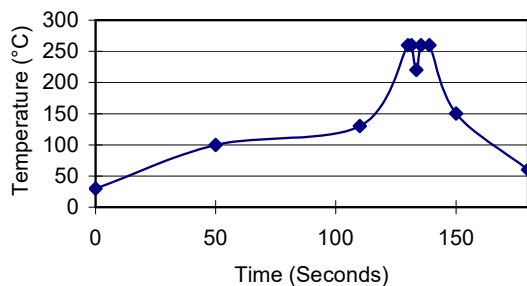


Note: Dimensions are in inches (millimeters)

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 $420 \pm 10^\circ\text{C}$ for up to 4~15seconds (less than 90W). Furthermore, the recommended soldering profile is shown below.

Lead Free Wave Soldering Profile

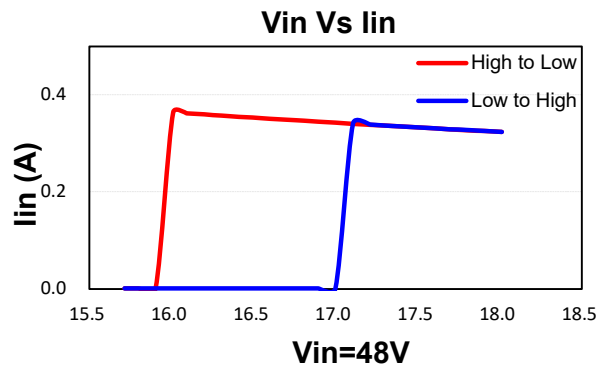
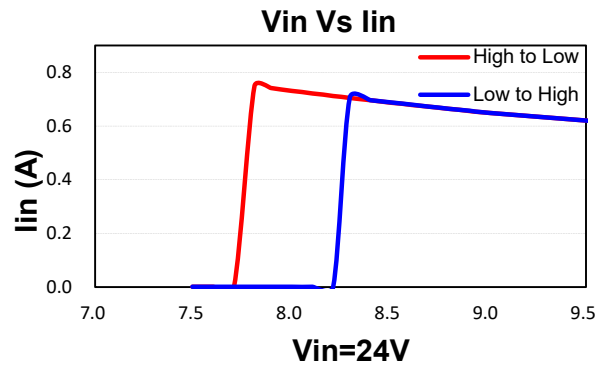


Wave Soldering Profiles

6. Features and Functions

6.1 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the EC2SBW-H 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.

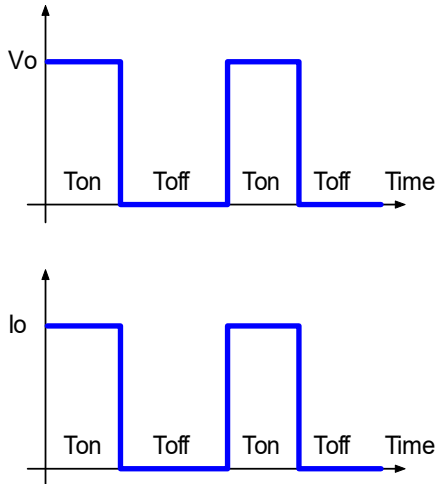




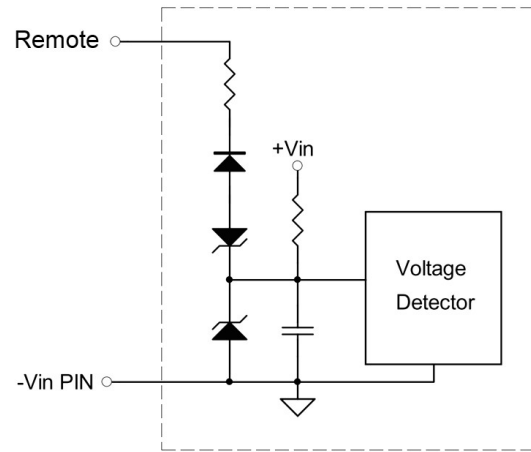
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6.2 Over Current / Short Circuit Protection

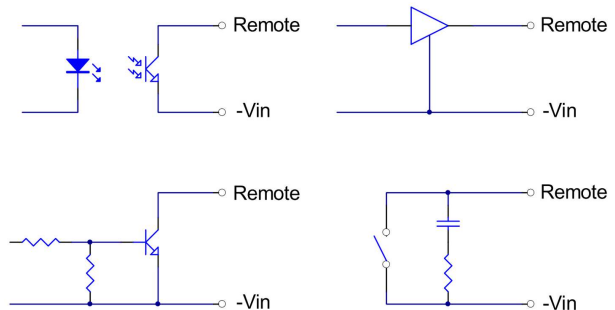
All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into hiccup mode protection.



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 Examples

6.3 Output Over Voltage Protection

The over-voltage protection consists of a zener diode to limiting the out voltage.

6.4 Remote On/Off

The EC2SBW-H 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 74Vdc 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). Converter will be turn on in positive mode.

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 74Vdc 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.

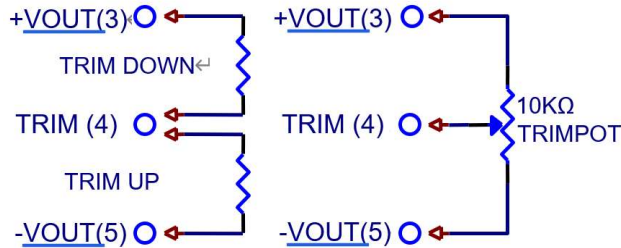
Logic State (Pin 6)	Negative Logic	Positive Logic
Logic Low	Module on	Module off
Logic High	Module off	Module on



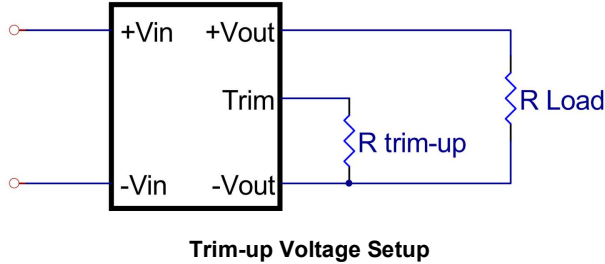
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6.5 Output Voltage Adjustment

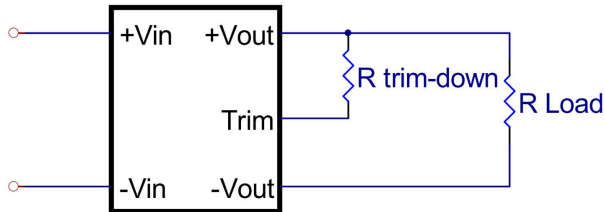
Output may be externally trimmed -10% to +10% (single output models only) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.



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



Trim-up Voltage Setup



Trim-down Voltage Setup

1. The value of R_{trim-up} defined as:

$$R_{trim-up} = \left(\frac{V_r \times R_1 \times (R_2 + R_3)}{(V_o - V_{o,nom}) \times R_2} \right) - R_t \text{ (K}\Omega\text{)}$$

Where

R_{trim-up} is the external resistor in Kohm.

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

V_o is the desired output voltage.

R₁, R_t, R₂, R₃ 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 (KΩ)	R2 (KΩ)	R3 (KΩ)	Rt (KΩ)	Vr (V)
EC2SBW-24S33H EC2SBW-48S33H	3.3	2.74	1.8	0.249	9.1	1.24
EC2SBW-24S05H EC2SBW-48S05H	5.0	2.32	2.32	0	8.2	2.5
EC2SBW-24S12H EC2SBW-48S12H	12.0	6.8	2.4	2.32	22	2.5
EC2SBW-24S15H EC2SBW-48S15H	15.0	8.06	2.4	3.9	27	2.5

For example, to trim-up the output voltage of 5.0V module (EC2SBW-24S05H) by 10% to 5.5V, R trim-up is calculated as follows:

$$V_o - V_{o,nom} = 5.5 - 5.0 = 0.5V$$

$$R_1 = .32 \text{ K}\Omega$$

$$R_2 = 2.32 \text{ K}\Omega$$

$$R_3 = 0 \text{ K}\Omega$$

$$R_t = 8.2 \text{ K}\Omega$$

$$V_r = 2.5 \text{ V}$$

$$R_{trim-up} = \left(\frac{2.5 \times 2.32 \times (2.32 + 0)}{0.5 \times 2.32} \right) - 8.2 = 3.4 \text{ (K}\Omega\text{)}$$

The typical value of R_{trim-up}

Trim up %	3.3V	5V	12V	15V
	R _{trim-up} (KΩ)			
1%	108.100	107.800	256.611	325.625
2%	49.500	49.800	117.306	149.313
3%	29.967	30.467	70.870	90.542
4%	20.200	20.800	47.653	61.156
5%	14.340	15.000	33.722	43.525
6%	10.433	11.133	24.435	31.771
7%	7.643	8.371	17.802	23.375
8%	5.550	6.300	12.826	17.078
9%	3.922	4.689	8.957	12.181
10%	2.620	3.400	5.861	8.263

2. The value of R_{trim-down} defined as:

$$R_{trim-down} = R_1 \times \left(\frac{V_r \times R_1}{(V_{o,nom} - V_o) \times R_2} - 1 \right) - R_t \text{ (K}\Omega\text{)}$$

Where

R_{trim-down} is the external resistor in Kohm.

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

V_o is the desired output voltage.

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



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For example, to trim-down the output voltage of 5.0V module (EC2SBW-24S05H) by 10% to 4.5V, R trim-down is calculated as follows:

$$V_{o,nom} - V_o = .0 - 4.5 = 0.5V$$

$$R1 = 2.32 \text{ K}\Omega$$

$$R2 = 2.32 \text{ K}\Omega$$

$$R3 = 0 \text{ K}\Omega$$

$$R_i = 8.2 \text{ K}\Omega$$

$$V_r = 2.5 \text{ V}$$

$$R_{trim-down} = 2.32 \times \left(\frac{(2.5 \times 2.32)}{0.5 \times 2.32} - 1 \right) - 8.2 = 1.08 \text{ (K}\Omega)$$

The typical value of R_{trim_down}

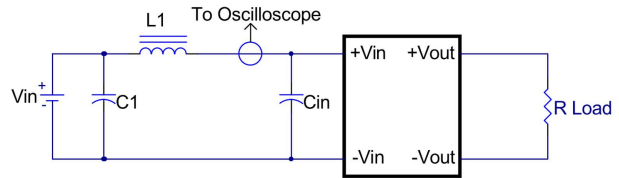
Trim down %	3.3V	5V	12V	15V
	R_{trim_down} (K Ω)			
1%	144.884	105.480	372.589	416.076
2%	66.522	47.480	171.894	190.508
3%	40.401	28.147	104.996	115.319
4%	27.341	18.480	71.547	77.724
5%	19.505	12.680	51.478	55.167
6%	14.281	8.813	38.098	40.129
7%	10.549	6.051	28.541	29.388
8%	7.751	3.980	21.374	21.332
9%	5.574	2.369	15.799	15.066
10%	3.832	1.080	11.339	10.054

The EC2SBW-H series models is adjustable within the range of $\pm 10\%$, see input & output trim curves for trim up and trim down ranges.

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. C_1 and L_1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L_1).

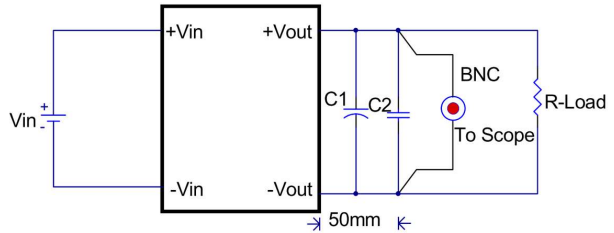


L_1 : 12 μ H

C_1 : None

C_{in} : 47 μ F ESR < 0.17 Ω @ 100KHz

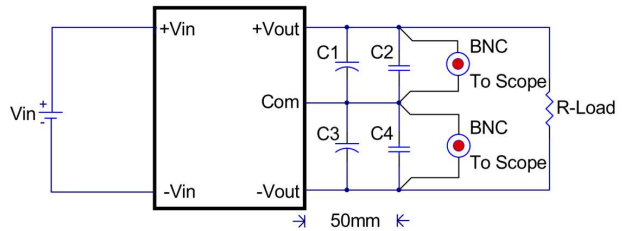
7.2 Output Ripple and Noise



C_1 : None

C_2 : 1 μ F ceramic capacitor

EC2SBW-H single output module



C_1 & C_3 : None

C_2 & C_4 : 1 μ F ceramic capacitor

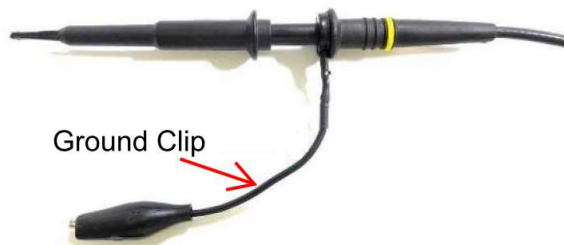
EC2SBW-H dual output module



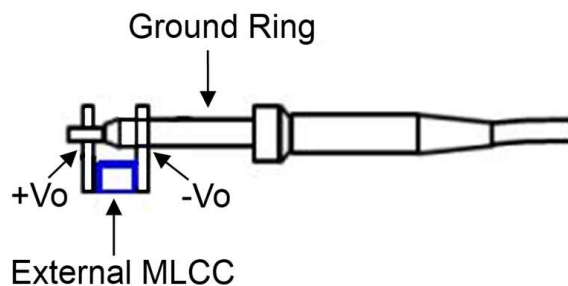
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Output ripple and noise measured with 1 μ F ceramic capacitor across output, A 20 MHz bandwidth oscilloscope is normally used for the measurement.

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



Another method is shown in below, in case of coaxial-cable/BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.



7.3 Output Capacitance

The EC2SBW-H series converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load (<100mm). PCB design emphasizes low resistance and inductance tracks in consideration of high current applications. Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. Cincon's converters are designed to work with load capacitance to see technical specifications.



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8. Thermal Design

8.1 Operating Temperature Range

The EC2SBW-H 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 models is influenced by usual factors, such as:

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

8.2 Convection Requirements for Cooling

To predict the approximate cooling needed for the 1"×1" module, refer to the power derating curves in **section 8.4**. 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).

8.3 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 8.4**. The power output of the module should not be allowed to exceed rated power ($V_{o_set} \times I_{o_max}$).

8.4 Power Derating

The operating case temperature range of EC2SBW-H series is -40°C to +105°C. When operating the EC2SBW-H series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 105°C (refer to datasheet)..



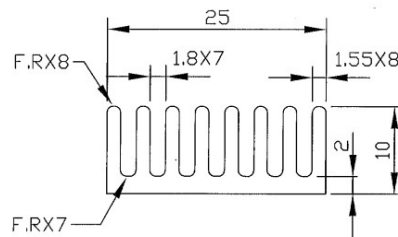
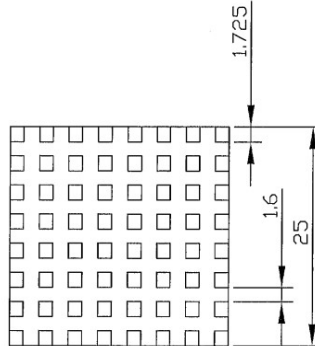
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8.5 1"x1" Case Heat Sinks Kit:

Cross Cut Heat Sink: SBC100 (K-C087)

All Dimensions in mm

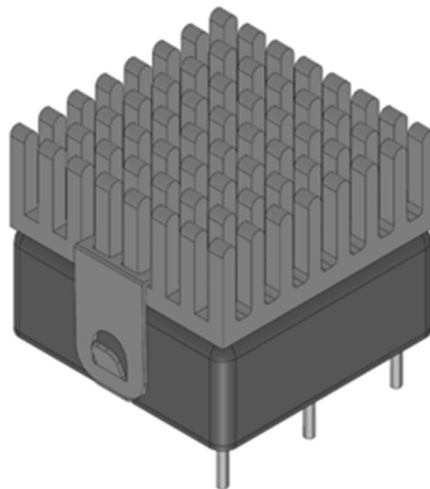
Rca: 12.5°C/W (typ.), at natural convection



Assembly:

Heat Sink: SBC100

Clip: HC01



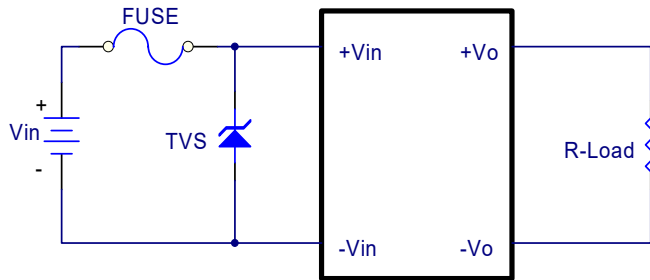


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9. Safety & EMC

9.1 Input Fusing and Safety Considerations

The EC2SBW-H series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a fast acting fuse 2A for 24V_{in} models and 1A for 48V_{in} modules. 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 transient voltage suppressor diode (TVS) are required if EC2SBW-H series has to meet EN61000-4-4, EN61000-4-5.

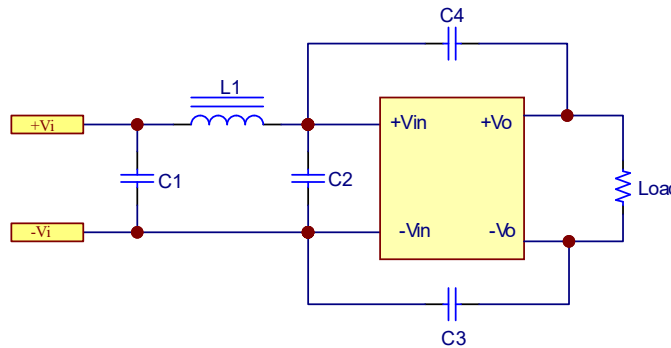
The TVS recommended 1.5KE47A for 24V_{in} models, and 1.5KE91A for 48V_{in} models.

9.2 EMC Considerations

EMI Test standard: EN 55032 Conducted & Radiated Emission.

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

(1) EMI meet EN 55032 / EN 55022



Connection circuit for conducted EMI testing

Model Number		C1	C2	C3	C4	L1
Class A	EC2SBW-H Serie	None	None	None	None	Jumper wire*2 Φ0.6mm
Class B	EC2SBW-H Serie	1uF/100V	None	3300pF 400VAC Y1 capacitor	680pF 400VAC Y1 capacitor	6.8uH 0403

Note:

C1: 1210 X7R ceramic capacitor

C3: Y1 capacitor or equivalent

C4: Y2 capacitor or equivalent

L1: SCD0403T-6R8M-N CHILISIN

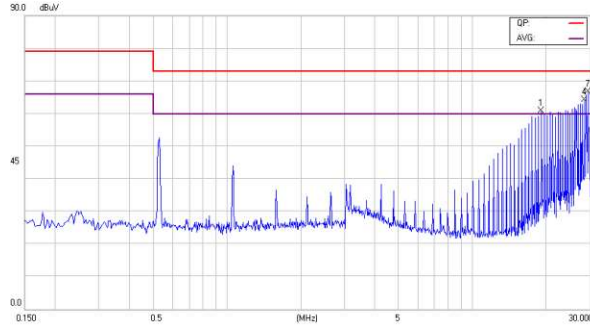


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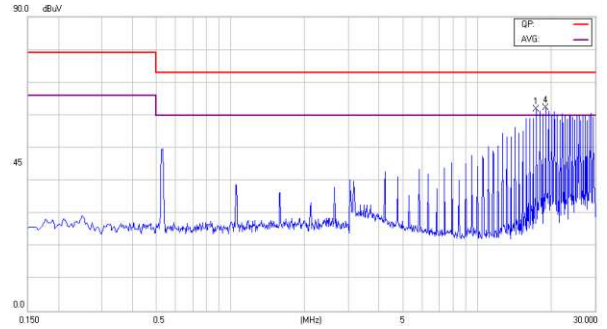
Conducted Emission Class A:

EC2SBW-24S33H

Line

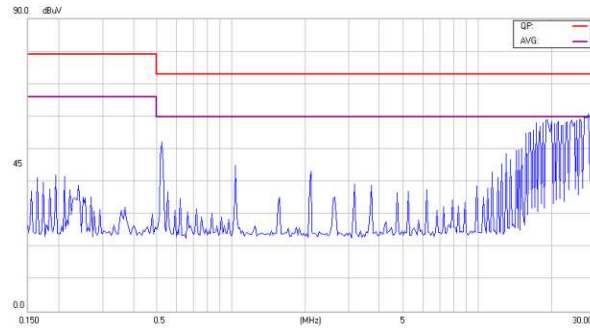


Neutral

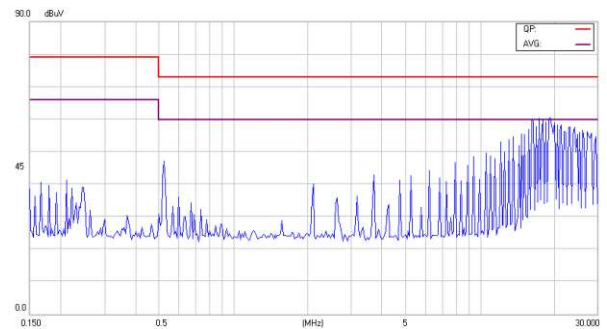


EC2SBW-24S05H

Line

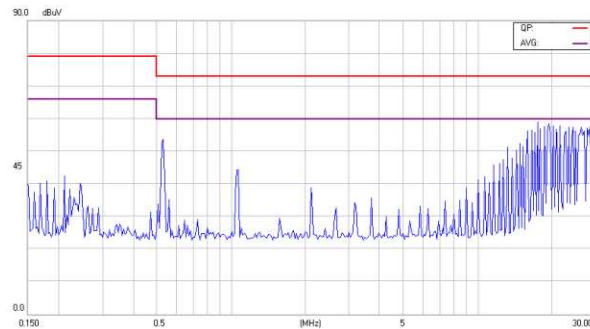


Neutral

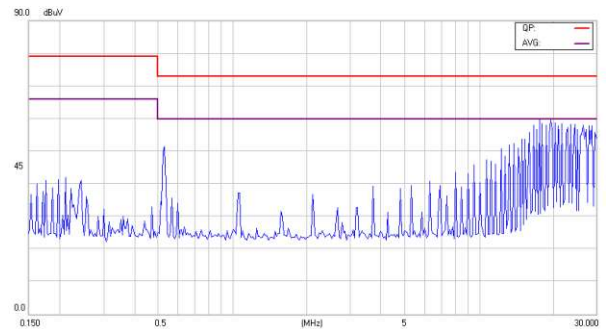


EC2SBW-24S12H

Line

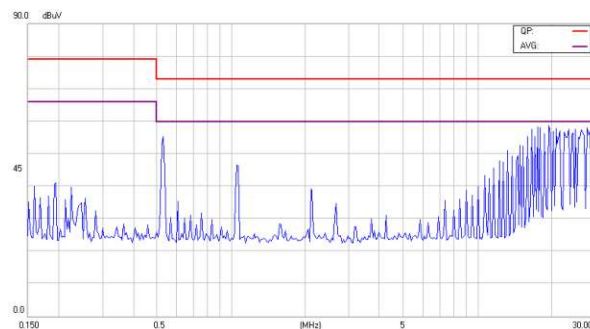


Neutral

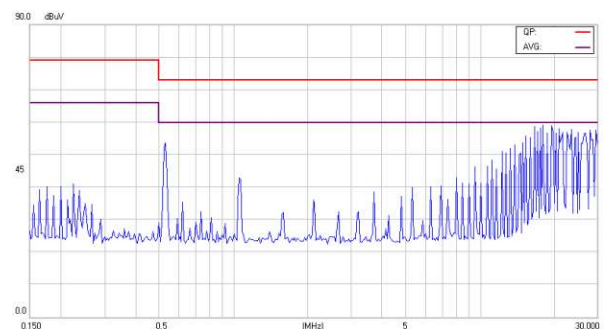


EC2SBW-24S15H

Line



Neutral

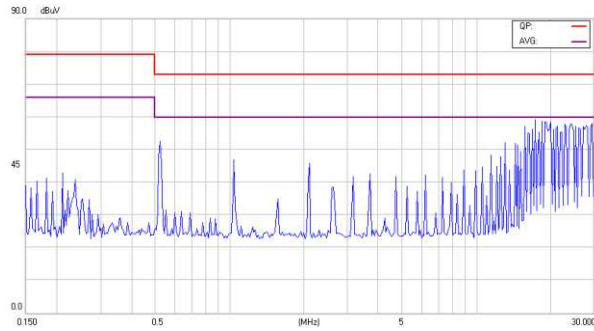




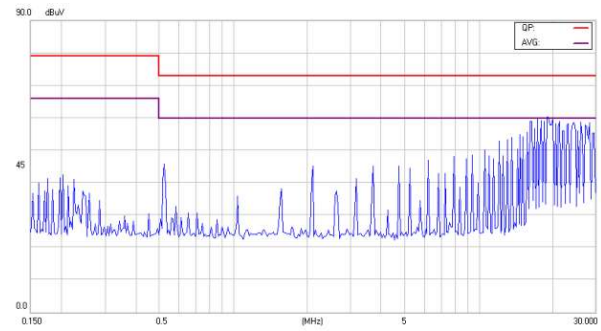
EC2SBW-H Series Application Note V10

EC2SBW-24D12H

Line

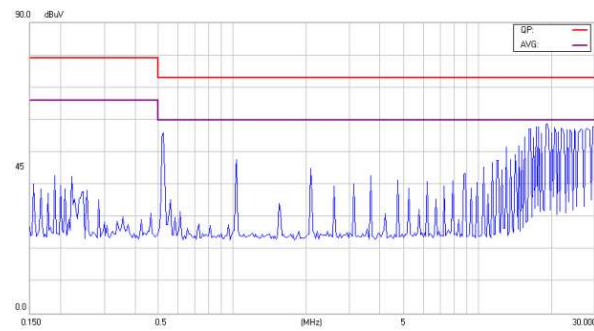


Neutral

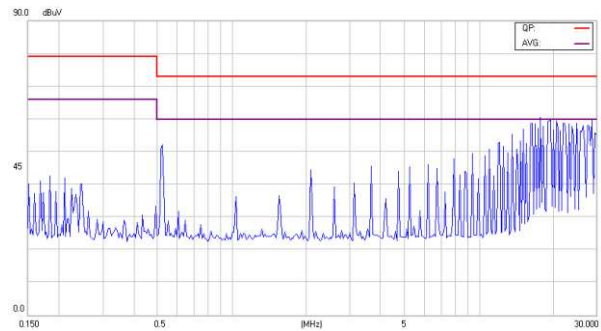


EC2SBW-24D15H

Line

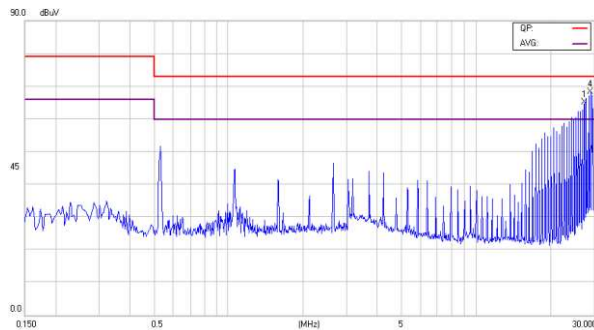


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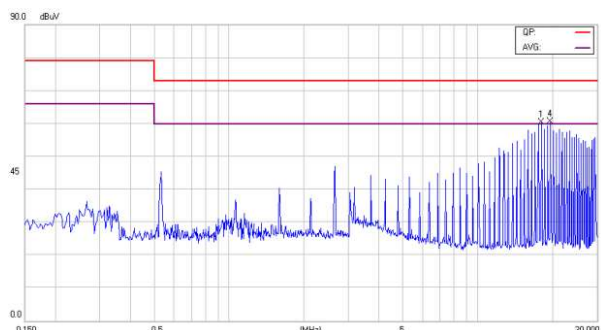


EC2SBW-48S33H

Line

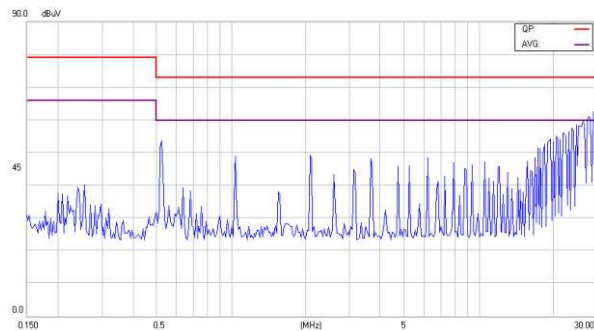


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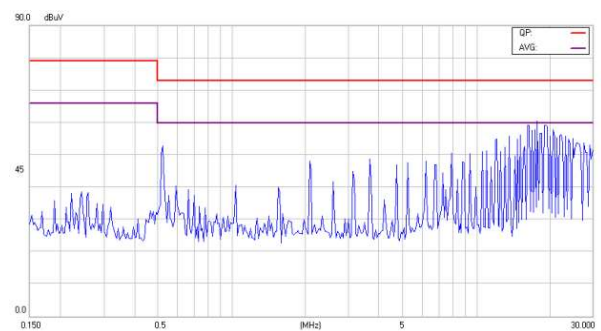


EC2SBW-48S05H

Line



Neutral

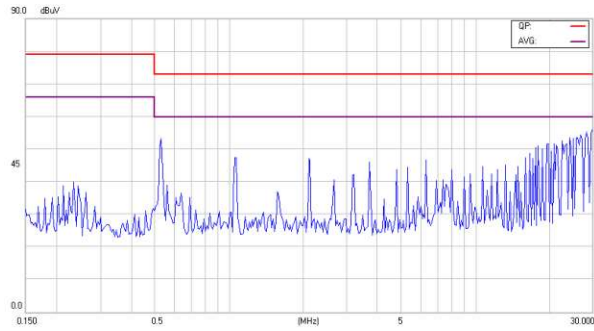




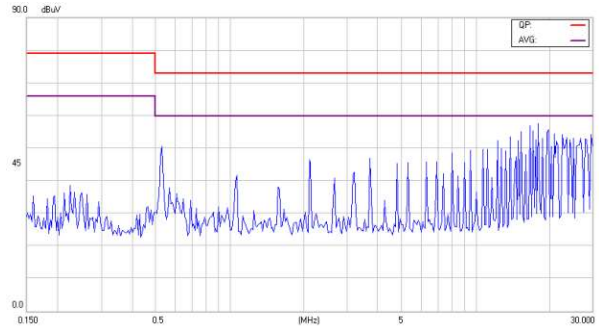
EC2SBW-H Series Application Note V10

EC2SBW-48S12H

Line

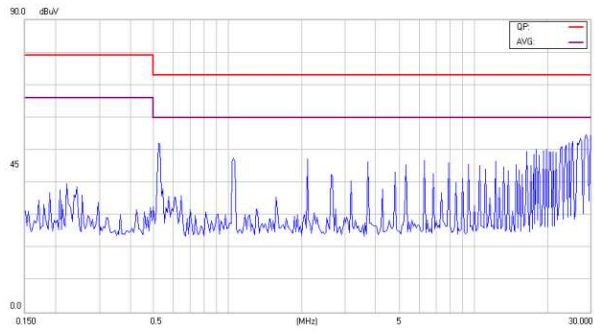


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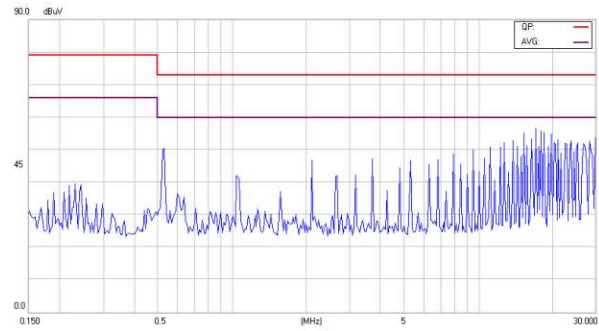


EC2SBW-48S15H

Line

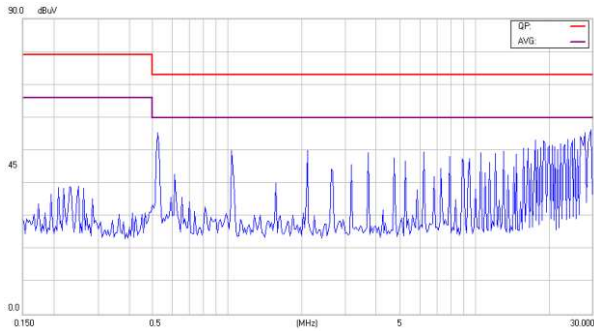


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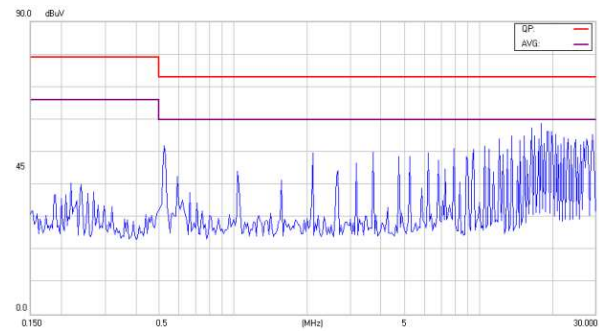


EC2SBW-48D12H

Line

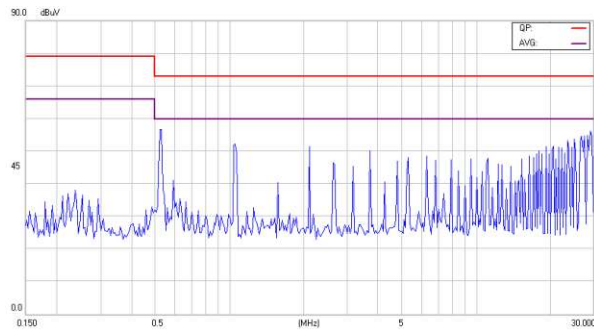


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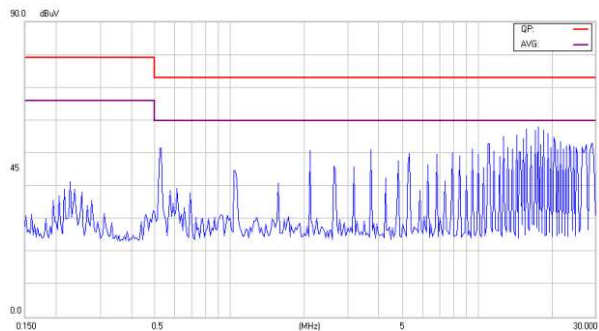


EC2SBW-48D15H

Line



Neutral



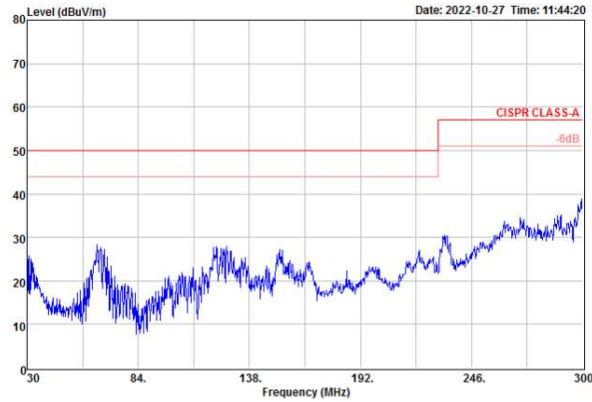


EC2SBW-H Series Application Note V10

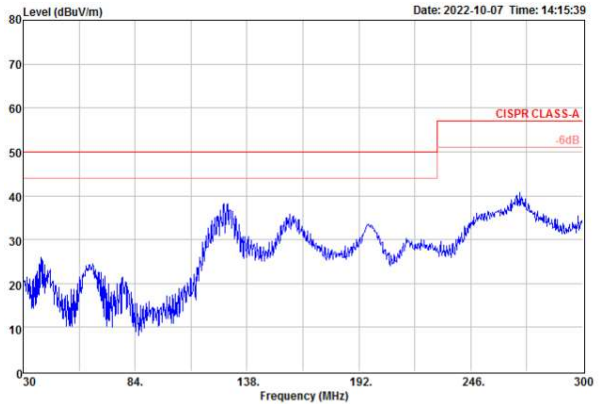
Radiated Emission Class A:

Vertical

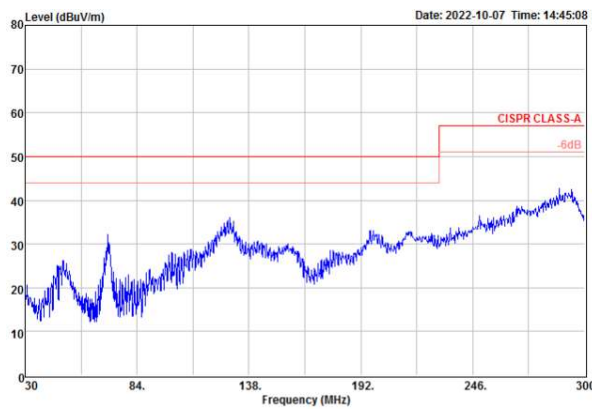
EC2SBW-24S33H



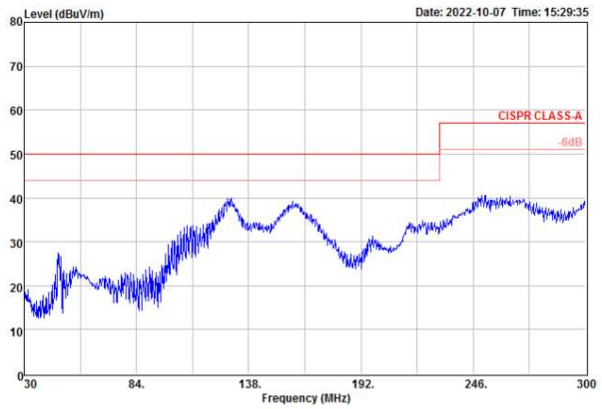
EC2SBW-24S05H



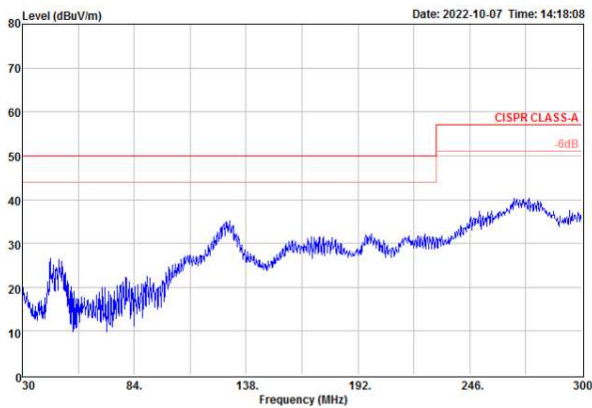
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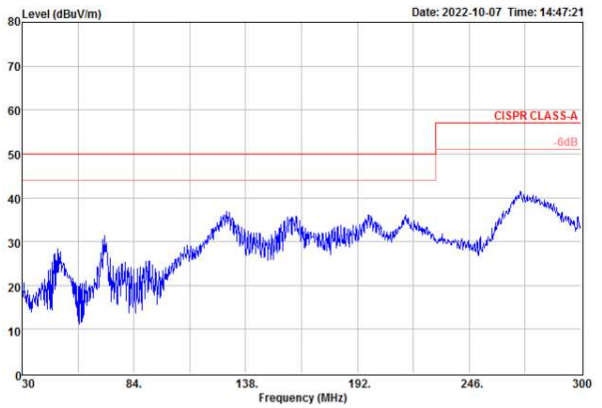
EC2SBW-24S15H



EC2SBW-24D12H



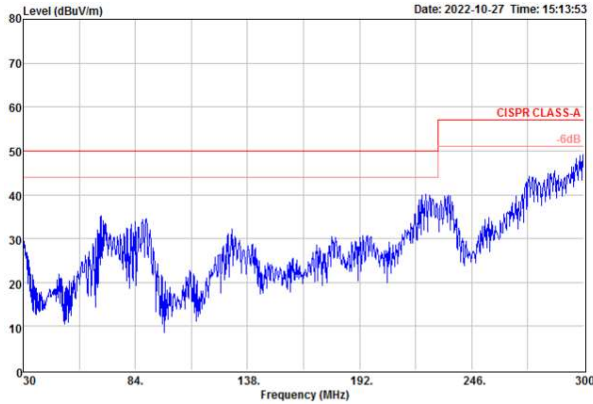
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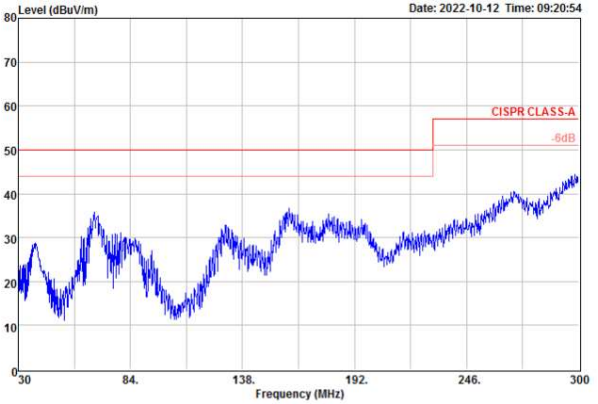


EC2SBW-H Series Application Note V10

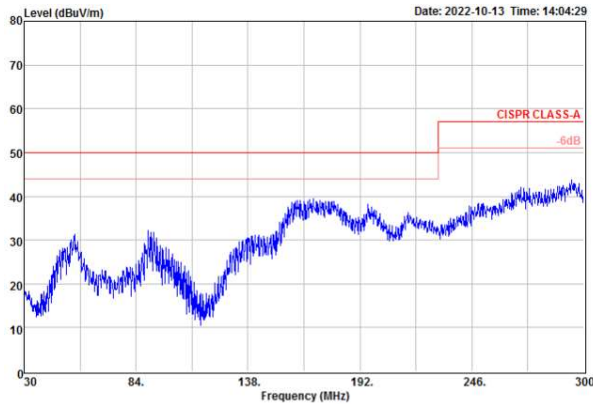
EC2SBW-48S33H



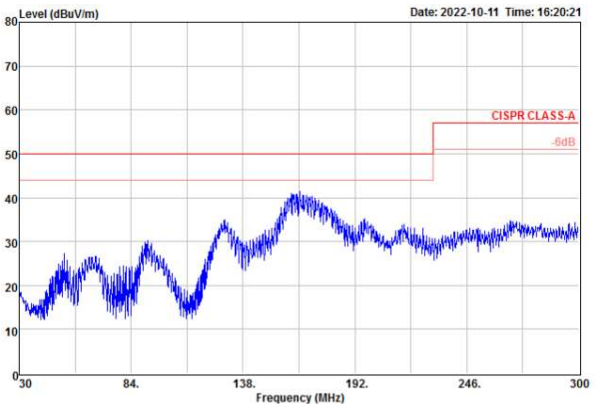
EC2SBW-48S05H



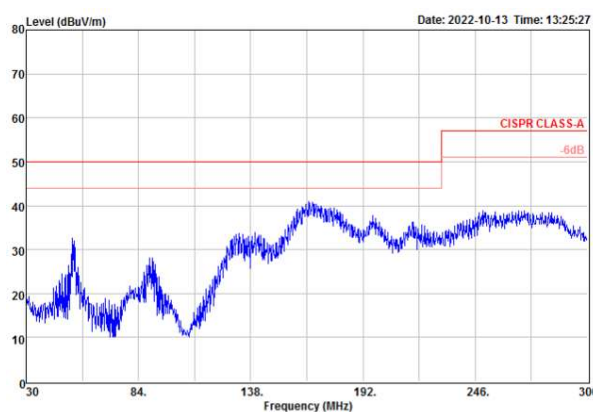
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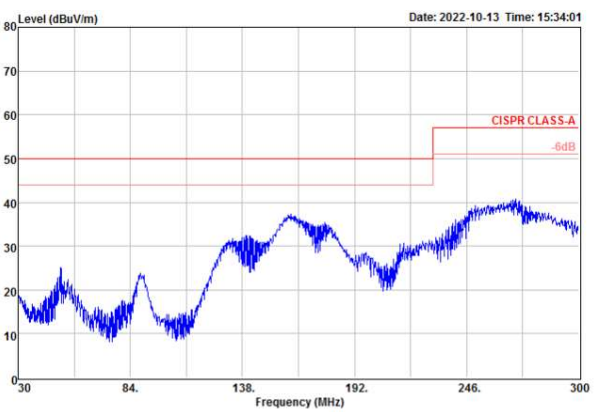
EC2SBW-48S15H



EC2SBW-48D12H



EC2SBW-48D15H



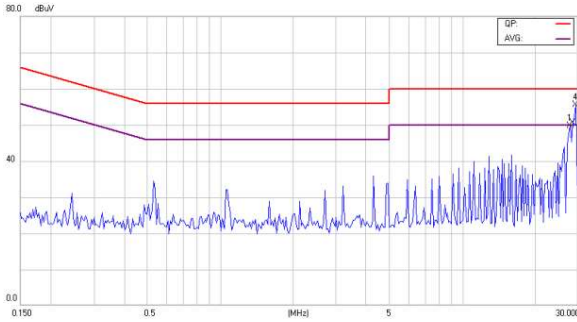


EC2SBW-H Series Application Note V10

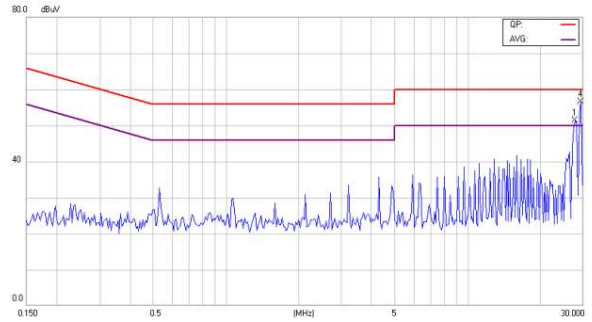
Conducted Emission Class B:

EC2SBW-24S33H

Line

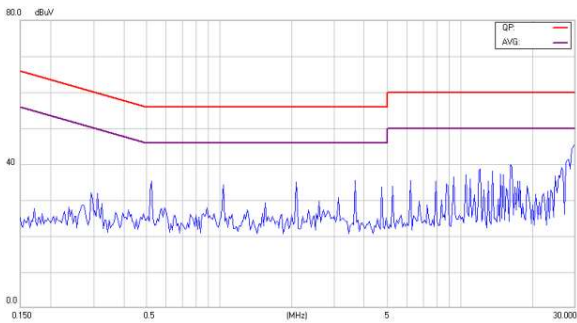


Neutral

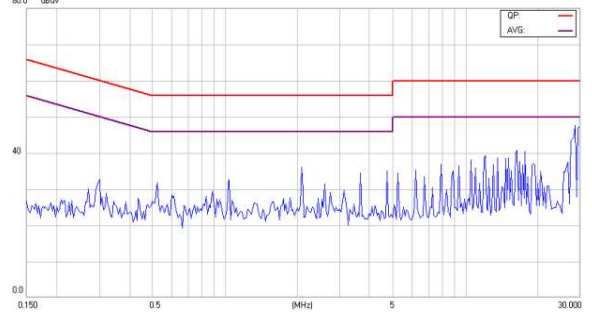


EC2SBW-24S05H

Line

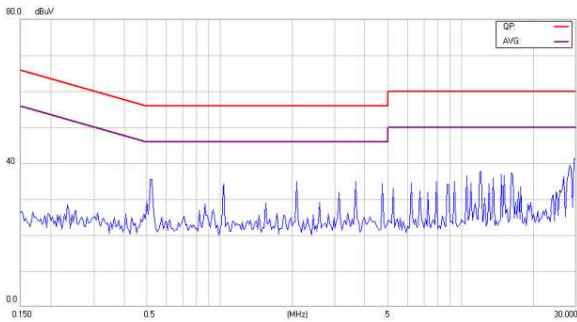


Neutral

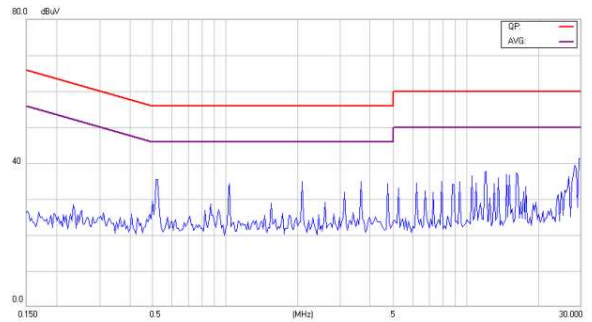


EC2SBW-24S12H

Line



Neutral

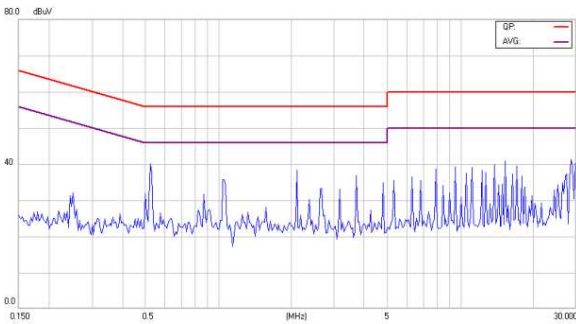




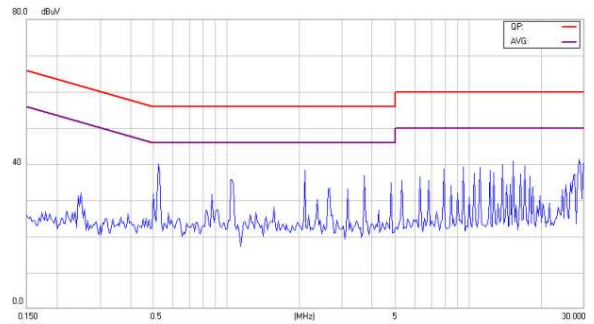
EC2SBW-H Series Application Note V10

EC2SBW-24S15H

Line

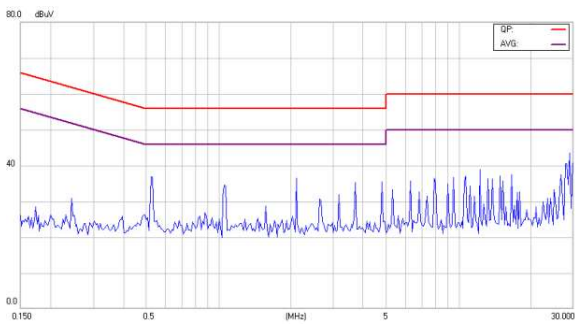


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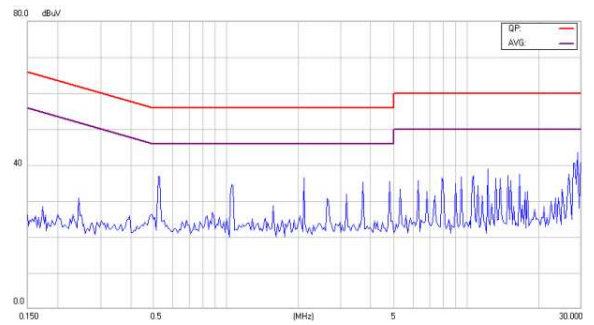


EC2SBW-24D12H

Line

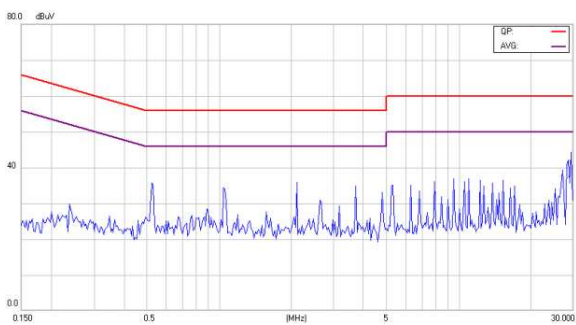


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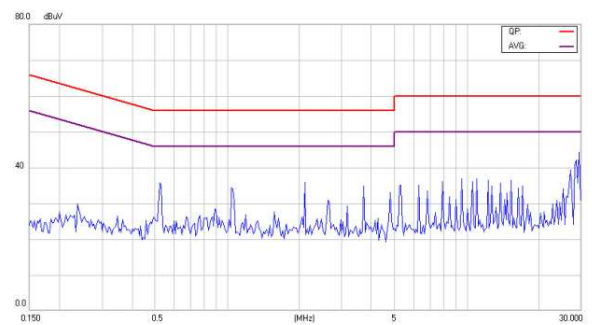


EC2SBW-24D15H

Line

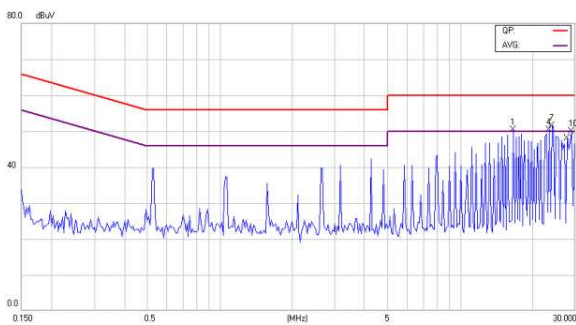


Neutral

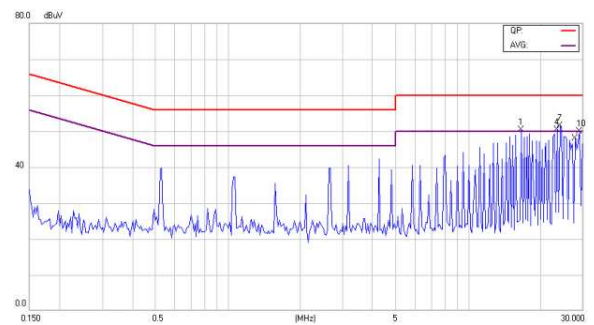


EC2SBW-48S33H

Line



Neutral

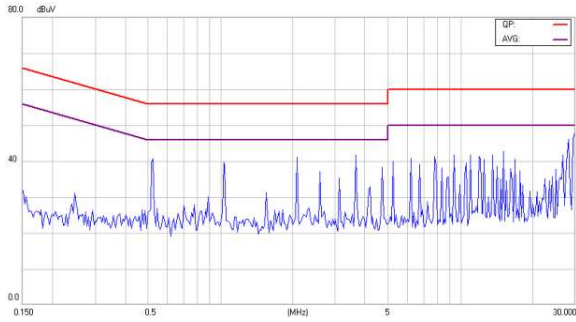




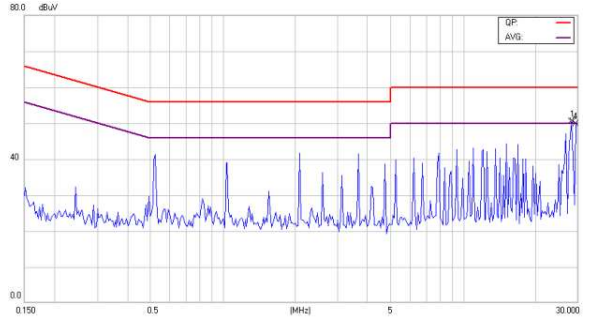
EC2SBW-H Series Application Note V10

EC2SBW-48D15H

Line



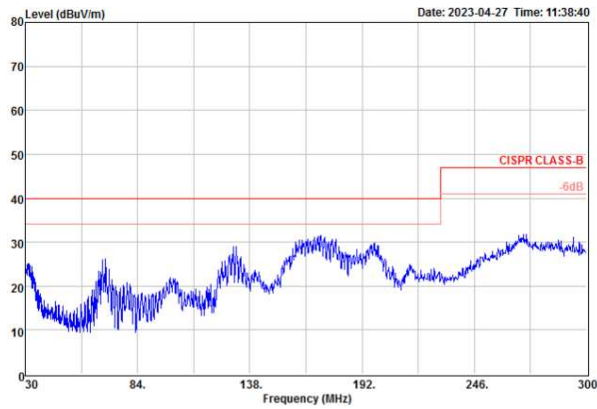
Neutral



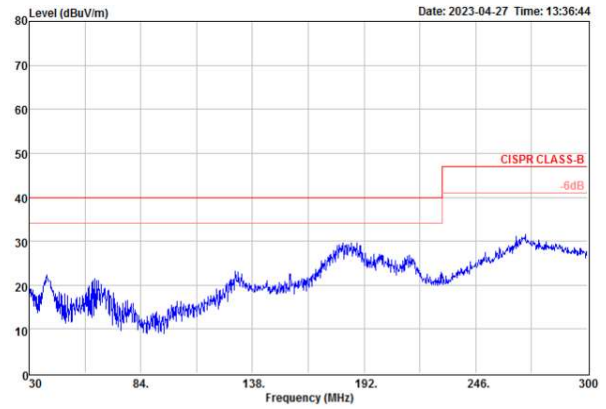
Radiated Emission Class B:

Vertical

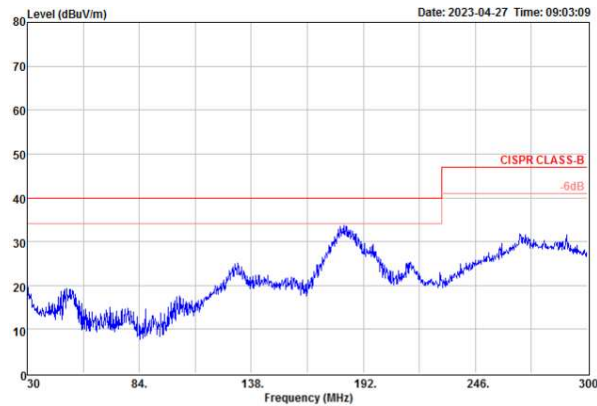
EC2SBW-24S33H



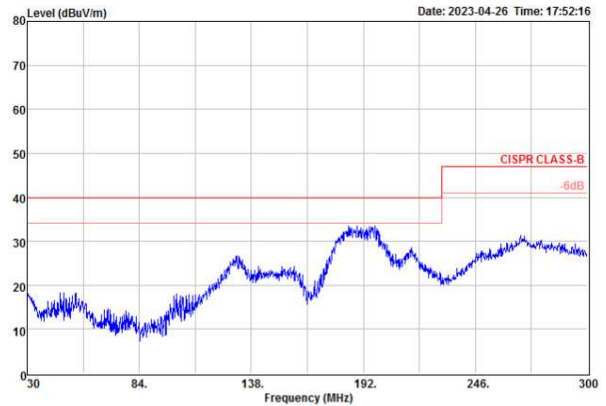
EC2SBW-24S05H



EC2SBW-24S12H



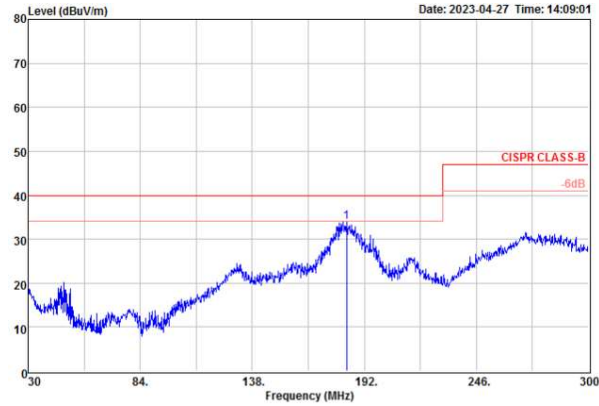
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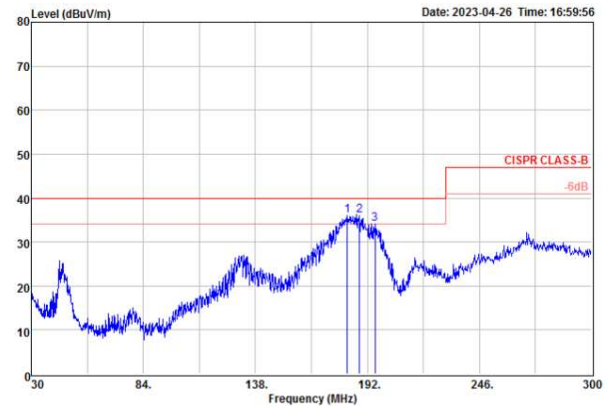


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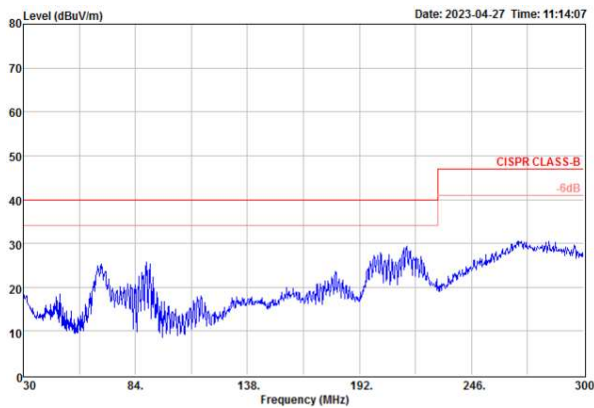
EC2SBW-24D12H



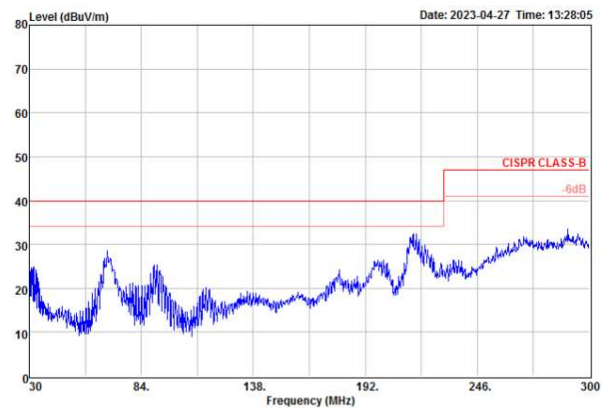
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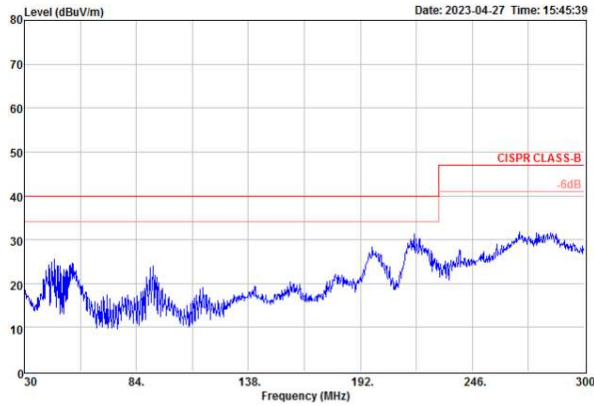
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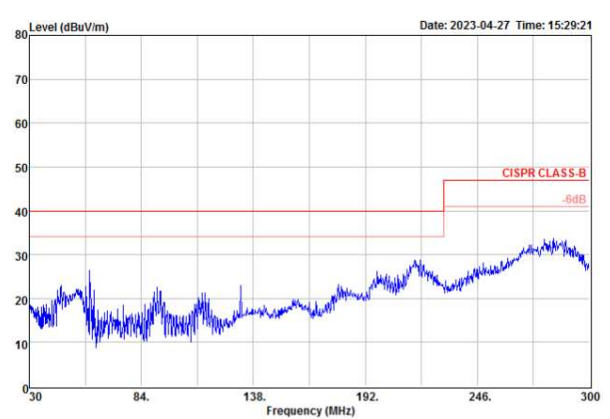
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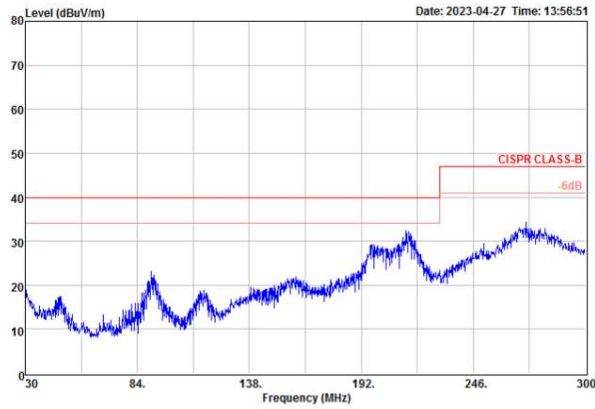
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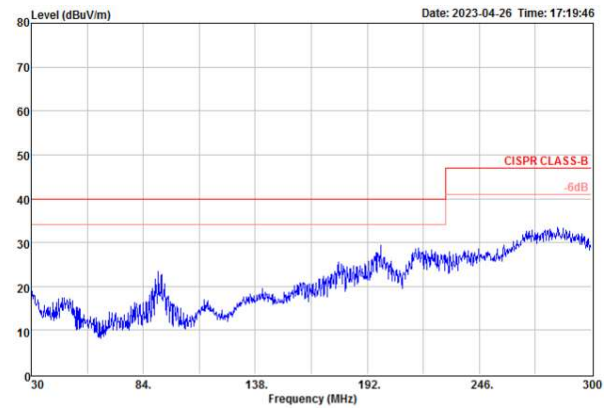


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