ISOLATED DC-DC CONVERTER
CHASSIS MOUNT
EC7BW18 ECRT/EDRT SERIES
APPLICATION NOTE

Approved By:

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EC7BW18 ECRT/EDRT Series
Application Note V10

Contents

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1. Introduction

The EC7BW18 ECRT/EDRT series of chassis mountable DC-DC converters offers 20 watts of output power @ output voltages of 5, 12, 15, ±12, ±15, ±24VDC. It has a wide (16:1) input voltage range of 10 to 160VDC (72VDC nominal) and 3000VAC reinforced isolation.

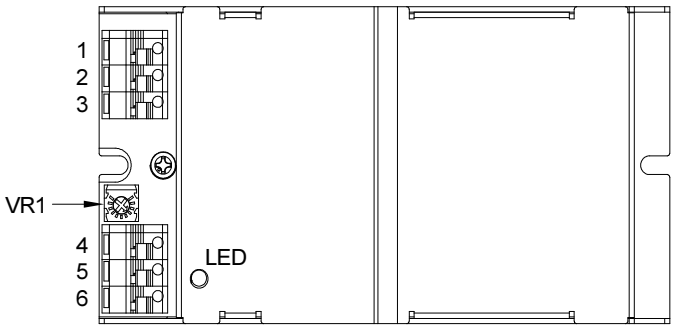
High efficiency up to 88%, allowing case operating temperature range of –40°C to 100°C. Very low no load power consumption (10mA), an ideal solution for energy critical systems. LED indicator for power on.

Compliant with EN50155, EN45545, EN50121-3-2. The standard control functions include negative remote on/off logic and +15%, -20% adjustable output voltage (single output only).

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

EC7BW18 ECRT/EDRT 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	CN1&CN2	Description	Reference
1	+V Input	Positive Supply Input	**Section 7.1/7.2**
2	-V Input	Negative Supply Input	**Section 7.1/7.2**
3	Remote	External Remote On/Off Control	**Section 6.5**
Single Output			
4	Not Applicable		
5	-V Output	Negative Power Output	**Section 7.3/7.4**
6	+V Output	Positive Power Output	**Section 7.3/7.4**
VR1	Variable Resistor	Output Voltage Adjustment	**Section 6.6**
Dual Output			
4	-V Output	Negative Power Output	**Section 7.3/7.4**
5	Common	Common Power Output	**Section 7.3/7.4**
6	+V Output	Positive Power Output	**Section 7.3/7.4**
VR1	No Component		

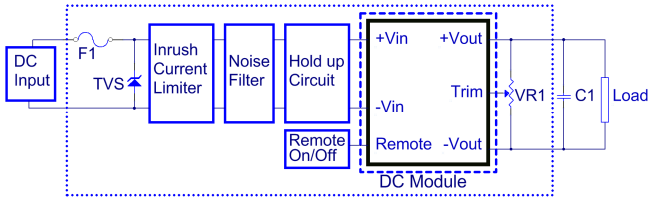
3. Terminal Block

Input and Output Terminal Block

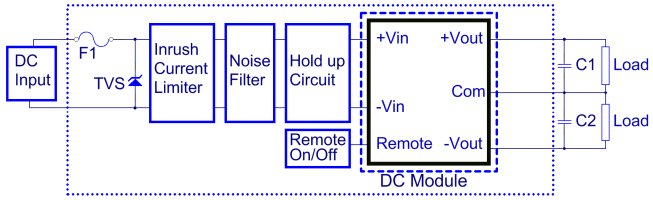
Terminal Type	Suitable Electric Wire (AWG)	Current Rating (max.)
DINKLE 0137-1103 or Equivalent	16-26	10A

4. Connection for Standard Use

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



EC7BW18-72SXX-ECRT/EDRT



EC7BW18-72DXX-ECRT/EDRT

Symbol	Component	Reference
F1, TVS	Input fuse, TVS	**Section 10.1**
C1, C2	External capacitor on the output side	**Section 7.3**
VR1	Internal output voltage adjustment By variable resistor	**Section 6.6**
Inrush Current Limiter	Internal input Inrush current limiter	**Section 7.2**
Noise Filter	Internal input noise filter	**Section 10.2**
Hold up Circuit	Internal input hold up circuit	**Section 7.1**
Remote On/Off	External Remote On/Off control	**Section 6.5**

5. 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.

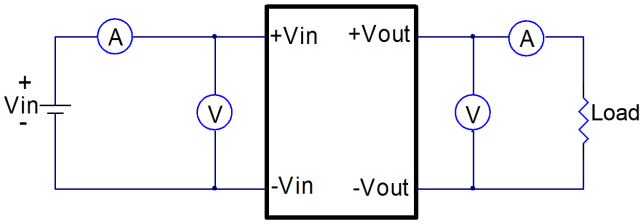
The value of line regulation is defined as:

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

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.

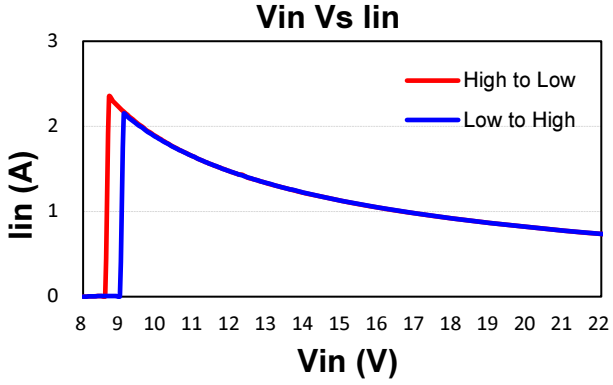


EC7BW18 ECRT/EDRT Series Test Setup

6. Features and Functions

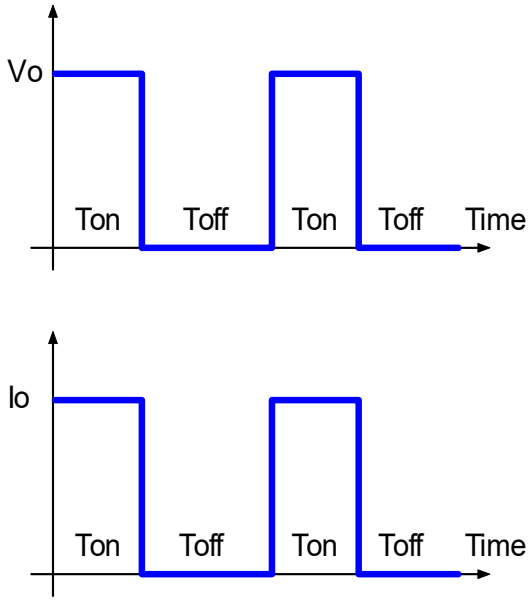
6.1 UVLO (Under Voltage Lock Out)

Input under voltage lock out is standard on the EC7BW18 ECRT/EDRT 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.



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.

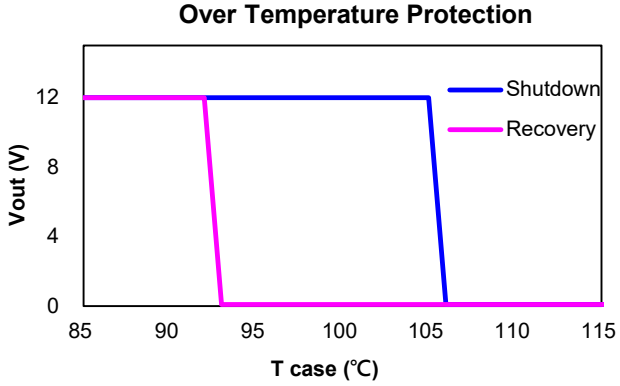


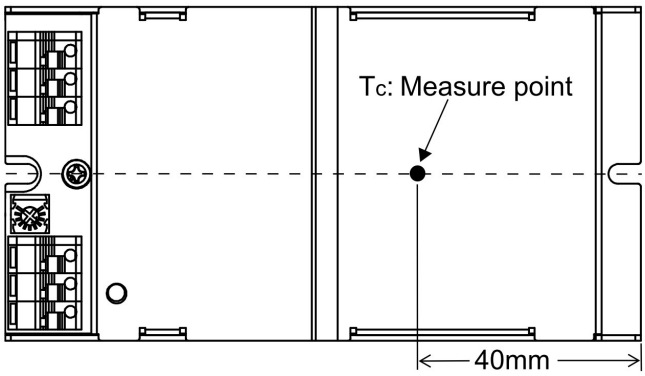
6.3 Output Over Voltage Protection

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

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. Case plate temperature measuring point refer to the following figure.





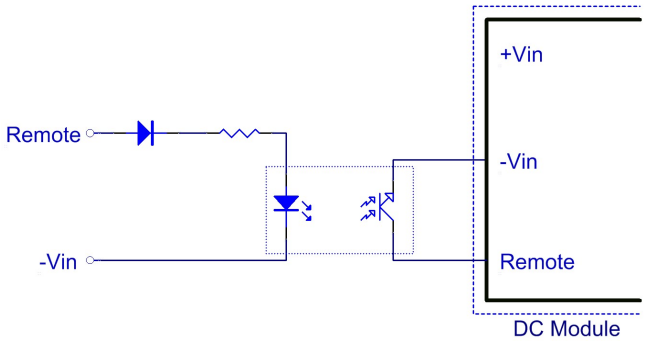
6.5 Remote On/Off

The EC7BW18 ECRT/EDRT series allows the user to switch the module on and off electronically with the remote On/Off feature. All models are available in “negative logic” versions. The converter turns off if the remote On/Off pin is high (>3.5Vdc to 12Vdc). Setting the pin low (0 to<1.2Vdc or open circuit) will turn the converter on. 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).

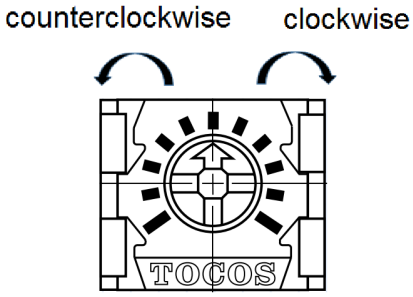
Logic State (CN1 Pin 3)	Negative Logic
Logic Low – 0 to 1.2Vdc or Open circuit	Module on
Logic High – 3.5 to 12Vdc	Module off

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.



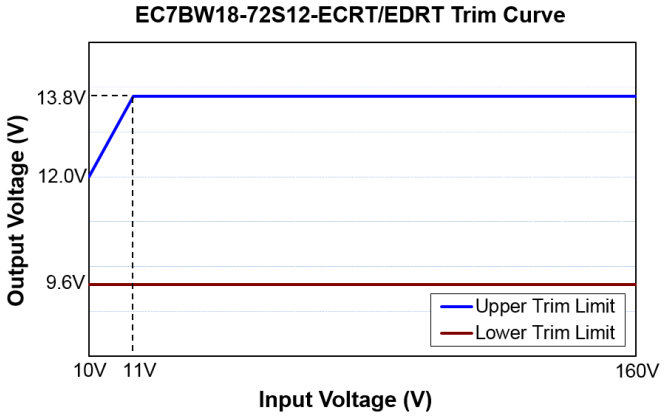
6.6 Output Voltage Adjustment

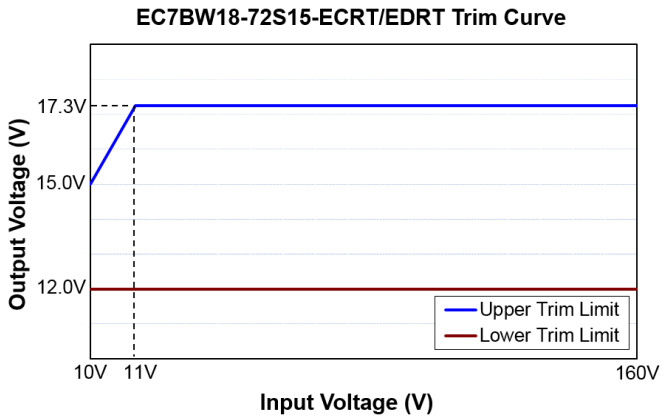
The single output voltage model output voltage can be adjusted by internal variable resistor VR1 (adjustment range: +15% to -20% of nominal output). Turning internal variable resistor clockwise reduces the output voltage and counterclockwise increases the output voltage.



The EC7BW18-72S05-ECRT/EDRT models is adjustable within the range of -20% to +15%.

For EC7BW18-72S12-ECRT/EDRT and EC7BW18-72S15-ECRT/EDRT models, see input & output trim curves for trim up and trim down ranges.



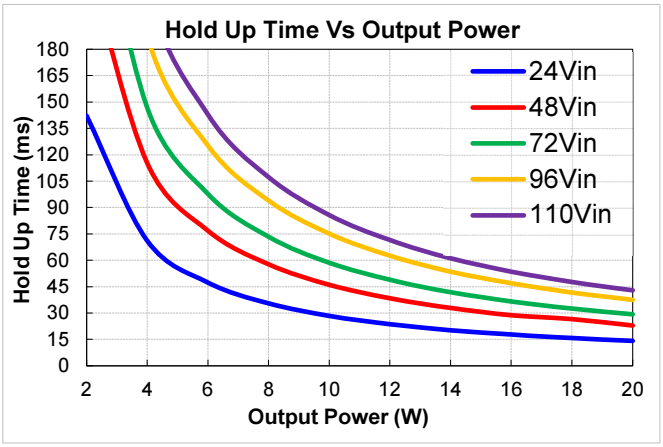


7. Input / Output Considerations

7.1 Hold Up Time

Hold up time is defined as the duration of time that DC/DC converter output will remain active following a loss of input power.

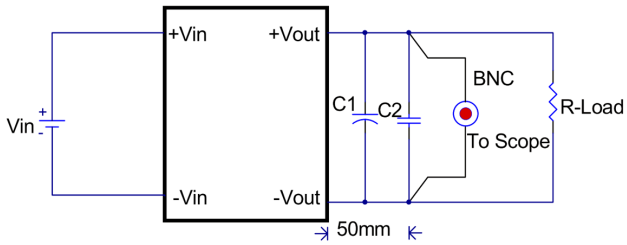
EC7BW18 ECRT/EDRT series internal with Hold up Bus Capacitor, Input voltage and output power will determine the output hold up time, refer to following figures.



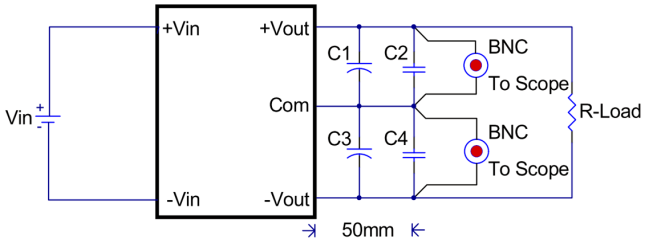
7.2 Inrush Current Limiter

These modules have inrush current limiter inside, it could reduce the inrush current from the input line to the internal capacitor when the power on.

7.3 Output Ripple and Noise



Note: C1: None, C2: 1uF ceramic capacitor.
EC7BW18-72SXX-ECRT/EDRT



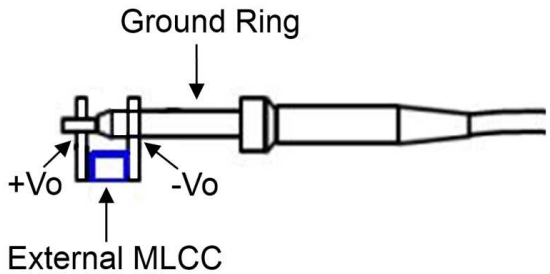
Note: C1 & C3: None, C2 & C4: 1uF ceramic capacitor.

EC7BW18-72DXX-ECRT/EDRT

Output ripple and noise measured with 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 -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.



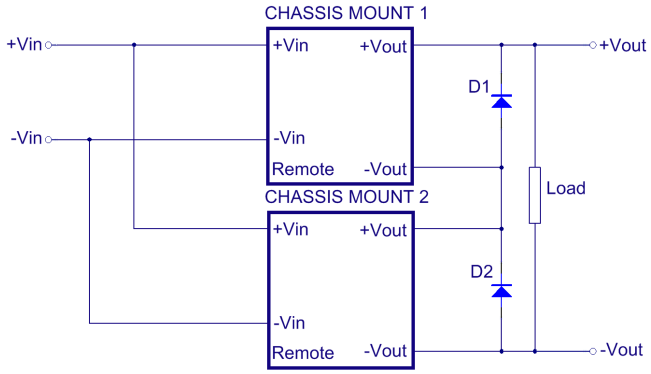
7.4 Output Capacitance

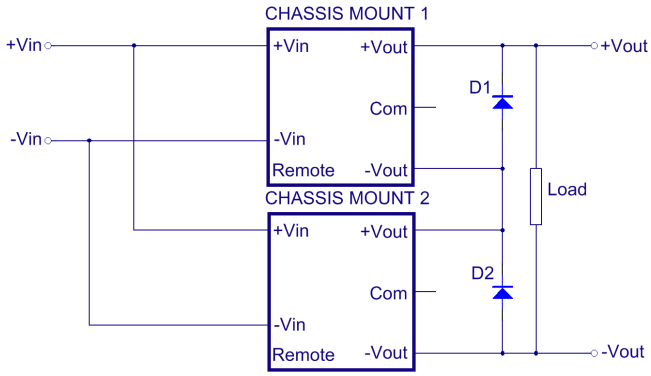
The EC7BW18 ECRT/EDRT series converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load (<100mm). PCB design emphasizes low resistance and inductance tracks in consideration of high 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.

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.

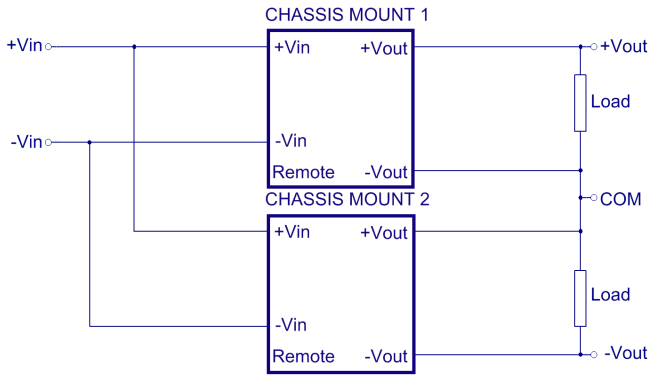


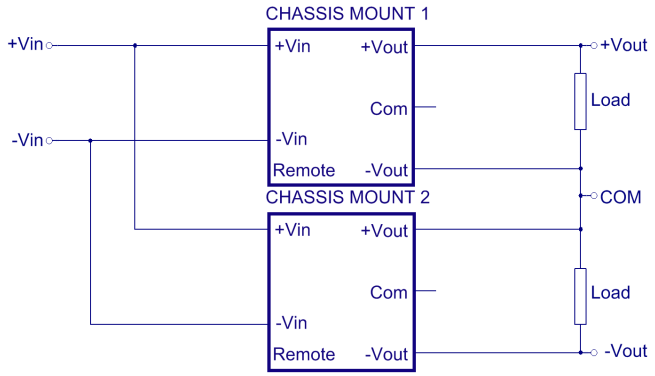


Simple Series Operation Connect Circuit

Note:
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

8.2 Parallel Operation

The EC7BW18 ECRT/EDRT series parallel operation is not possible.

9. Thermal Design

9.1 Operating Temperature Range

The EC7BW18 ECRT/EDRT series converters can be operated within a wide case temperature range of -40°C to 100°C. Consideration must be given to the derating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from chassis mount models is influenced by usual factors, such as:

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

9.2 Convection Requirements for Cooling

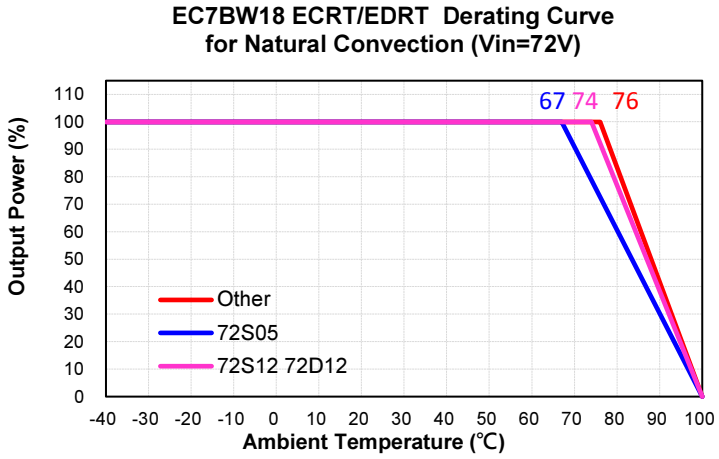
To predict the approximate cooling needed for the chassis mount module, refer to the power derating curves in **section 9.4**. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's case plate temperature should be monitored to ensure it does not exceed 100°C (case plate temperature measuring point refer to the **section 6.4**).

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 EC7BW18 ECRT/EDRT series is -40°C to +100°C. When operating the EC7BW18 ECRT/EDRT series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 100°C (case temperature measure point refer to the section 6.4).
The following curve is the de-rating curve of EC7BW18 ECRT/EDRT series.



AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	8.7 ℃/W

Example:

What is the maximum ambient temperature for a EC7BW18-72S05-ECRT operating at nominal line voltage, an output current of 4A, and natural convection?

Solution:

Given: V_{in}= 72V_{dc}, Vo= 5V_{dc}, I_o= 4A

Determine Power dissipation (P_d): $P_d= P_i-P_o= P_o(1-\eta)/\eta$, P_d= 5×4×(1-0.84)/0.84= 3.81Watts

Determine Maximum temperature rise: $\Delta T= P_d \times R_{ca}$ = 3.81× 8.7= 33.1°C

Determine Maximum Ambient temperature: $T_a= T_{c\,max.}- \Delta T$=100°C- 33.1°C= 66.9°C

Where:

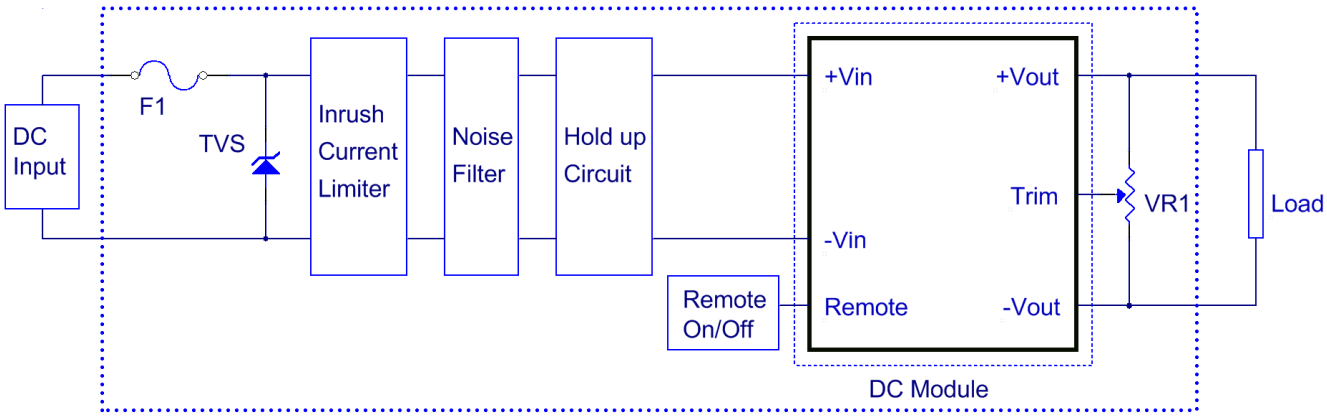
The R_{ca} is thermal resistance from case to ambient environment.

T_a is ambient temperature and $T_{c\,max.}$ is maximum operating case temperature.

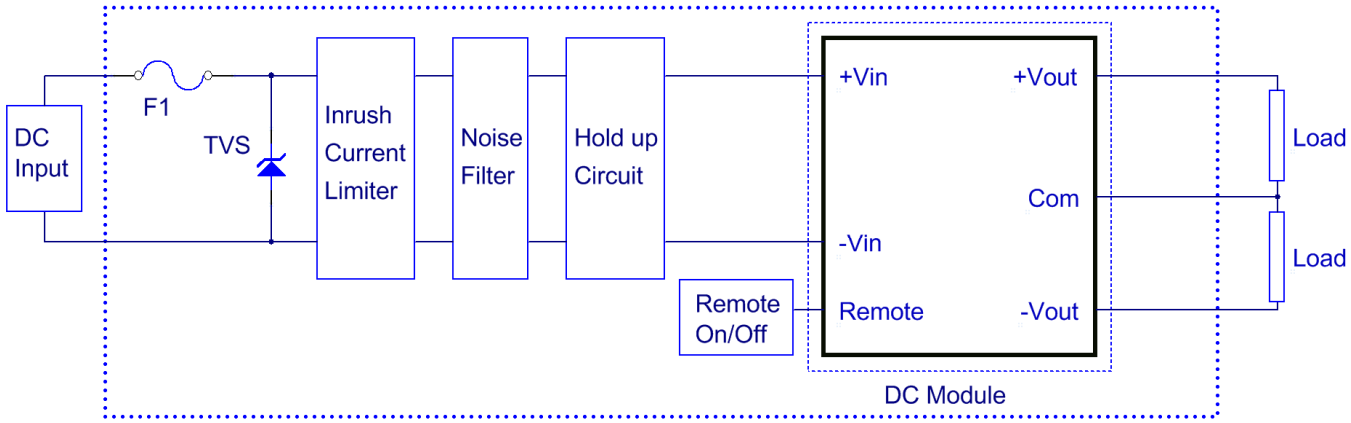
10. Safety & EMC

10.1 Input Fusing and Safety Considerations

The EC7BW18 ECRT/EDRT series converters have internal fuse. Achieve maximum safety and system protection, Input line fuse specification is 3.15A time delay. 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).



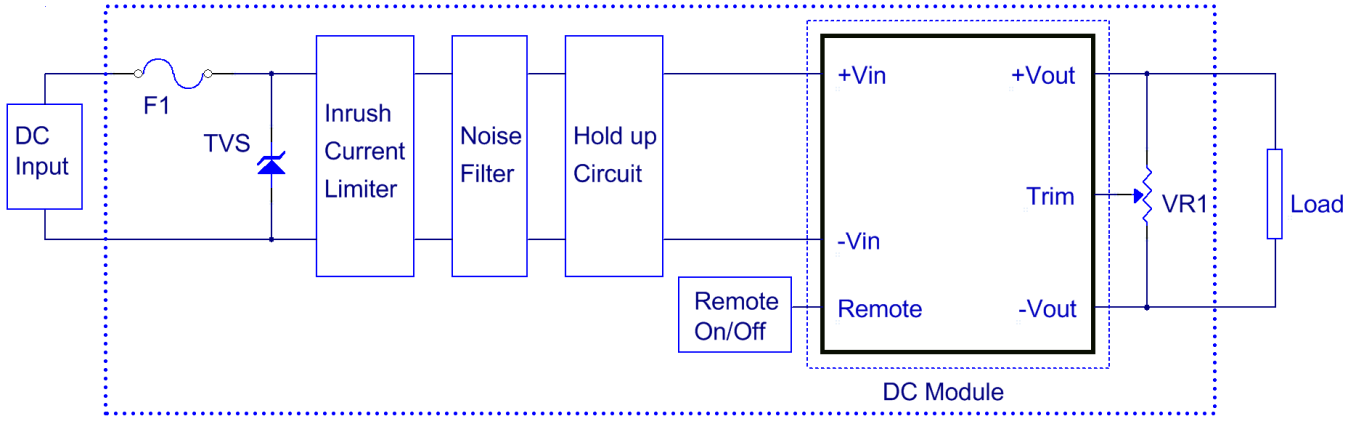
EC7BW18-72SXX-ECRT/EDRT



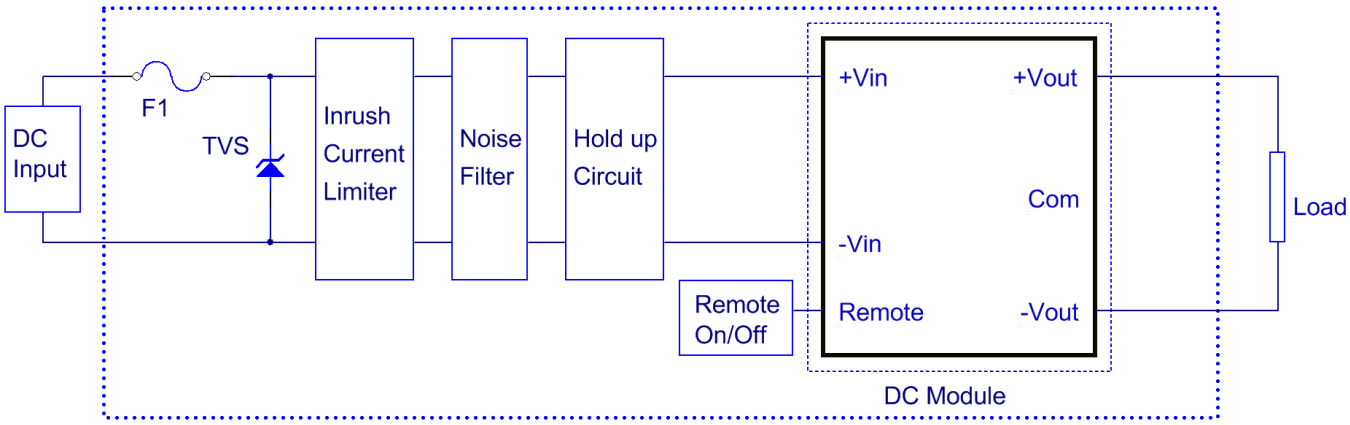
EC7BW18-72DXX-ECRT/EDRT

10.2 EMC Considerations

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



EC7BW18-72SXX-ECRT



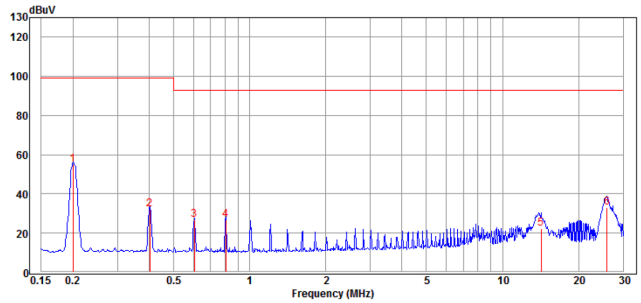
EC7BW18-72DXX-ECRT

Connection circuit for EN50121-3-2 EMI testing

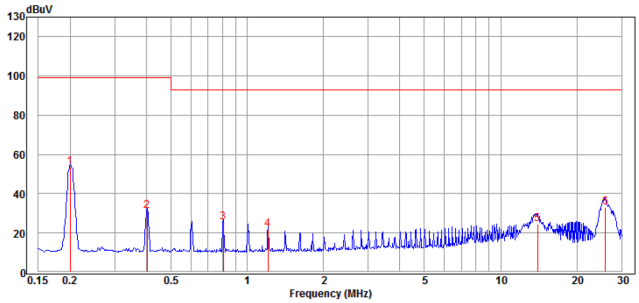
Input Conducted Emission:

EC7BW18-72S05-ECRT

Line

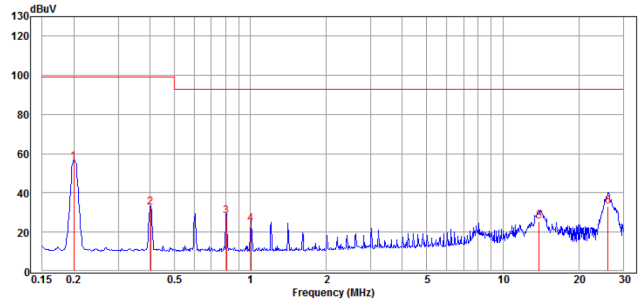


Neutral

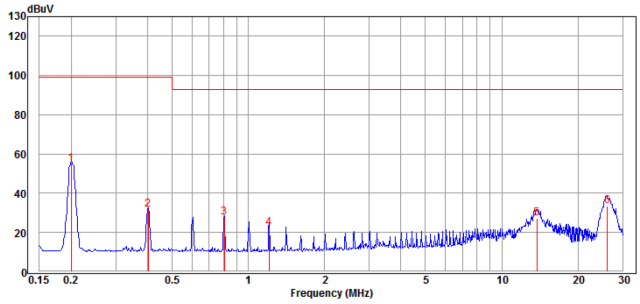


EC7BW18-72S12-ECRT

Line

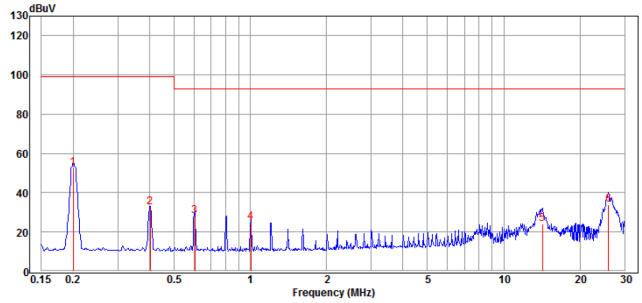


Neutral



EC7BW18-72S15-ECRT

Line



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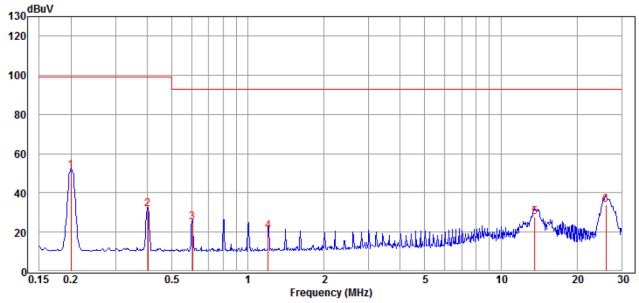
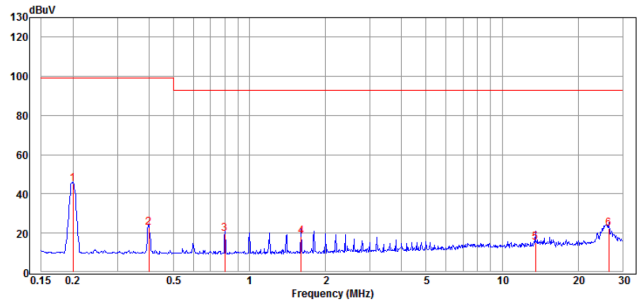


EC7BW18-72D12-ECRT

Line



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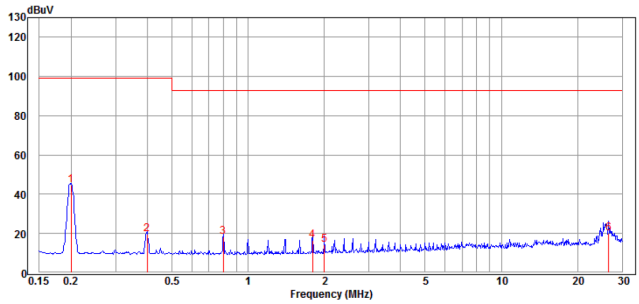
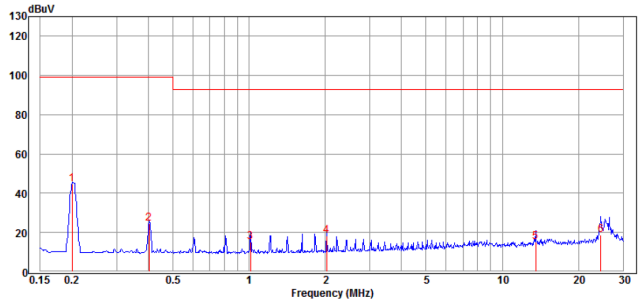


EC7BW18-72D15-ECRT

Line



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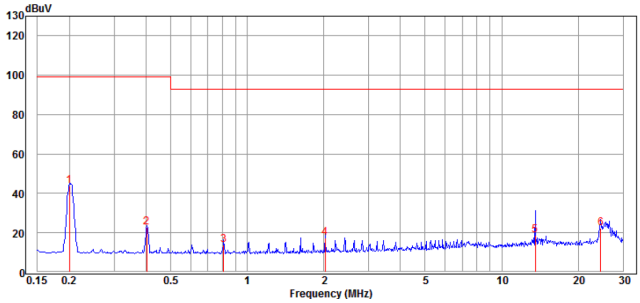
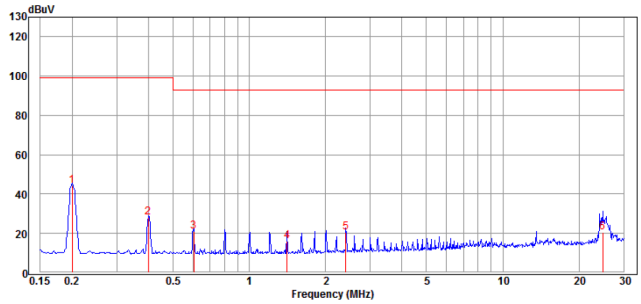
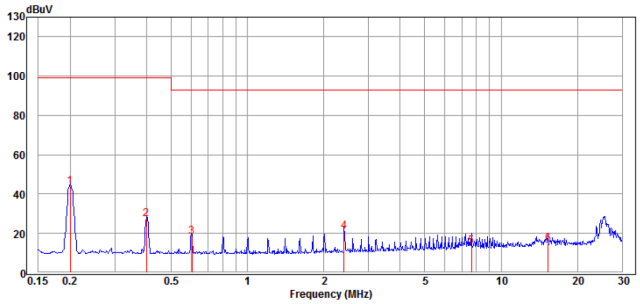


EC7BW18-72D24-ECRT

Line



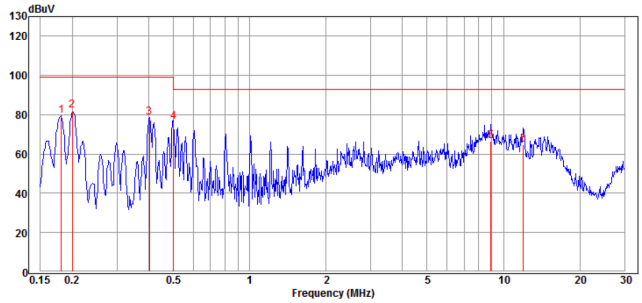
Neutral



Output Conducted Emission:

EC7BW18-72S05-ECRT

Positive



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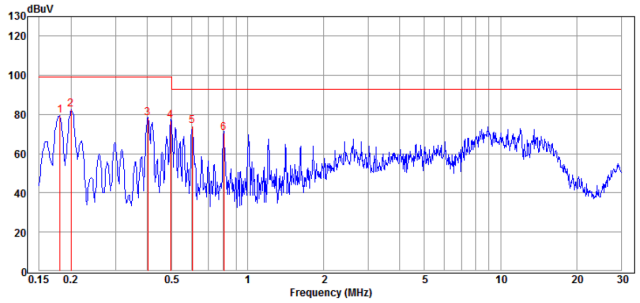
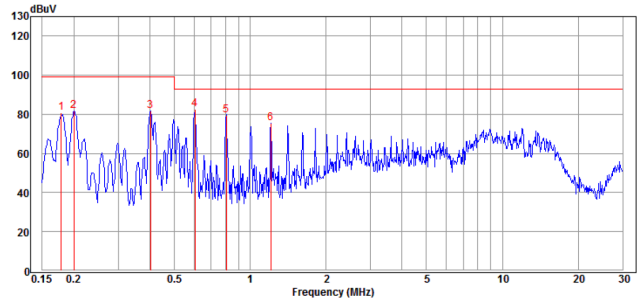


EC7BW18-72S12-ECRT

Positive



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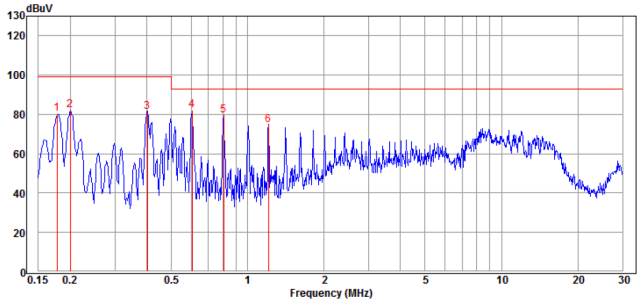
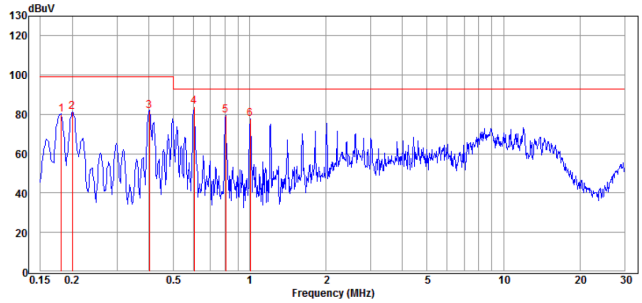
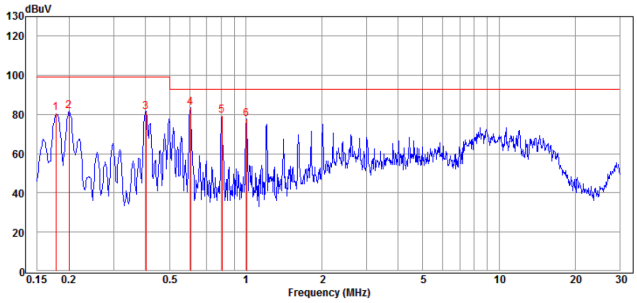


EC7BW18-72S15-ECRT

Positive

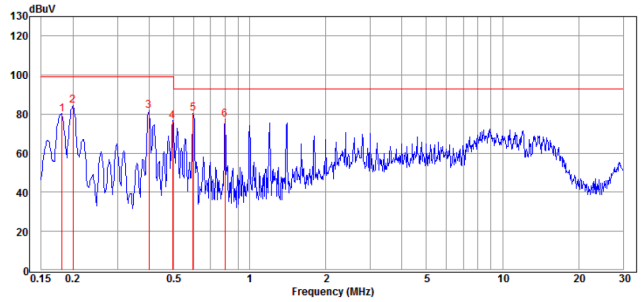


Negative

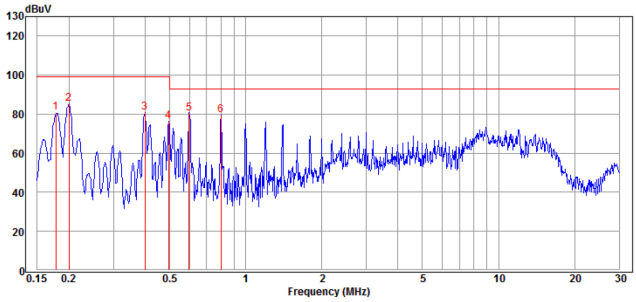


EC7BW18-72D12-ECRT

Positive



Negative



EC7BW18-72D15-ECRT

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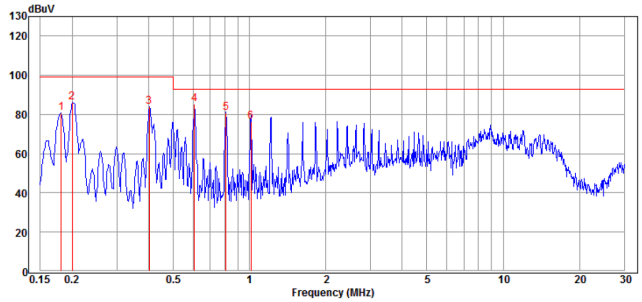
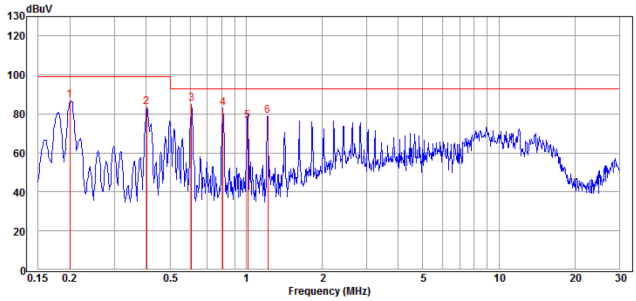
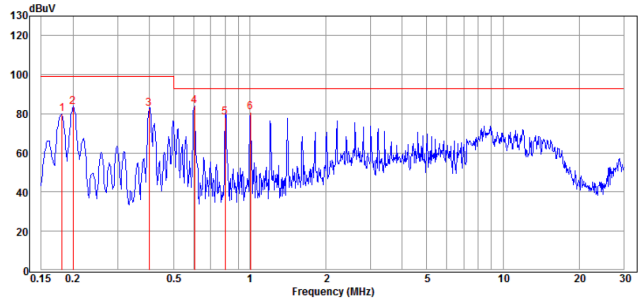


Negative



EC7BW18-72D24-ECRT

Positive



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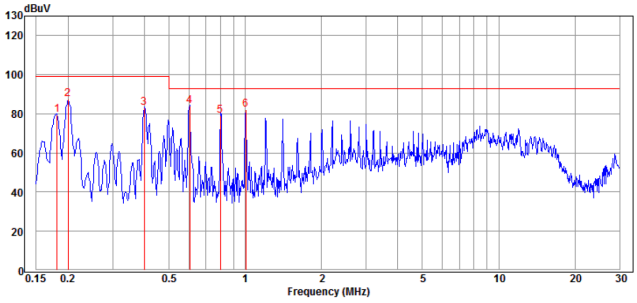
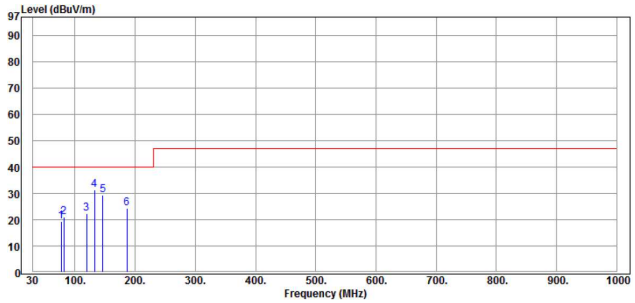


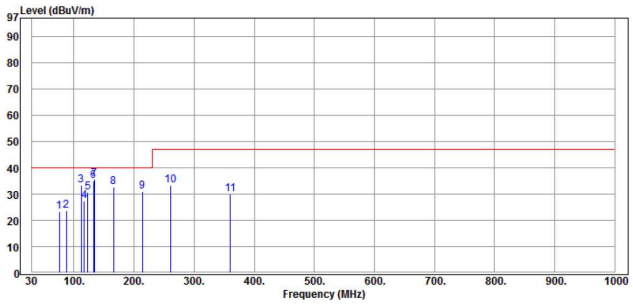
Radiated Emission:

EC7BW18-72S05-ECRT

Vertical

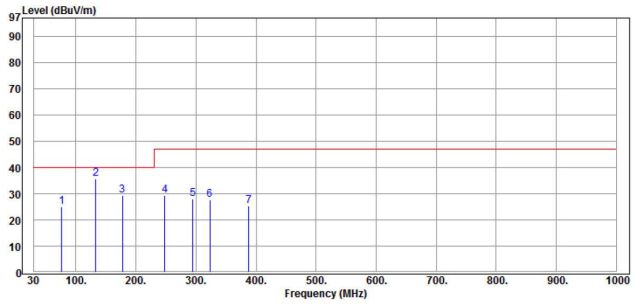


Horizontal

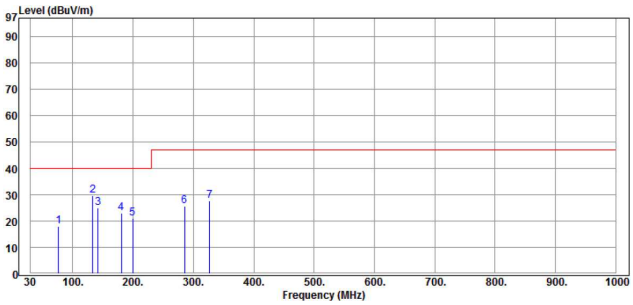


EC7BW18-72S12-ECRT

Vertical

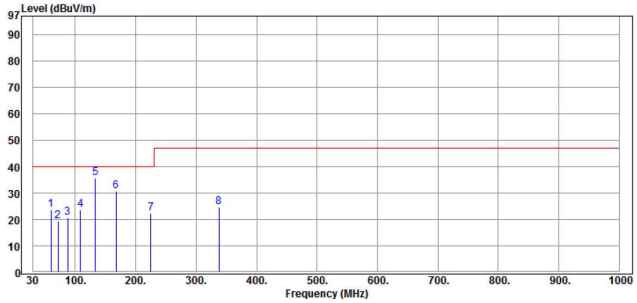


Horizontal



EC7BW18-72S15-ECRT

Vertical



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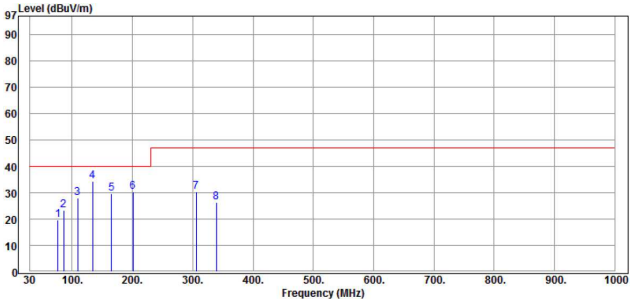
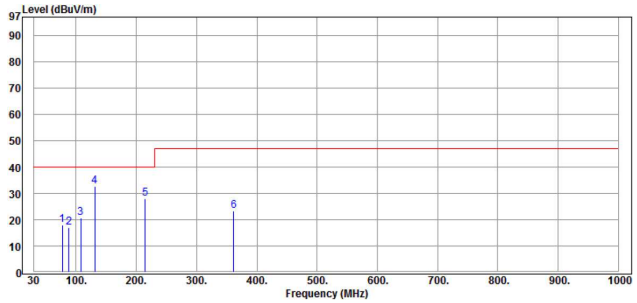


EC7BW18-72D12-ECRT

Vertical



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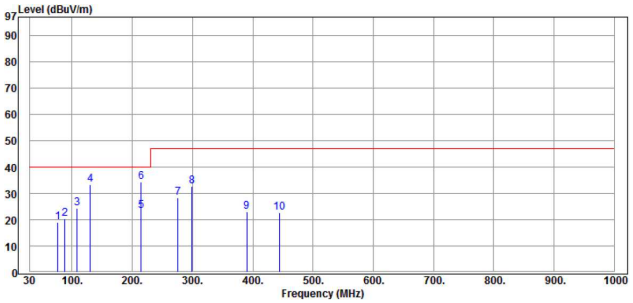
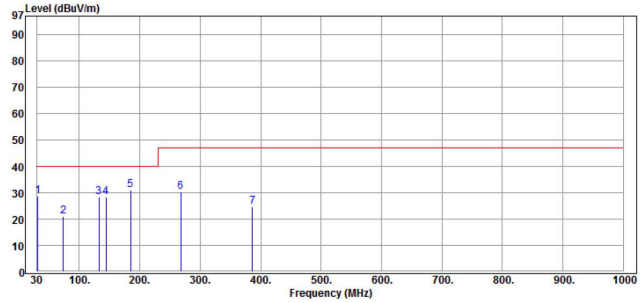


EC7BW18-72D15-ECRT

Vertical



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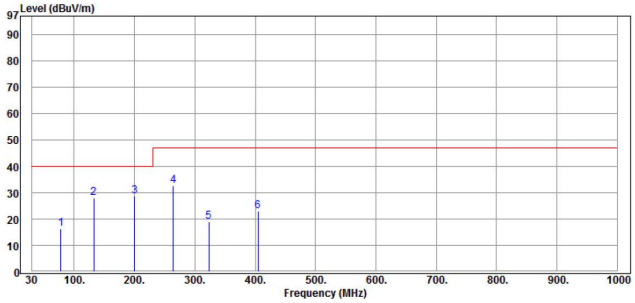
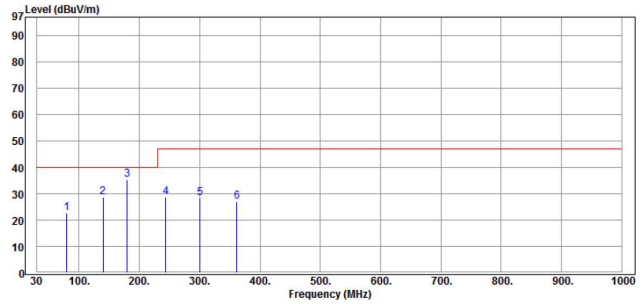
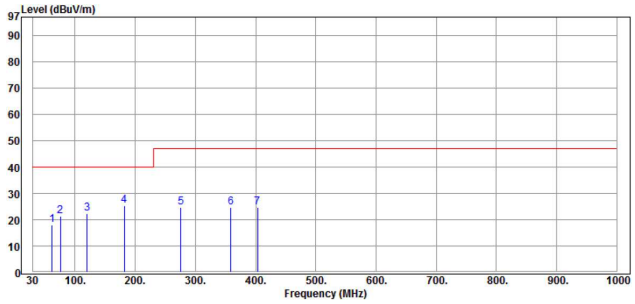


EC7BW18-72D24-ECRT

Vertical



Horizontal



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