ISOLATED DC-DC CONVERTER
CRT100W12 SERIES
APPLICATION NOTE

Approved By:

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CRT100W12 Series
Application Note V11 February 2025

Contents

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1. Introduction

The CRT100W12 series of DC-DC converters offers 100 watts of output power at single output voltages of 12, 24, 48VDC with enclosed chassis mount or Din rail. It has a ultrawide (12:1) input voltage range of 14.4 to 160VDC (72VDC nominal) and 3000VAC isolation.

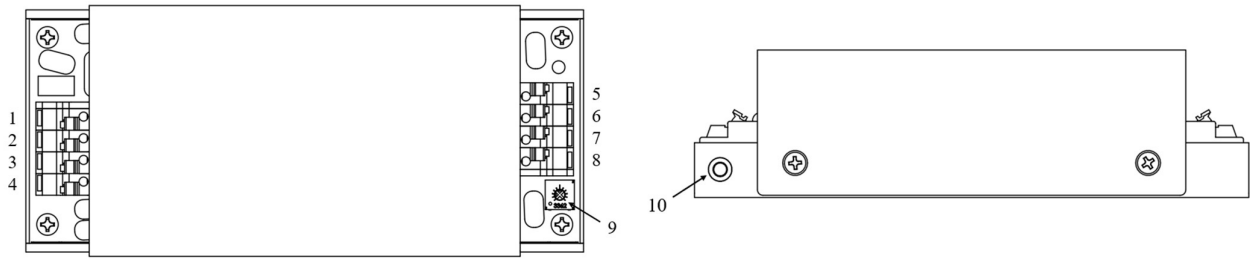
It complies with EN 55021/35/155, EN 50121-3-2, EN 45545-2. High efficiency up to 92%, allowing operating ambient temperature range of -40℃ to 90℃. There is a very low power consumption (10mA) at no load, which is an ideal solution for energy critical systems. Moreover, LED indicator shows whether the power is on or not.

The standard control functions include remote **on/off** (positive or negative) and +20% to -15% (except for 12Vout +25% to -15%) adjustable output voltage.

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

CRT100W12 series is designed primarily for common railway applications of 24V, 36V, 48V, 72V, 96V, 110V nominal voltage and is 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**
2	-Vin	-V Input	Negative Supply Input	**Section 7.1/7.2**
3	Remote	Remote	External Remote On/Off Control	**Section 6.5**
4	FG	Function Ground	Grounding	**N/A**
5	+Vo	+V Output	Positive Power Output	**Section 7.3/7.4**
6	+Vo	+V Output	Positive Power Output	**Section 7.3/7.4**
7	-Vo	-V Output	Negative Power Output	**Section 7.3/7.4**
8	-Vo	-V Output	Negative Power Output	**Section 7.3/7.4**
9	VR	Output Voltage Adj.	Adjusted Output Voltage	**N/A**
10	PG	Protective Ground	Grounding	**N/A**

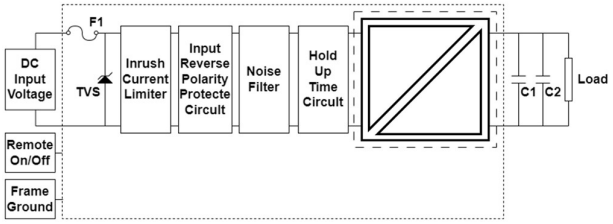
3. Terminal Block

Input and Output Terminal Block

Terminal Type	DINKLE 0137-1104
Suitable Electric Wire (AWG)	16-26
Current Rating (max.)	10A

4. 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, 10uF aluminum capacitor and 1uF ceramic capacitor for all models.



Symbol	Component	Reference
F1, TVS	Input fuse, TVS	**Section 10.1**
Inrush Current Limiter	Internal input inrush current limiter	**Section 7.2**
Input Reverse Polarity Protect Circuit	Internal input reverse polarity protect circuit	**Section 7.4**
Noise Filter	Internal input noise filter	**Section 10.2**
Hold Up Circuit	Internal input hold up circuit	**Section 7.1**
C1, C2	External capacitor on the output side	**Section 7.3**
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:

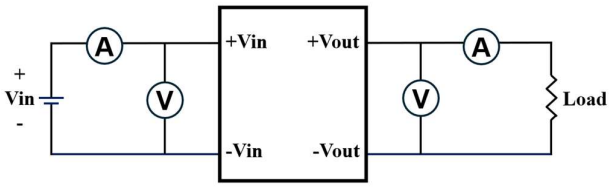
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at no load

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

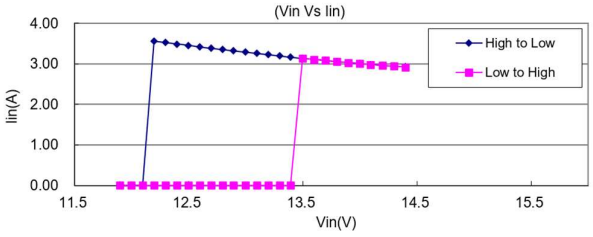


CRT100W12 Series Test Setup

6. Features and Functions

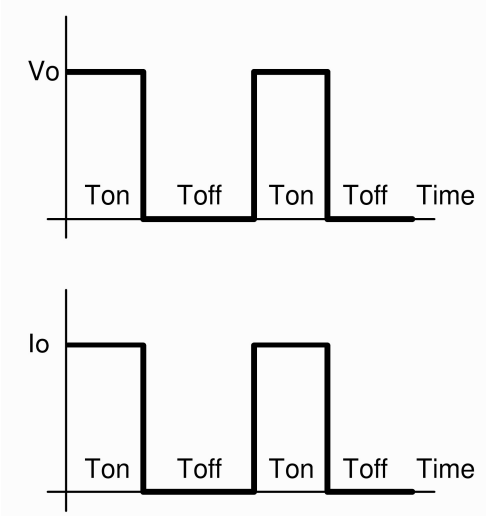
6.1 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the CRT100W12 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.

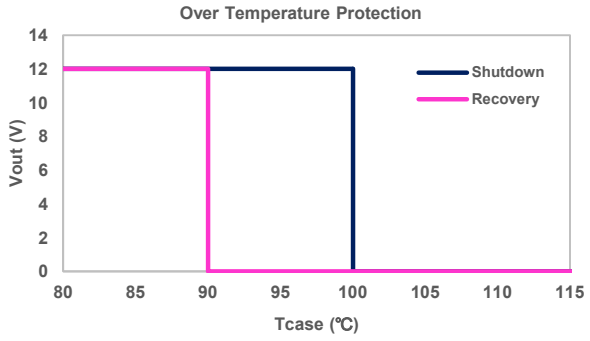


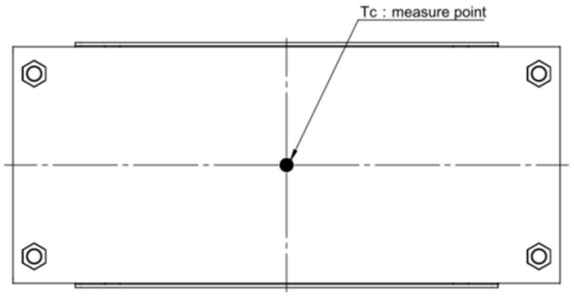
6.3 Output Over Voltage Protection

The output over voltage protection consists of circuitry that internally limits the output voltage. Typically, this limit is set at 135% of the output voltage, except for the 48V output, which is limited to 125%.

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.





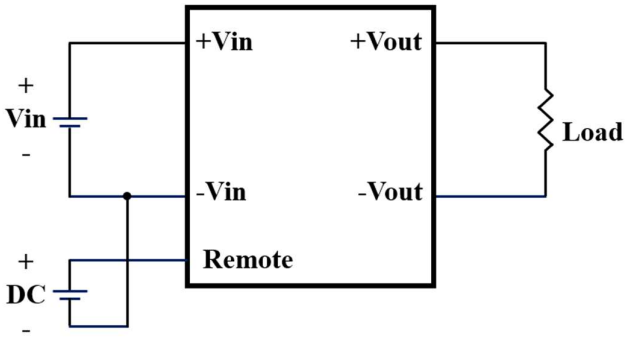
6.5 Remote On/Off

The CRT100W12 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.

In the positive logic version, the converter turns on when the remote **on/off** pin is high (>3.5Vdc to 160Vdc). Setting the pin low (0 to <1.2Vdc or open circuit) will turn the converter off. Note that, by default, the converter is off.

For models with a part number suffix "N," the remote **on/off** operates in "negative logic." In this case, the unit turns off when the remote On/Off pin is high (>3.5Vdc to 160Vdc) and turns on when the pin is low (0 to <1.2Vdc or open circuit). The signal level of the remote **on/off** input is referenced to ground. If the remote **on/off** pin is not used, leave it open, and the converter will remain on.

Logic State (Pin 3)	Negative Logic	Positive Logic
Logic Low	Module on	Module off
Logic High	Module off	Module on
Open Circuit	Module on	Module off



CRT100W12 Series Remote Setup

6.6 Output Voltage Adjustment

The output voltage can be fine-tuned using a variable resistor. The adjustment range for the output voltage is +20% to -15% of nominal output, except for the 12V output, which has a range of +25% to -15% of 12V.

Please note that when adjusting the output voltage, the output current must be adjusted accordingly to ensure that the output power remains below 100W.

6.7 Reverse Polarity Protection Circuit

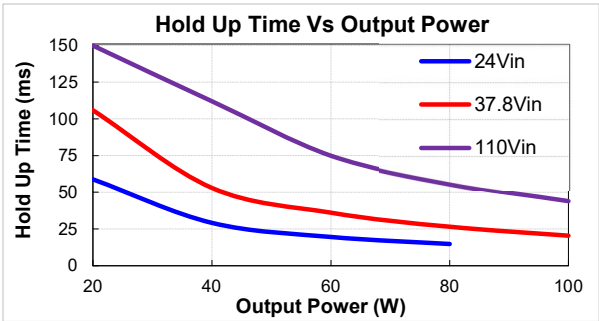
CRT100W12 series has a built-in input reverse polarity detection circuit. When the input is reversed, the unit will turn off for protection, recover when the polarity is corrected.

7. Input/Output Considerations

7.1 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.

CRT100W12 series with Hold up Bus Capacitor, Input voltage and output power will determine the output hold up time, refer to following figures.

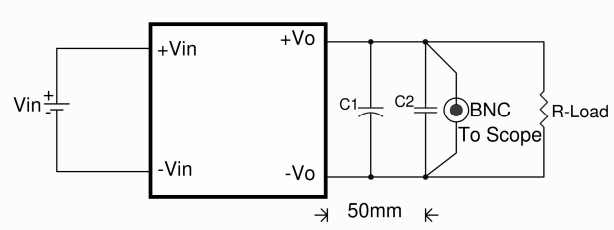


Output Power(W)	24Vin	37.8Vin	110Vin
20	58.8 ms	106 ms	150 ms
40	29.2 ms	53 ms	112 ms
60	19.6 ms	36 ms	75 ms
80	14.8 ms	26.4 ms	56 ms
100	NA	20.4 ms	44 ms

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

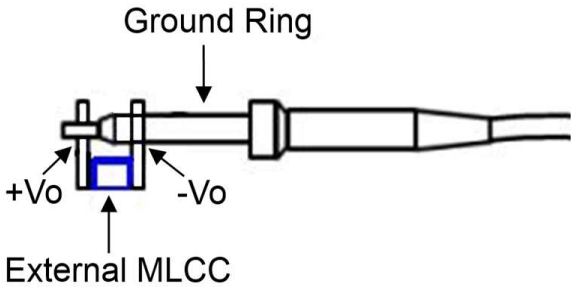


Note:
C1: 10uF aluminum capacitor
C2: 1uF ceramic capacitor

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

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

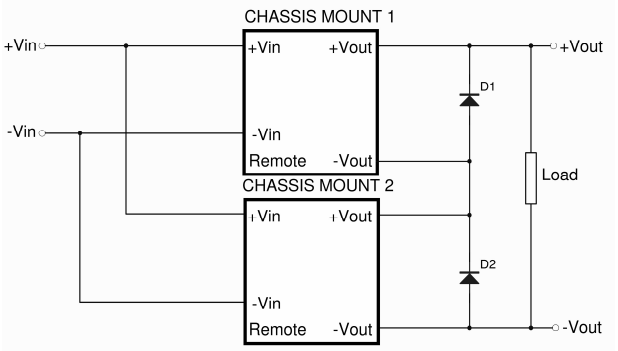
Another method is shown in below, in case of coaxial-cable/BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.



8. Series and Parallel Operation

8.1 Series Operation

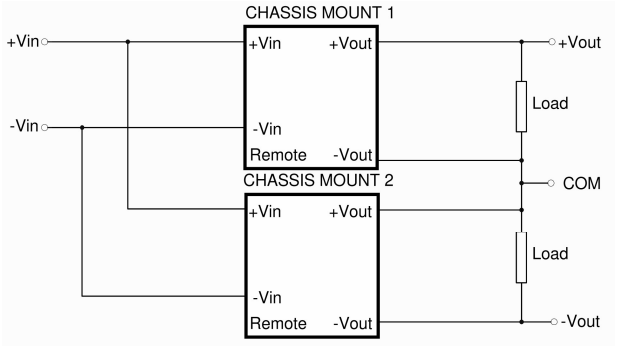
Series operation is possible by connecting the outputs two or more units. Connection is shown in below. The output current in series connection should be lower than the lowest rate current in each power module.



Simple Series Operation Connect Circuit

Note:

Recommend Schottky Diodes (D1, D2) are 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.



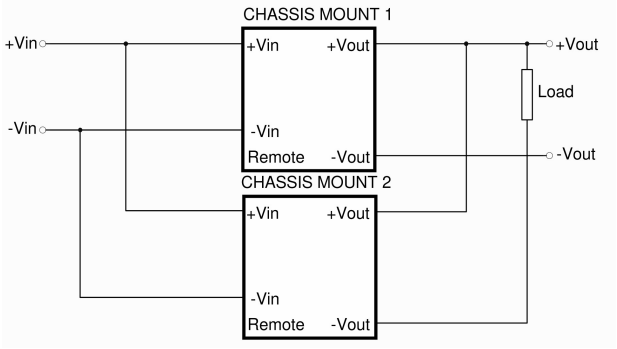
Simple ±Output Operation Connect Circuit

8.2 Parallel Operation

The CRT100W12 series parallel operation is **not** possible.

8.3 Redundant Operation

The CRT100W12 series includes a built-in Oring detection circuit, enabling parallel redundancy operation. For models with the built-in Oring function, select the version with the "Q" designation. If the "Q" version is not chosen, an external circuit will need to be connected manually.



Simple Redundant Operation Connect Circuit

9. Thermal Design

9.1 Operating Temperature Range

The CRT100W12 series converters can be operated within a wide case temperature range of -40℃ to 95℃. 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
- Baseplate

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 95℃ 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

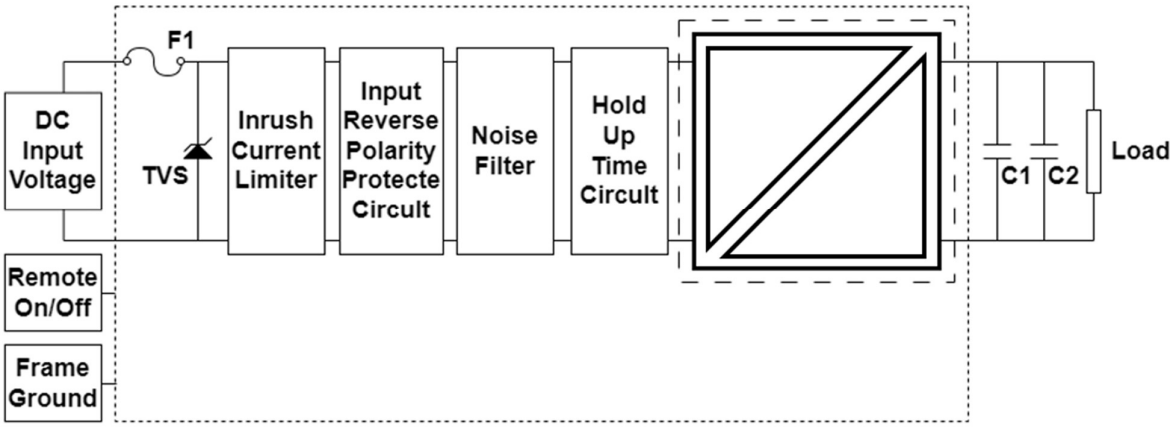
The operating case temperature range of CRT100W12 series is -40℃ to +95℃. When operating the CRT100W12 series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 95℃.

10. Safety & EMC

10.1 Input Fusing and Safety Considerations

The CRT100W12 series converters are equipped with an internal 10A time-delay fuse across all models. For optimal system safety and protection, it is recommended that the maximum current from the external circuit does not exceed 26.67A.

In addition, the CRT100W12 series features a transient voltage suppressor (TVS) diode to safeguard the unit against surge or spike voltages, as shown in the diagram.



CRT100W12-72SXX

10.2 EMC Considerations

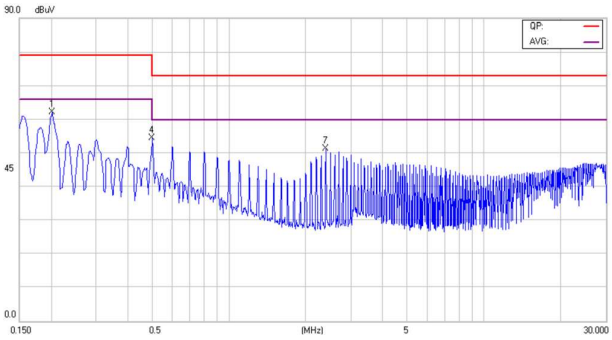
The CRT100W12 series converters are equipped with a built-in EMI filter and safety capacitors to ensure compliance with electromagnetic interference standards.

EMI Test standard: EN 55032 Class A/EN50121-3-2:2016 Conducted & Radiated Emission
Test Condition: Input Voltage: 48Vdc, Output Load: Full Load/Input Voltage: 110Vdc, Output Load: Full Load

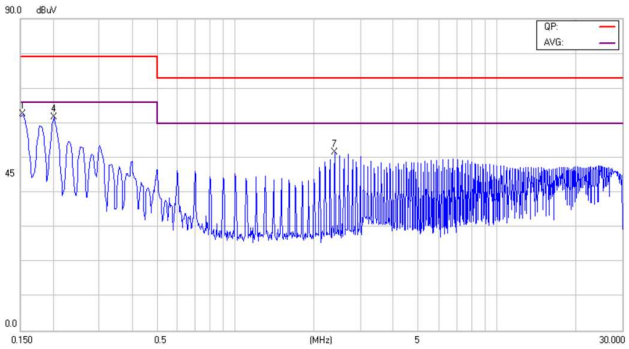
Input Conducted Emission(EN 55032):

CRT100W12-72S12

Line

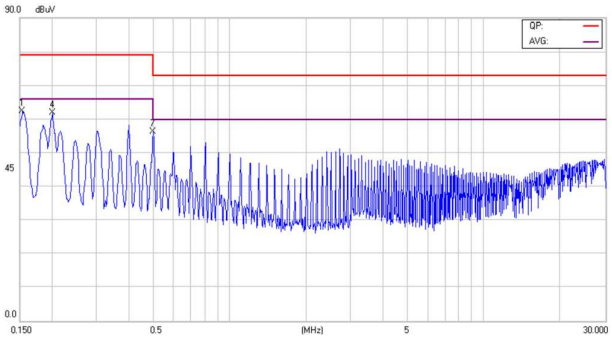


Neutral

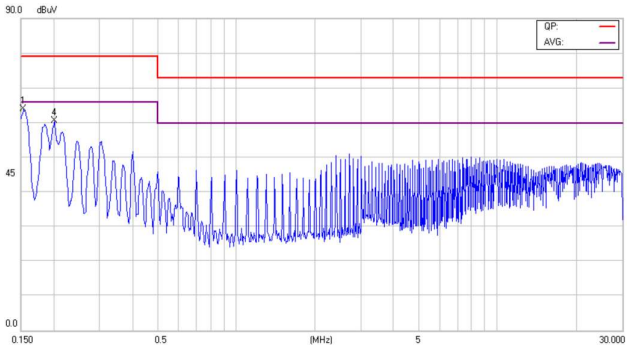


CRT100W12-72S24

Line

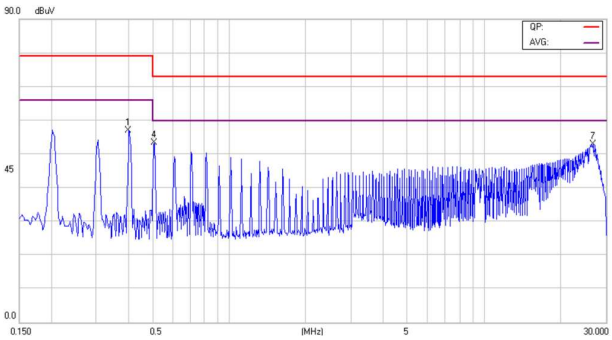


Neutral

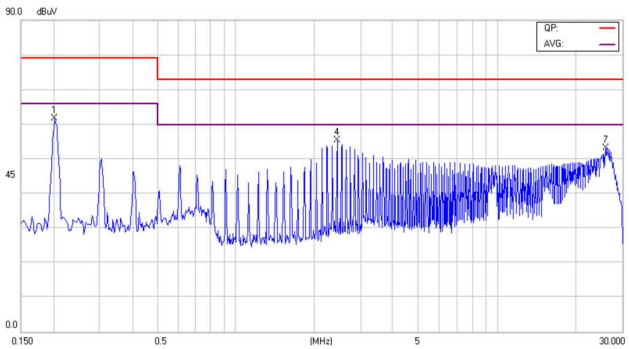


CRT100W12-72S48

Line



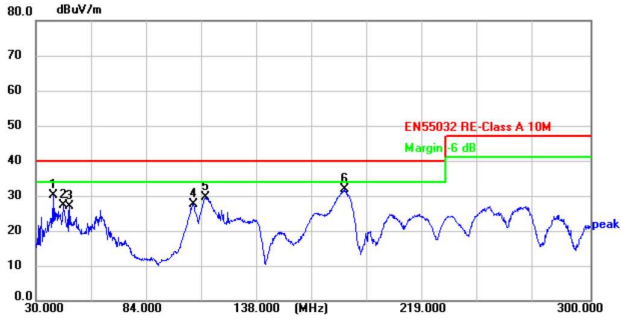
Neutral



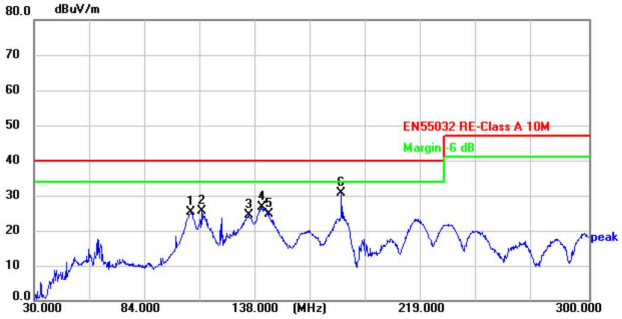
Radiated Emission(EN 55032):

CRT100W12-72S12

Vertical

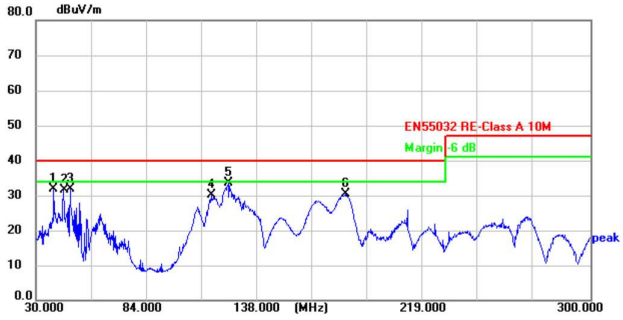


Horizontal

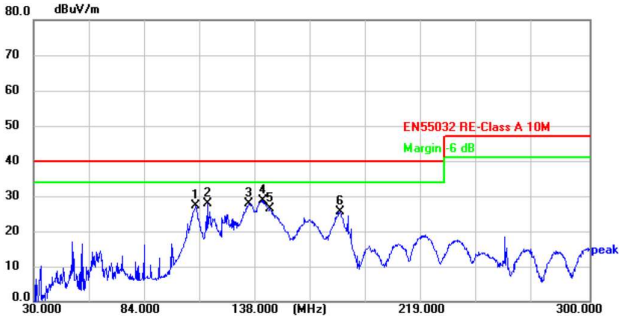


CRT100W12-72S24

Vertical

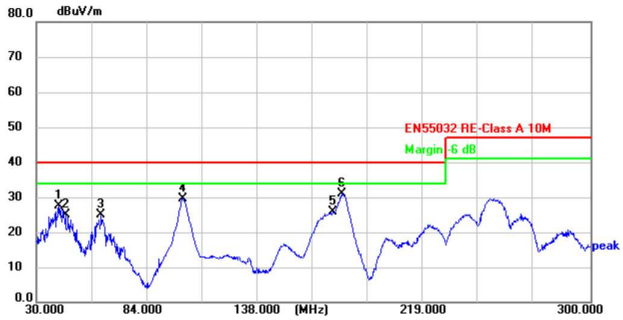


Horizontal

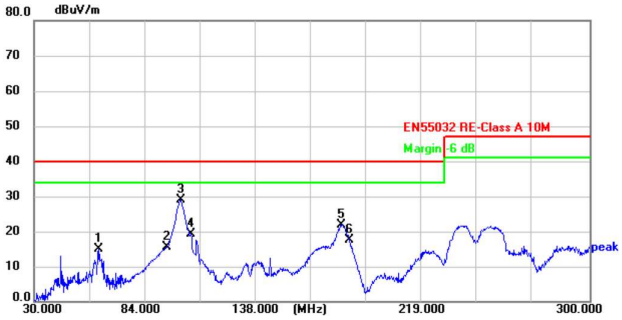


CRT100W12-72S48

Vertical



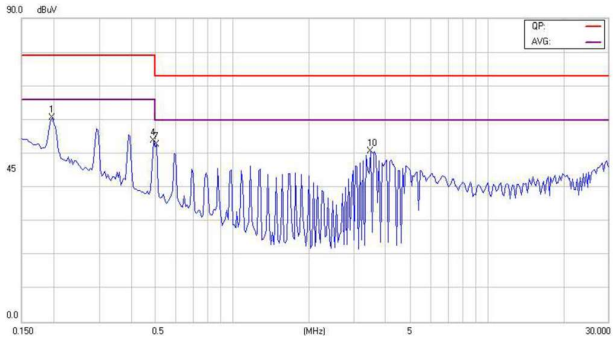
Horizontal



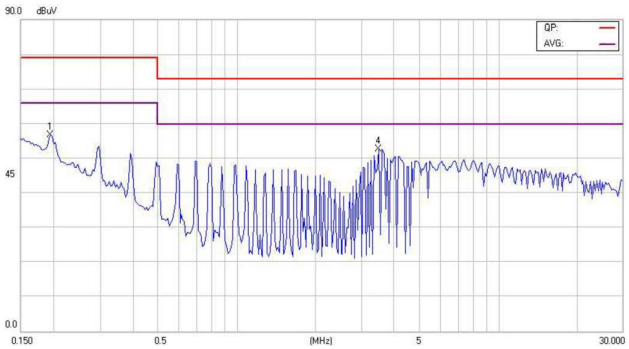
Input Conducted Emission(EN50121-3-2):

CRT100W12-72S12

Line

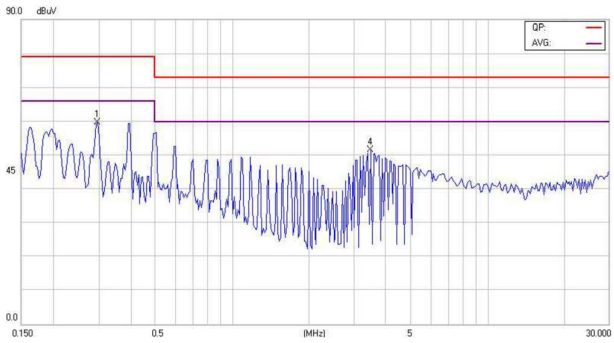


Neutral

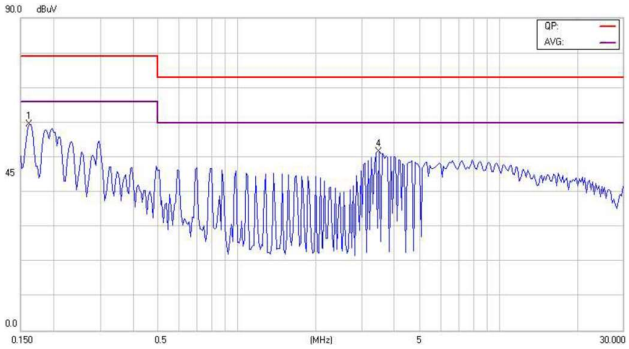


CRT100W12-72S24

Line

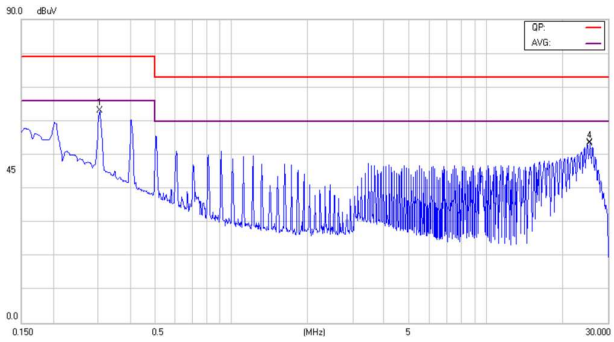


Neutral

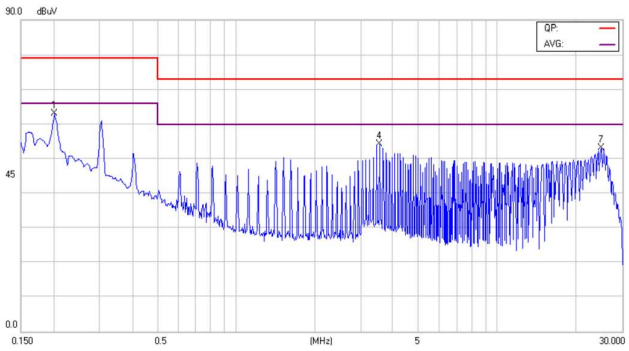


CRT100W12-72S48

Line



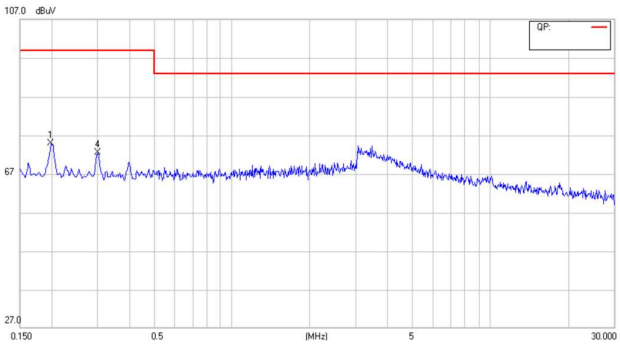
Neutral



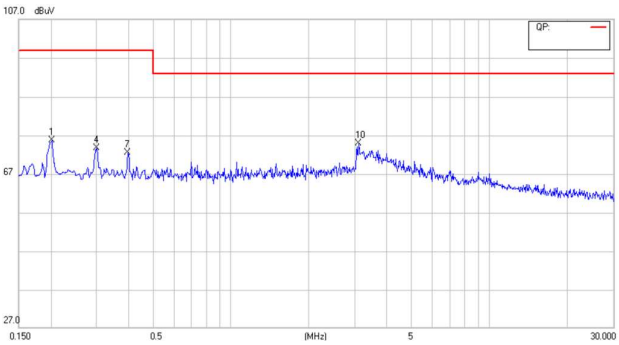
Output Conducted Emission(EN50121-3-2):

CRT100W12-72S12

Positive

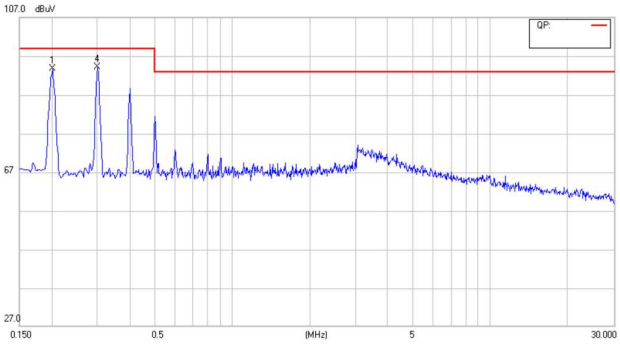


Negative

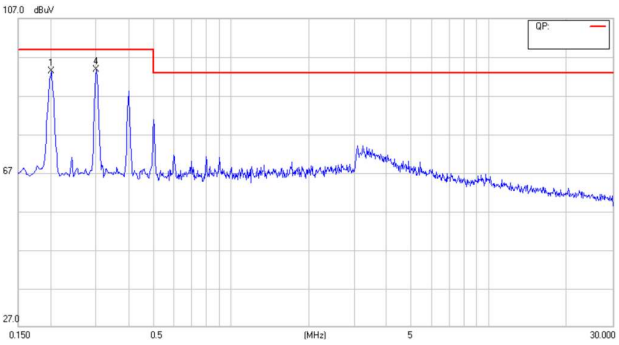


CRT100W12-72S24

Positive

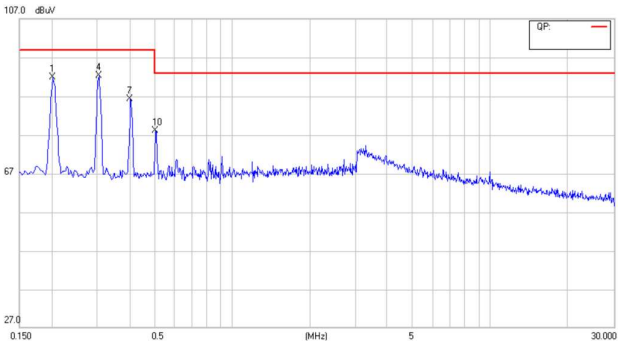


Negative



CRT100W12-72S48

Positive



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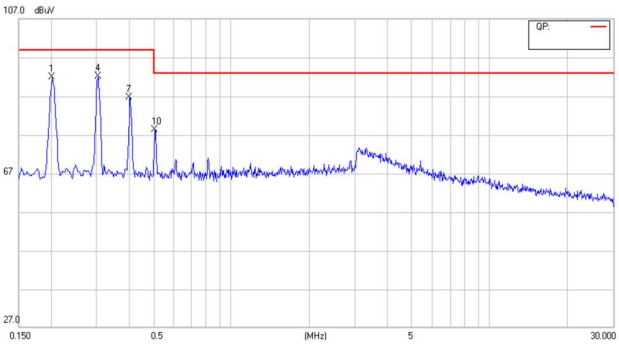
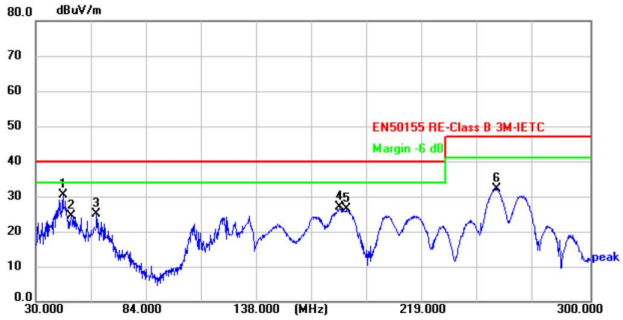


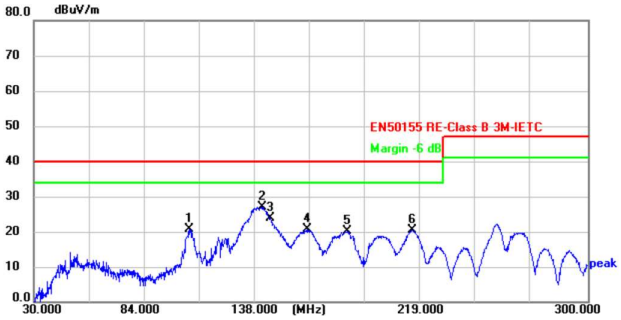
Radiated Emission(EN50121-3-2):

CRT100W12-72S12

Vertical

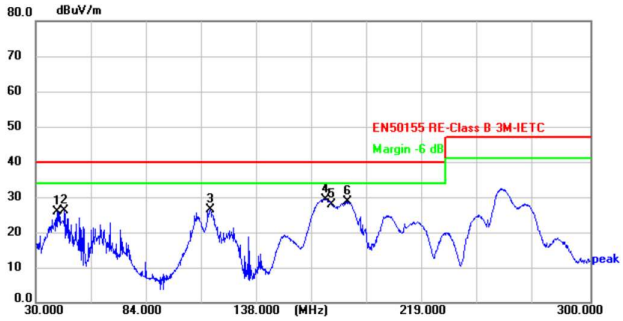


Horizontal

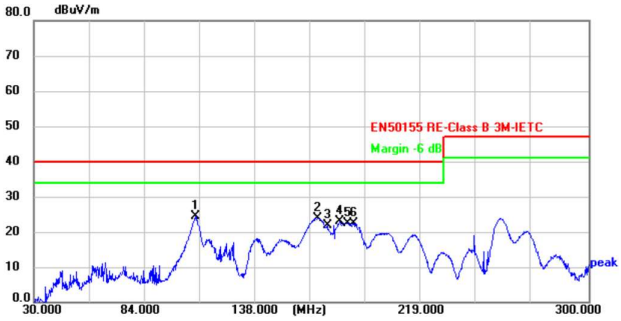


CRT100W12-72S24

Vertical

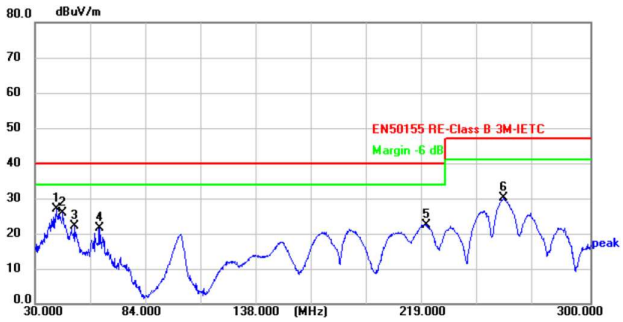


Horizontal

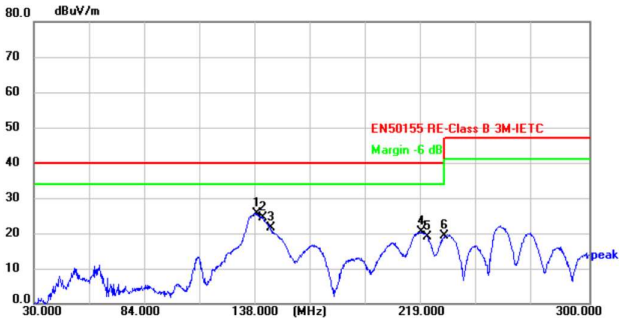


CRT100W12-72S48

Vertical



Horizontal



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