TE150-12V & 24V Family External Power Supplies

DoE Level VI Compliant

AN-P020

OVERVIEW

The SL Power TE Family of external power supplies was designed to provide high power conversion efficiency, meeting the U.S. Department of Energy (DoE) Level VI efficiency and No Load power consumption requirements. In addition, this model family has enhanced Electro-Magnetic Compatibility (EMC) features offering heavy industrial ESD, AC mains surge, and RF immunity resulting in a more robust and reliable product. The TE150 model's AC mains emissions comply with FCC & EN55032 class B levels with margin. Output emissions for differential ripple and common mode voltage and current have been reduced to minimize system level EMI and system circuit interference.

For long term reliability, this model family uses high quality components to provide long life, and have been thoroughly tested and approved by regulatory agencies. See the product datasheet for more details.

This application note provides guidance for proper use, selection criteria, system design consideration and key performance data. Additional performance data is available upon request for other voltage models.

PROPER USE

The external power supplies have high power conversion efficiency; however they do rely on convection cooling to the surrounding environment (air) to prevent overheating or excessive internal and external surface temperatures. Therefore, there needs to be adequate access to ambient air to ensure proper thermal performance of the power supply.

- Do not cover the power supply with blankets, clothing, pillows, or any other poor thermal conductor.
- Do not immerse the power supply in any liquid.
- Avoid dropping the power supply on hard surfaces.
- Avoid impacting the case of the power supply with any hard object.
- Use the proper power Input cord (desktop version) for the power supply.
- Use a proper mating connector for connection to the output of the power supply.
- Do not exceed the power rating of the product.

PERFORMANCE VERIFICATION

Efficiency and No Load Power

The DoE Level VI efficiency and No Load performance is specified to comply at 115VAC. When measuring efficiency, care must be taken to minimize the input and output connection voltage drops as these can significantly affect the results of the measurement. Consult SLPE application notes AN-G001 and AN-G002 for more information regarding efficiency and no load power measurements.

Output Ripple and Noise

- Output noise and ripple limits are defined in the product datasheet and may vary depending on the output voltage. Consult the product datasheet prior to assessing the output ripple and noise measurement results.
- Noise measurements are made at the output connector with typically a 10uF electrolytic capacitor in parallel with a 0.1uF ceramic capacitor. Use a short tip oscilloscope voltage probe when making the measurement. This is required to eliminate measurement error due to impedance imbalance errors introduced by the scope probe ground lead length.

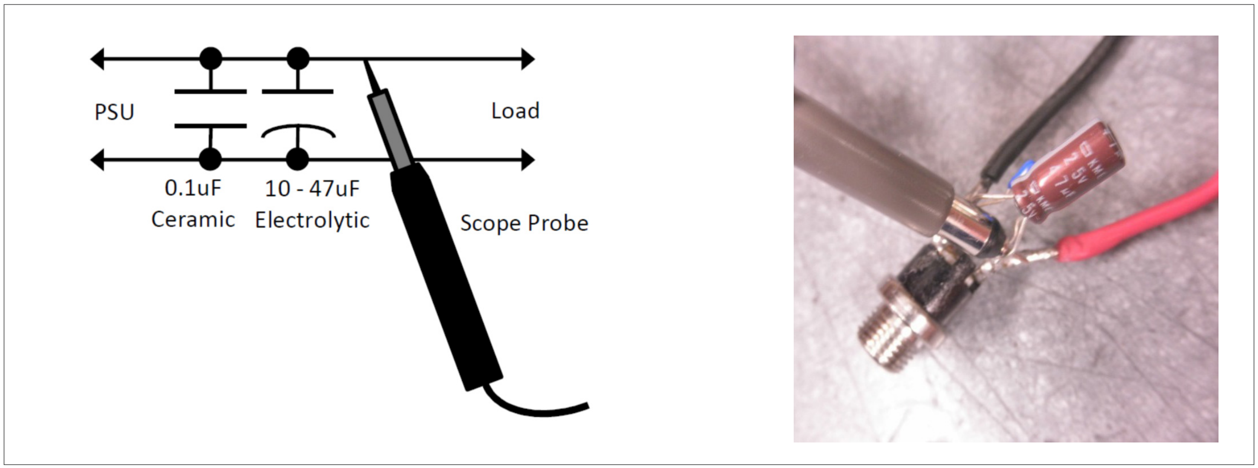

Fig. 1: Noise Measurement Caps and Probe with picture of the technique.

- Common mode noise is electrical signal that appears between either output and earth ground or chassis ground. This comes about due to parasitic capacitance and inductive coupling in the power supply that couples electrical energy from the primary to the secondary or from the secondary to earth ground. Although the coupling is minimized by design and construction, it cannot easily be eliminated. Be aware of any special needs in the application for low common mode noise. The Class I AC input models have lower common mode noise in general and in some case, where the output can be connected to AC/earth ground, it can be virtually eliminated.

Load and Noise Filtering Capacitors

- The external adapters have output filtering capacitors to minimize the switching frequency voltage ripple and noise that is an artifact of the switching power conversion process. However, additional end load capacitance may be needed depending on the application. With an electronic circuitry as the load, it is recommended to add ceramic capacitors (~ 0.1 – 1uF) for noise spike reduction and electrolytic capacitors for ripple reduction and transient response voltage dip reductions. The amount of voltage dip during a transient is a function of the load step amplitude and rise/fall time of the load. The output of the power adapter is regulated in the adapter and does not compensate for the output cable voltage drop. The overall load regulation specified is measured at the adapter output connector, however.

Thermal

- No special cooling requirements are needed other than operating within the specified operating temperature range and locating the external power adapter in an environment with unencumbered access to the room ambient air.
- Adhere to the product datasheet derating curve when exposure to elevated temperatures is expected.

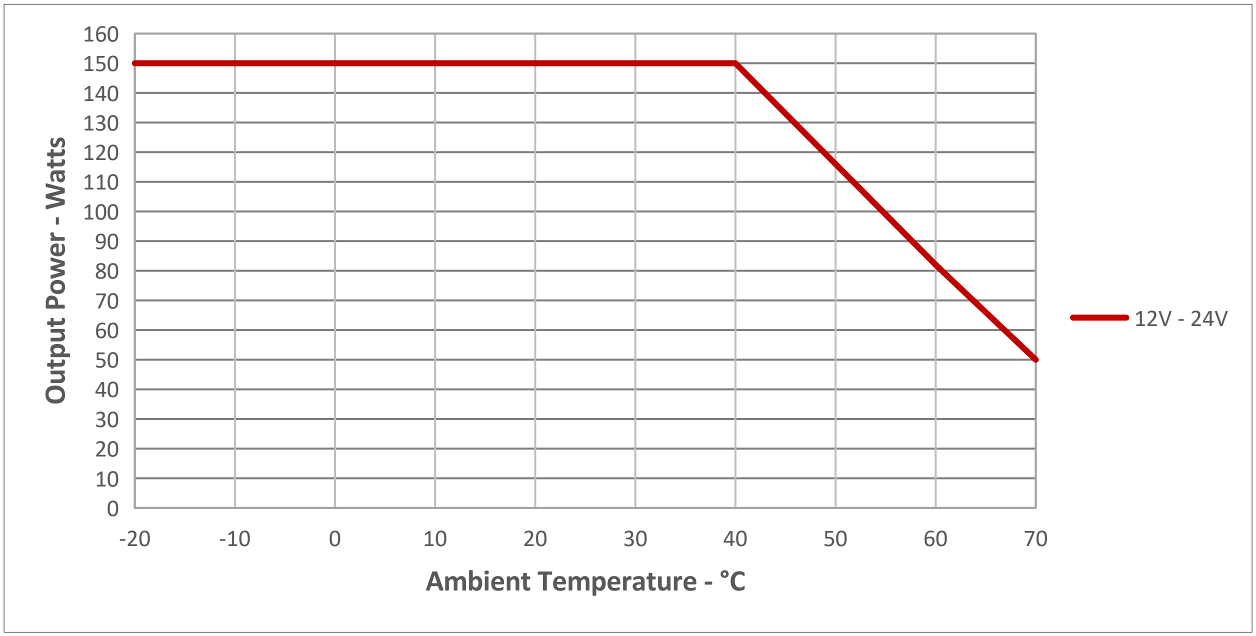

Fig. 2: TE150 family derating curve.

RELIABILITY AND ROBUSTNESS

The external power supply is often handled and not permanently fixed to a structure. It could be dropped on various surfaces which can cause impact shock damage to the enclosure or internal components. To help assess the potential of damage, shock and vibration requirements should be specified and verified. Low cost products often use low cost materials and components that can limit the life of the power supply or result in permanent damage if dropped on to a hard surface.

SLPE uses FR4 PCB material (versus CEM material) which provides a higher level of quality and protection to impact shock.

Electrolytic capacitors are one of the main life limiting components used in the power supply. Selecting high quality capacitors with high life ratings are essential to achieve long product life in excess of 8 to 10 years. SL Power Electronics uses only high quality electrolytic capacitors in its TE150 model family. Calculations and measurements are performed to verify capacitor ripple current, voltage and thermal stress and life time estimations.

PERFORMANCE DATA

The following data is provided to aid in proper selection and system design. Additional performance data is available upon request. The following data represents typical performance, actual results may vary depending on test conditions and unit variations.

INRUSH CURRENT

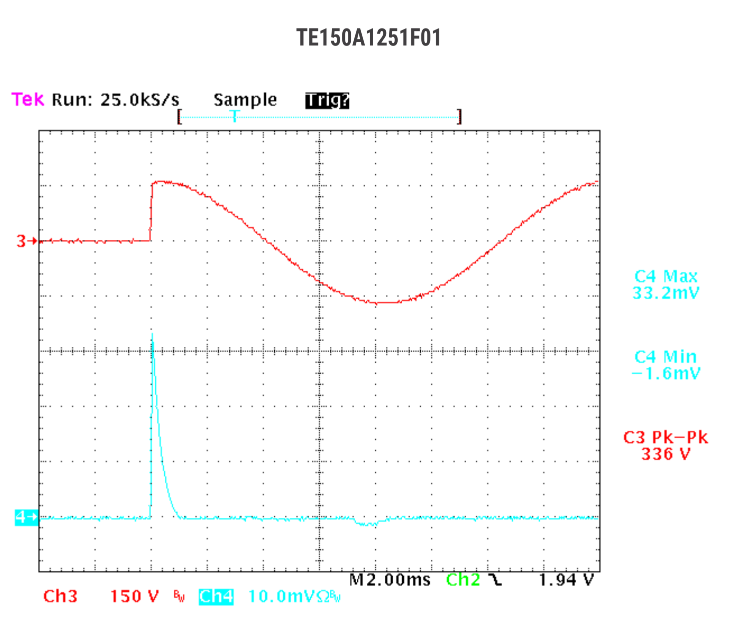

Fig. 3: INRUSH CURRENT AT 115VAC 24V/6.25A – CH4: 20A/Div.
I(inrush) = 66.4A peak.

$I^2t = 2.20A^2s$.

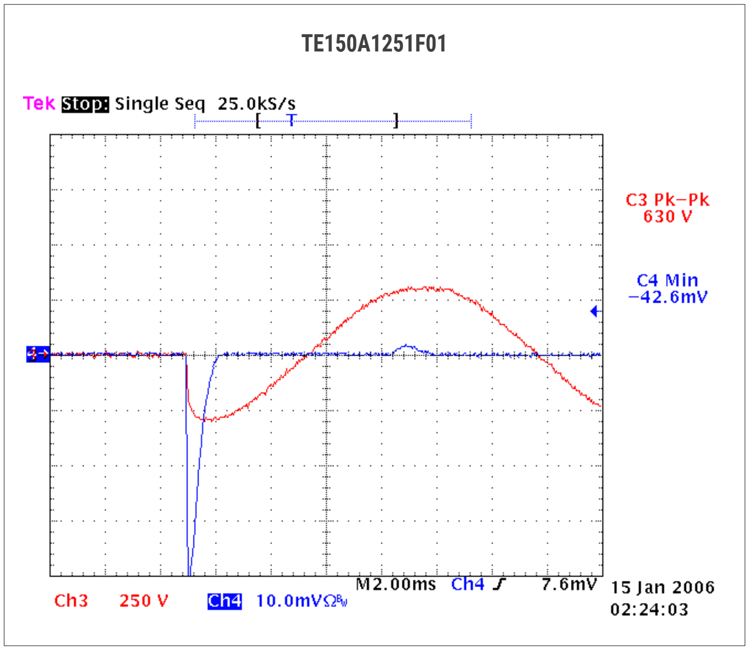

Fig. 4: INRUSH CURRENT AT 230VAC 24V/6.25A – CH4: 20A/Div.
I(inrush) = 85.2A peak.

$I^2t = 4.35A^2s$.

OUTPUT TURN-ON DELAY TIME

TE150A1251F01

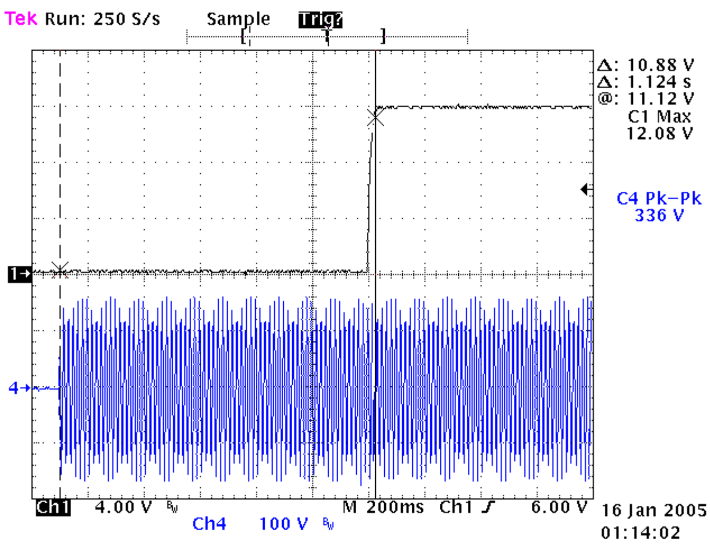

Fig. 5: TURN-ON DELAY AT 115VAC – 12.5A LOAD

TE150A1251F01

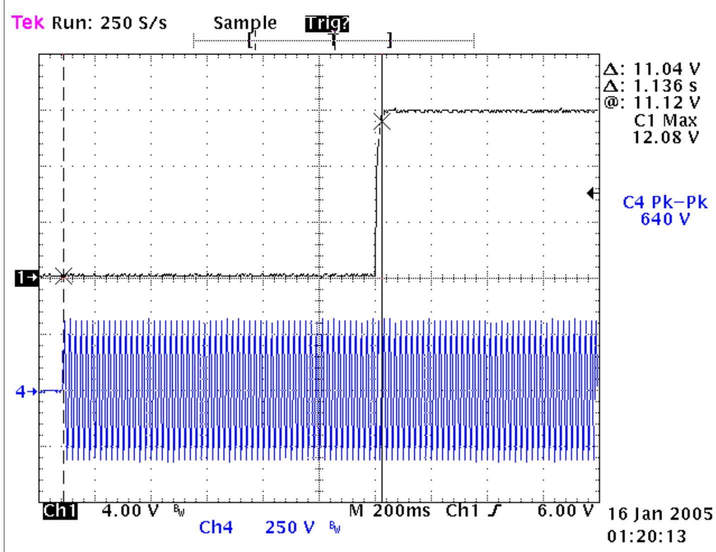

Fig. 6: TURN-ON DELAY AT 230VAC – 12.5A LOAD

TE150A2451F01

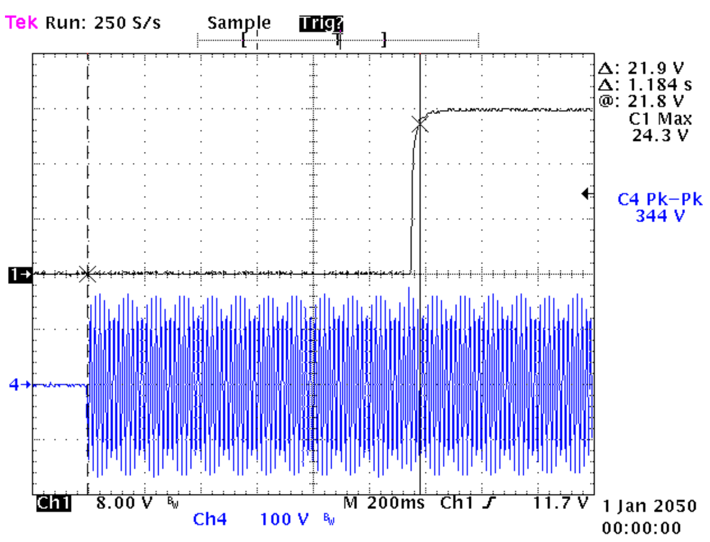

Fig. 7: TURN-ON DELAY AT 115VAC – 6.25A LOAD

TE150A2451F01

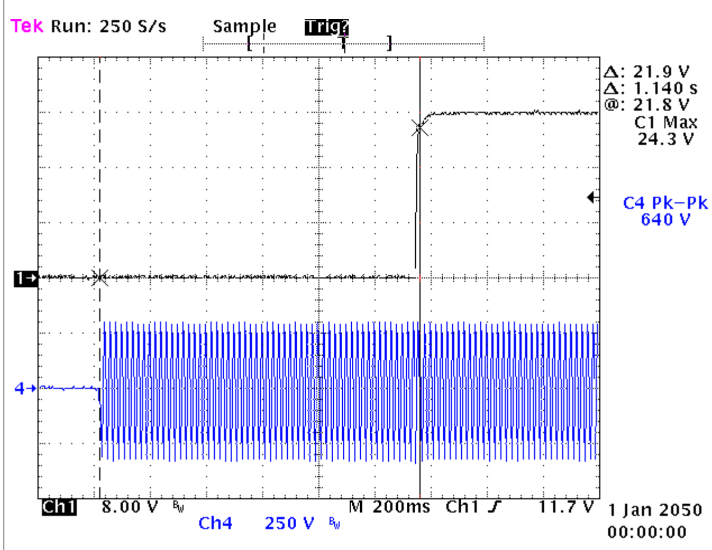

Fig. 8: TURN-ON DELAY AT 230VAC – 6.25A LOAD

OUTPUT TURN-ON RISE TIME

TE150A1251F01

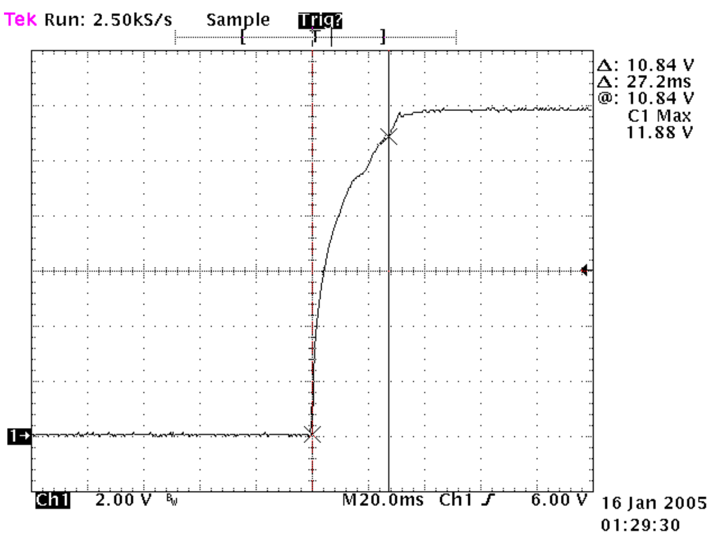

Fig. 9: TURN-ON RISE TIME AT 90VAC – 12.5A LOAD

TE150A1251F01

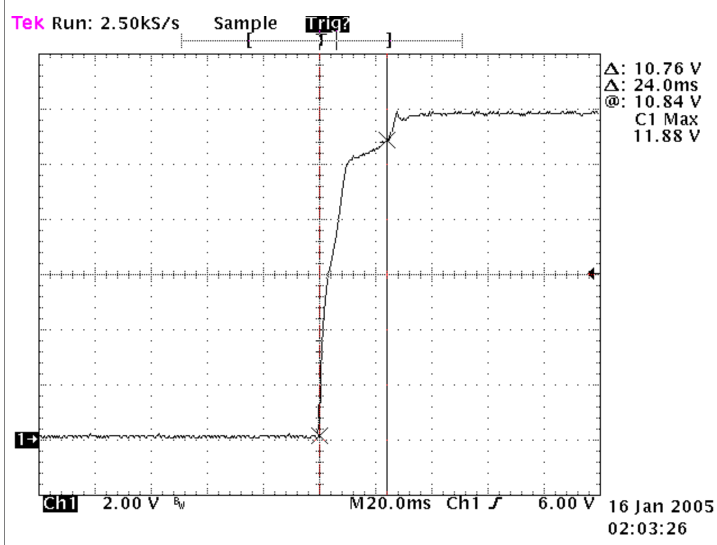

Fig. 10: TURN-ON RISE TIME AT 264VAC – 12.5A LOAD

TE150A1251F01

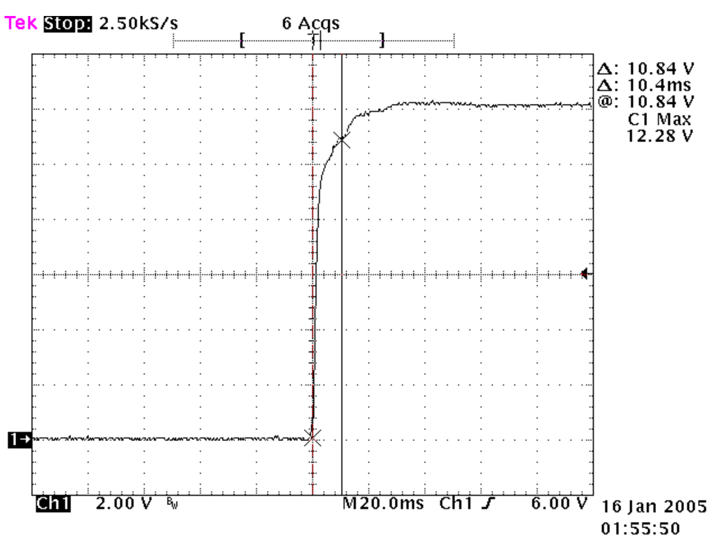

Fig. 11: TURN-ON RISE TIME AT 90VAC – NO LOAD

TE150A1251F01

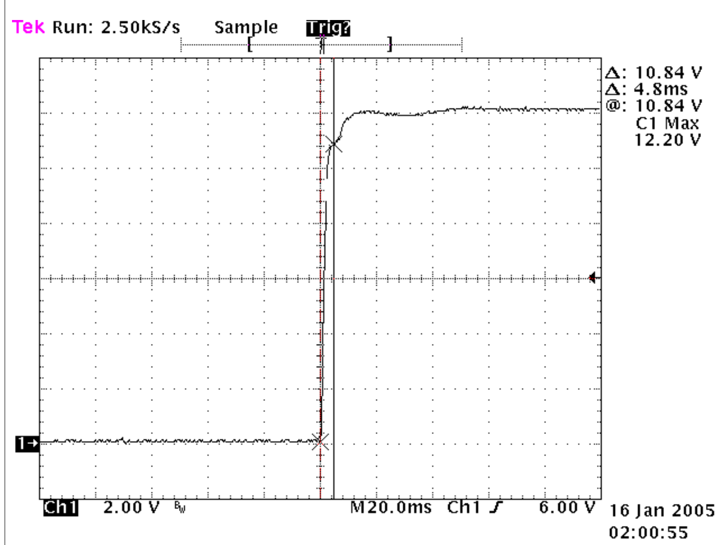

Fig. 12: TURN-ON DELAY AT 264VAC – NO LOAD

OUTPUT TURN-ON RISE TIME

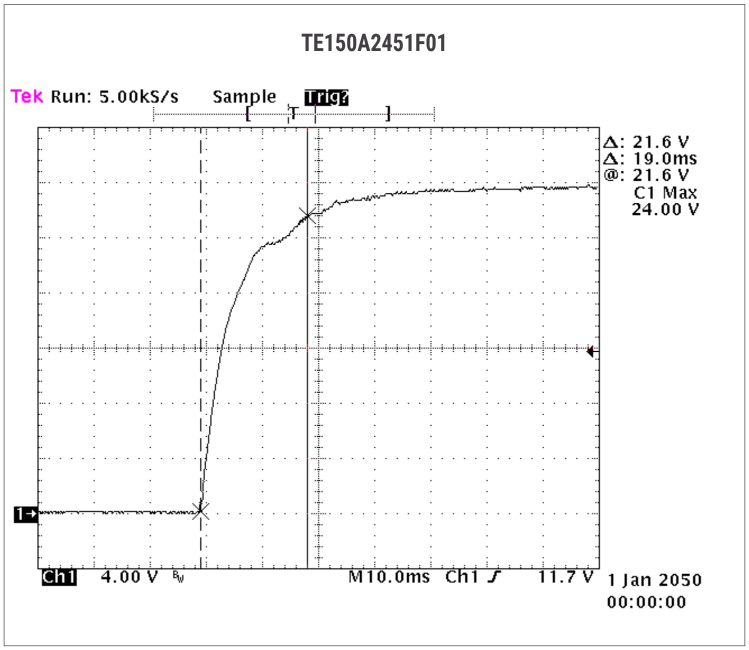

Fig. 13: TURN-ON RISE TIME AT 90VAC – 6.25A LOAD

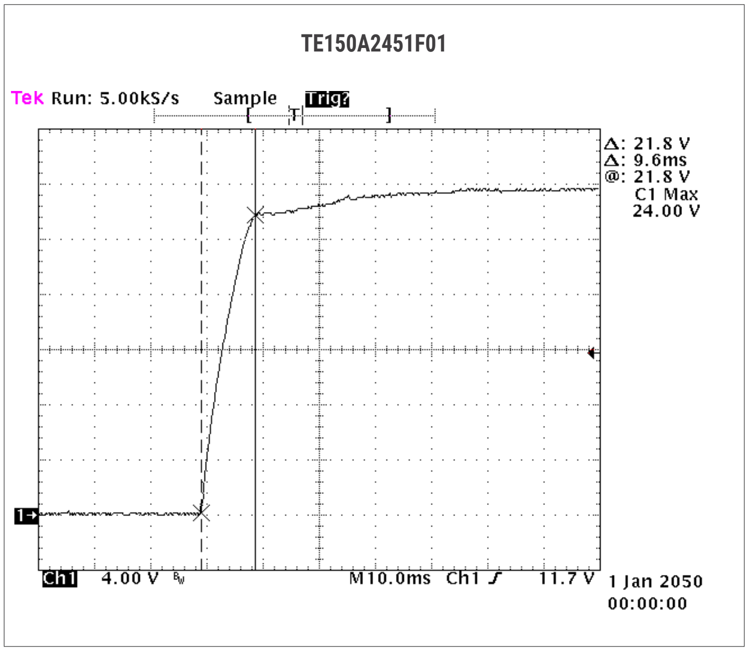

Fig. 14: TURN-ON RISE TIME AT 264VAC – 6.25A LOAD

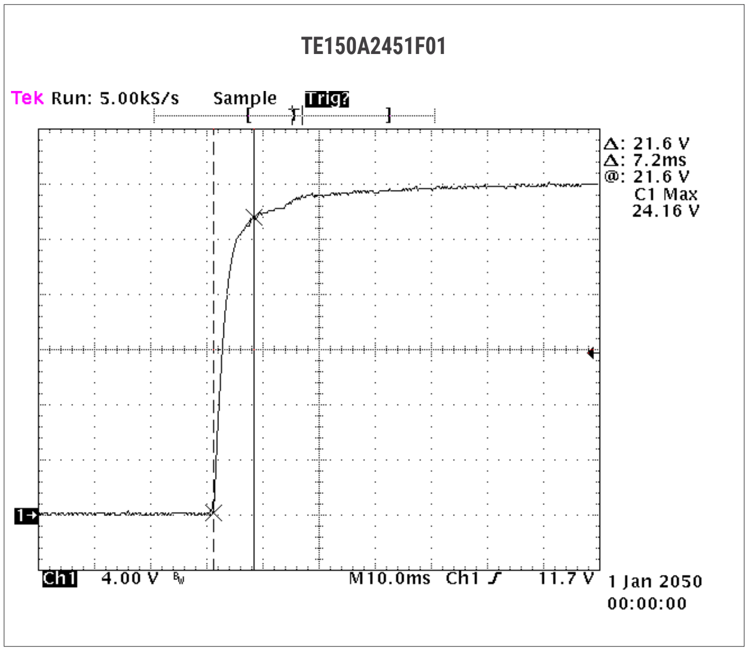

Fig. 15: TURN-ON RISE TIME AT 90VAC – NO LOAD

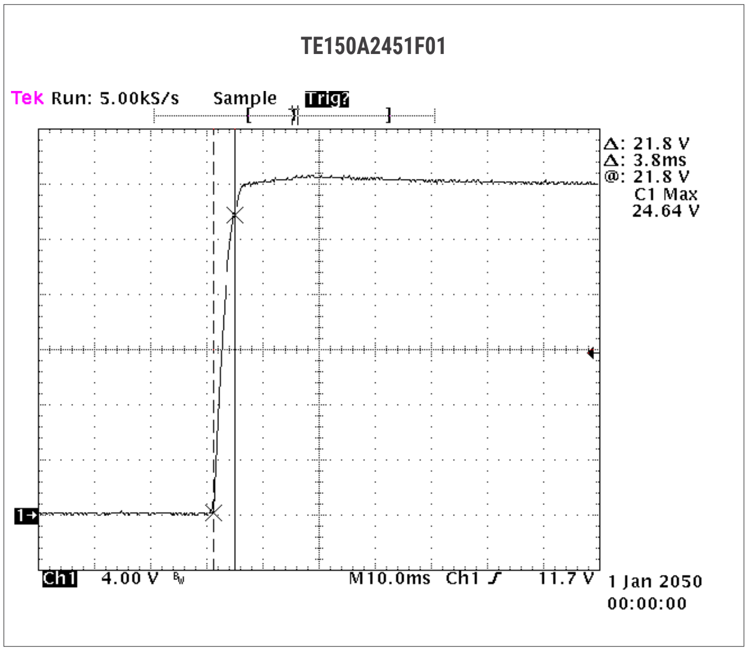

Fig. 16: TURN-ON RISE TIME AT 264VAC – NO LOAD

HOLD-UP TIME

TE150A1251F01

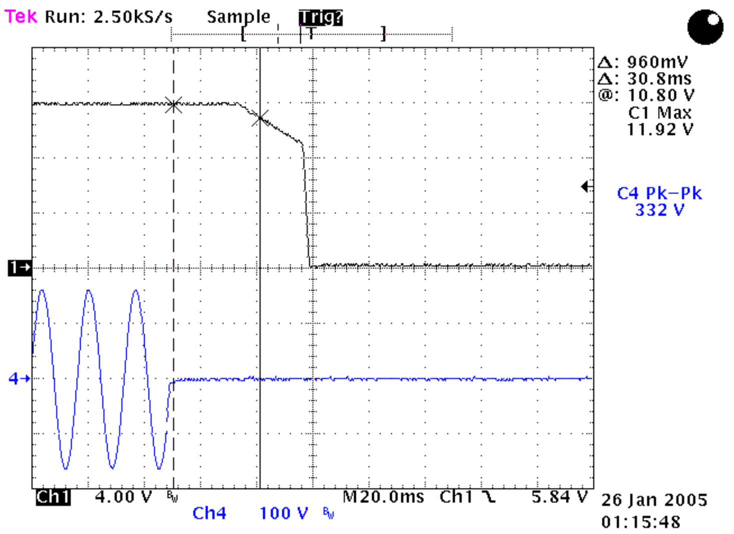

Fig. 17: HOLD-UP TIME FROM LOSS OF AC AT 115VAC – 12.5A LOAD

TE150A1251F01

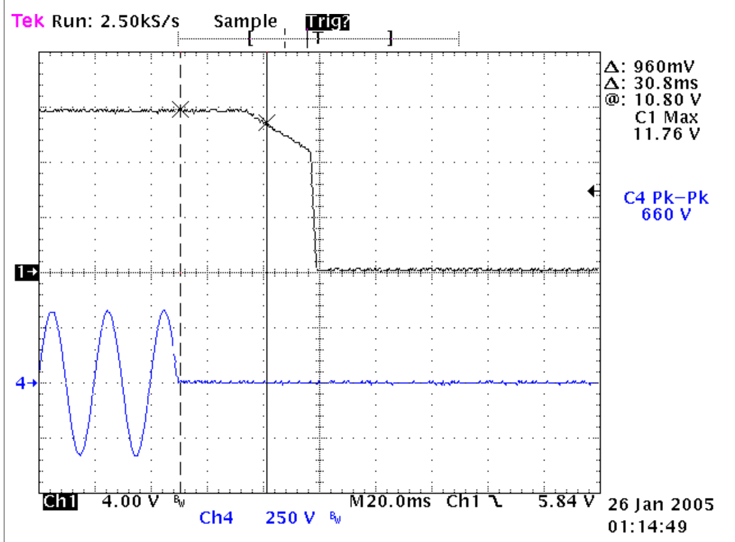

Fig. 18: HOLD-UP TIME FROM LOSS OF AC AT 230VAC – 12.5A LOAD

TE150A2451F01

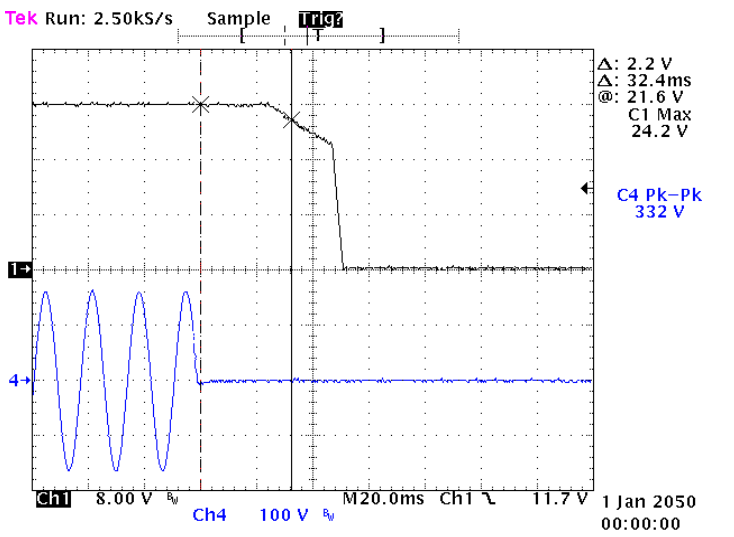

Fig.19: HOLD-UP TIME FROM LOSS OF AC AT 115VAC – 6.25A LOAD

TE150A2451F01

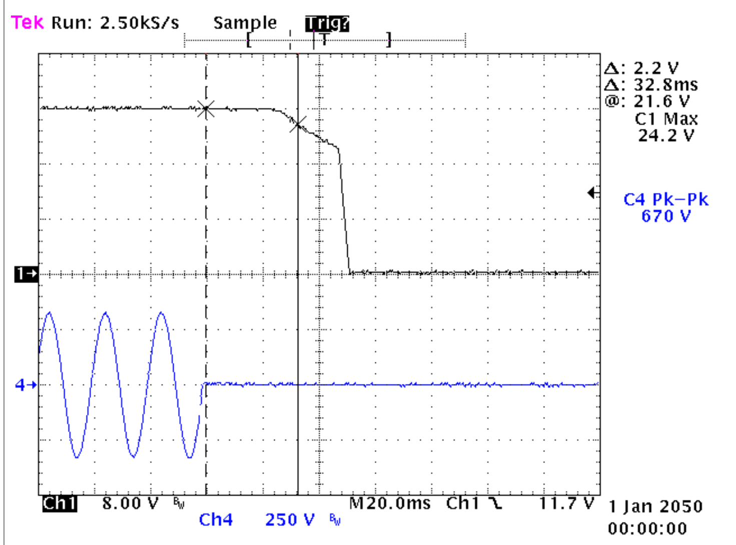

Fig. 20: HOLD-UP TIME FROM LOSS OF AC AT 230VAC – 6.25A LOAD

OUTPUT OVER LOAD PROTECTION

TE150A1251F01

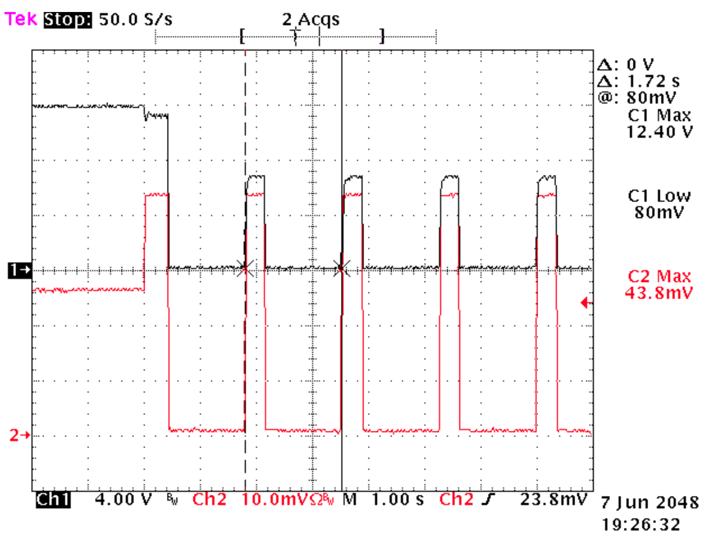

Fig. 21: OUTPUT OVER LOAD AT 115VAC

CH1: Vout,
CH2: OVER LOAD CURRENT (5A/10mV)

TE150A1251F01

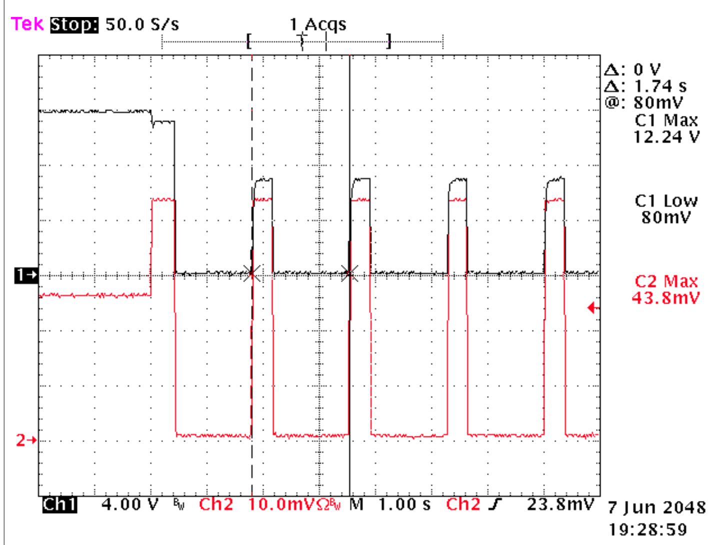

Fig. 22: OUTPUT OVER LOAD AT 230VAC

CH1: Vout,
CH2: OVER LOAD CURRENT (5A/10mV)

TE150A2451F01

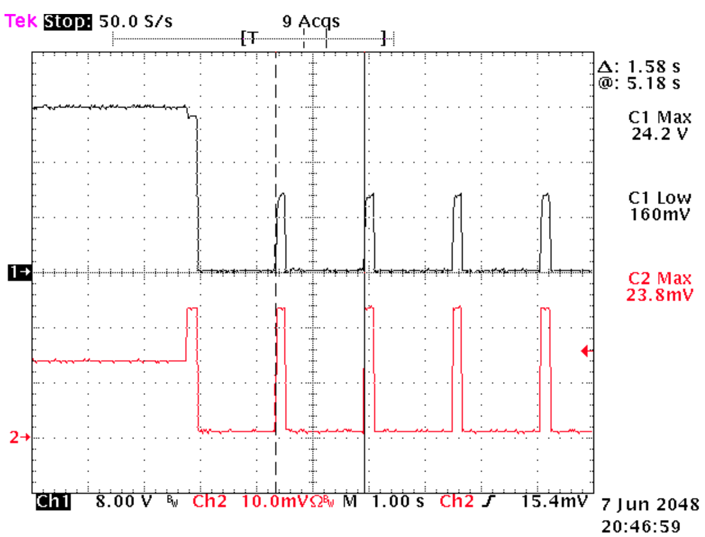

Fig. 23: OUTPUT OVER LOAD AT 115VAC

CH1: Vout,
CH2: OVER LOAD CURRENT (5A/10mV)

TE150A2451F01

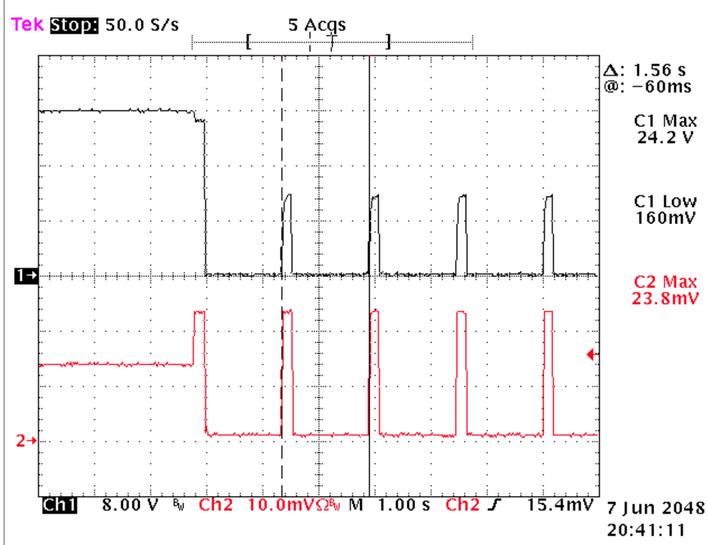

Fig. 24: OUTPUT OVER LOAD AT 230VAC

CH1: Vout,
CH2: OVER LOAD CURRENT (5A/10mV)

OUTPUT SHORT CIRCUIT PROTECTION

TE150A1251F01

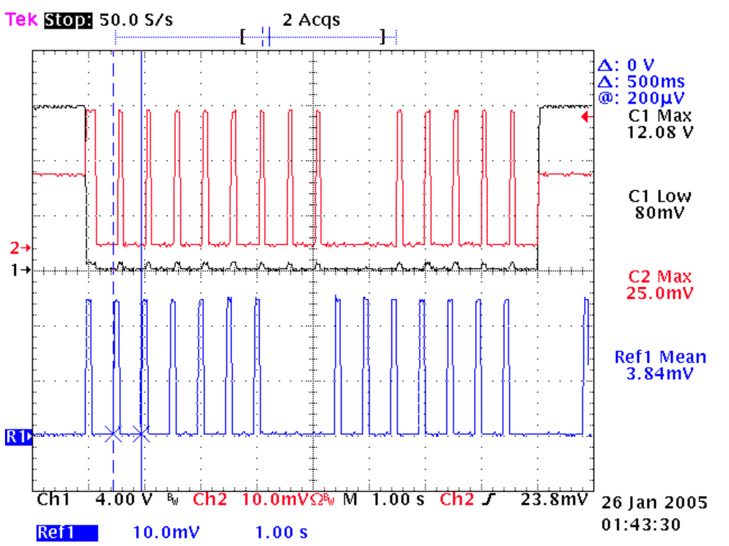

Fig. 25: OUTPUT SHORT CIRCUIT AT 115VAC

CH1: Vout,
CH2 & Ref1: SHORT CIRCUIT CURRENT (10A/10mV)

TE150A1251F01

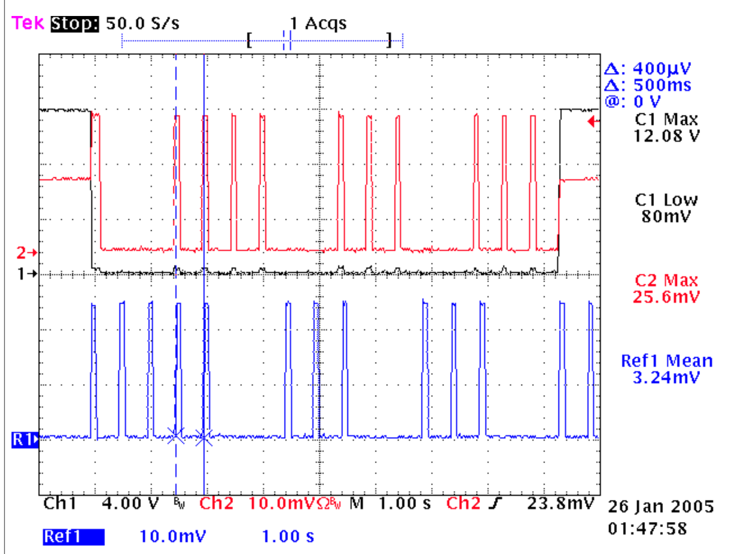

Fig. 26: OUTPUT SHORT CIRCUIT AT 230VAC

CH1: Vout,
CH2 & Ref1: SHORT CIRCUIT CURRENT (10A/10mV)

TE150A2451F01

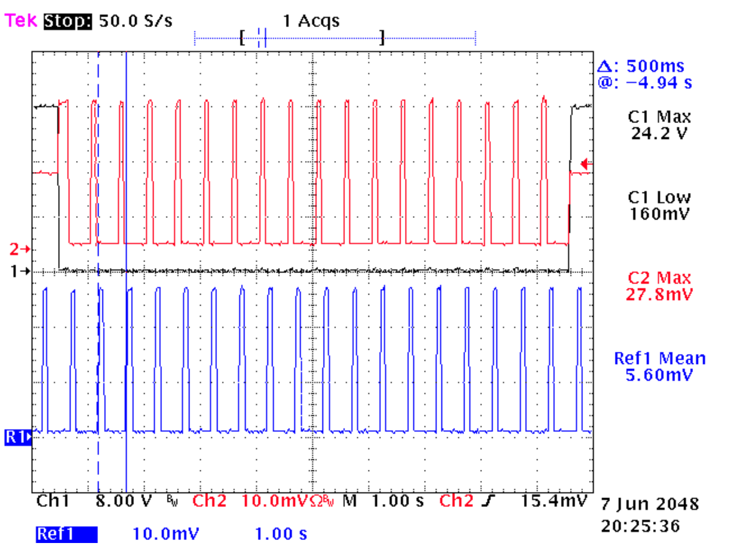

Fig. 27: OUTPUT SHORT CIRCUIT AT 115VAC

CH1: Vout,
CH2 & Ref1: SHORT CIRCUIT CURRENT (5A/10mV)

TE150A2451F01

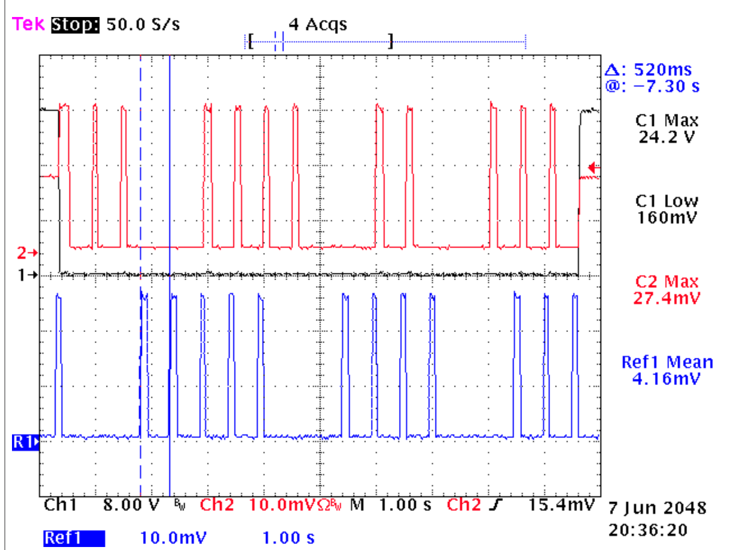

Fig. 28: OUTPUT SHORT CIRCUIT AT 230VAC

CH1: Vout,
CH2 & Ref1: SHORT CIRCUIT CURRENT (5A/10mV)

COMMON MODE CURRENT

TE150A1251F01

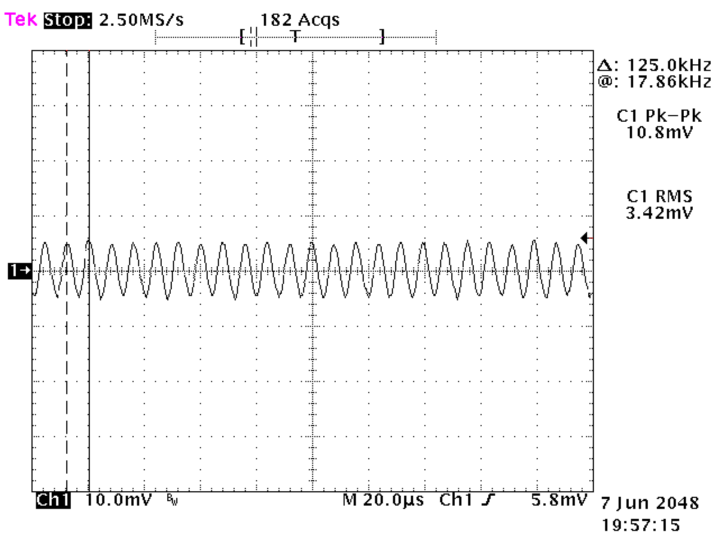

Fig. 29: COMMON MODE CURRENT AT 115VAC – CURRENT PROBE: 1mA/mV

TE150A1251F01

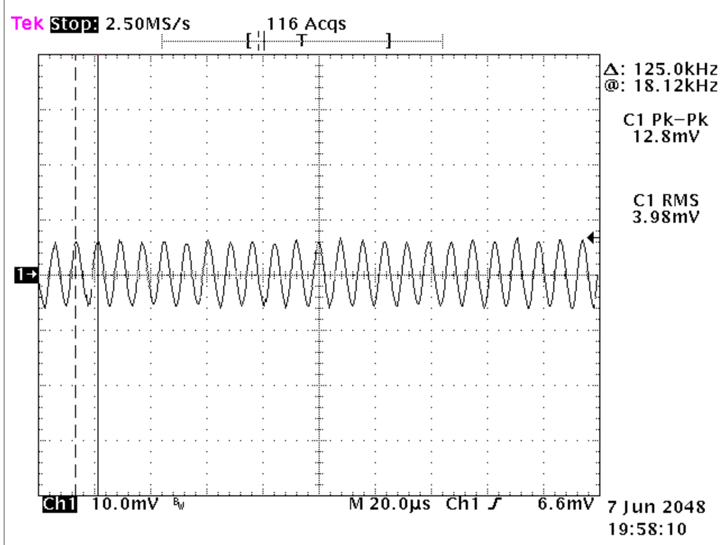

Fig. 30: COMMON MODE CURRENT AT 230VAC – CURRENT PROBE: 1mA/mV

TE150A2451F01

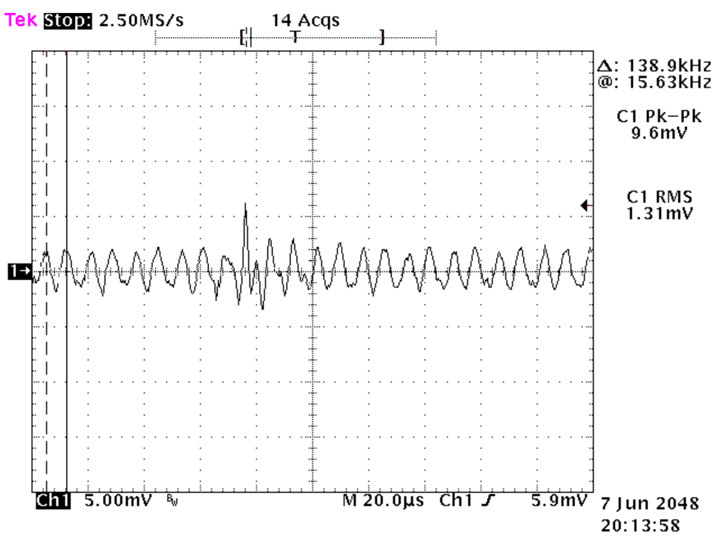

Fig. 31: COMMON MODE CURRENT AT 115VAC – CURRENT PROBE: 1mA/mV

TE150A2451F01

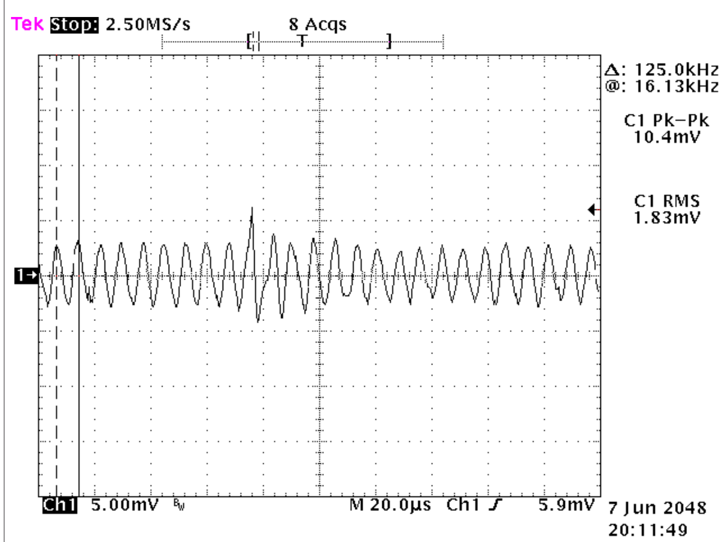

Fig. 32: COMMON MODE CURRENT AT 230VAC – CURRENT PROBE: 1mA/mV

CONDUCTED EMISSIONS

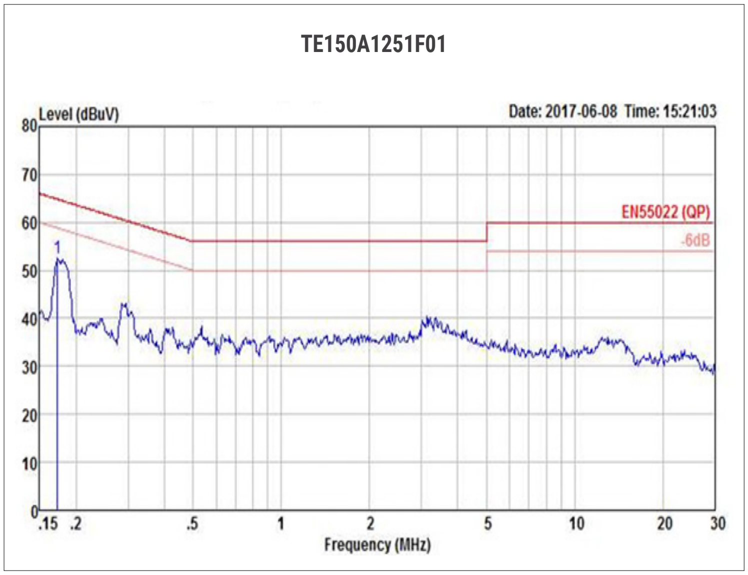

Fig. 33: CISPR32 CLASS B – 2230V/50Hz 100% LOAD QP MARGIN: >12dB

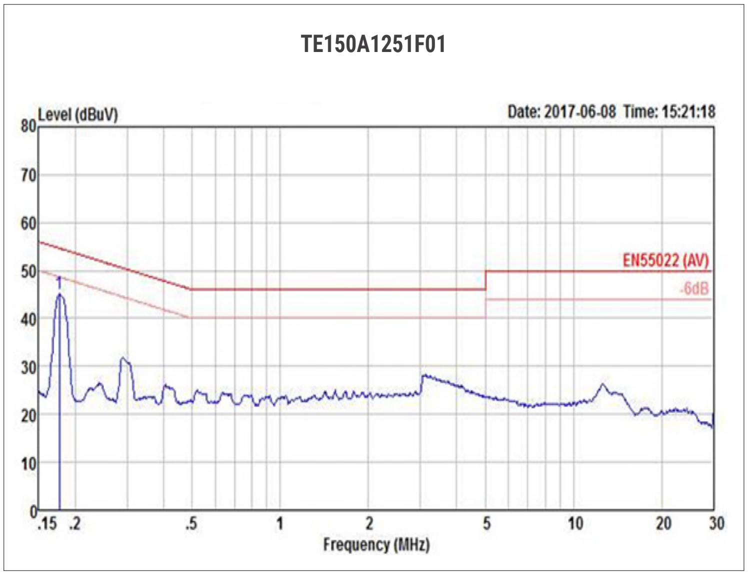

Fig. 34: CISPR32 CLASS B – 230V/50Hz 100% LOAD AVE MARGIN: >9dB

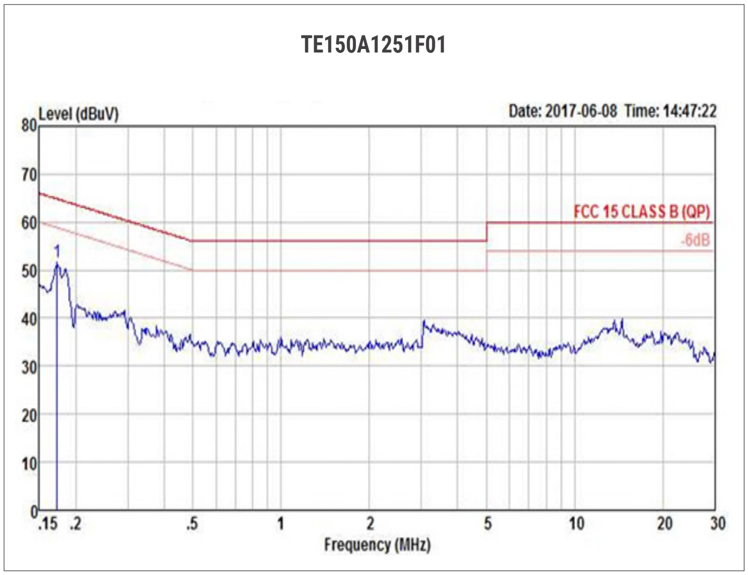

Fig. 35: FCC15 CLASS B – 115V/60Hz 100% LOAD QP MARGIN: >13dB

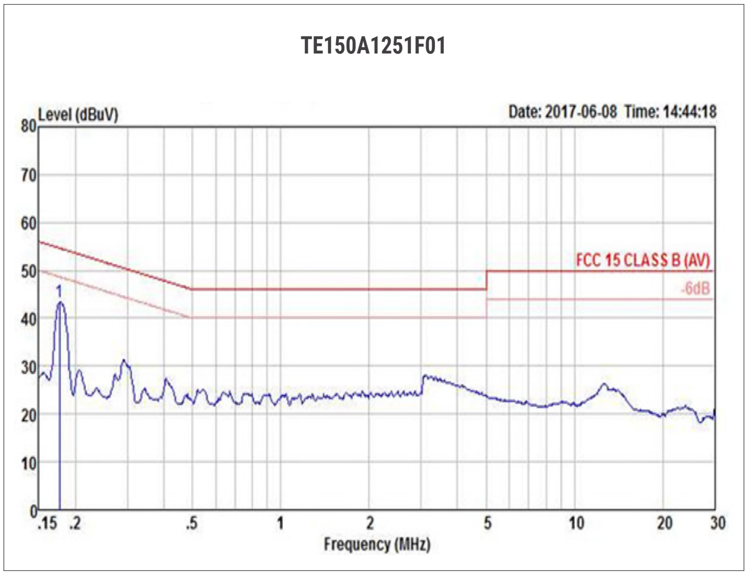

Fig. 36: FCC15 CLASS B – 115V/60Hz 100% LOAD AVE MARGIN: >11dB

CONDUCTED EMISSIONS

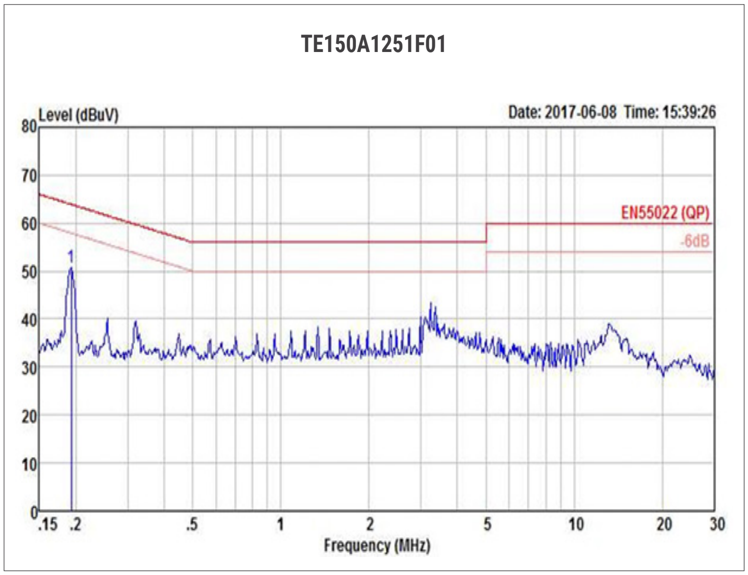

Fig. 37: CISPR32 CLASS B – 2230V/50Hz 10% LOAD QP MARGIN: >13dB

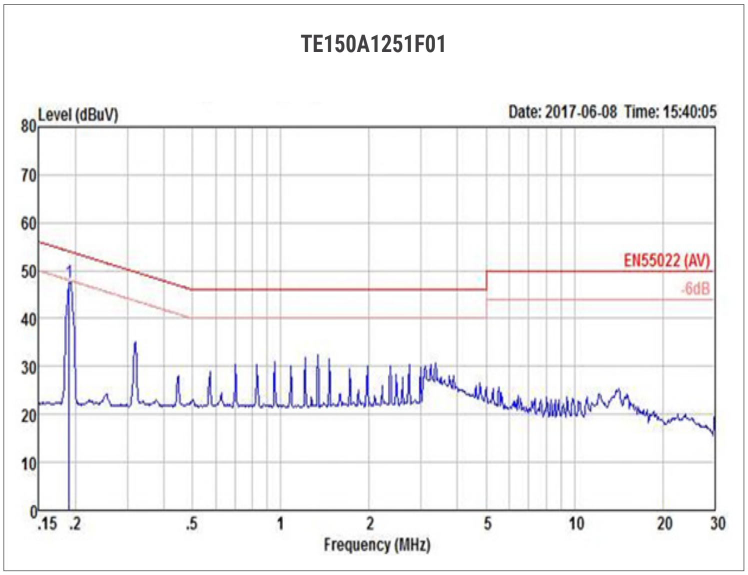

Fig. 38: CISPR32 CLASS B – 230V/50Hz 10% LOAD AVE MARGIN: >6dB

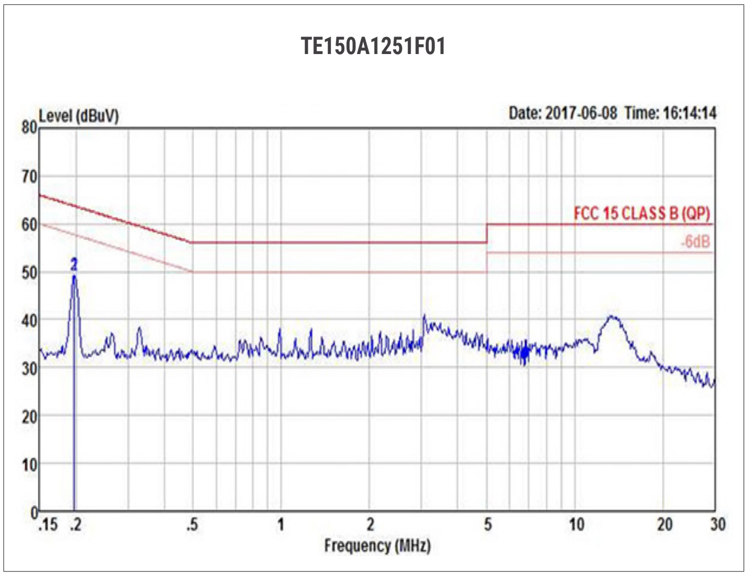

Fig. 39: FCC15 CLASS B – 115V/60Hz 10% LOAD QP MARGIN: >14dB

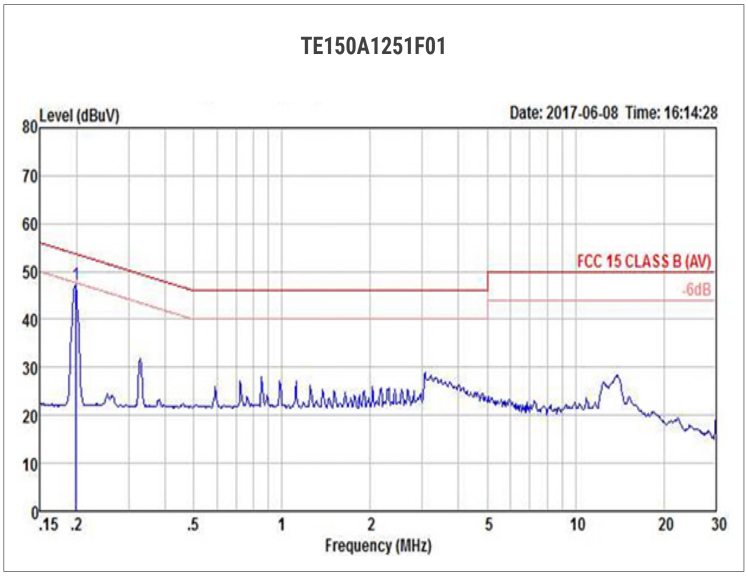

Fig. 40: FCC15 CLASS B – 115V/60Hz 10% LOAD AVE MARGIN: >6dB

CONDUCTED EMISSIONS

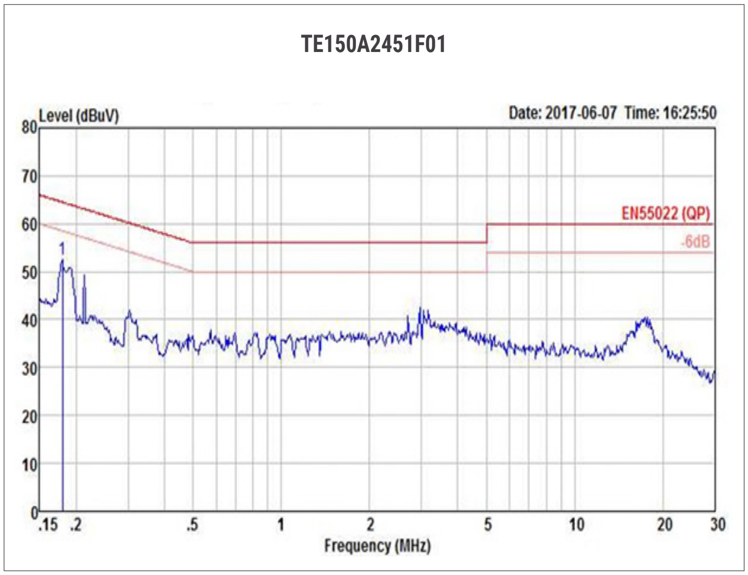

Fig. 41: CISPR32 CLASS B – 2230V/50Hz 100% LOAD QP MARGIN: >12dB

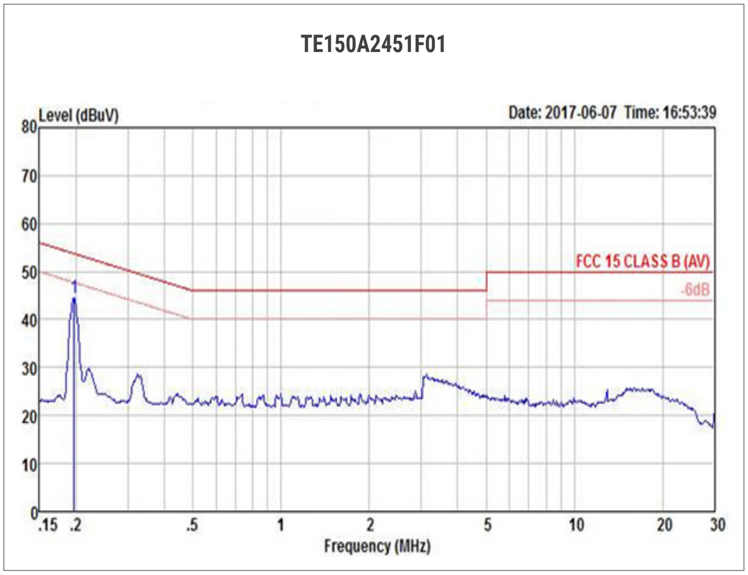

Fig. 42: CISPR32 CLASS B – 230V/50Hz 100% LOAD AVE MARGIN: >9dB

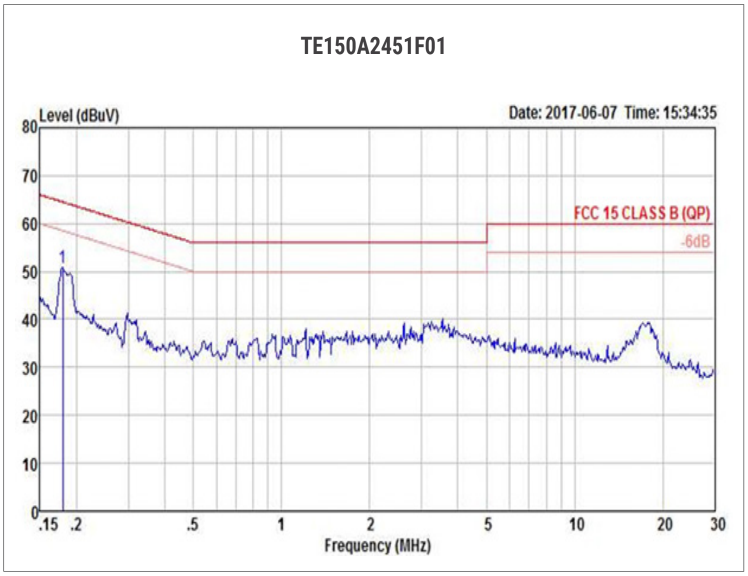

Fig. 43: FCC15 CLASS B – 115V/60Hz 100% LOAD QP MARGIN: >13dB

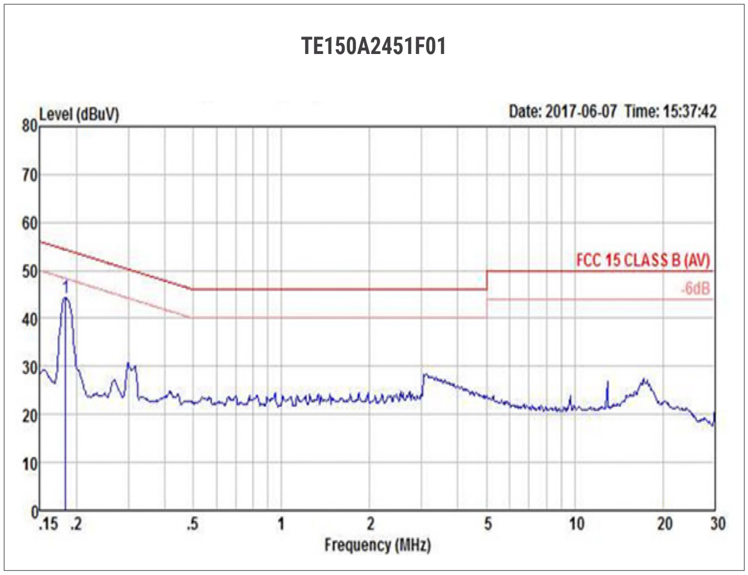

Fig. 44: FCC15 CLASS B – 115V/60Hz 100% LOAD AVE MARGIN: >10dB

CONDUCTED EMISSIONS

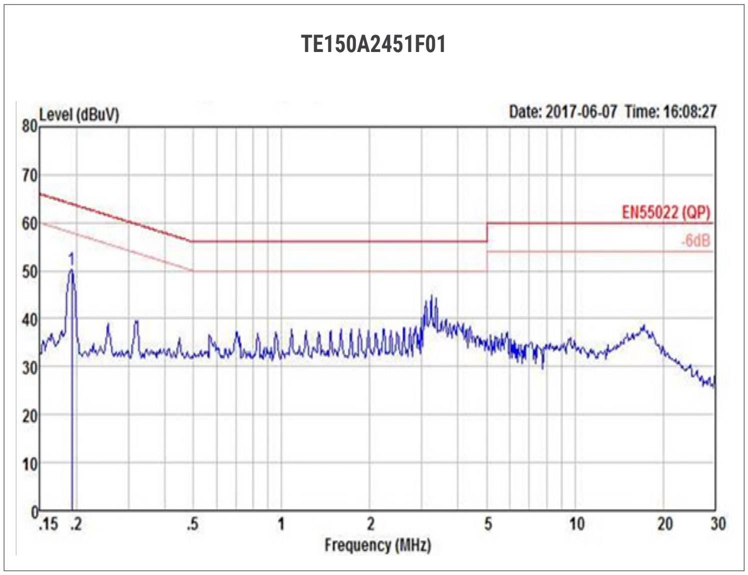

Fig. 45: CISPR32 CLASS B – 2230V/50Hz 10% LOAD QP MARGIN: >13dB

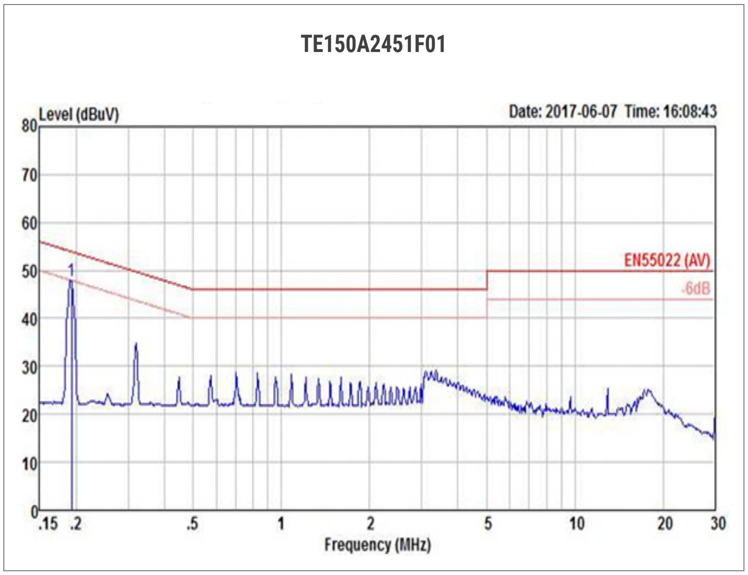

Fig. 46: CISPR32 CLASS B – 230V/50Hz 10% LOAD AVE MARGIN: >6dB

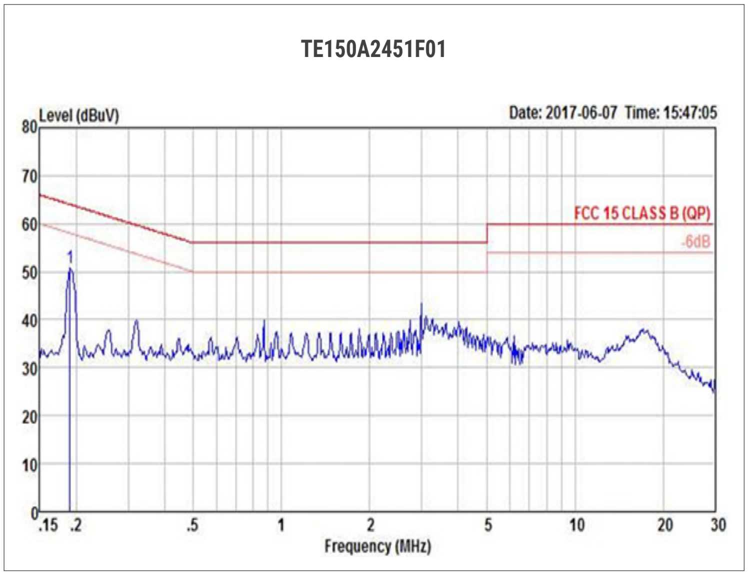

Fig. 47: FCC15 CLASS B – 115V/60Hz 10% LOAD QP MARGIN: >13dB

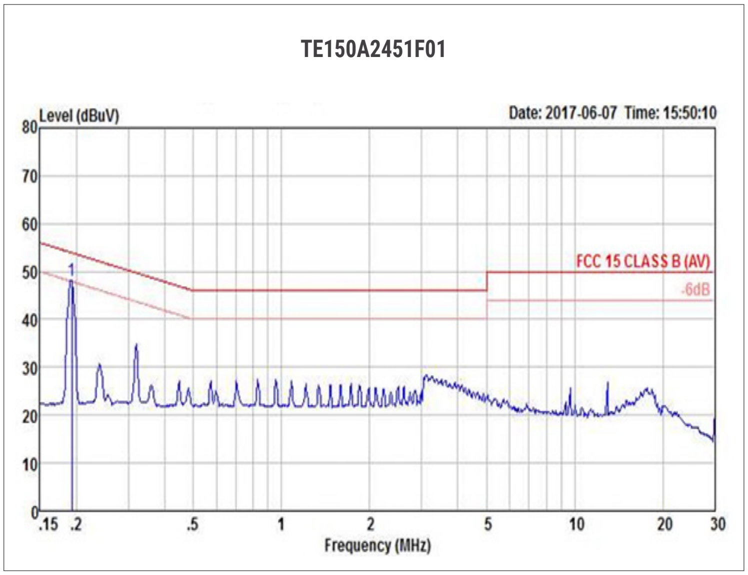

Fig. 48: FCC15 CLASS B – 115V/60Hz 10% LOAD AVE MARGIN: >6dB

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