

SLPE Lean Line 6W Family Class II External Power Supplies

AN-P051/19



OVERVIEW

The SL Power SLE06 Family of external power supplies are approved to IEC/UL/EN62368 and IEC/UL/EN60601-1 safety standards and comply with the IEC60601-1-2 4th Edition collateral standard for Electromagnetic disturbances. This adapter family is well suited for ITE, multimedia, industrial and medical applications. Although IEC60601-1-2 is a system level standard, the power adapter is the interface between the medical device and the AC power source and is an essential component in the path to achieving compliance to the standard.

The SLE06 series of adapters has leading edge power conversion efficiency to reduce component temperatures, extend product use life and reduce energy consumption. The SLE series adapters meet the U.S. Department of Energy (DoE) Level VI efficiency and No-Load power consumption requirements. In addition SL Power Electronics has taken the lead in developing and providing IEC60601-1-2 4th Edition compliant power adapters.

The SLE06 series power supplies have enhanced Electro- Magnetic Compatibility (EMC) features offering increased Electrostatic Discharge (ESD) protection, AC mains surge and Radio Frequency (RF) immunity, resulting in a more robust and reliable product. The SLE06 model's AC mains emissions comply with FCC & EN55032 and 55011 Class B levels with margin. Output emissions for differential ripple and common mode voltage and current have been reduced to minimize system level electromagnetic interference (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.

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 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

- When measuring efficiency, care must be taken to minimize input and output connection voltage drops, as these can significantly affect the results of the measurement. Consult SL Power's 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.

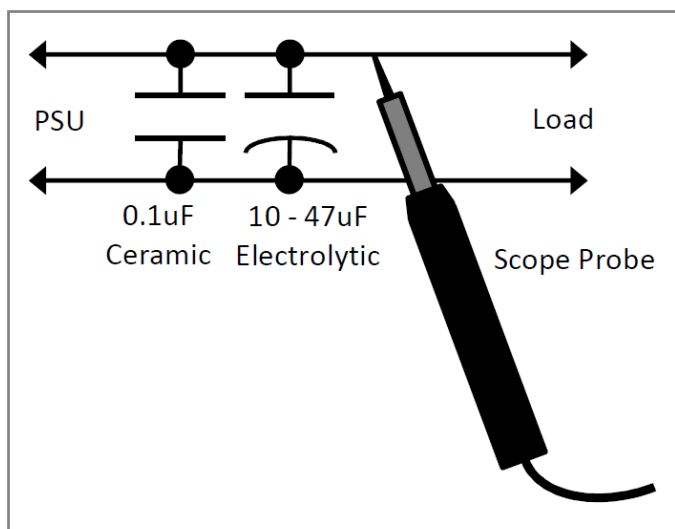


FIGURE 1: Noise measurement caps and probe with picture of the technique.

- Common mode noise is an 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.

– 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 circuit as the load, it is recommended to add ceramic capacitors ($\sim 0.1 - 1\mu\text{F}$) for noise spike reduction and an electrolytic capacitor 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.

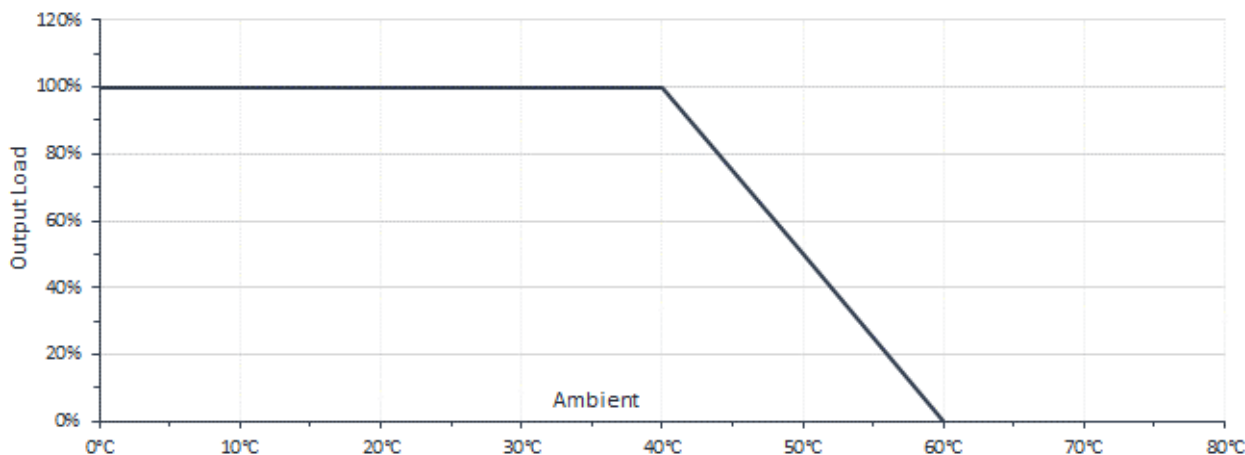


FIGURE 2: SLE06 family derating curve.

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 onto a hard surface.

SL Power 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 is essential to achieving long product life in excess of 7 to 10 years. SL Power Electronics uses only high-quality electrolytic capacitors in its products. Calculations and measurements are performed to verify capacitor ripple current, voltage and thermal stress and lifetime estimations.

PERFORMANCE DATA

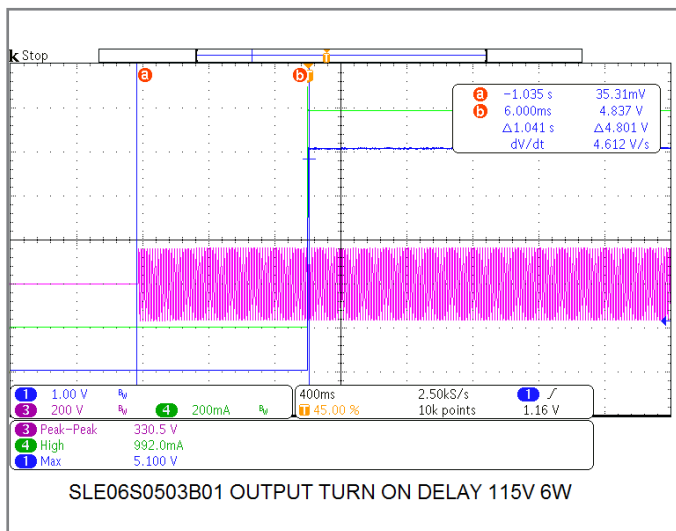
The following data is provided to aid in proper selection and system design. Additional performance data is available upon request.



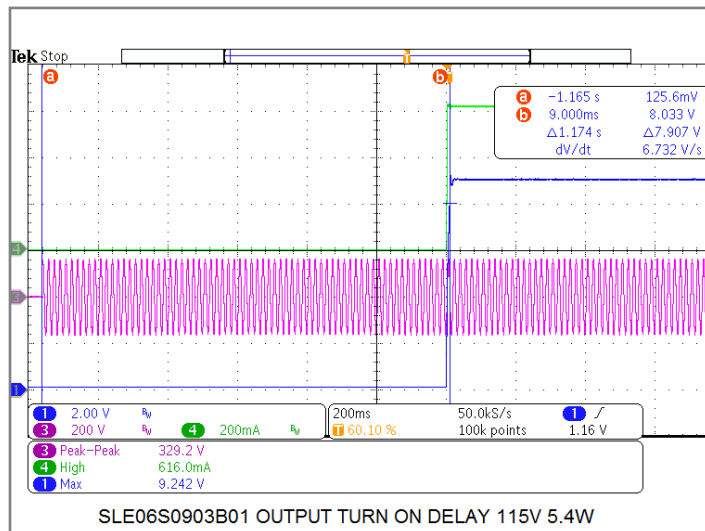
TURN-ON DELAY

Start-up Turn-On Delay typical times at 115VAC.

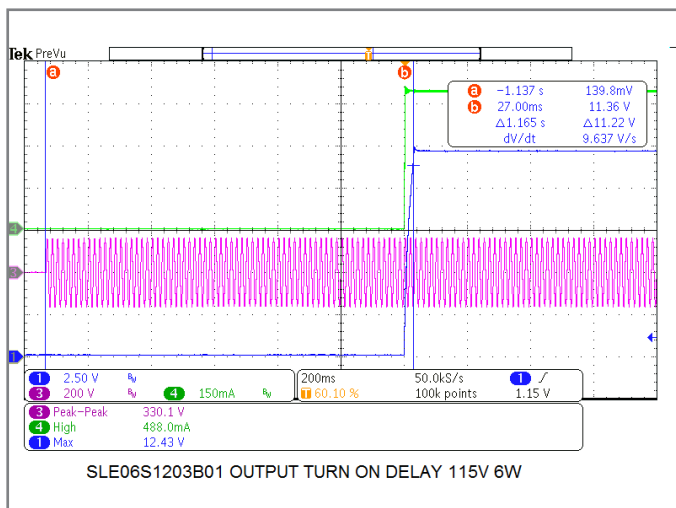
Note: The electronic load used for these plots was in constant current mode.



6W/5V Model Turn-On Delay Time



6W/9V Model Turn-On Delay Time



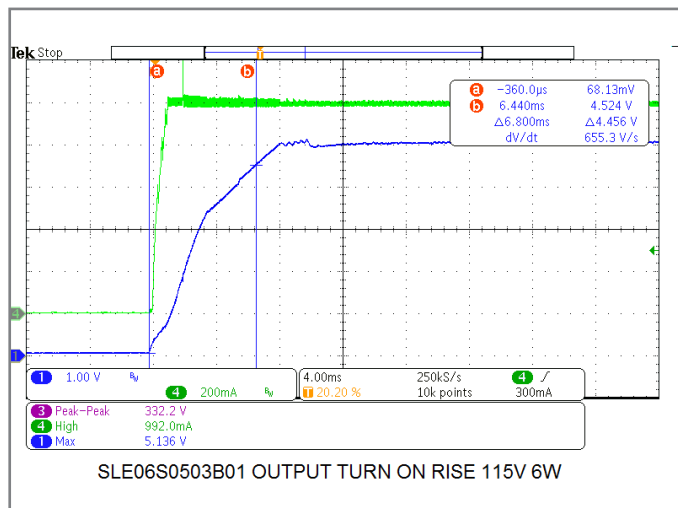
6W/12V Model Turn-On Delay Time



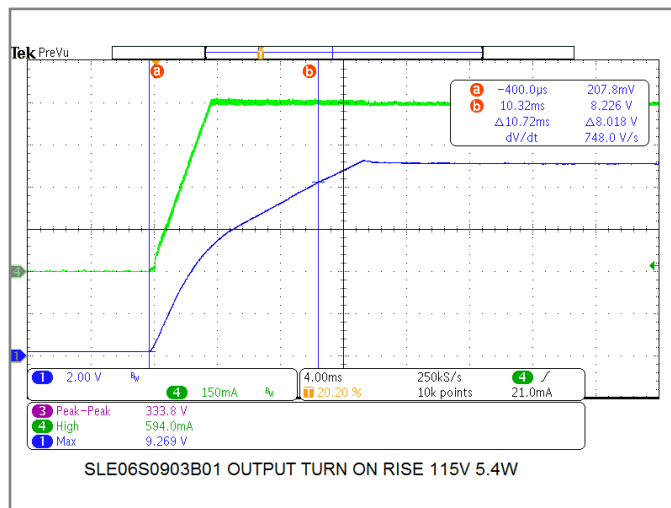
OUTPUT RISE TIME

After the output turn-on delay, there is the output turn-on rise time. The rise time is slightly impacted by line and load. Below are the data plots of the typical output rise time at 115VAC and full load.

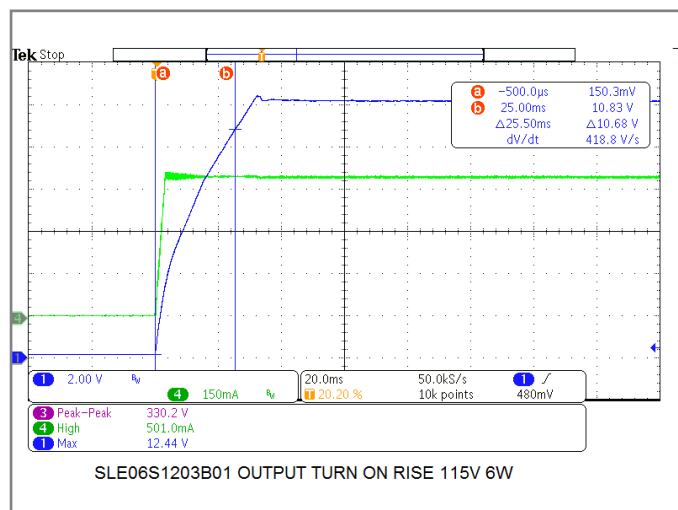
Note: The electronic load used for these plots was in constant current mode.



6W/5V Model Output Turn-On Rise Time



6W/9V Model Output Turn-On Rise Time

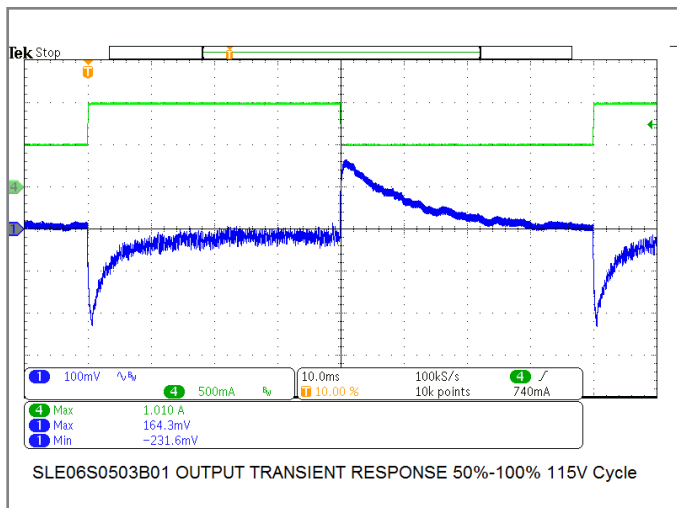


6W/12V Model Output Turn-On Rise Time

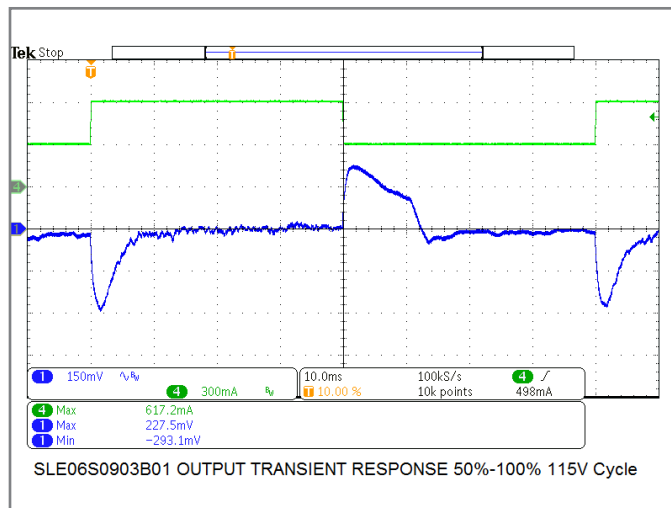


TRANSIENT RESPONSE

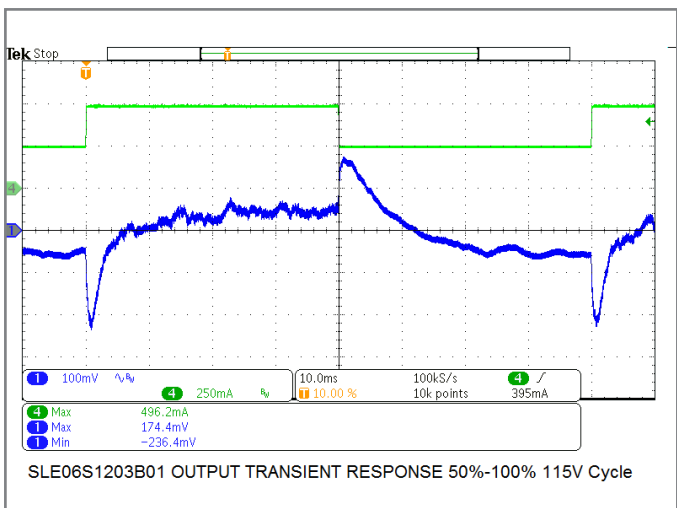
The transient response below shows a typical recovery time at 115VAC and that the output can hold its consistency.



6W/5V Model Transient Response



6W/9V Model Transient Response

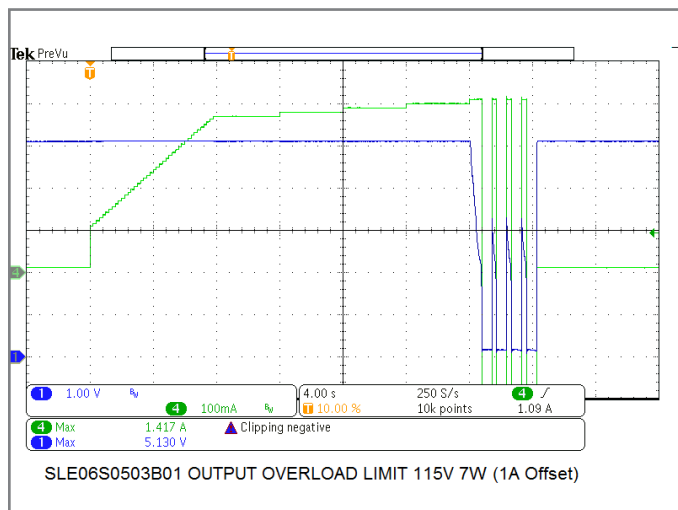


6W/12V Model Transient Response

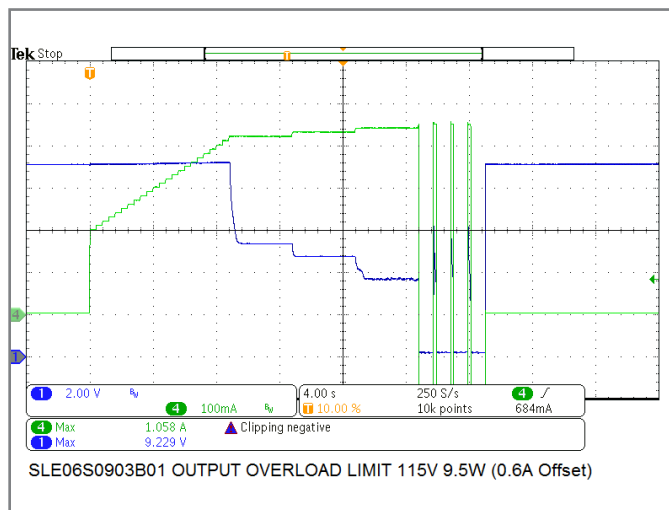


OUTPUT OVERLOAD PROTECTION

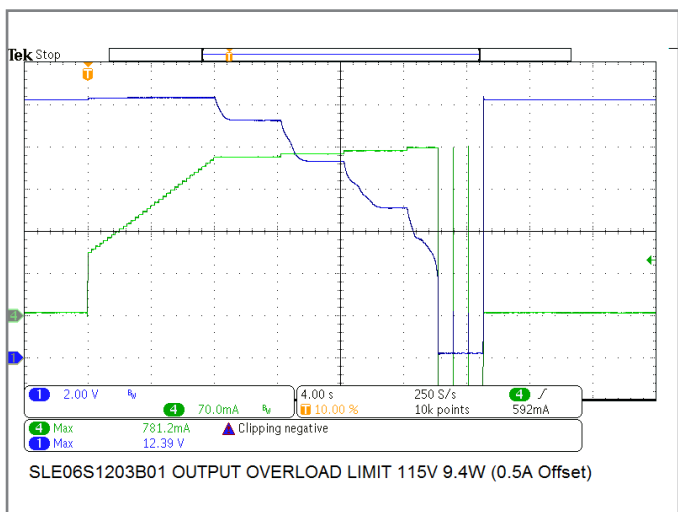
If the output happens to undergo an overload fault condition it will protect itself by going into a hiccup mode. Hence, it will auto recover when the overload fault condition is no longer present.



6W/5V Model Output Overload Protection



6W/9V Model Output Overload Protection

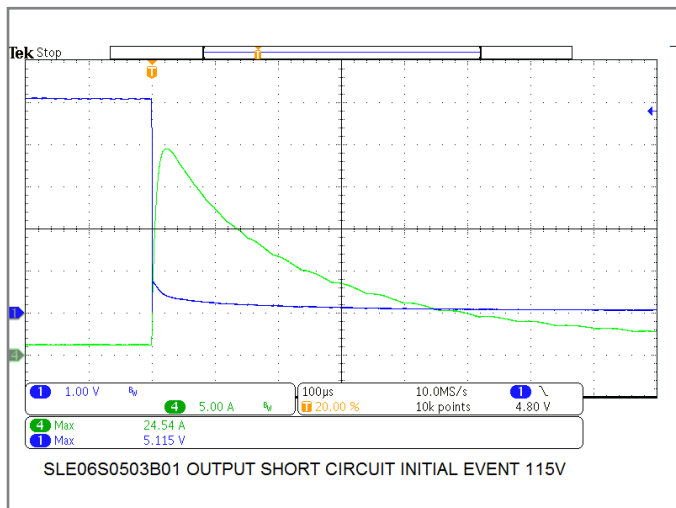


6W/12V Model Output Overload Protection

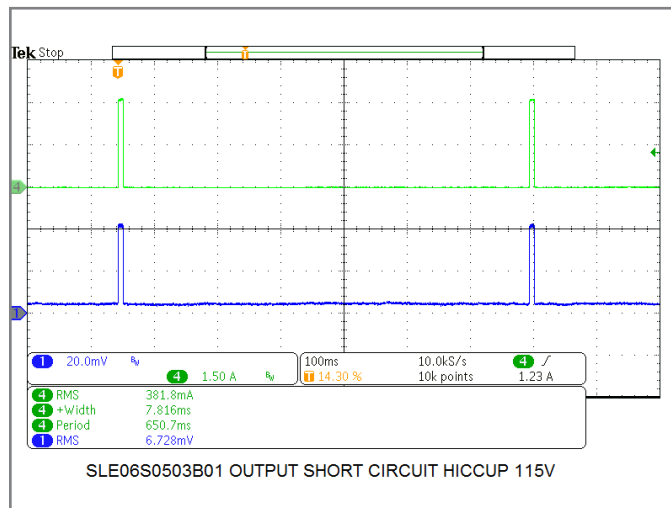


OUTPUT SHORT CIRCUIT PROTECTION

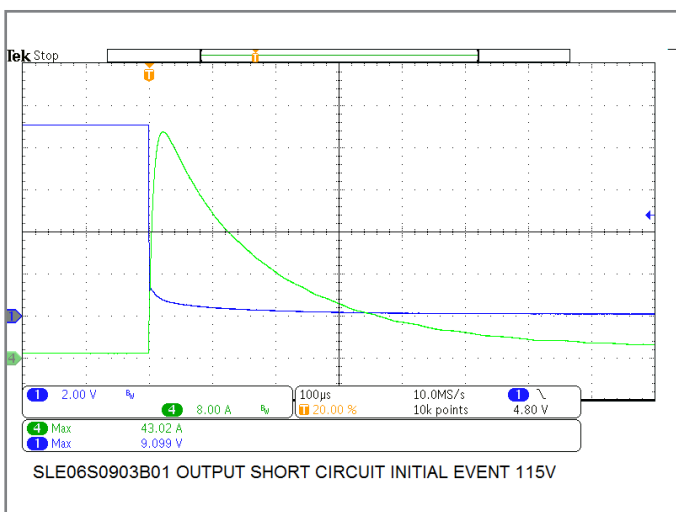
If the output happens to be short circuit, it will protect itself by going into a hiccup mode. It will auto recover when the short circuit condition has been removed.



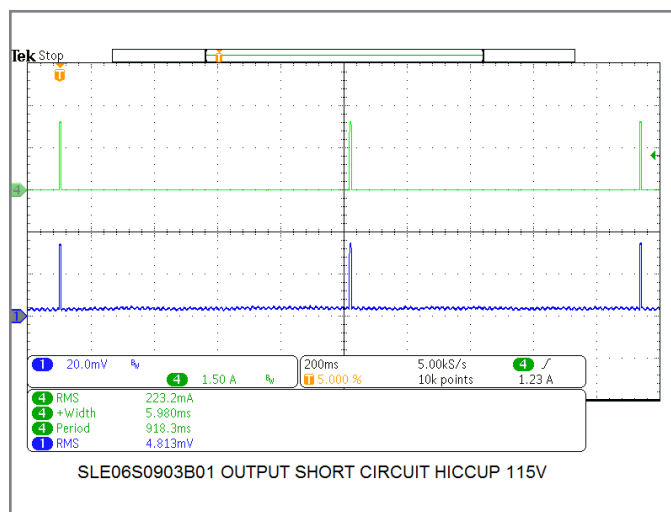
6W/5V Model Output Short Circuit Initial Event



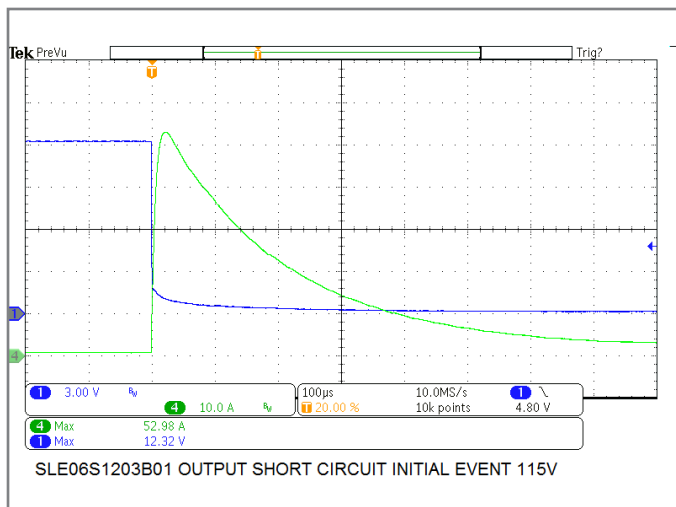
6W/5V Model Output Short Circuit Hiccup Mode



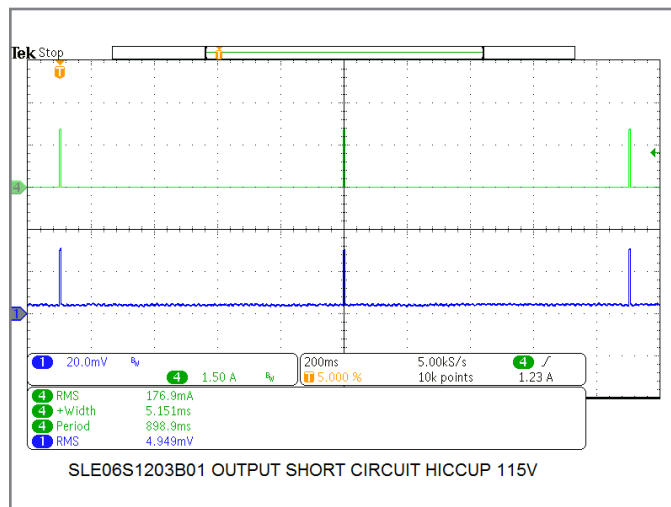
6W/9V Model Output Short Circuit Initial Event



6W/9V Model Output Short Circuit Hiccup Mode



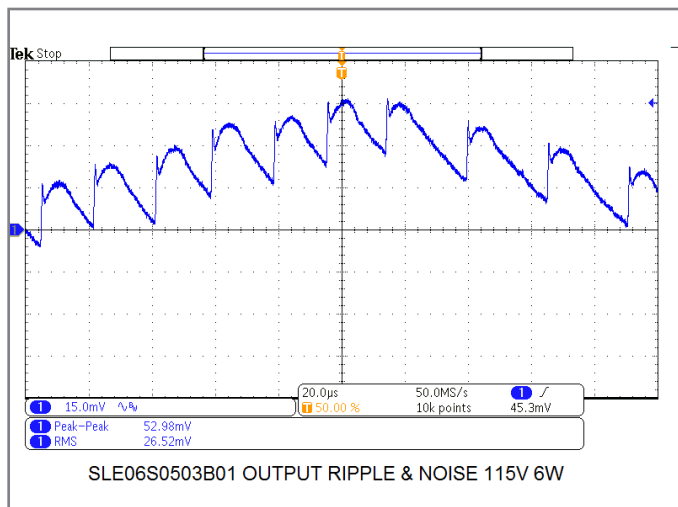
6W/12V Model Output Short Circuit Initial Event



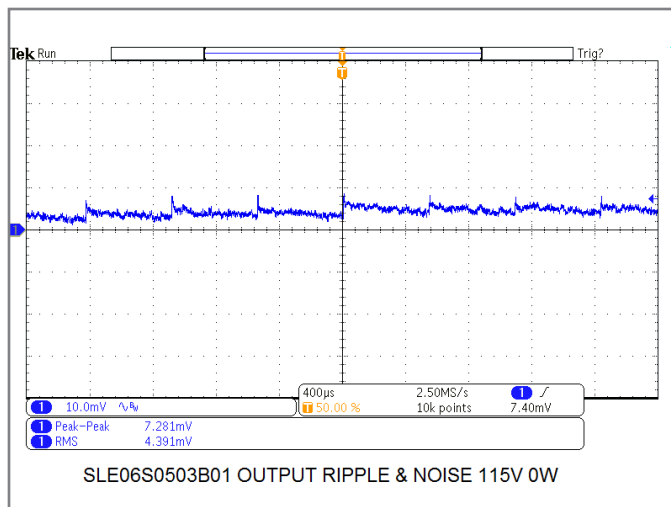
6W/12V Model Output Short Circuit Hiccup Mode

OUTPUT RIPPLE AND NOISE

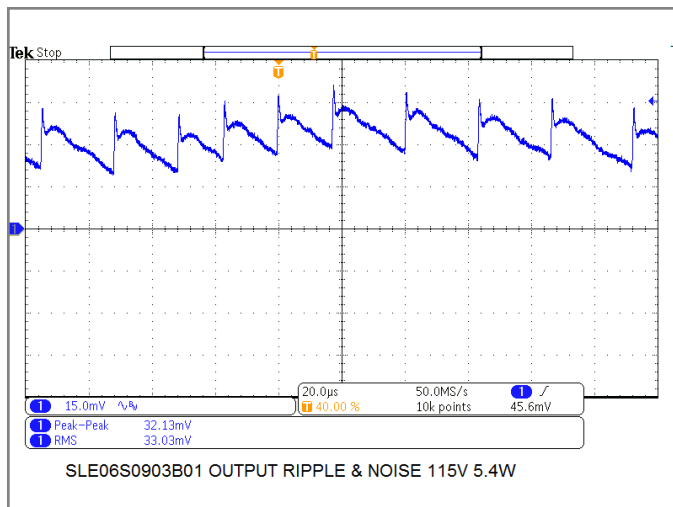
This is an inherent ac component of the output voltage due to internal switching, and its amplitude is shown on the plots below and considered to be within an acceptable level.



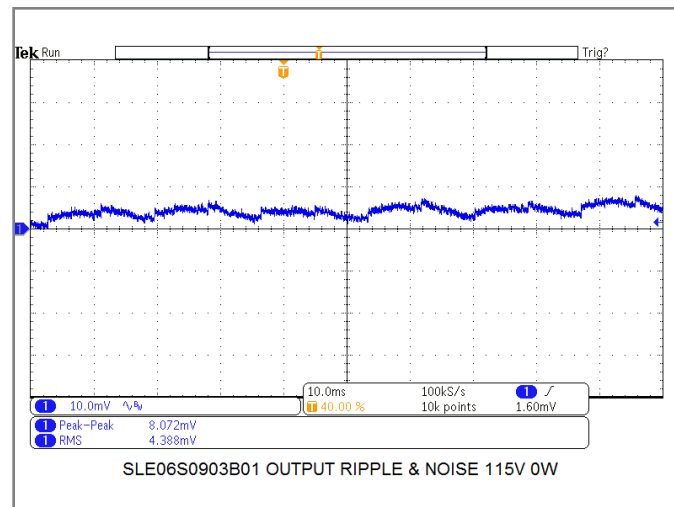
6W/5V Model Output Ripple & Noise at Full Load



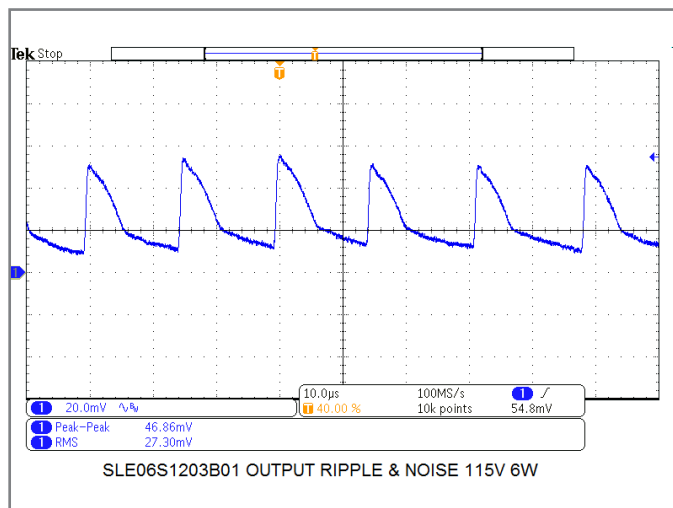
6W/5V Model Output Ripple & Noise at No Load



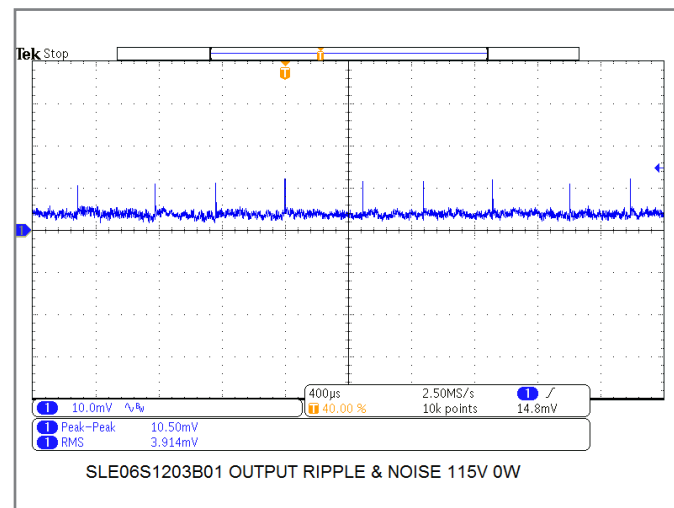
6W/9V Model Output Ripple & Noise at Full Load



6W/9V Model Output Ripple & Noise at No Load



6W/12V Model Output Ripple & Noise at Full Load

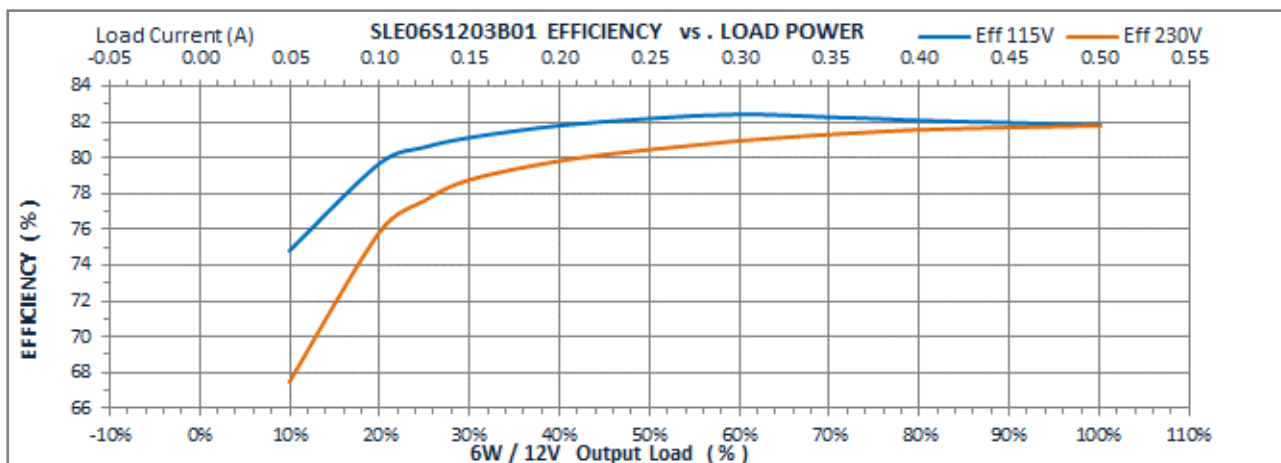
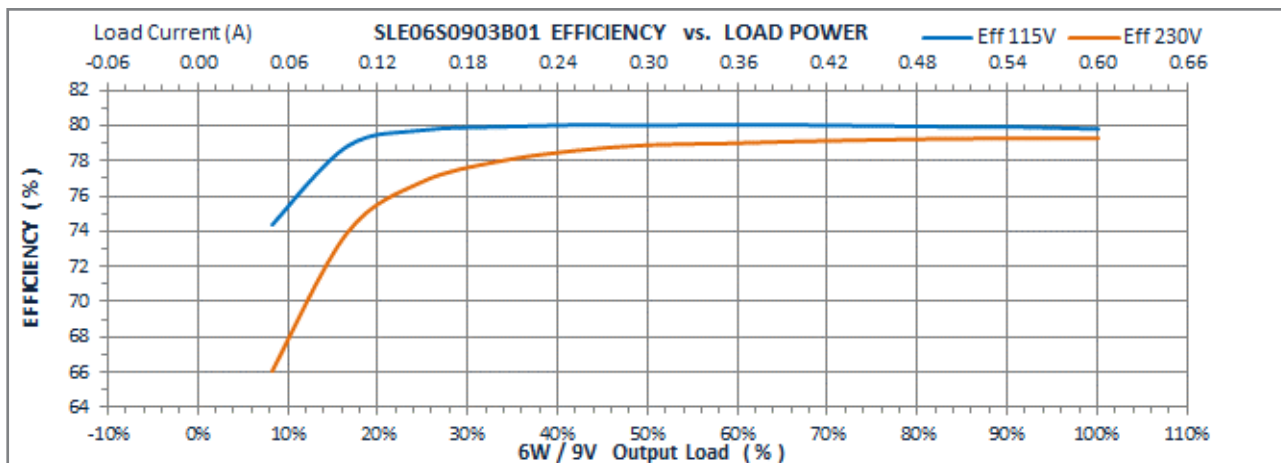
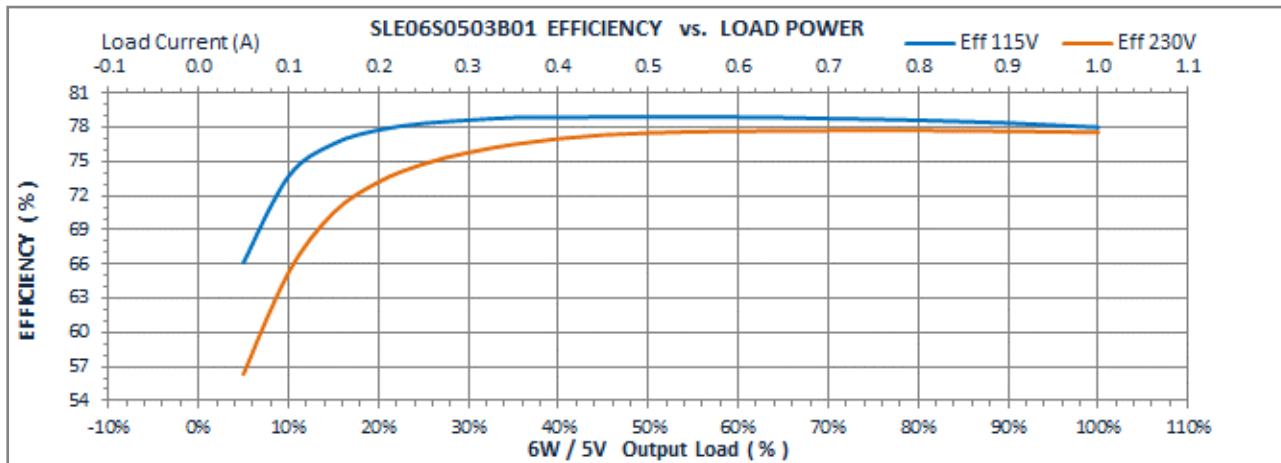


6W/12V Model Output Ripple & Noise at No Load



EFFICIENCY

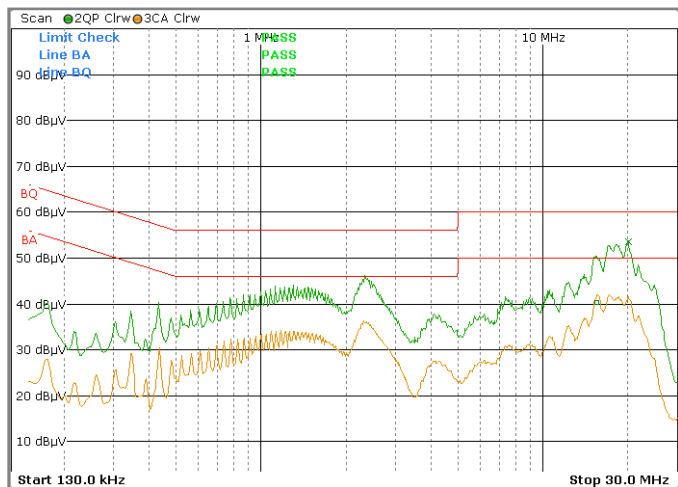
The ratio of total output power to input power is charted on the plot below in percentage from no load to full load at both nominal line voltage of 115VAC and 230VAC for each model.



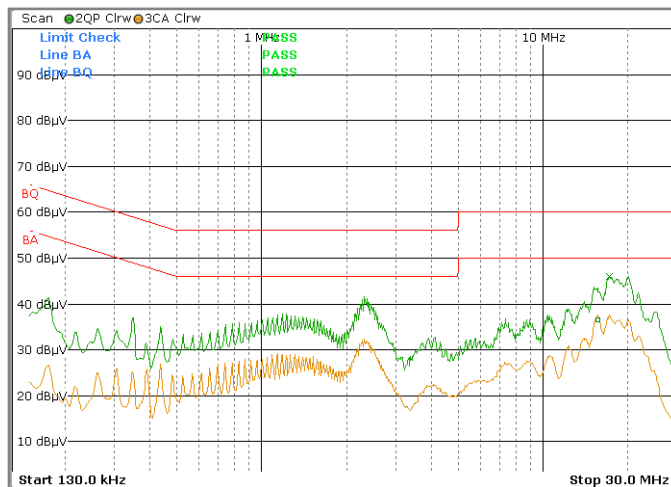


CONDUCTED ELECTROMAGNETIC INTERFERENCE (EMI)

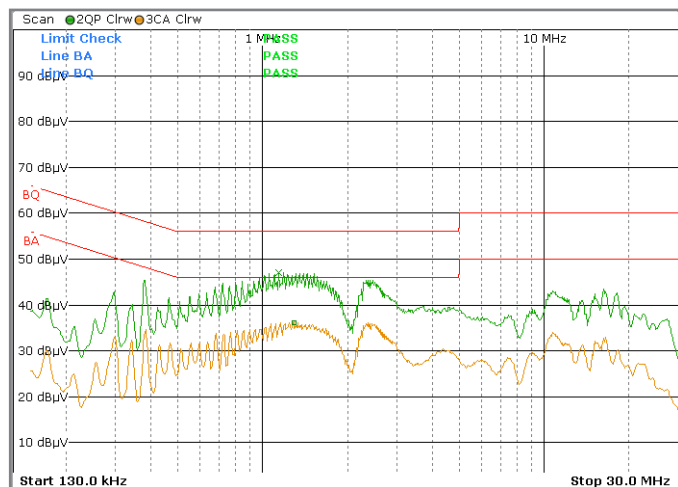
The EMI disturbance generated by the models herein described below are Line and Neutral a 120VAC/60Hz and it is within EN55032 Class B limits with good margin.



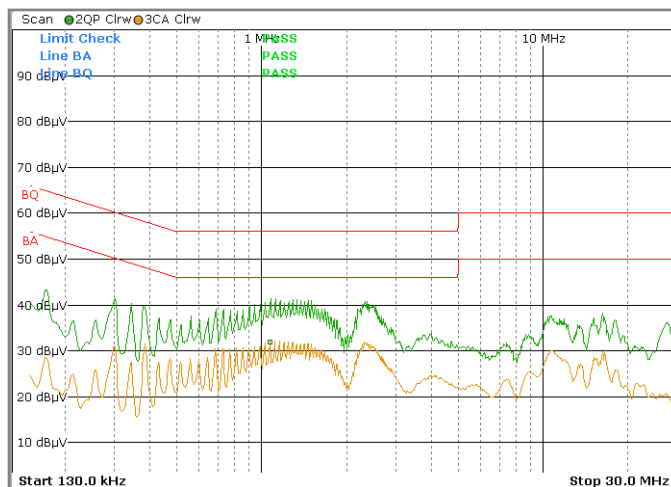
6W/5V Model _ Line 120V/60Hz 100% 5V@1.0A



6W/5V Model _ Neutral 120V/60Hz 100% 5V@1.0A



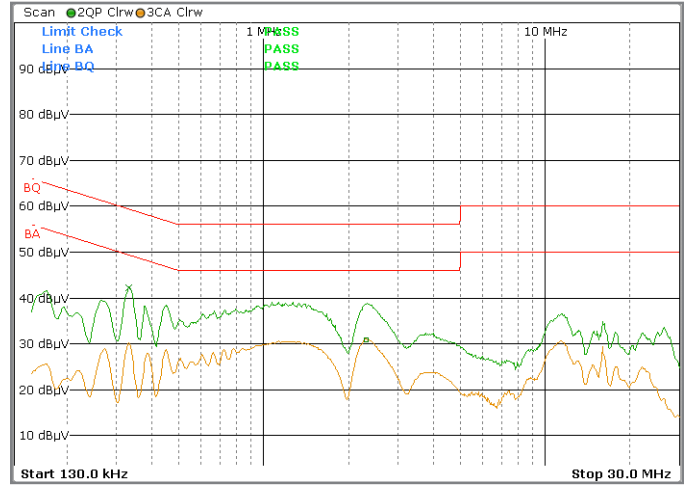
6W/9V Model _ Line 120V/60Hz 100% 9V@0.6A



6W/9V Model _ Neutral 120V/60Hz 100% 9V@0.6A



6W/12V Model _ Line 120V/60Hz 100% 12V@0.5A



6W/12V Model _ Neutral 120V/60Hz 100% 12V@0.5A



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