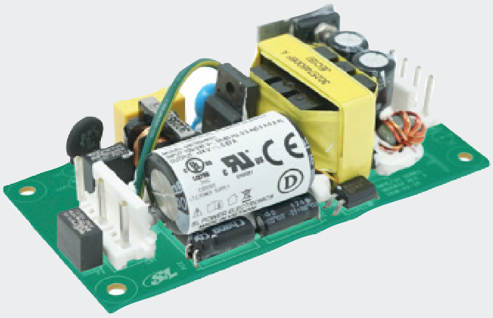
APPLICATION NOTE

SL POWER GB40 SERIES

40 Watts Family

Medical/Industrial Applications



Medical

Industrial

GB40 is a superior performance 40 Watt AC to DC converter, designed for medical and industrial applications. It is highly efficient (meets DOE level VI) and can effortlessly integrate in any system that requires 10 Watts of convection cooled power. All models are CE marked to low voltage directive and approved to CSA/EN/IEC/UL62368 and CSA/EN/IEC/UL60601-1 3.2 Edition. It meets Heavy Industrial and IEC60601-1-2 4th Edition Levels of EMC and meets Class B Radiated & Conducted Emissions with margin. The GB40 is offered in both Class I and Class II input. This application note will explain the features, benefits and considerations while using GB40 in medical/industrial devices or systems.

MODEL SELECTION

Model Number[1, 3]	Output Voltage	Output Current	Efficiency[2]	OVP
		Convection		Threshold
GB40S05K01	5.0 V	5.0A	86%	6.7V ± 0.7V
GB40S09K01	9.0 V	4.0A	88%	12.1V ± 1.3V
GB40S12K01	12.0 V	3.4A	89%	16.2V ± 1.8V
GB40S15K01	15.0 V	2.7A	89%	20.2V ± 2.2V
GB40S18K01	18.0 V	2.27A	89%	24.3V ± 2.7V
GB40S24K01	24.0 V	1.7A	89%	32.4V ± 3.6V
GB40S48K01	48.0 V	0.83A	88%	56.8V ± 2.1V

Note:
1. Change “K” to “C” for Class II input.
2. Efficiency is Typical at 230VAC, 25°C. See Charts in datasheet for load conditions.
3. Check datasheet for latest model information.

FEATURES

Size

When GB40 is a single output AC to DC power supply designed to fit into the 1U chassis. 1U is a rack unit or unit of measure defined as 1.75 inches (45 millimeters) height. While designing a system with a power supply, the engineer must consider the heat dissipations from integrated components and ensure enough clearance between the system components and the chassis or enclosure parts. The small dimensions of the GB40 2” x 4” x 1” package (50.8mm x 101.6mm x 25.4mm) allow to easily integrate it into the 1U chassis with enough space for airflow or convection cooling from top and bottom surfaces.

Power vs Temperature

The GB40 series power supplies are capable to provide up to 40 Watts of power in a convection-cooled environment up to 50°C ambient. At higher operating temperatures, refer to the Power Derating curve to avoid the internal over temperature protection (OTP) shutting down the power supply during excessive temperature excursions. The over temperature protection is based on an auto-recovery principle with the hysteresis of 30°C. See the Proper Use and Thermal Considerations sections of this application note.

Premium Electrolytic Capacitors

The life time of the power supply is mostly dependent on life limiting components such as electrolytic capacitors. This is particularly the case for convection cooled applications. AC ripple currents in these capacitors create additional heat, but the main cause of temperature rise is from operating ambient and adjacent heat sources. The higher the long-term temperature the electrolytic capacitors exposure, the shorter the life of the capacitor. GB40 series were designed to keep the temperature of critical electrolytic capacitors as low as possible but also fitted with premium electrolytic capacitors to benefit from best technologies of capacitor manufacturers. This approach allows GB40 life cycle of over 5 years (24/7 operation) at ambient temperature of 50°C.

Class B Conducted and Radiated EMI performance margins

GB40 series was designed to pass EN55032 Class B and FCC part 15 Class B with typical margin of 6db for conducted emissions and 3db for radiated emissions.

FEATURES

Safety and Isolation Type Rated

GB40 series provides 2 x MOPP (Means of Patient Protection) to in accordance with the IEC60601-1 medical standard. All models are CE marked to the EU Low Voltage Directive. Please contact the application engineering team for CE/UL certificates or CB reports if not found on the www.slpower.com website for this product.

Designed to meet new IEC 60601-1-2 4th Edition EMC requirements

The new 4th edition of standard IEC60601-1-2 for EMC requirements was lately released. The most significant change of the standard is harmonization with IEC60601-1-11 to classify medical devices into main groups, professional health-care facility environment and home healthcare environment which is more stringent and requires more attention of the system designers. .

Even though the certification is given at the system level, some of the tests are directly related to the functionality of the power supply. The GB10 design takes into consideration the new IEC 60601-1-2 4th Edition EMC requirements.

Leakage Current

Because of the lower values of allowable leakage current in medical power supplies, it is important to control the capac-itances that cause leakage currents. Reducing their value can severely reduce the EMI filter's effectiveness. SL Power's EMI filtering design tech-niques have overcome this barrier. Patient Leakage Current (Output to Earth) of GB40 is <90μA @264VAC, 60Hz input, NC. The model is suitable for BF Type applications.

Common Mode Noise

Common mode noise on the output of the power supply is rarely specified. In some applications, it is not an issue.How-ever in some Telecom and Network application, there are limits for common mode disturbances per EN55103-1 and EN55022/CISPR22. The GB40 series are designed with very low common mode noise, which easily meet the standard requirement.

PROPER USE

The GB40 power supplies have high power conversion efficiency, however they do rely on convection cooling in the surrounding environment (air) to prevent overheating or excessive component temperatures. Therefore, there needs to be adequate access to ambient air to ensure proper thermal performance of the power supply.

Do not exceed the power rating of the product.

Mounting standoff height should be ≥ 0.2in, for more information please refers to application note “open frame” and the prodt datasheet

A non-conductive insulator should be placed between the bottom of the unit and any conductive surface to ensure minimal creepage and clearance distances complying to the safety standard. If an insulator is not possible, increase standoffs to 0.3 inch to the bottom components or leads to keep safety clearance. Verify the safety requires for your application.

The GB40 is designed for both Class I and Class II AC input applications. Using the GB40 earth terminal for the end-product protective earthing is not recommended. A separate dedicated bonding conductor and suitable termination-should be used to connect the chassis to the end product protective earth.

PROPER USE

Use a proper mating connector for connection to the input and output connectors of the power supply. Refer to the GB40 datasheet for connector information.

For better EMI performance, avoid cable routing close to power supply especially near magnetics or switching components. If that is not possible, consider shielding cables of the power supply. Contact your local SLPE application engineer for support.

If the system requires an additional EMI filter, carefully consider properly selecting system EMI filters. Power Entry Modules (PEM) could cause resonance due to its inductive and capacitive reactance interfering with the power supply EMI filter. Choosing an appropri-ate Power Entry Module with the right capacitance and inductance to use with the power supply is critical. For proper performance, it is needed to place the PEM near the intended power supply with the interconnect wires as short and close to the chassis as possible. On the other hand, the interconnect wires between the power supply output and system board, power converter modules and so on are acting as antenna which are susceptible to electric and magnetic field couplings. They often need to be twisted and/or shielded and keep them short.

THERMAL CONSIDERATION

The following table lists the main components of GB40 series and their maximum allowed temperature. Monitoring and keeping these parts below the limits helps to extend the service life of the power supply. Take proper precautions whenmeasuring component temperatures as some components are located on the hazardous voltage (mains) side of thepower supply. Thermal couples need to be electrically isolated. The following table and pictures list the critical components and maximum allowable temperatures.

Model Number	Output Voltage	Reference Designator	Max. allowed temperature
Capacitor X-Type	Yes	CX1	100°C
Input Bulk Capacitor	Yes	PC1	105°C
Output Capacitors	-	SC1, SC2，SC6	105°C
Electrolytic Capacitor	-	PC2	105°C
Power Transformer	Yes	T1	145°C
Inductors	Yes	LF1	130°C

As already mentioned, life of electrolytic capacitors are significantly affected by temperature. It is strongly recommended to keep their temperature 5°C to 10°C below the max allowed values in the table under worst case condition.

Even if the transformer and inductors offer enough thermal margins from maximum allowed temperature, their temperature can reach 110°C. System designers must consider carefully while placing other system components near it.

For proper worst-case verification, use low line input voltage of 90 VAC with the highest load at 50°C. Place thermocouples on the listed components on a non-conductive area to measure excessive temperatures and to determine correct thermal design.

Caution! Almost all components are located on primary side of the AC to DC power supply! Use appropriate safetymeasures as these components are at hazardous voltage levels. Only qualified personnel should attempt to make these measurements.

THERMAL CONSIDERATIONS

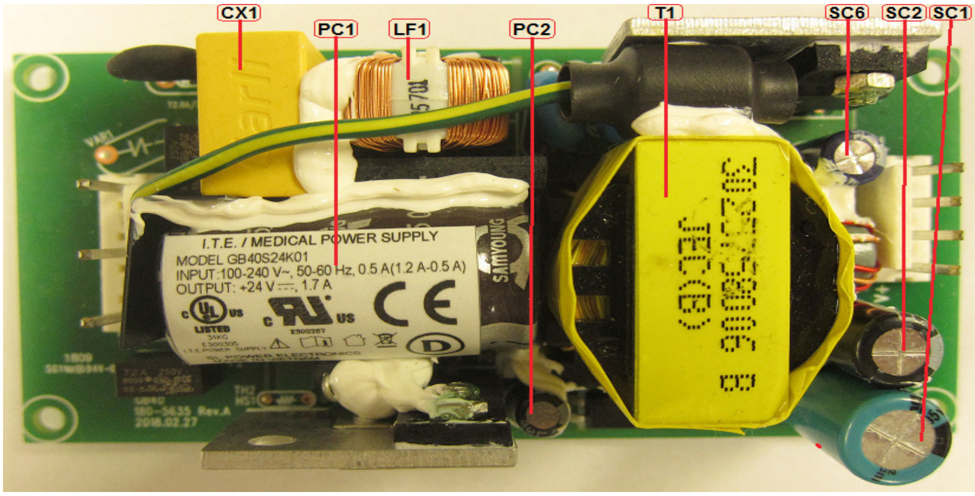


Figure 1: Cassis Mount Type

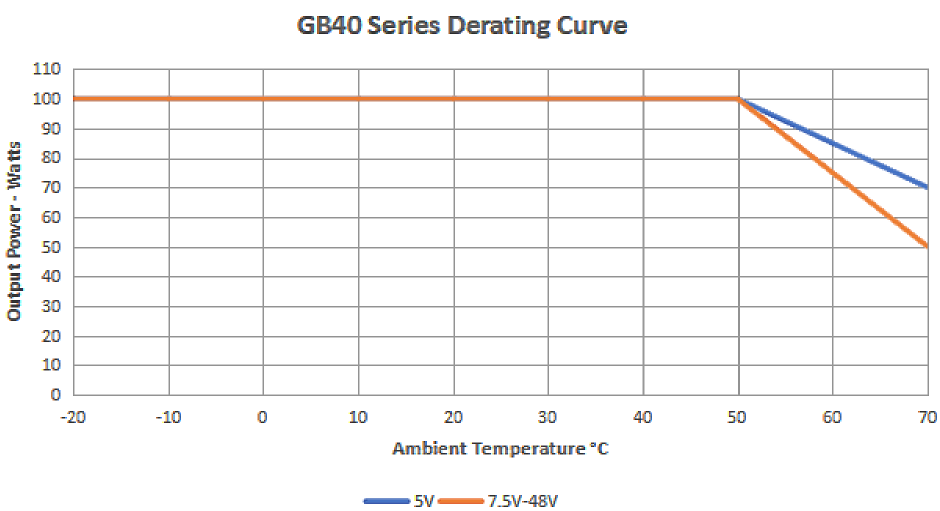


Figure 2: GB40 Series Derating Curve

PERFORMANCE DATA

Inrush Current

GB40S05K01

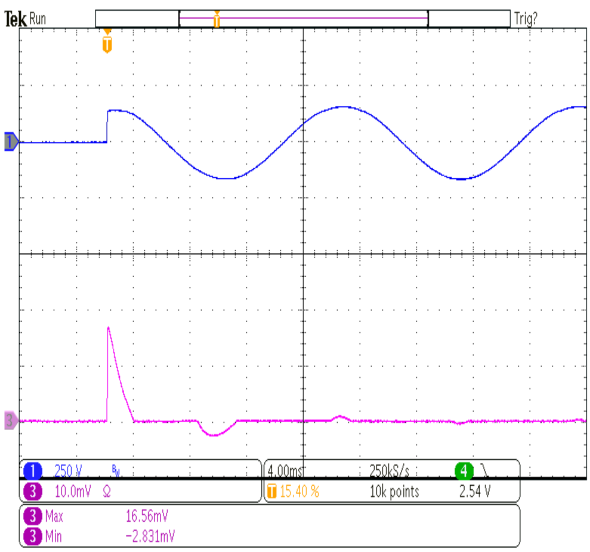


Figure 3: Inush Current at 115Vac 5V/5A - CH3: 10A/Div

I(inrush) = 16.56A peak

$I^2t = 0.27A^2S$

GB40S05K01

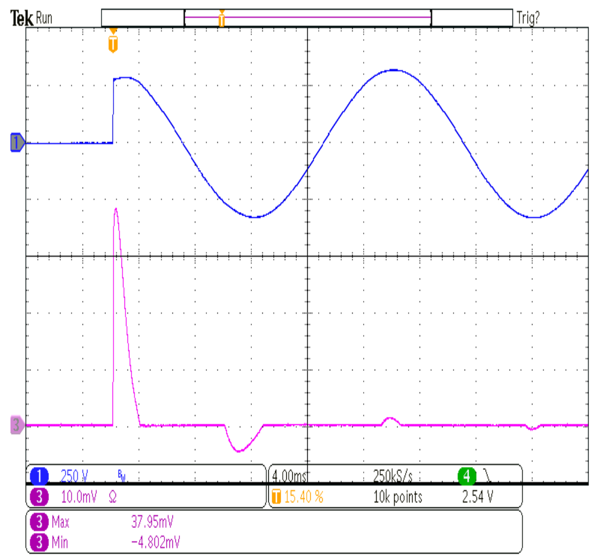


Figure 4: Inush Current at 230Vac 5V/5A - CH3: 10A/Div

I(inrush) = 37.95A peak

$I^2t = 1.45A^2S$

GB40S12K01

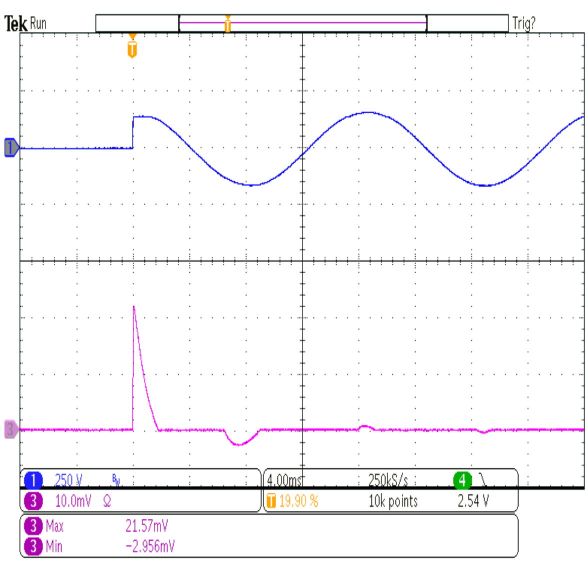


Figure 5: Inush Current at 115Vac 12V/3.4A - CH3: 10A/Div

I(inrush) = 21.57A peak

$I^2t = 0.45A^2S$

GB40S12K01

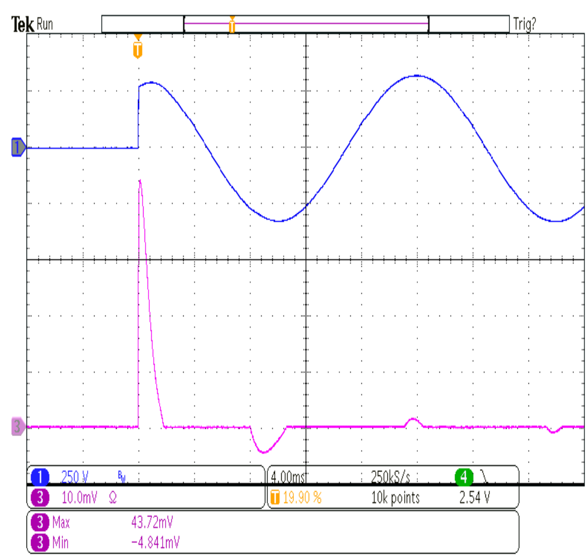


Figure 6: Inush Current at 230Vac 12V/3.4A - CH3: 10A/Div

I(inrush) = 43.72A peak

$I^2t = 1.85A^2S$

PERFORMANCE DATA

Inrush Current

GB40S24K01

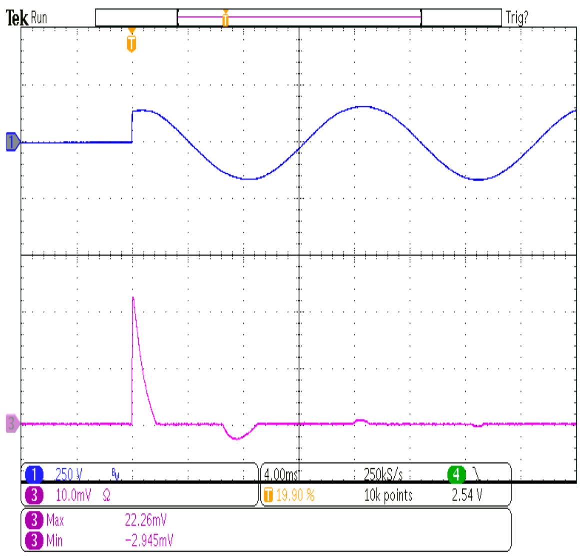


Figure 7: Inush Current at 115Vac 24V/1.7A - CH3: 10A/Div

I(inrush) = 22.26A peak

$I^2t = 0.45A^2S$

GB40S24K01

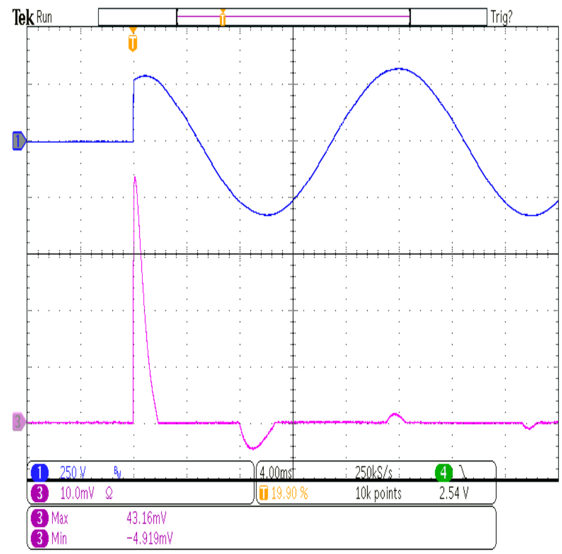


Figure 8: Inush Current at 230Vac 24V/1.7A - CH3: 10A/Div

I(inrush) = 43.16A peak

$I^2t = 1.80A^2S$

GB40S48K01

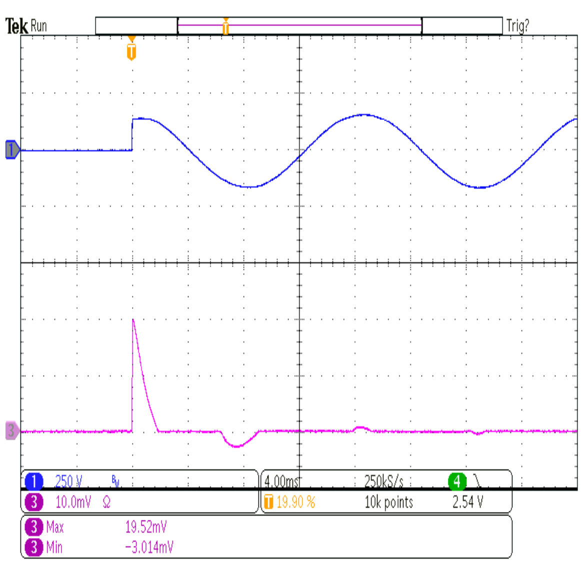


Figure 9: Inush Current at 115Vac 48V/0.83A - CH3: 10A/Div

I(inrush) = 19.52A peak

$I^2t = 0.37A^2S$

GB40S48K01

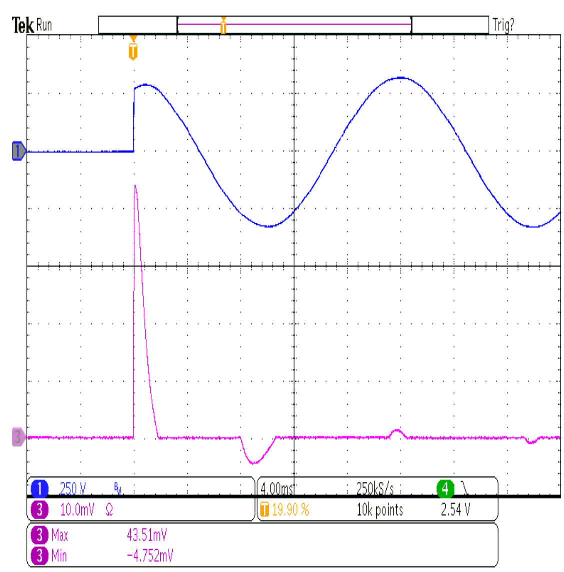


Figure 10: Inush Current at 230Vac 48V/0.83A - CH3: 10A/Div

I(inrush) = 43.51A peak

$I^2t = 1.87A^2S$

PERFORMANCE DATA

Output Turn-On Delay Time

GB40S05K01

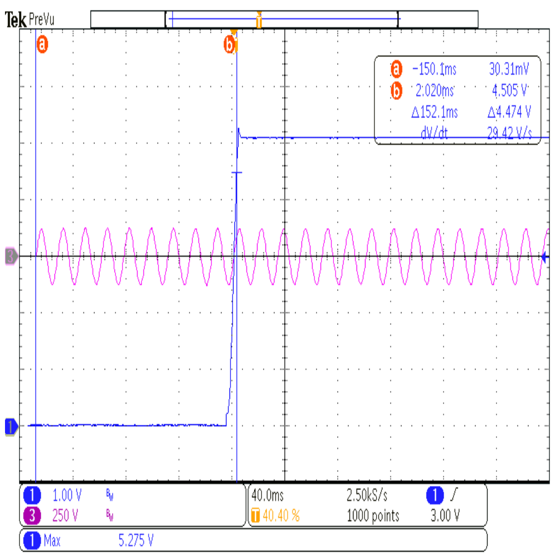


Figure 11: Turn-on delay at 90Vac - 5A load

GB40S05K01

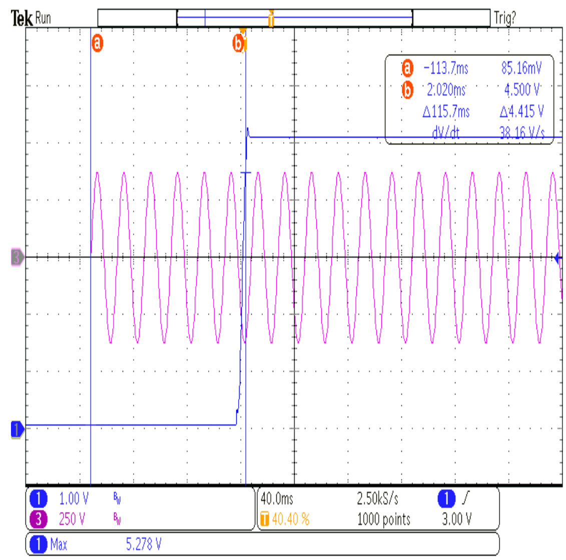


Figure 12: Turn-on delay at 264Vac - 5A load

GB40S12K01

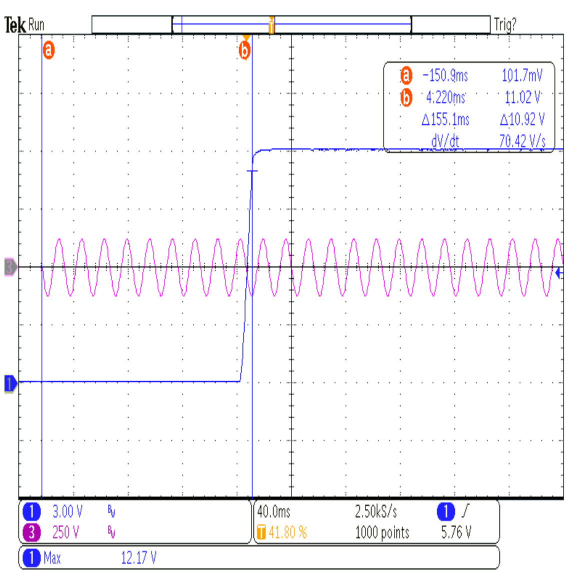


Figure 13: Turn-on delay at 90Vac - 3.4A load

GB40S12K01

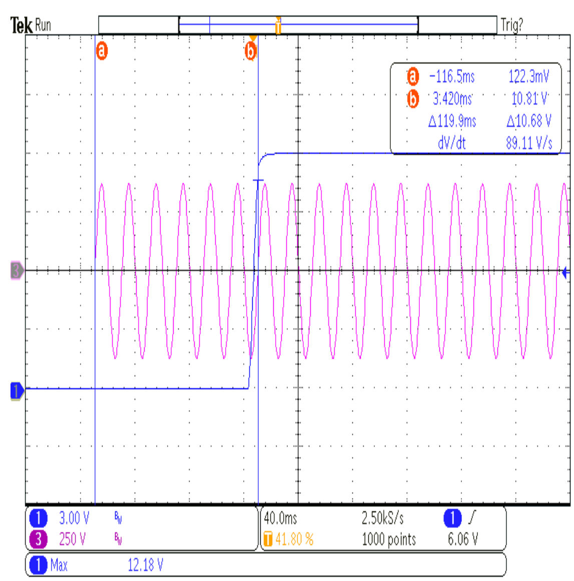


Figure 14: Turn-on delay at 264Vac - 3.4A load

PERFORMANCE DATA

Output Turn-On Delay Time

GB40S24K01

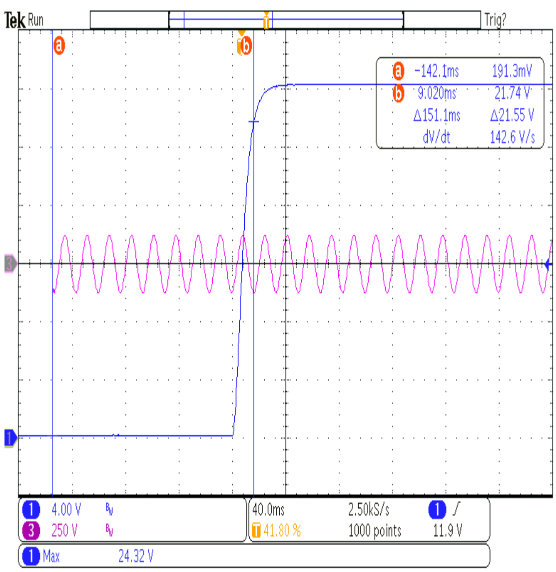


Figure 15: Turn-on delay at 90Vac - 1.7A load

GB40S24K01

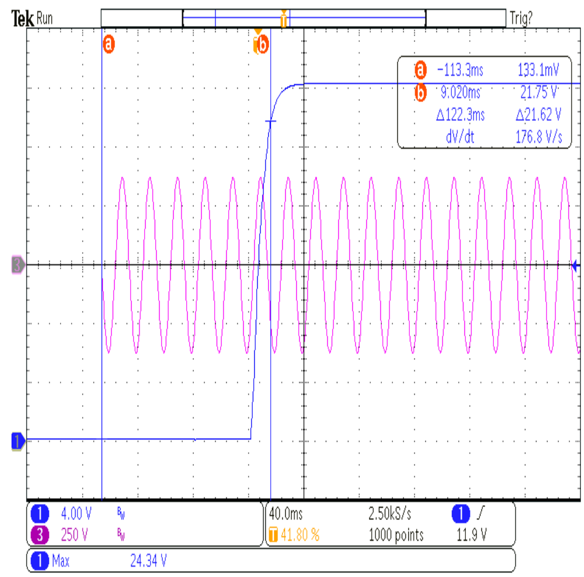


Figure 16: Turn-on delay at 264Vac - 1.7A load

GB40S48K01

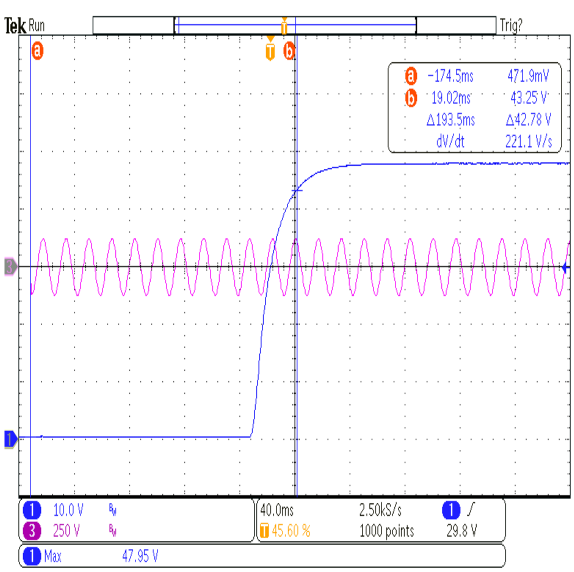


Figure 17: Turn-on delay at 90Vac - 0.83A load

GB10S24K01

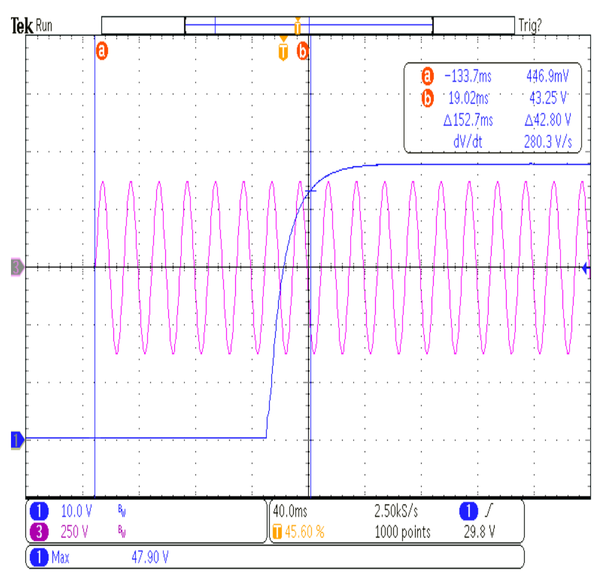


Figure 18: Turn-on delay at 264Vac - 0.83A load

PERFORMANCE DATA

Output Turn-On Rise Time

GB40S05K01

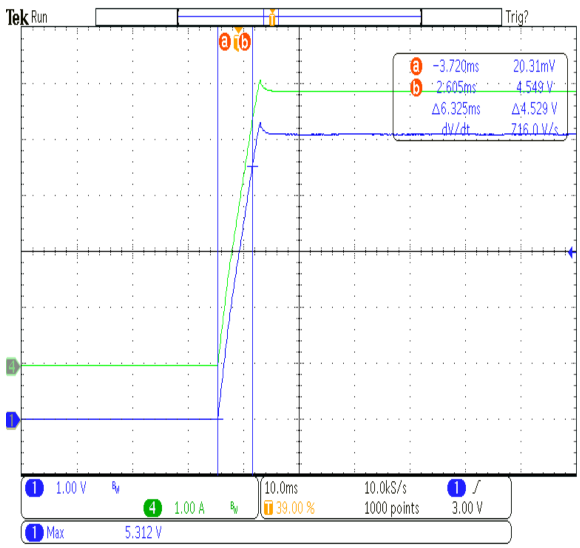


Figure 19: Turn-on rise time at 90Vac - 5A load

CH1: Vout

CH4: Load Current

GB40S05K01

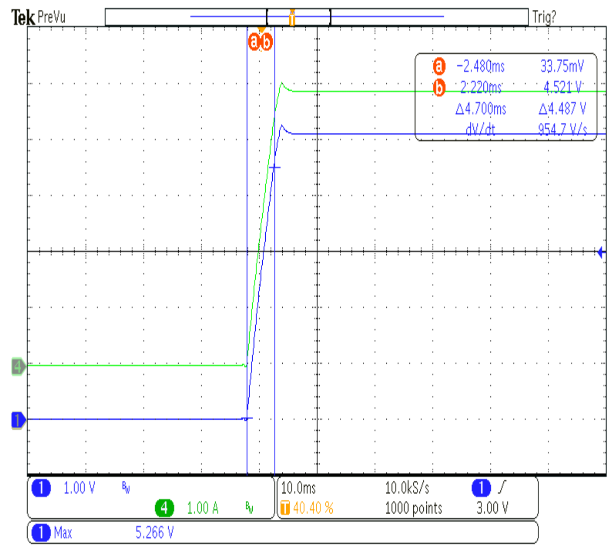


Figure 20: Turn-on rise time at 264Vac - 5A load

CH1: Vout

CH4: Load Current

GB40S12K01

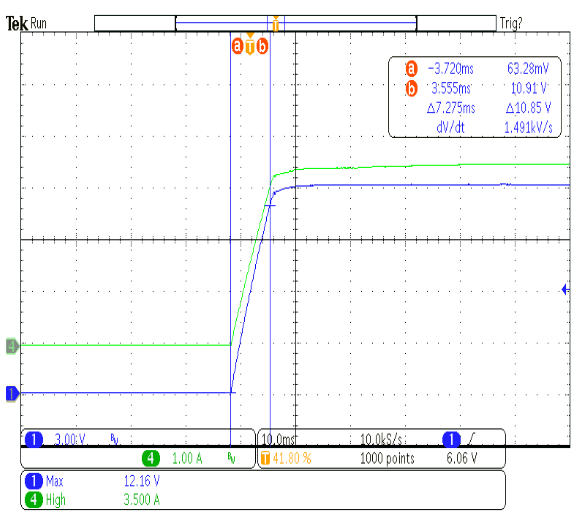


Figure 21: Turn-on rise time at 90Vac - 3.4A load

CH1: Vout

CH4: Load Current

GB40S12K01

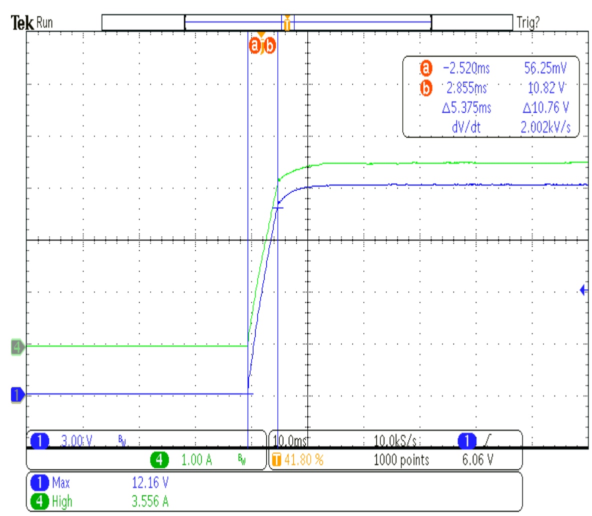


Figure 22: Turn-on rise time at 264Vac - 3.4A load

CH1: Vout

CH4: Load Current

Advanced Energy

PERFORMANCE DATA

Output Turn-On Rise Time

GB40S24K01

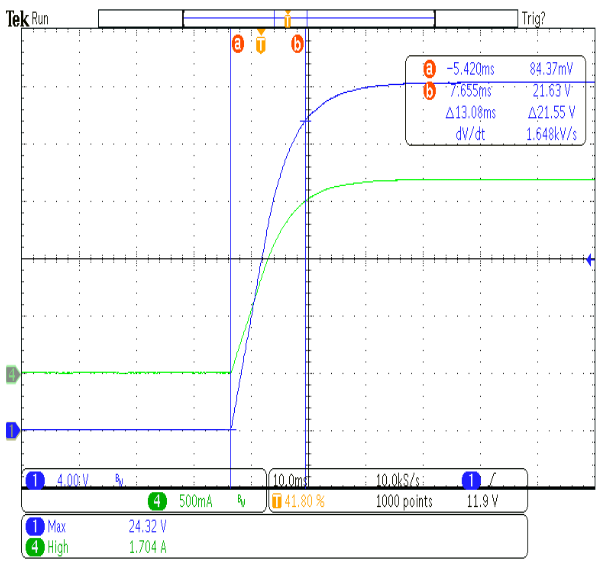


Figure 23: Turn-on rise time at 90Vac - 1.7A load

CH1: Vout

CH4: Load Current

GB40S24K01

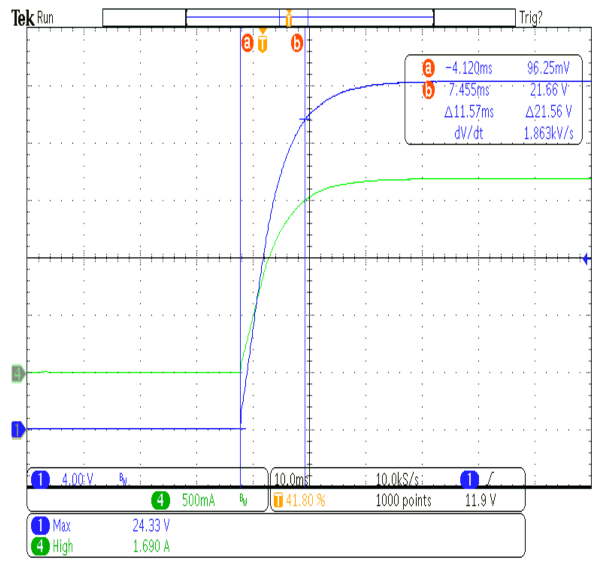


Figure 24: Turn-on rise time at 264Vac - 1.7A load

CH1: Vout

CH4: Load Current

GB40S48K01

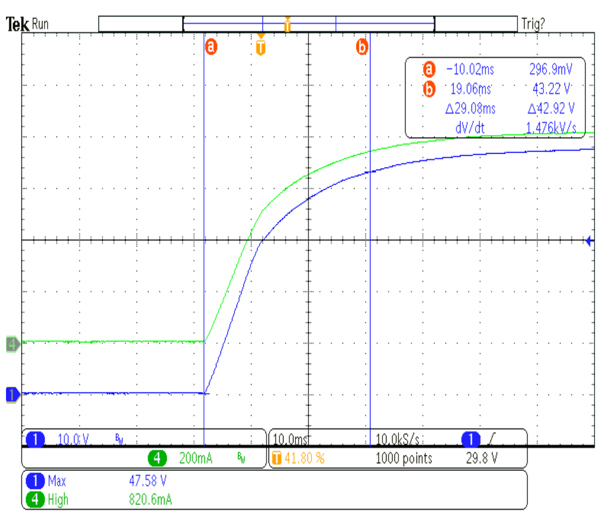


Figure 25 Turn-on rise time at 90Vac - 0.83A load

CH1: Vout

CH4: Load Current

GB40S48K01

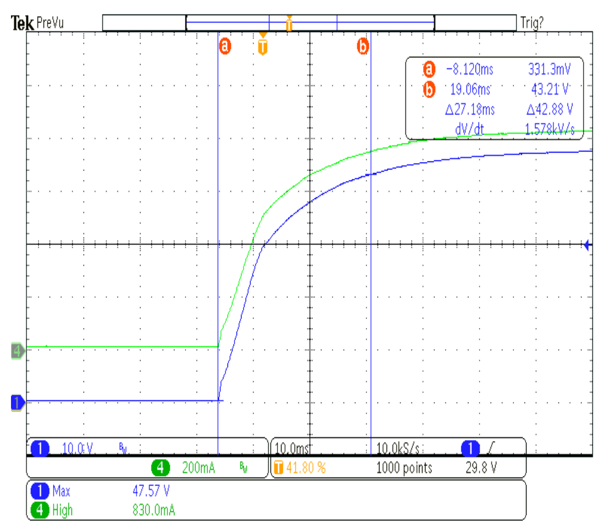


Figure 26: Turn-on rise time at 264Vac - 0.83A load

CH1: Vout

CH4: Load Current

PERFORMANCE DATA

Hold-Up Time

GB40S05K01

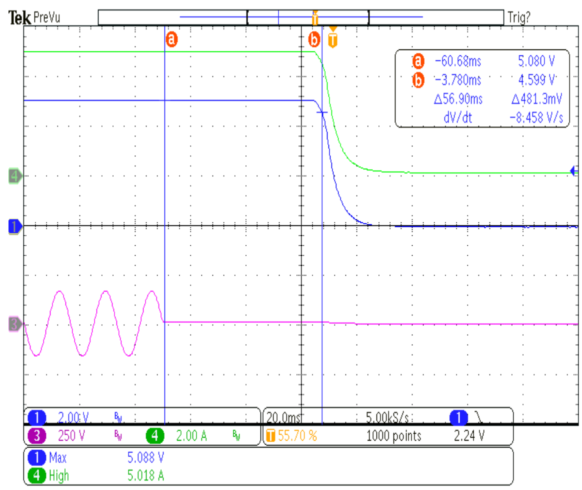


Figure 27: Hold-up time at 115Vac - 5A load

GB40S05K01

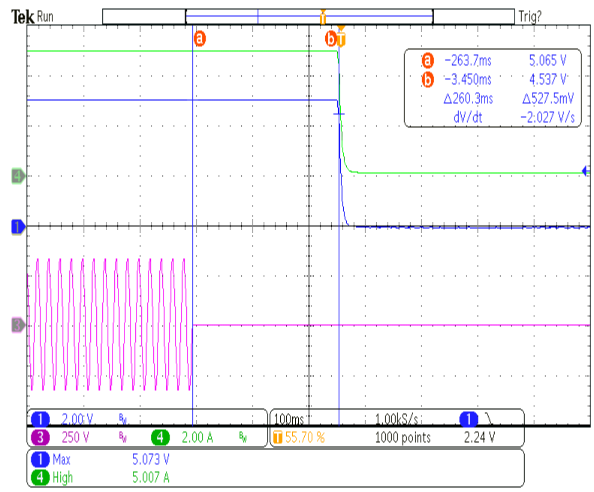


Figure 28: Hold-up time at 230Vac - 5A load

GB40S12K01

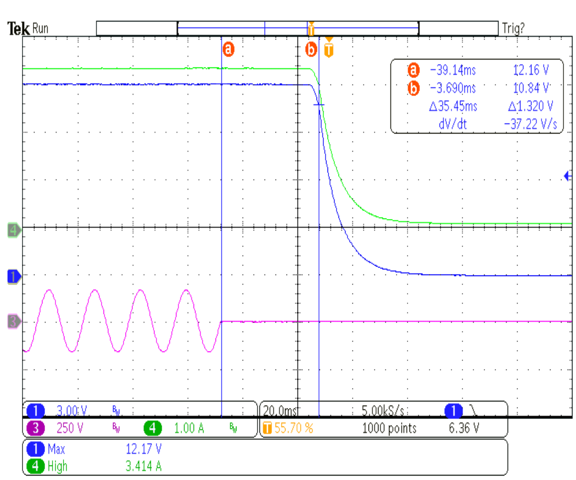


Figure 29 Tutn-on rise time at 115Vac - 3.4A load

GB40S12K01

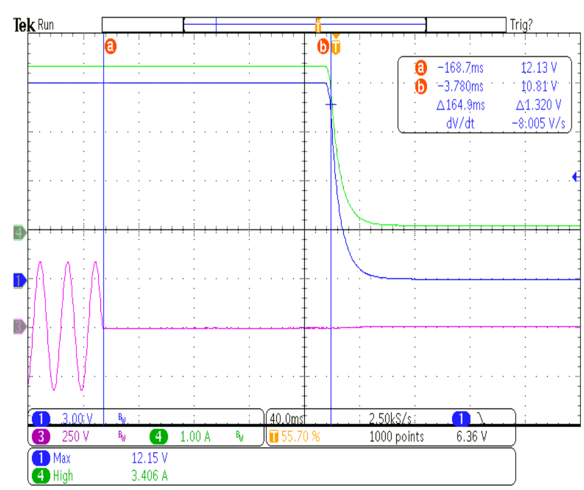


Figure 30: Tutn-on rise time at 230Vac - 3.4A load

PERFORMANCE DATA

Hold-Up Time

GB40S24K01

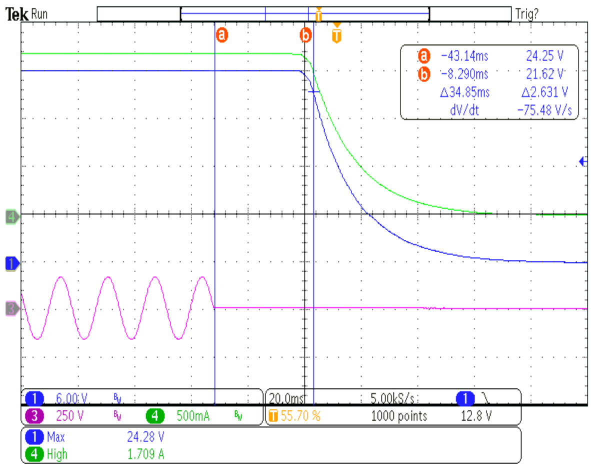


Figure 31: Hold-up time at 115Vac - 1.7A load

GB40S24K01

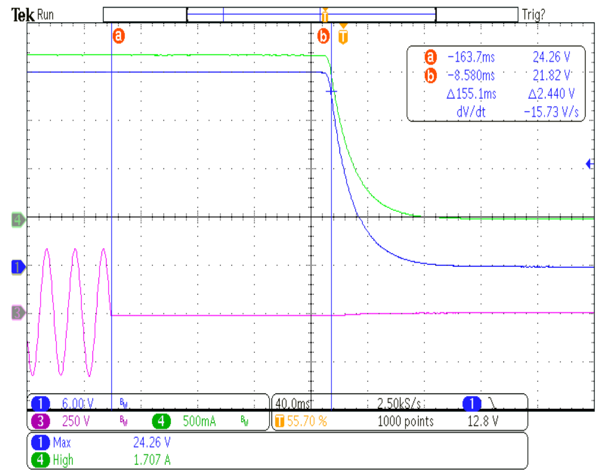


Figure 32: Hold-up time at 230Vac - 1.7A load

GB40S48K01

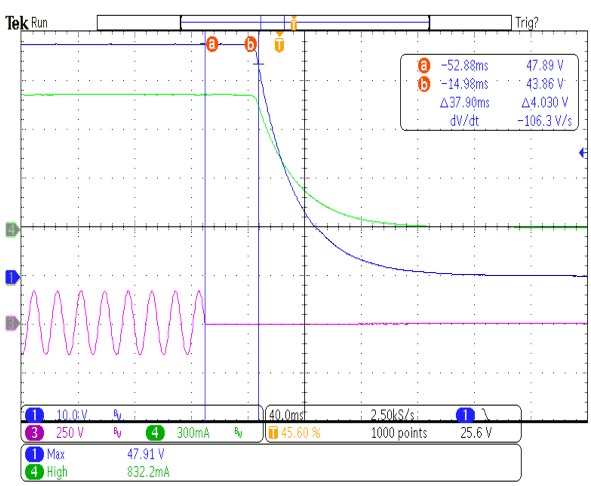


Figure 33 Tutn-on rise time at 115Vac - 0.83A load

GB40S48K01

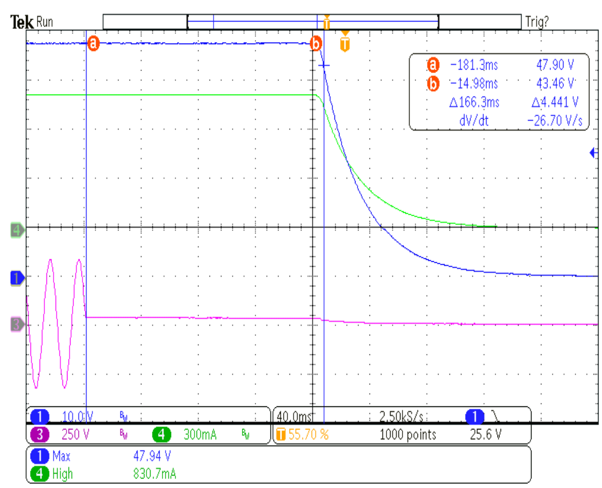


Figure 34: Tutn-on rise time at 230Vac - 0.83A load

PERFORMANCE DATA

Outpot Over-Load Protection

GB40S05K01

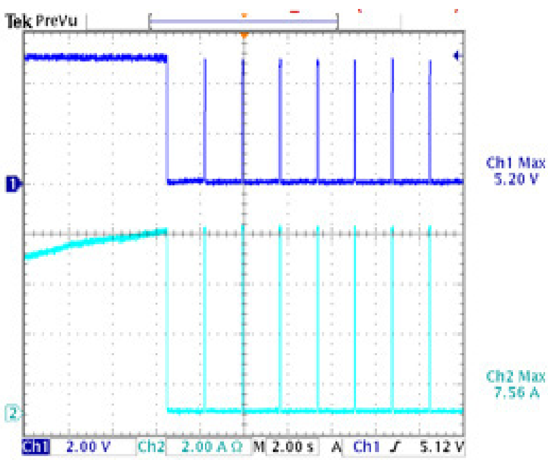


Figure 35: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S05K01

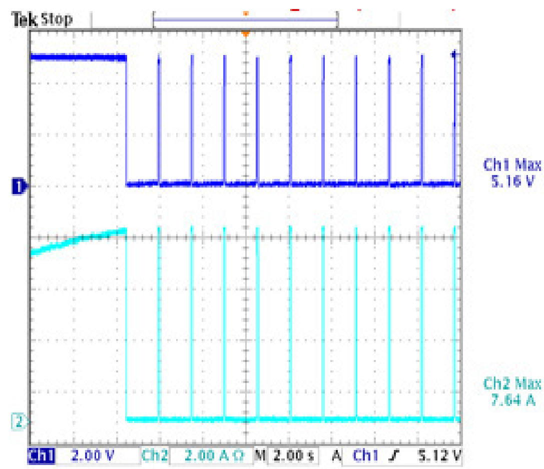


Figure 36: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

GB40S12K01

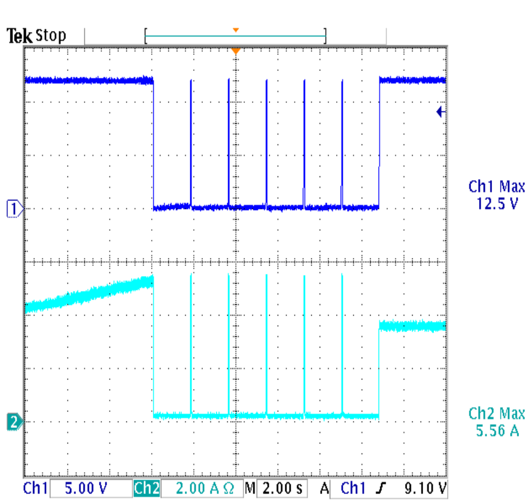


Figure 37: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S12K01

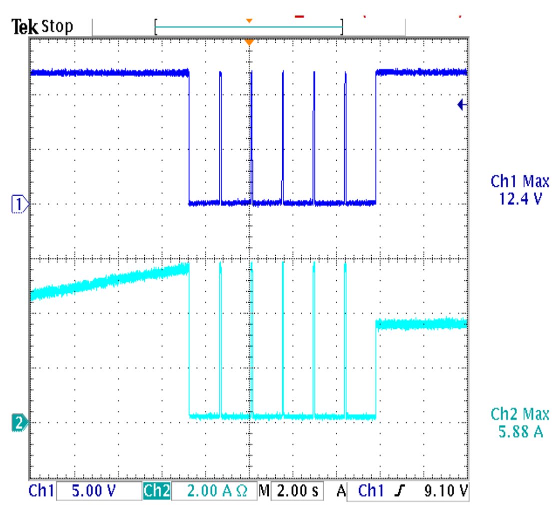


Figure 38: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

PERFORMANCE DATA

Outpot Over-Load Protection

GB40S24K01

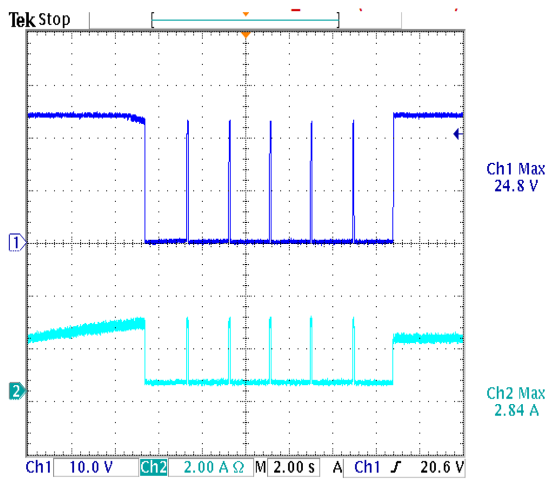


Figure 39: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S24K01

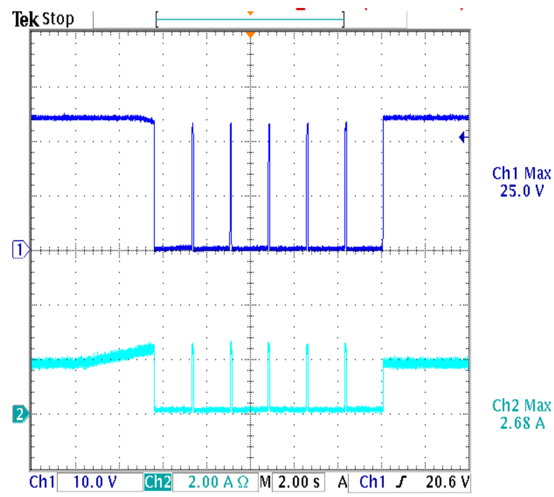


Figure 40: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

GB40S48K01

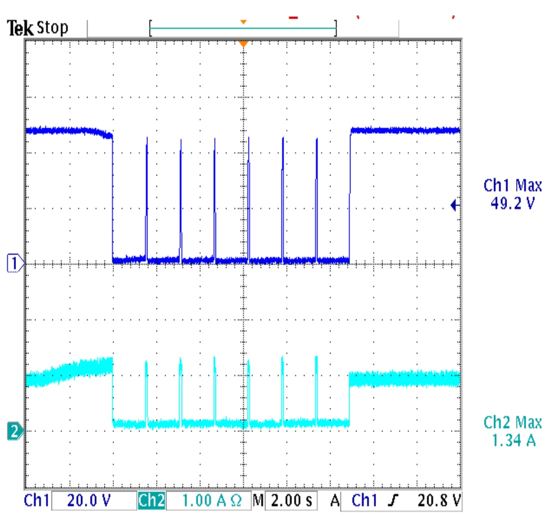


Figure 41: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S48K01

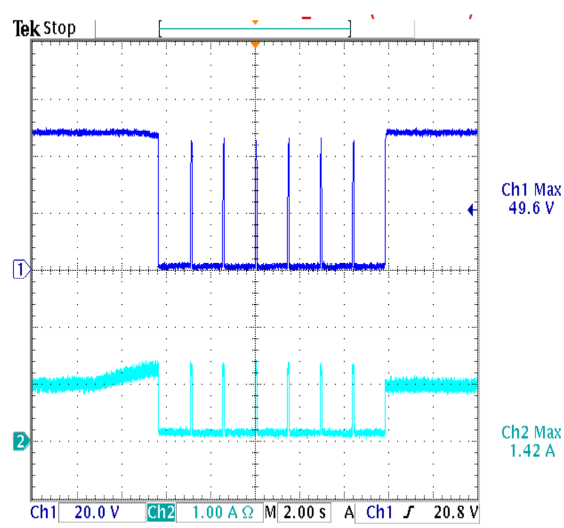


Figure 42: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

PERFORMANCE DATA

Outpot Short Circuit Protection

GB40S05K01

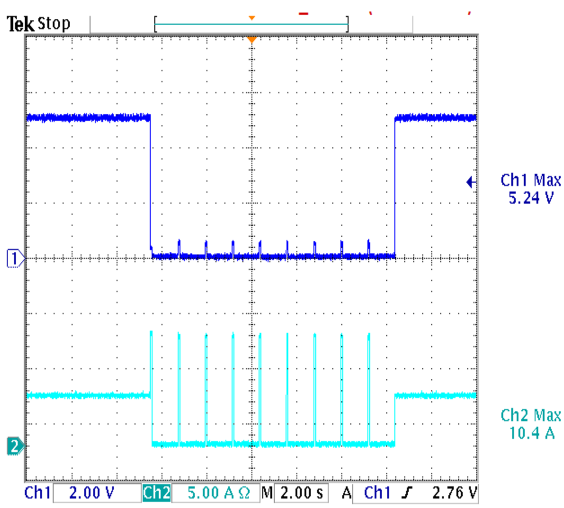


Figure 43: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S05K01

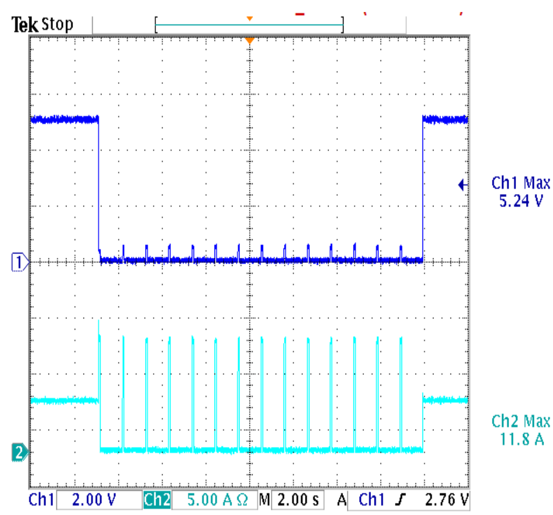


Figure 44: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

GB40S12K01

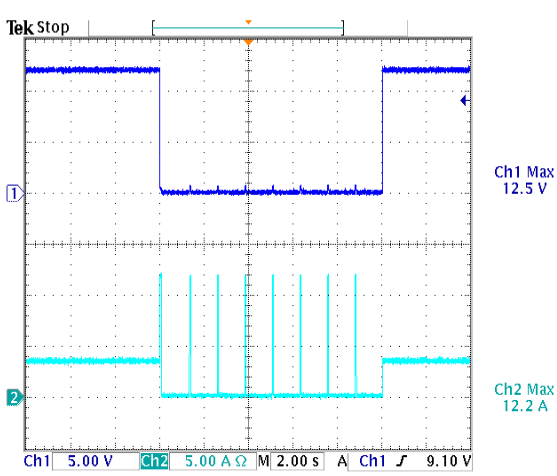


Figure 45: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S12K01

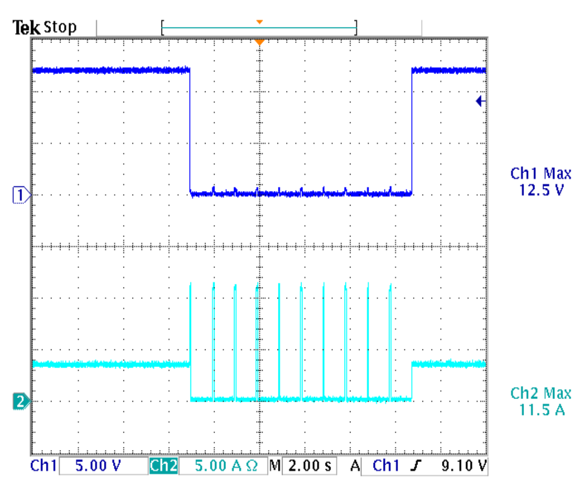


Figure 46: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

PERFORMANCE DATA

Outpot Short Circuit Protection

GB40S24K01

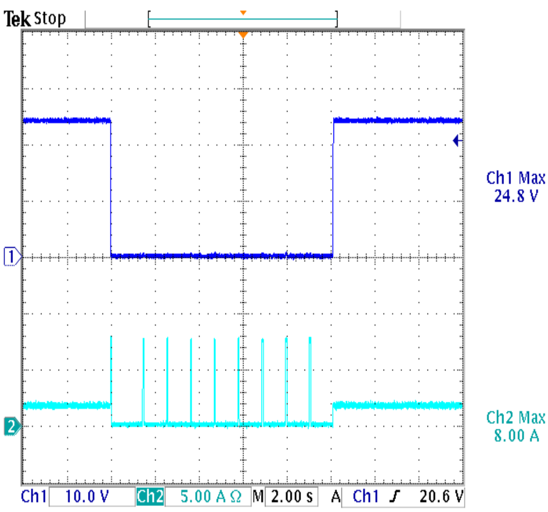


Figure 47: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S24K01

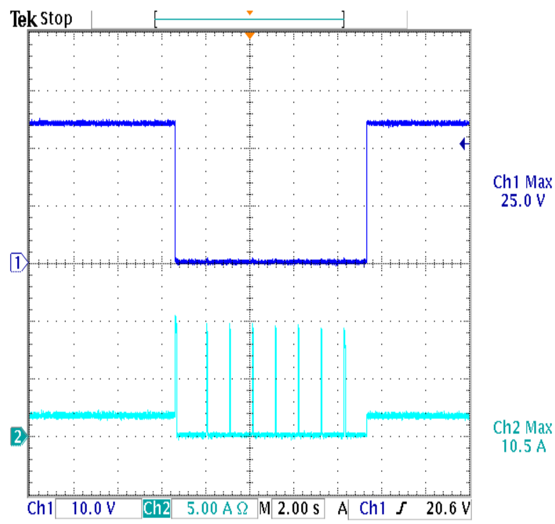


Figure 48: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

GB40S48K01

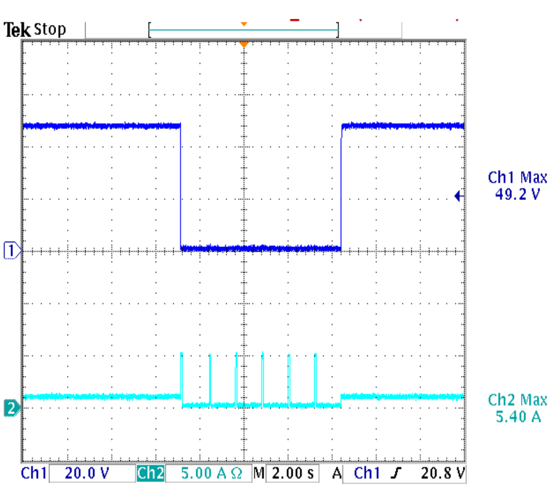


Figure 49: Output Over Load at 115Vac

CH1: Vout

CH2: Over Load Current

GB40S48K01

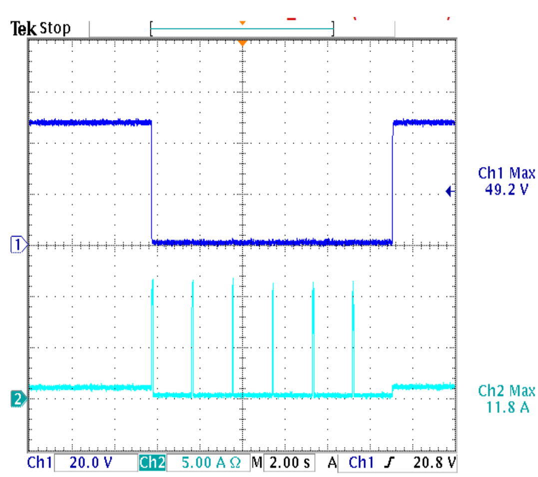


Figure 50: Output Over Load at 230Vac

CH1:Vout

CH2: Over Load Current

PERFORMANCE DATA

Transient Response

GB40S05K01

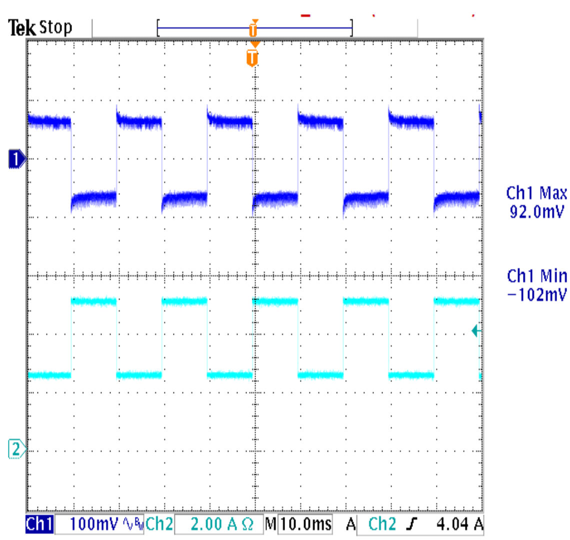


Figure 51: Transient Response at 115Vac, 50%-100% step load

CH1: Vout

CH2: Load Current

GB40S05K01

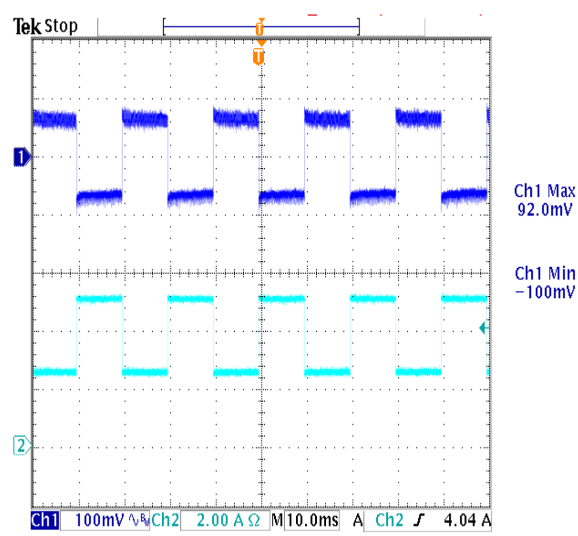


Figure 52: Transient Response at 230Vac, 50%-100% step load

CH1:Vout

CH2: Load Current

GB40S12K01

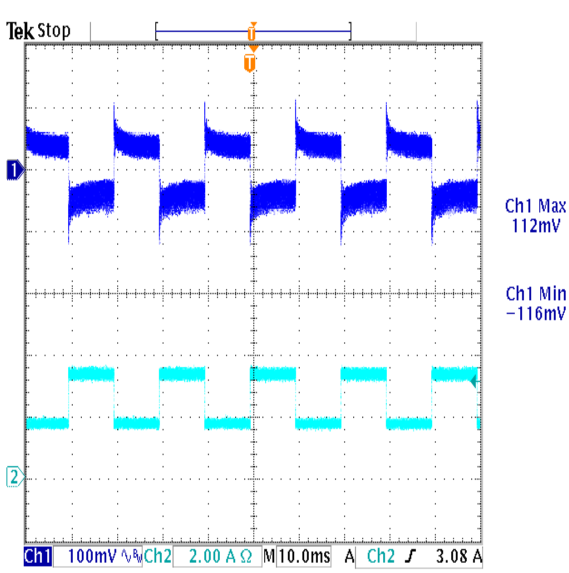


Figure 53: Transient Response at 115Vac, 50%-100% step load

CH1: Vout

CH2: Load Current

GB40S12K01

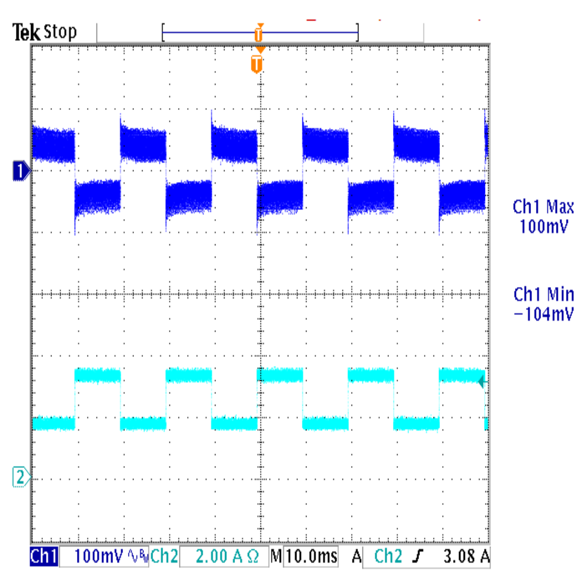


Figure 54: Transient Response at 230Vac, 50%-100% step load

CH1:Vout

CH2: Load Current

PERFORMANCE DATA

Transient Response

GB40S24K01

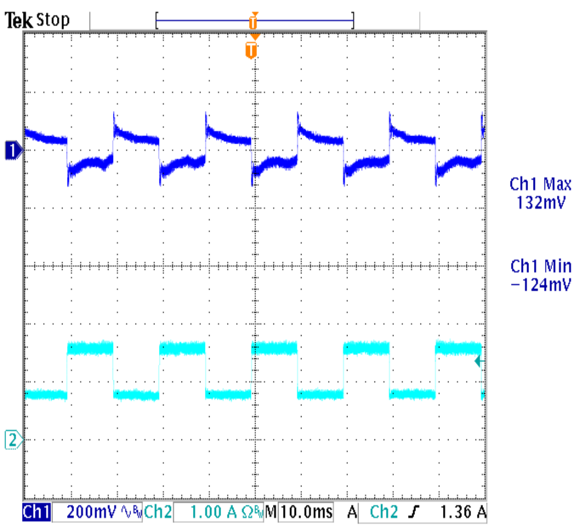


Figure 55: Transient Response at 115Vac, 50%-100% step load

CH1: Vout

CH2: Load Current

GB40S24K01

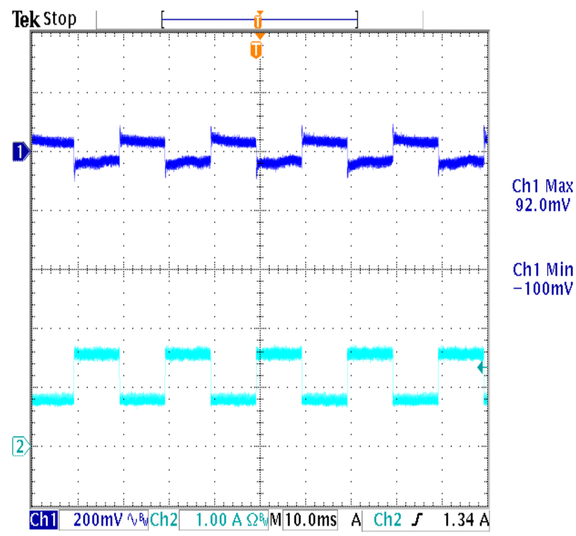


Figure 56: Transient Response at 230Vac, 50%-100% step load

CH1:Vout

CH2: Load Current

GB40S48K01

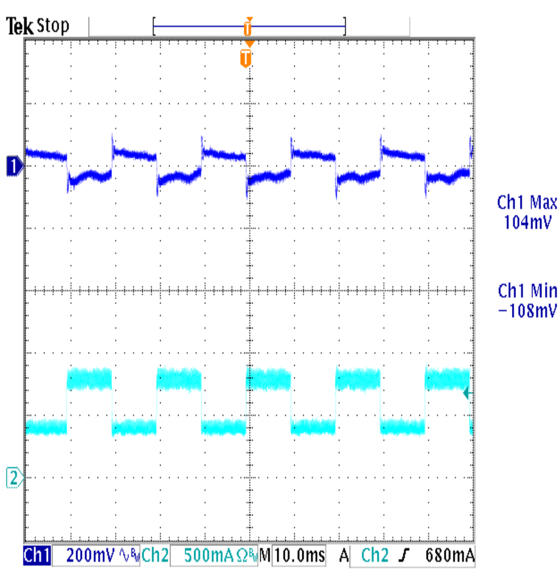


Figure 57: Transient Response at 115Vac, 50%-100% step load

CH1: Vout

CH2: Load Current

GB40S48K01

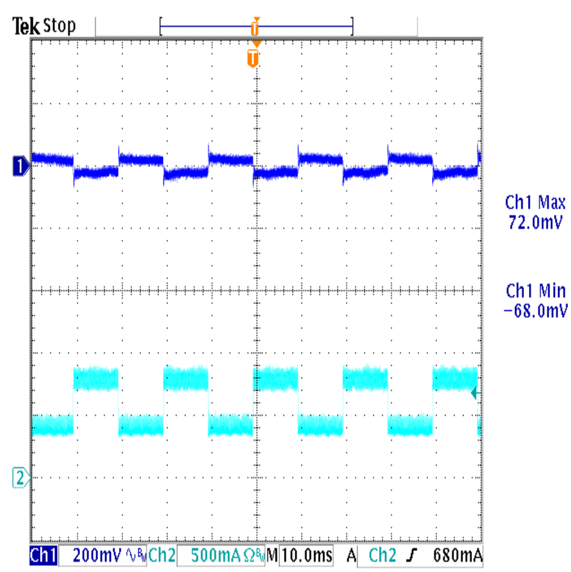


Figure 58: Transient Response at 230Vac, 50%-100% step load

CH1:Vout

CH2: Load Current

PERFORMANCE DATA

Output Return Shorted to Ground Common Mode Current

GB40S05K01

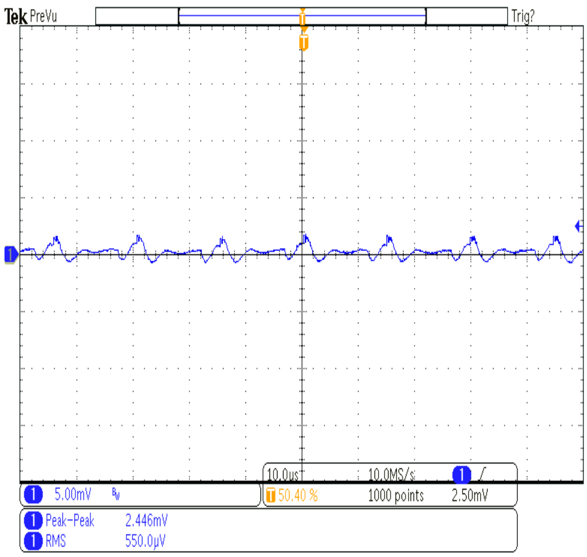


Figure 59: Common Mode Current at 115Vac

Current Probe:1mA/mV

GB40S05K01

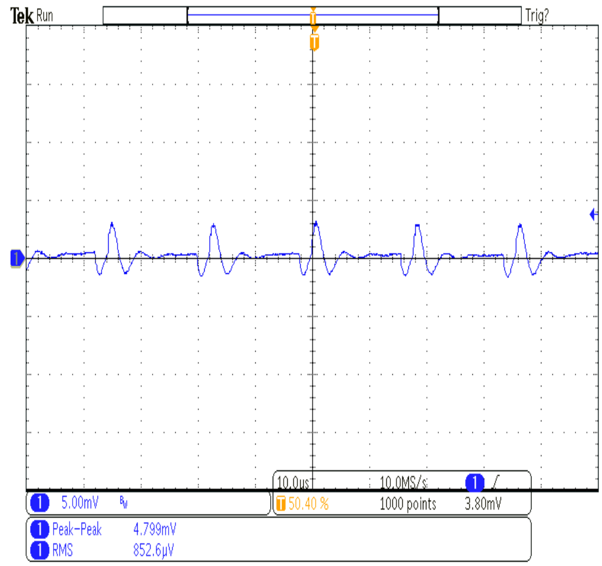


Figure 60: Common Mode Current at 230Vac

Current Probe:1mA/mV

GB40S12K01

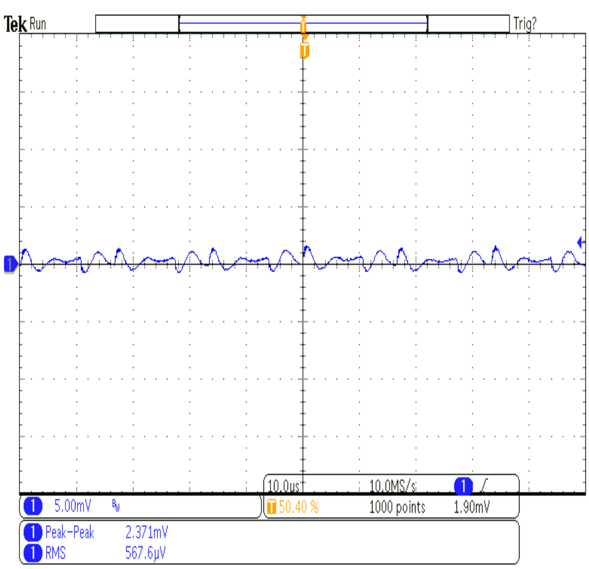


Figure 61: Common Mode Current at 115Vac

Current Probe:1mA/mV

GB40S12K01

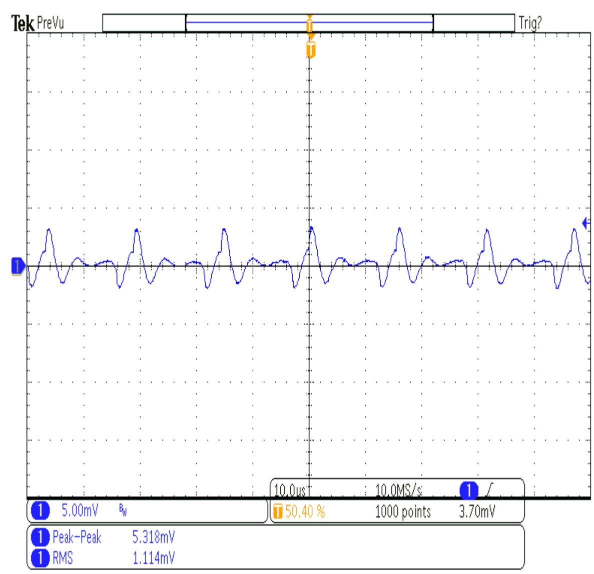


Figure 62: Common Mode Current at 230Vac

Current Probe:1mA/mV

PERFORMANCE DATA

Output Return Shorted to Ground Common Mode Current

GB40S24K01

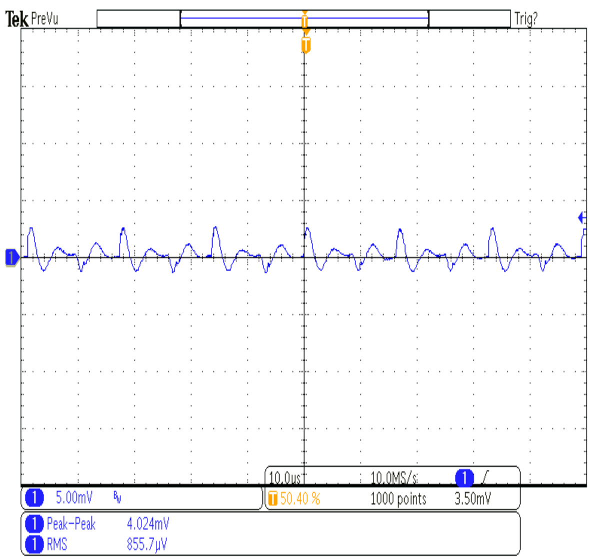


Figure 63: Common Mode Current at 115Vac

Current Probe:1mA/mV

GB40S24K01

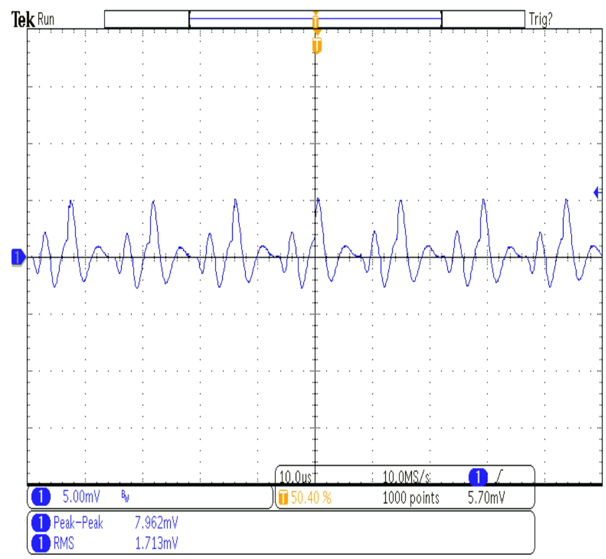


Figure 64: Figure 60: Common Mode Current at 230Vac

Current Probe:1mA/mV

GB40S48K01

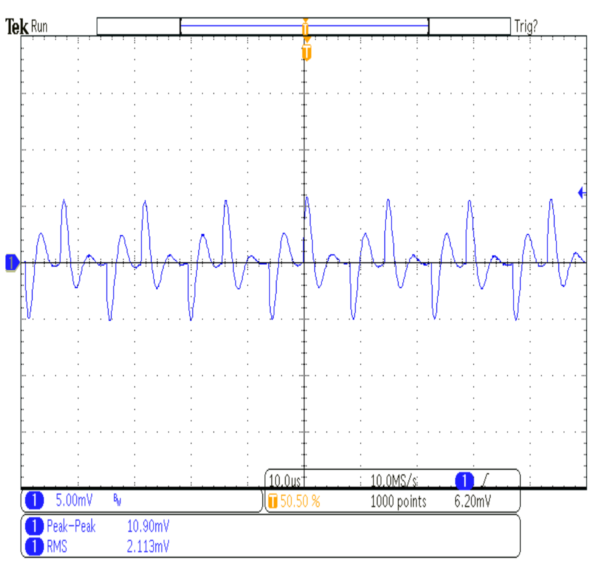


Figure 65: Common Mode Current at 115Vac

Current Probe:1mA/mV

GB40S48K01

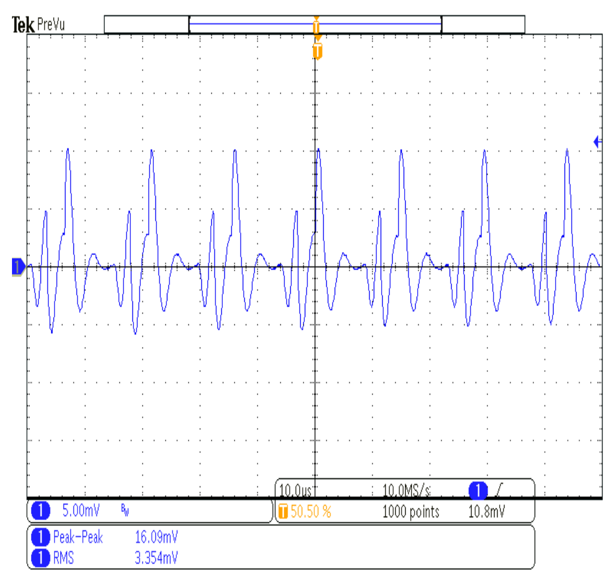


Figure 66: Common Mode Current at 230Vac

Current Probe:1mA/mV

PERFORMANCE DATA

Load Capacitance

Model Number	Recommended Max Load Cpacitance (µF)
GB40S05K01	80,000
GB40S09K01	55,000
GB40S12K01	37,000
GB40S15K01	26,000
GB40S18K01	18,000
GB40S24K01	10,000
GB40S48K01	3,000

Consult with SLPE Field Application Engineer if higher load capacitance level is required.

Efficiency Curves

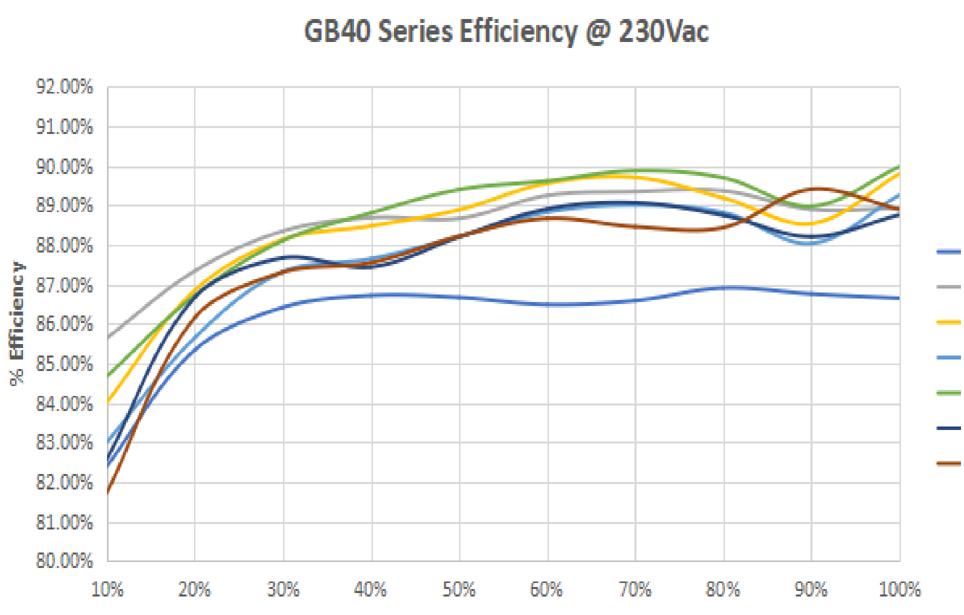


Fig. 67: GB40 Series Efficiency Curves.

PERFORMANCE DATA

Conducted Emissions

GB40S05K01

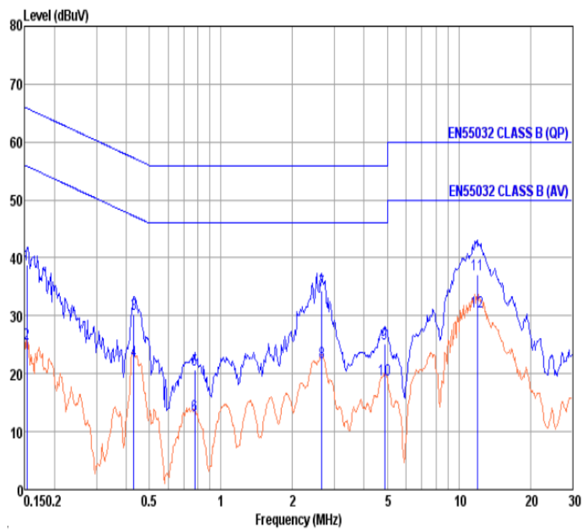


Figure 68: EN55032 CLASS B – 120V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S05K01

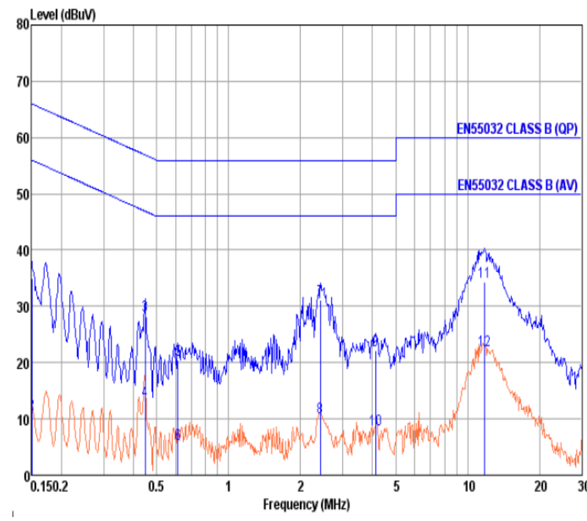


Figure 69: EN55032 CLASS B – 120V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S05K01

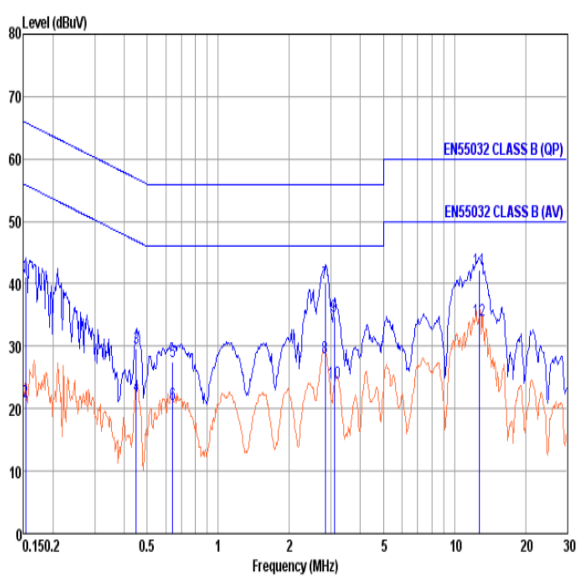


Figure 70: EN55032 CLASS B – 230V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S05K01

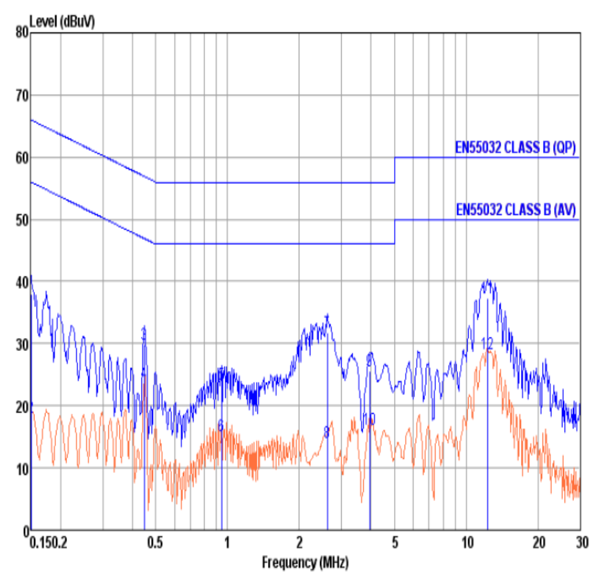


Figure 71: EN55032 CLASS B – 230V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

PERFORMANCE DATA

Conducted Emissions

GB40S12K01

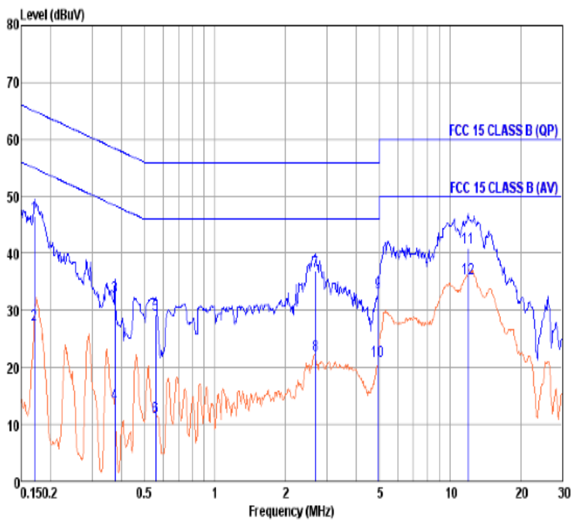


Figure 72: EN55032 CLASS B – 120V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S12K01

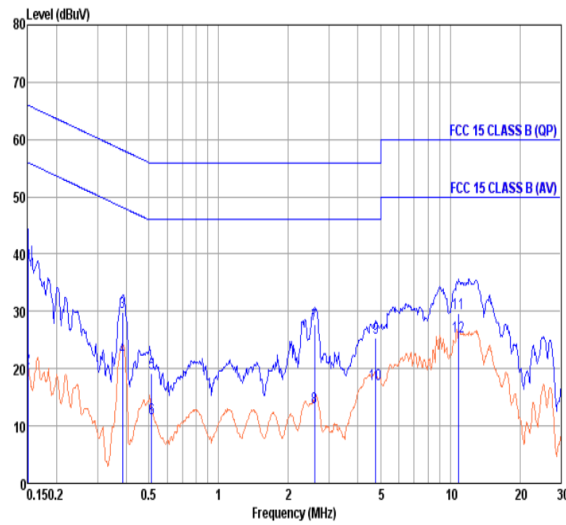


Figure 73: EN55032 CLASS B – 120V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S12K01

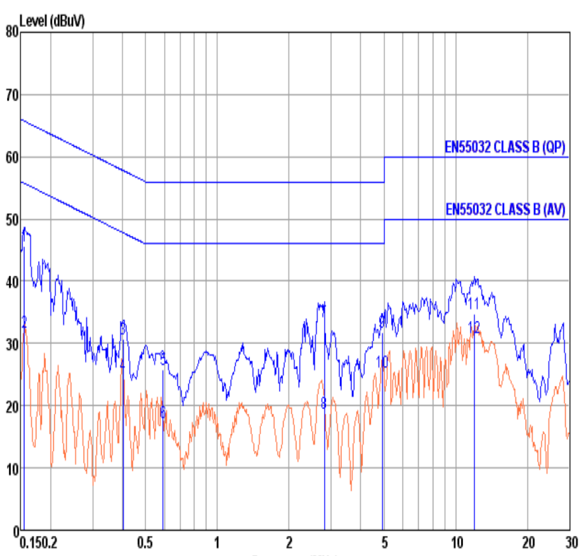


Figure 74 EN55032 CLASS B – 230V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S12K01

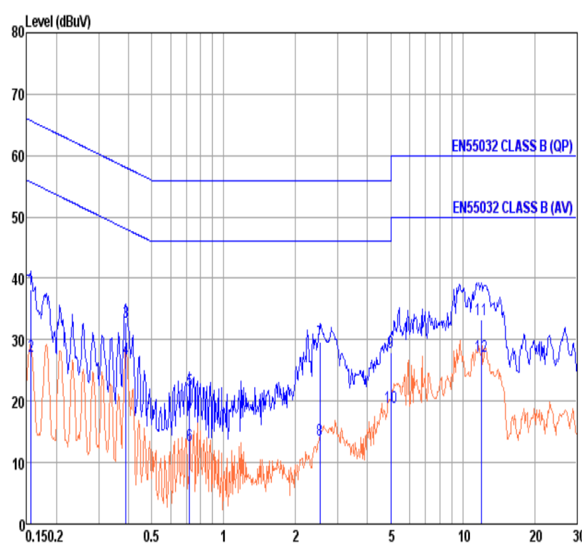


Figure 75: EN55032 CLASS B – 230V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

PERFORMANCE DATA

Conducted Emissions

GB40S24K01

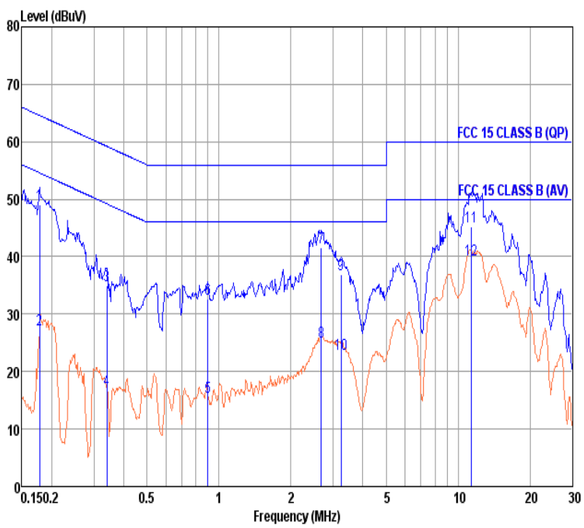


Figure 76: EN55032 CLASS B – 120V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S24K01

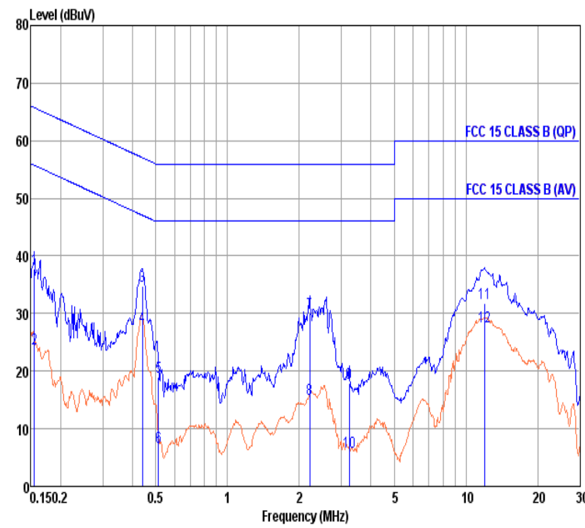


Figure 77: EN55032 CLASS B – 120V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S24K01

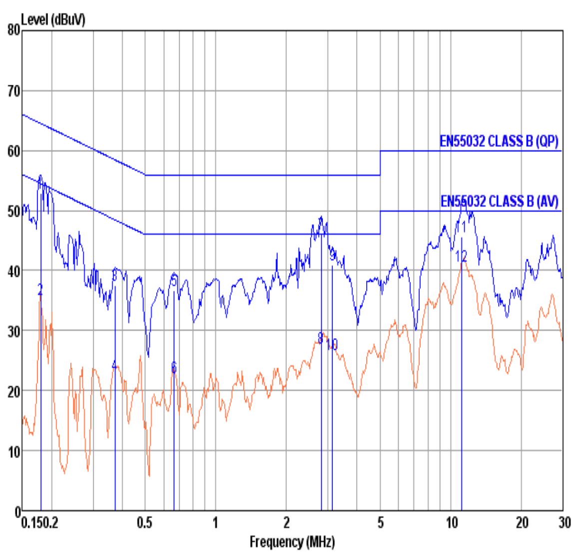


Figure 78: EN55032 CLASS B – 230V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S24K01

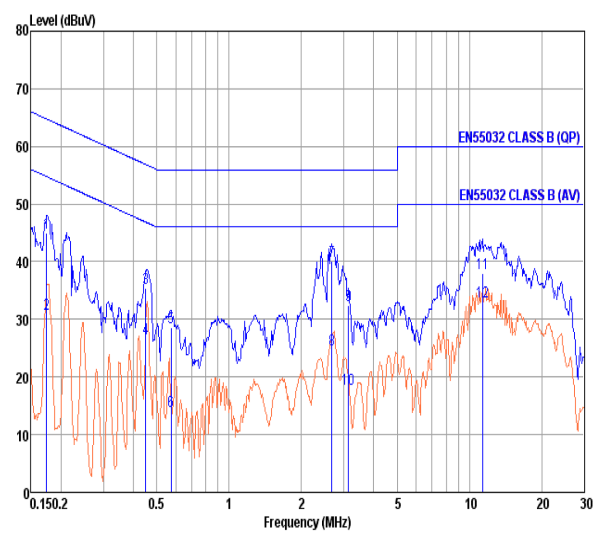


Figure 79: EN55032 CLASS B – 230V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

PERFORMANCE DATA

Conducted Emissions

GB40S48K01

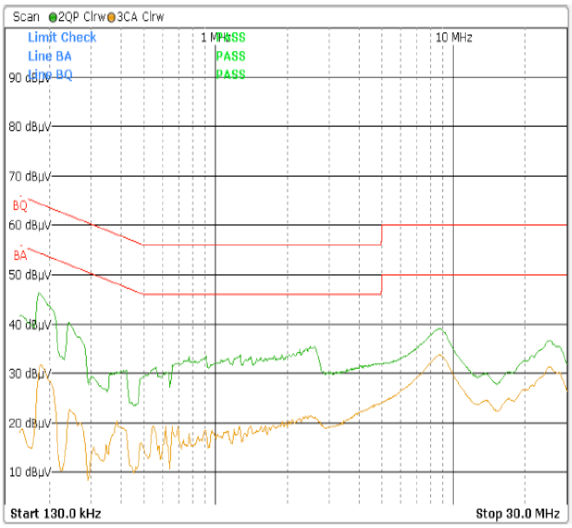


Figure 80:EN55032 CLASS B – 120V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S48K01

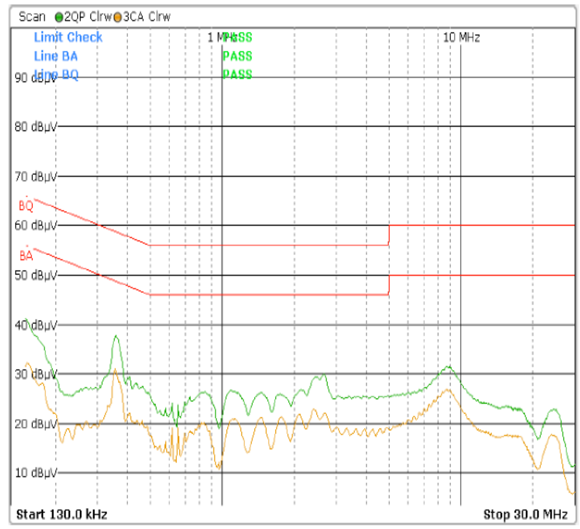


Figure 81: EN55032 CLASS B – 120V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S48K01

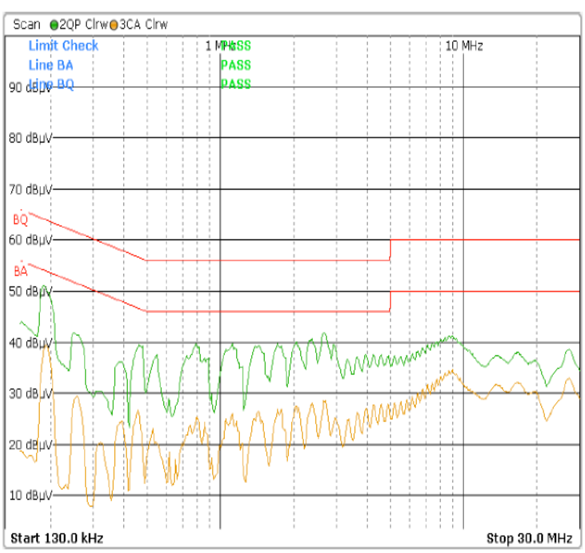


Figure 82:EN55032 CLASS B – 230V/60Hz 100% Load magin >10 dB.

Blue Plot: Quasi-Peak. Red Plot: Average.

GB40S48K01

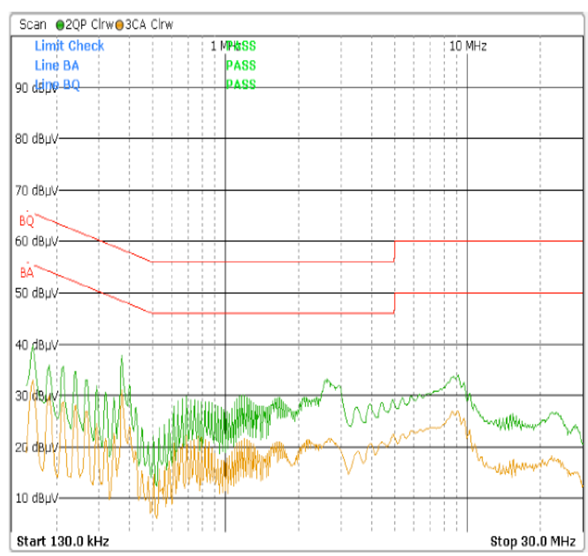


Figure 83: EN55032 CLASS B – 230V/60Hz 10% Load magin >10 dB

Blue Plot: Quasi-Peak. Red Plot: Average.

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

PRECISION | POWER | PERFORMANCE | TRUST

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