			BOBBIN		
AE			20.10	mm^2	Core Effective Cross Sectional Area
LE			37.60	mm^2	Core Effective Path Length
AL			1100.00	nH/turn^2	Ungapped Core Effective Inductance
BW			10.00	mm	Bobbin Physical Winding Width
M			0.00	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	3		3.00		Number of Primary Layers
NS			13.00		Number of Secondary Turns. To adjust Secondary number of turns change DCON
DC INPUT VOLTAGE PARAMETERS					
VMIN			93.03	V	Minimum DC bus voltage
VMAX			374.77	V	Maximum DC bus voltage
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.44		Maximum duty cycle measured at VMIN
IAVG			0.12	A	Input Average current
IP			0.39	A	Peak primary current
IR			0.39	A	Primary ripple current
IRMS			0.17	A	Primary RMS current
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LPMIN			1542.94	uH	Minimum Primary Inductance
LPTYP			1714.38	uH	Typical Primary inductance
LP_TOLERANCE			10.00		Tolerance in primary inductance
NP			141.00		Primary number of turns. To adjust Primary number of turns change BM_TARGET
ALG			86.23	nH/turn^2	Gapped Core Effective Inductance
BM_TARGET	2490		2490.00	Gauss	Target Flux Density
BM			2480.14	Gauss	Maximum Operating Flux Density (calculated at nominal inductance), BM < 2500 is recommended
BP		*Warning*	3000.97	Gauss	!!! Warning. Peak Flux density exceeds 3000 Gauss and is not recommended. Reduce BP by increasing NS
BAC			1240.07	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			163.75		Relative Permeability of Ungapped Core
LG			0.30	mm	Gap Length (LG > 0.1 mm)
BWE			30.00	mm	Effective Bobbin Width
OD			0.21	mm	Maximum Primary Wire Diameter including insulation
INS			0.04		Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.17	mm	Bare conductor diameter
AWG			34.00		Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			40.32		Bare conductor effective area in circular mils
CMA			234.48		Primary Winding Current Capacity (200 < CMA < 500)
TRANSFORMER SECONDARY DESIGN PARAMETERS					
Lumped parameters					
ISP			4.22	A	Peak Secondary Current
ISRMS			1.54	A	Secondary RMS Current
IRIPPLE			1.38	A	Output Capacitor RMS Ripple Current
CMS			308.96		Secondary Bare Conductor minimum circular mils
AWGS			25.00		Secondary Wire Gauge (Rounded up to next larger standard AWG value)
VOLTAGE STRESS PARAMETERS					
VDRAIN			679.48	V	Maximum Drain Voltage Estimate (Assumes 20% clamping voltage tolerance and an additional 10% temperature tolerance)

PIVS			46.55	V	Output Rectifier Maximum Peak Inverse Voltage
FINE TUNING					
RUPPER_ACTUAL	30			k-ohm	Actual Value of upper resistor (RUPPER) used on PCB
RLOWER_ACTUAL	5,6			k-ohm	Actual Value of lower resistor (RLOWER) used on PCB
Actual (Measured) Output Voltage (VDC)				V	Measured Output voltage from first prototype
Actual (Measured) Output Current (ADC)				Amps	Measured Output current from first prototype
RUPPER_FINE			30.00	k-ohm	New value of Upper resistor (RUPPER) in Feedback resistor divider. Nearest standard value is 30,1 k-ohms
RLOWER_FINE			5.60	k-ohm	New value of Lower resistor (RLOWER) in Feedback resistor divider. Nearest standard value is 5,62 k-ohms

Note: Spreadsheet values may be different from values generated from different spreadsheet revisions.

The spreadsheet flags 3 warnings:

1) PO – The data sheet figures for maximum output power is 6 W. This power was recommended for a 5 V output. As this design is for a 12 V output and the thermal performance is acceptable, this warning can be ignored.
2) VOR – This warning appears if VOR > 135 V. As in this design, the peak drain voltage VDRAIN < 680 V, this warning can be ignored.
3) BP – This warning shows up if BP > 3000 Gauss. In this design, this guideline is only slightly violated. Since no transformer saturation was seen, this warning can be ignored.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

9 Performance Data

All measurements performed at room temperature unless otherwise specified, 50 Hz input frequency.

9.1 Efficiency

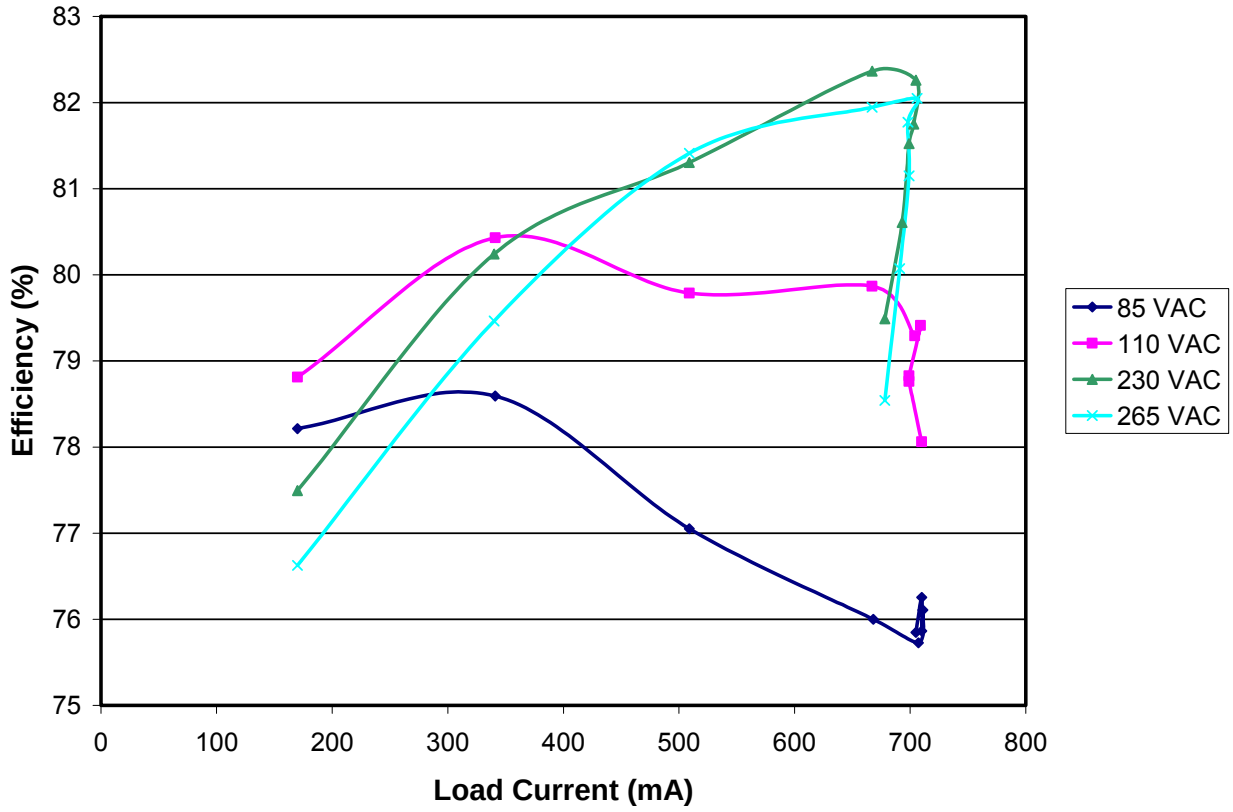

Figure 5 – Efficiency vs. Output Power.

9.2 Active Mode Efficiency

Percent of Full Load	Efficiency (%)	
	115 VAC	230 VAC
25	78.8	77.5
50	80.4	80.3
75	79.8	81.3
100	79.3	81.6
Average	**79.6**	**80.1**
US EISA (2007) requirement	79.5	
ENERGY STAR 2.0 requirement	79.5	

Figure 6 – Efficiency vs. Input Voltage and Load, Room Temperature, 50 Hz.

9.3 Energy Efficiency Requirements

The external power supply requirements below all require meeting active mode efficiency and no-load input power limits. Minimum active mode efficiency is defined as the average efficiency of 25, 50, 75 and 100% of output current (based on the nameplate output current rating).

For adapters that are single input voltage only then the measurement is made at the rated single nominal input voltage (115 VAC or 230 VAC), for universal input adapters the measurement is made at both nominal input voltages (115 VAC and 230 VAC).

To meet the standard the measured average efficiency (or efficiencies for universal input supplies) must be greater than or equal to the efficiency specified by the standard.

The test method can be found here:

http://www.energystar.gov/ia/partners/prod_development/downloads/power_supplies/EPSupplyEffic_TestMethod_0804.pdf

For the latest up to date information please visit the PI Green Room:

http://www.powerint.com/greenroom/regulations.htm

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

9.3.1 USA Energy Independence and Security Act 2007

This legislation mandates all single output single output adapters, including those provided with products, manufactured on or after July 1st, 2008 must meet minimum active mode efficiency and no load input power limits.

Active Mode Efficiency Standard Models

Nameplate Output (P_O)	Minimum Efficiency in Active Mode of Operation
< 1 W	$0.5 \times P_O$
≥ 1 W to ≤ 51 W	$0.09 \times \ln(P_O) + 0.5$
> 51 W	0.85

ln = natural logarithm

No-load Energy Consumption

Nameplate Output (P_O)	Maximum Power for No-load AC-DC EPS
All	≤ 0.5 W

This requirement supersedes the legislation from individual US States (for example CEC in California).

9.3.2 ENERGY STAR EPS Version 2.0

This specification takes effect on November 1st, 2008.

Active Mode Efficiency Standard Models

Nameplate Output (P_O)	Minimum Efficiency in Active Mode of Operation
≤ 1 W	$0.48 \times P_O + 0.14$
> 1 W to ≤ 49 W	$0.0626 \times \ln(P_O) + 0.622$
> 49 W	0.87

ln = natural logarithm

Active Mode Efficiency Low Voltage Models (V_O<6 V and $I_O \geq 550$ mA)

Nameplate Output (P_O)	Minimum Efficiency in Active Mode of Operation
≤ 1 W	$0.497 \times P_O + 0.067$
> 1 W to ≤ 49 W	$0.075 \times \ln(P_O) + 0.561$
> 49 W	0.86

ln = natural logarithm

No-load Energy Consumption (both models)

Nameplate Output (P_O)	Maximum Power for No-load AC-DC EPS
0 to < 50 W	≤ 0.3 W
≥ 50 W to ≤ 250 W	≤ 0.5 W

9.4 No-Load Input Power

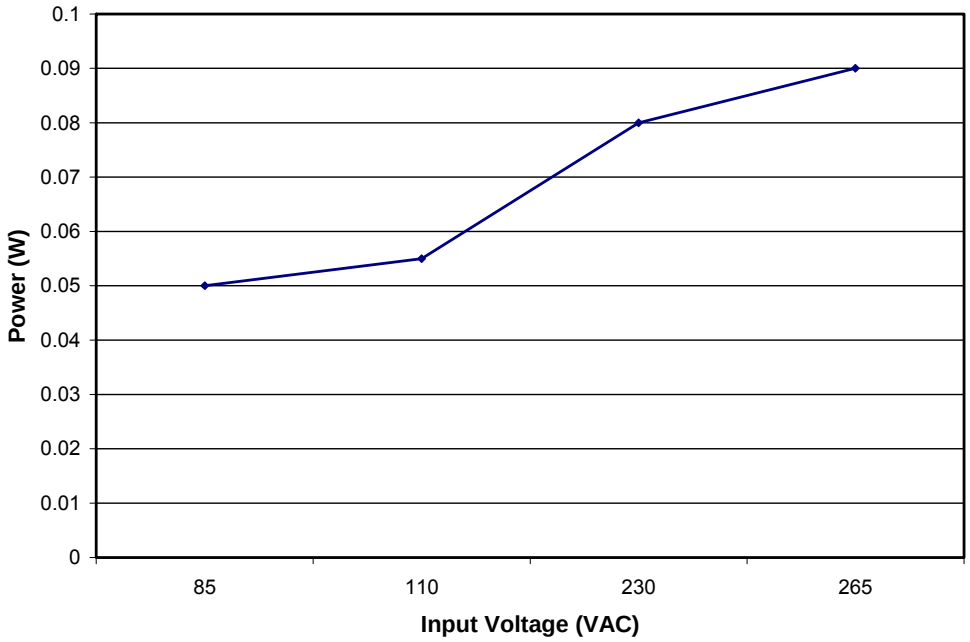

Figure 7 – Zero Load Input Power vs. Input Line Voltage, Room Temperature, 50 Hz.

9.5 Regulation

9.5.1 Load

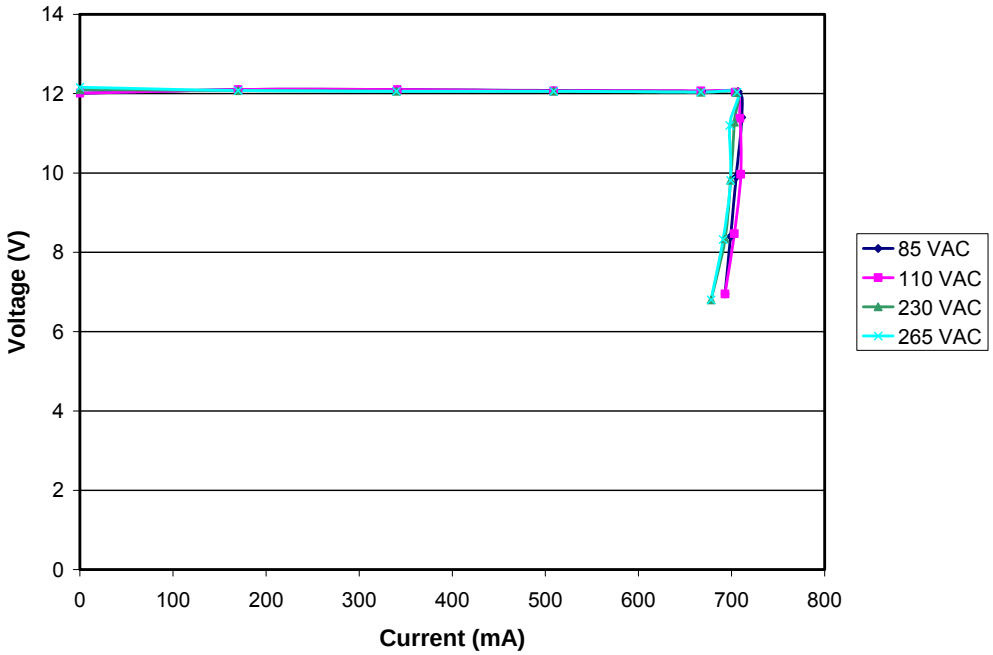

Figure 8 – Typical CC/CV Characteristic at Ambient Temperature.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

10 Thermal Performance

Measurements made at full load, 50Hz electric system.

Item	115 VAC	230 VAC
Ambient	25 ^{0}C	25 ^{0}C
LNK606PG (U1)	52 ^{0}C	56 ^{0}C
T1 Transformer	49 ^{0}C	50 ^{0}C

11 Waveforms

11.1 Drain Voltage and Current, Normal Operation

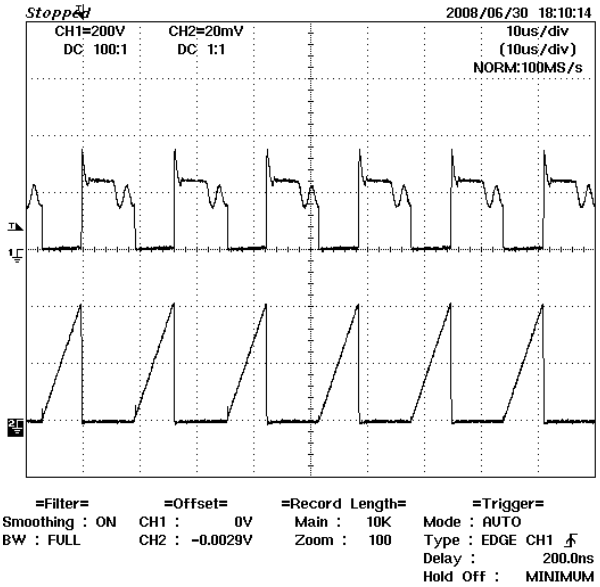

Figure 9 – 85 VAC, Full Load.
Upper: V_{DRAIN}, 200 V / div.
Lower: I_{DRAIN}, 200 mA / div, 10 μs / div.

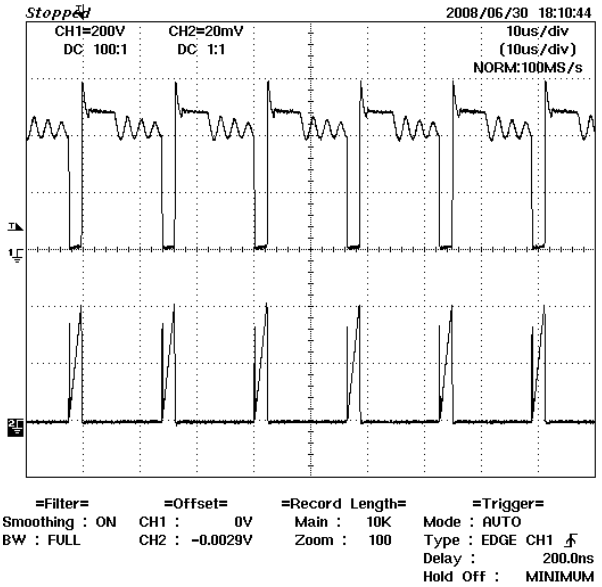

Figure 10 – 265 VAC, Full Load.
Upper: V_{DRAIN}, 200 V / div.
Lower: I_{DRAIN}, 200 mA / div, 10 us / div.

11.2 Output Voltage Start-up Profile

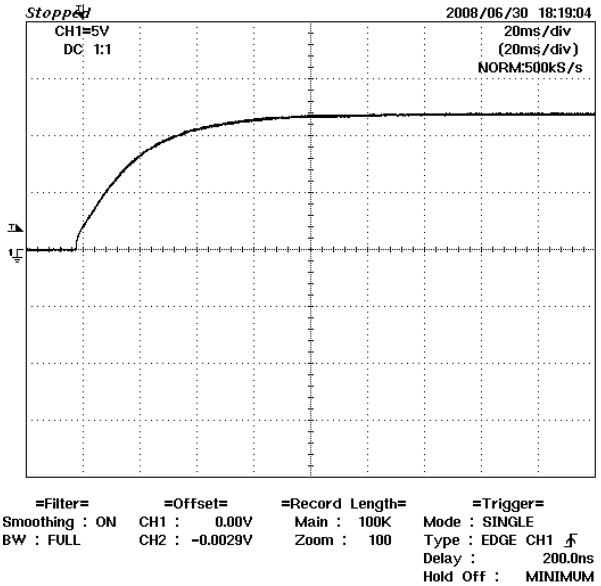

Figure 11 – Start-up Profile (Full load), 85 VAC
5 V, 20 ms / div.

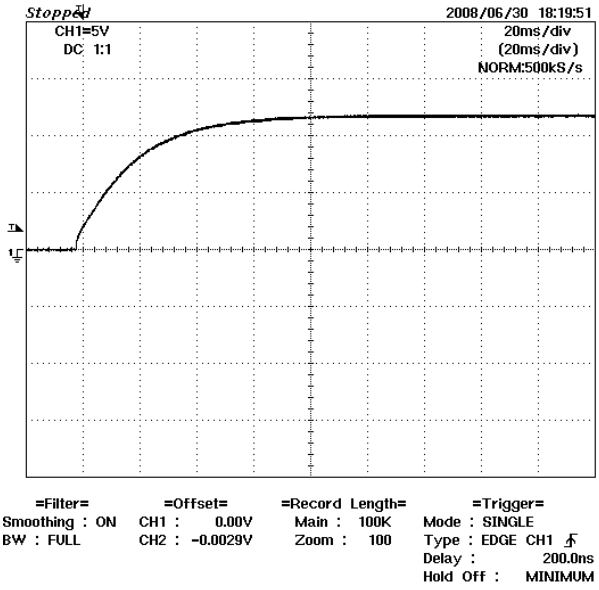

Figure 12 – Start-up Profile (Full Load), 265 VAC
5 V, 20 ms / div.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

11.3 Drain Voltage and Current Start-up Profile

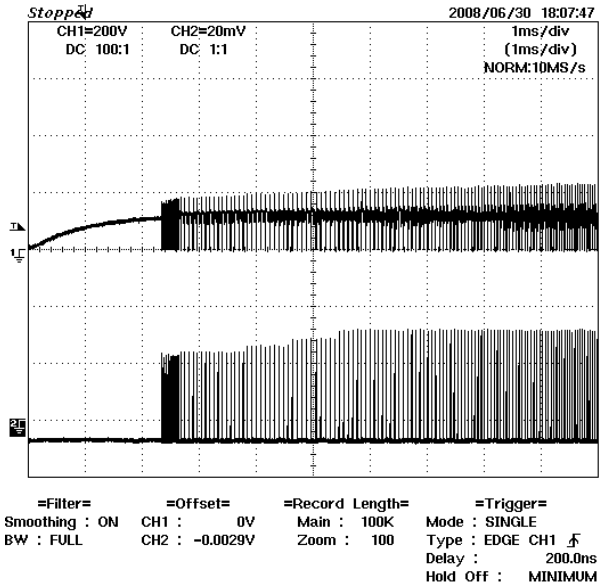

Figure 13 – 85 VAC Input and Maximum Load.
Upper: V_{DRAIN}, 200 V & 1 ms / div.
Lower: I_{DRAIN}, 200 mA / div.

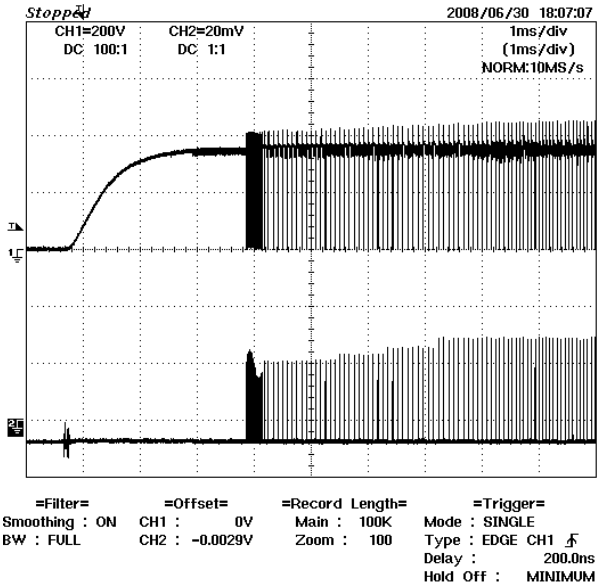

Figure 14 – 265 VAC Input and Maximum Load.
Upper: V_{DRAIN}, 200 V & 1 ms / div.
Lower: I_{DRAIN}, 200 mA / div.

11.4 Output Ripple Measurements

11.4.1 Ripple Measurement Technique

For DC output ripple measurements, a modified oscilloscope test probe must be utilized in order to reduce spurious signals due to pickup. Details of the probe modification are provided below.

The 5125BA probe adapter is affixed with two capacitors tied in parallel across the probe tip. The capacitors include one (1) 0.1 μF/50 V ceramic type and one (1) 10 μF/50 V aluminum electrolytic. ***The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).***

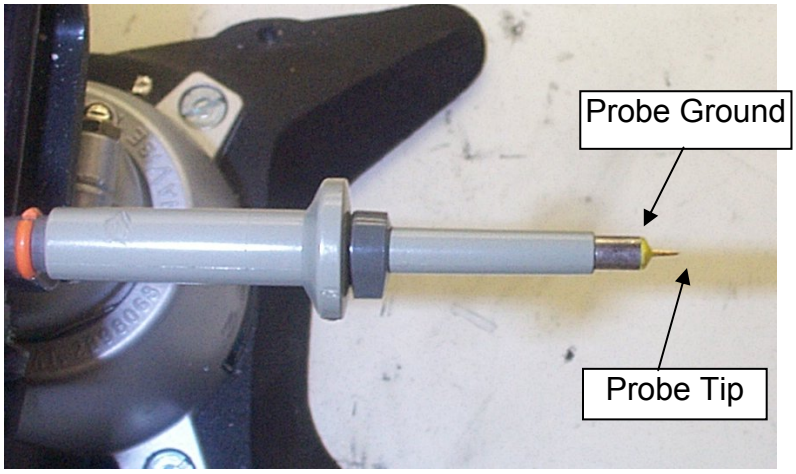

Figure 15 – Oscilloscope Probe Prepared for Ripple Measurement (End Cap and Ground Lead Removed).

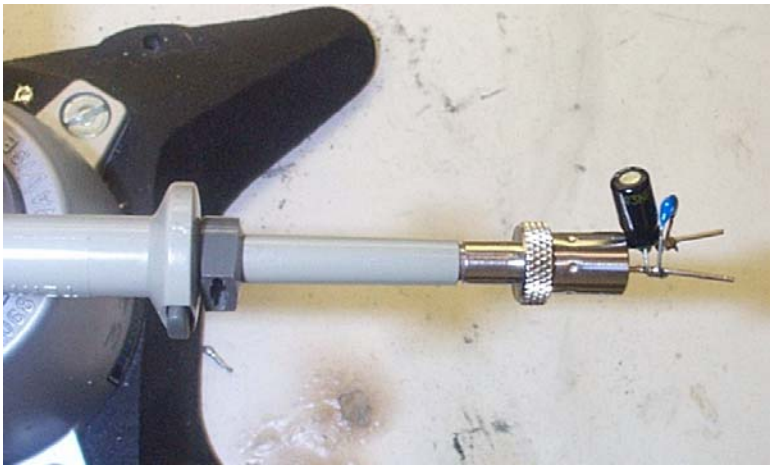

Figure 16 – Oscilloscope Probe with Probe Master 5125BA BNC Adapter (Modified with Wires for Probe Ground for Ripple measurement and Two Parallel Decoupling Capacitors Added).

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

11.4.2 Measurement Results

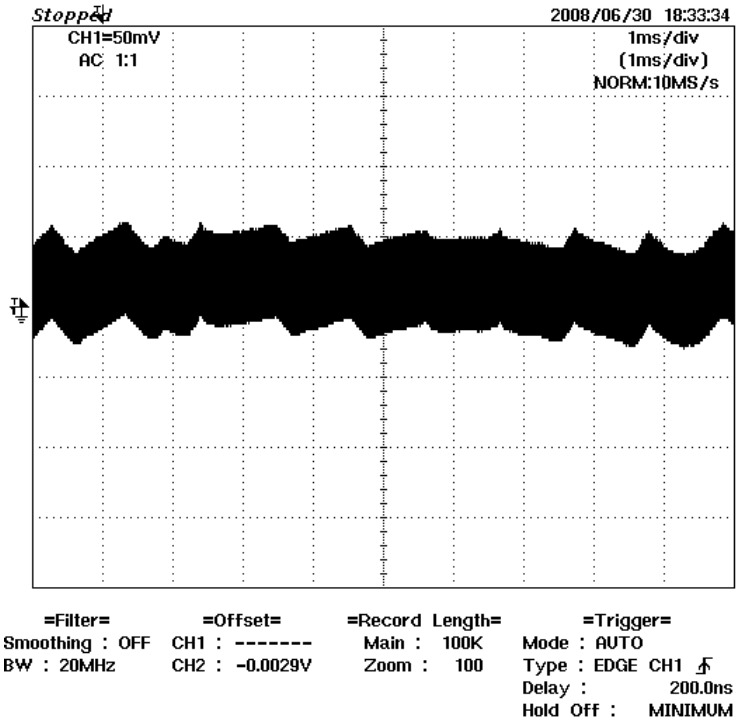

Figure 17 – Ripple, 85 VAC, Full Load, 50 mV, 1 ms / div.

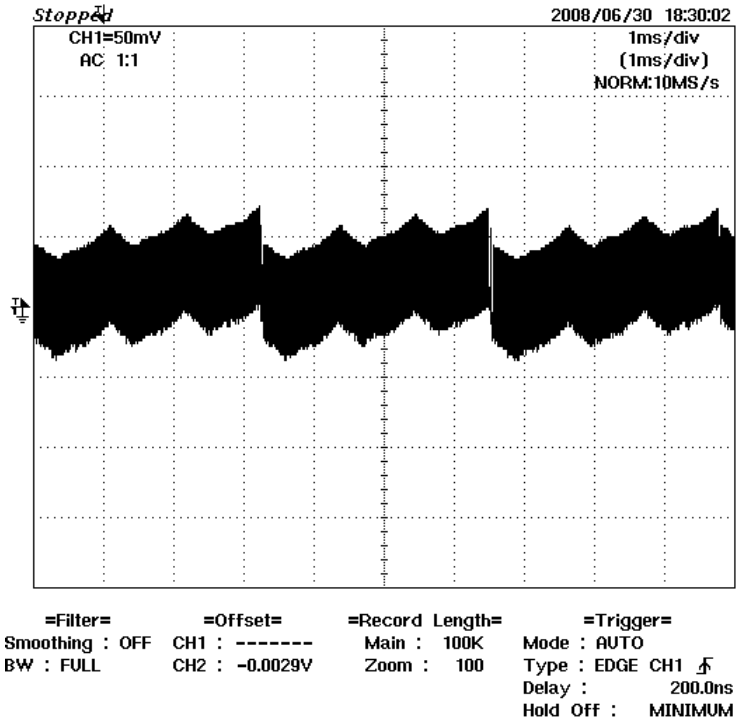

Figure 18 – Ripple, 265 VAC, Full Load, 50 mV, 1 ms / div.

12 Conducted EMI

All Conducted EMI tests were made using the artificial hand connected to the secondary return.

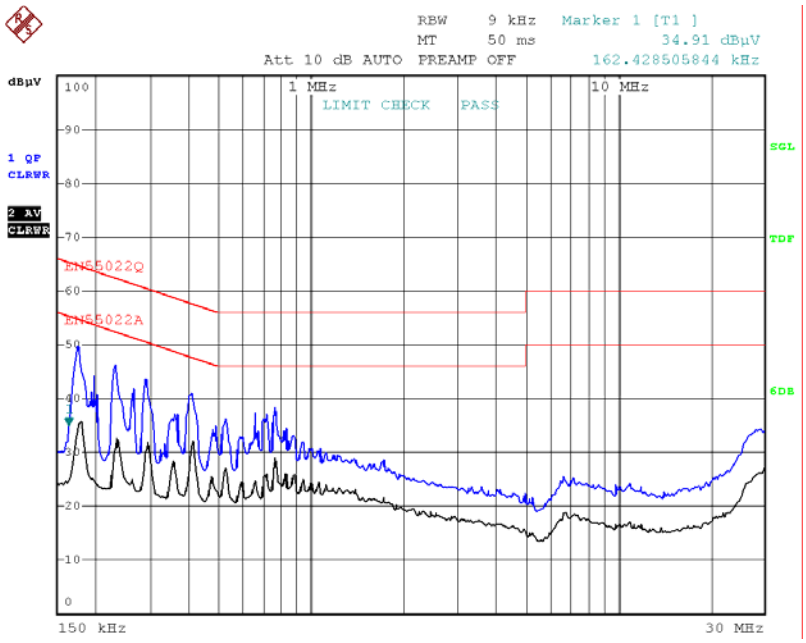

Figure 19 – Conducted EMI, 115 VAC, Line, Full load, EN55022Q: QP Limit; EN55022A: Average Limit; Blue: QP Scan; Black: Average Scan.

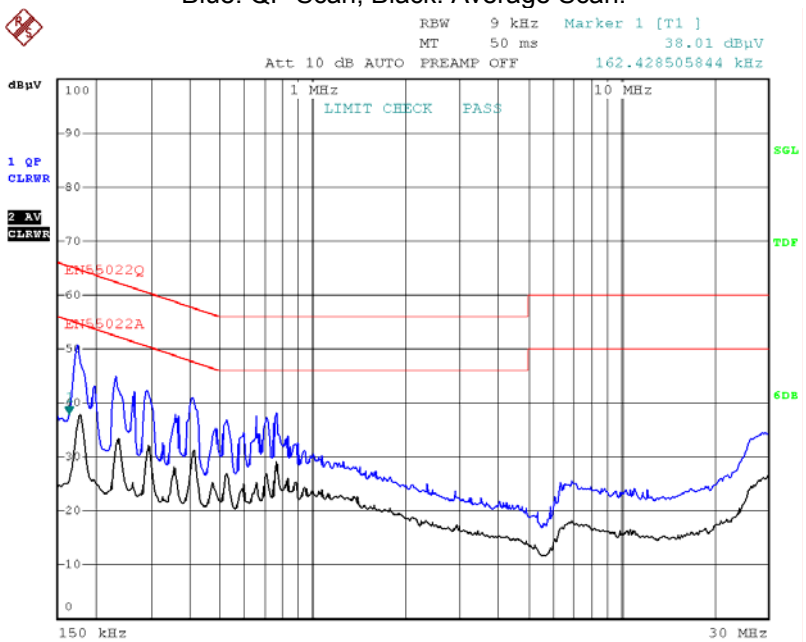

Figure 20 – Conducted EMI, 115 VAC, Neutral, Full Load, EN55022Q: QP Limit; EN55022A: Average Limit; Blue: QP Scan; Black: Average Scan.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

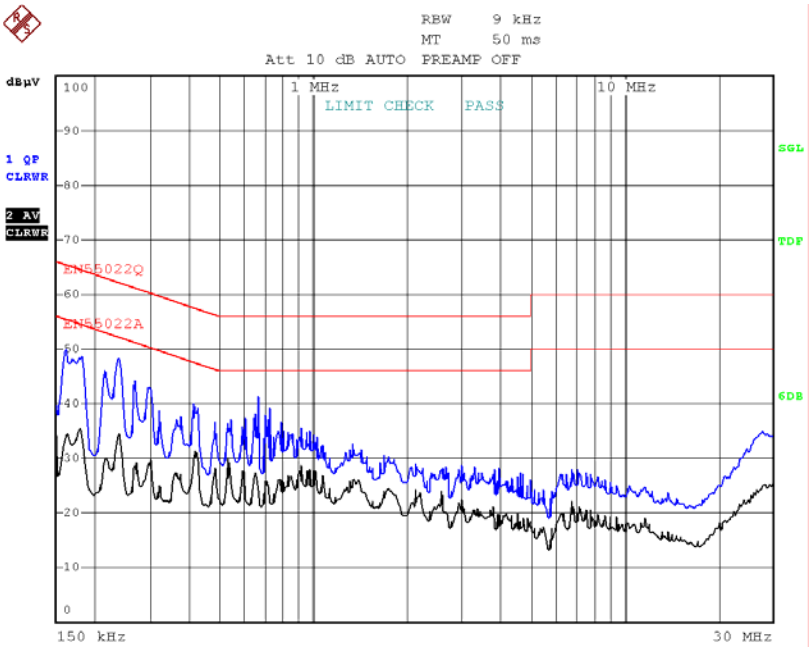

Figure 21 – Conducted EMI, 230 VAC, Line, Full Load, EN55022Q: QP limit; EN55022A: Average Limit; Blue: QP Scan; Black: Average Scan.

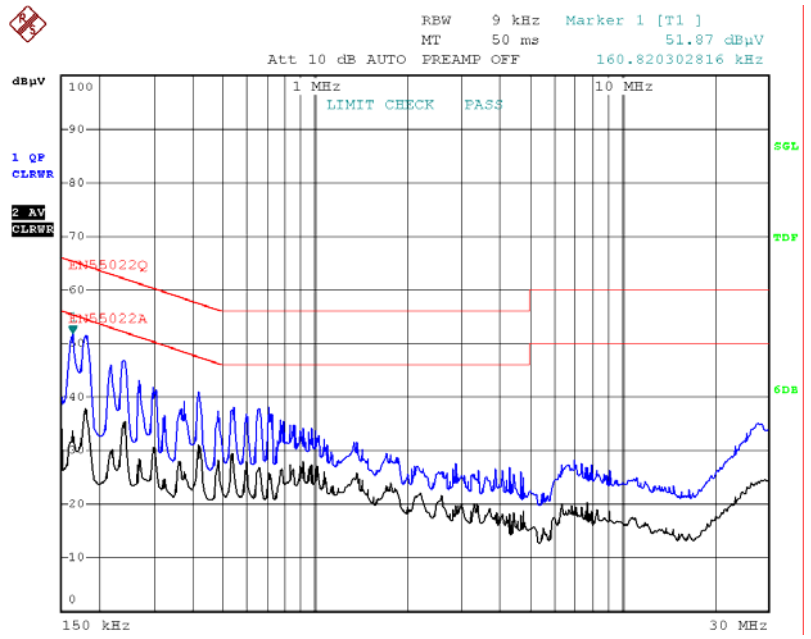

Figure 22 – Conducted EMI, 230 VAC, Neutral, Full load, EN55022Q: QP Limit; EN55022A: Average Limit; Blue: QP Scan; Black: Average Scan.

13 Revision History

Date	Author	Revision	Description & changes	Reviewed
01-May-09	RP	1.0	Initial Release	Apps & Mktg

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com

For the latest updates, visit our website: *www.powerint.com*

Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS.

PATENT INFORMATION

The products and applications illustrated herein (including transformer construction and circuits external to the products) may be covered by one or more U.S. and foreign patents, or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at www.powerint.com. Power Integrations grants its customers a license under certain patent rights as set forth at http://www.powerint.com/ip.htm.

Power Integrations Worldwide Sales Support Locations

WORLD HEADQUARTERS
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1-408-414-9200
Customer Service:
Phone: +1-408-414-9665
Fax: +1-408-414-9765
e-mail: usasales@powerint.com

GERMANY
Rueckertstrasse 3
D-80336, Munich
Germany
Phone: +49-89-5527-3911
Fax: +49-89-5527-3920
e-mail: eurosales@powerint.com

JAPAN
Kosei Dai-3 Bldg.,
2-12-11, Shin-Yokohama,
Kohoku-ku, Yokohama-shi,
Kanagawa 222-0033
Phone: +81-45-471-1021
Fax: +81-45-471-3717
e-mail:
japansales@powerint.com

TAIWAN
5F, No. 318, Nei Hu Rd., Sec. 1
Nei Hu Dist.
Taipei, Taiwan 114, R.O.C.
Phone: +886-2-2659-4570
Fax: +886-2-2659-4550
e-mail:
taiwansales@powerint.com

CHINA (SHANGHAI)
Rm 1601/1610, Tower 1,
Kerry Everbright City
No. 218 Tianmu Road West,
Shanghai, P.R.C. 200070
Phone: +86-21-6354-6323
Fax: +86-21-6354-6325
e-mail:
chinasales@powerint.com

INDIA
#1, 14th Main Road
Vasanthanagar
Bangalore-560052 India
Phone: +91-80-41138020
Fax: +91-80-41138023
e-mail: indiasales@powerint.com

KOREA
RM 602, 6FL
Korea City Air Terminal B/D,
159-6
Samsung-Dong, Kangnam-Gu,
Seoul, 135-728, Korea
Phone: +82-2-2016-6610
Fax: +82-2-2016-6630
e-mail:
koreasales@powerint.com

UNITED KINGDOM
1st Floor, St. James's House
East Street, Farnham
Surrey, GU9 7TJ
United Kingdom
Phone: +44 (0) 1252-730-141
Fax: +44 (0) 1252-727-689
e-mail:
eurosales@powerint.com

CHINA (SHENZHEN)
Rm A, B & C 4th Floor, Block C,
Electronics Science and
Technology Building, 2070
Shennan Zhong Rd,
Shenzhen, Guangdong,
China, 518031
Phone: +86-755-8379-3243
Fax: +86-755-8379-5828
e-mail:
chinasales@powerint.com

ITALY
Via De Amicis 2
20091 Bresso MI – Italy
Phone: +39-028-928-6000
Fax: +39-028-928-6009
e-mail: eurosales@powerint.com

SINGAPORE
51 Newton Road,
#15-08/10 Goldhill Plaza,
Singapore, 308900
Phone: +65-6358-2160
Fax: +65-6358-2015
e-mail:
singaporesales@powerint.com

APPLICATIONS HOTLINE
World Wide +1-408-414-9660

APPLICATIONS FAX
World Wide +1-408-414-9760