

General Description

This demonstration board utilizes the AL1676 Buck LED driver-converter with single winding inductor providing a cost effective non-dimmable solution for offline high brightness LED applications. This user-friendly evaluation board provides users with quick connection to their different types of LEDs string. The demonstration board can be modified to adjust the LED output current and the number of series connected LEDs that are driven.

A BOM, schematic and layout are included that describes the parts used on this demonstration board, along with measured performance characteristics. These materials can be used as a reference design.

Key Features

- Non-Dimmable
- Single winding inductor
- High efficiency >88%
- Non-isolate buck LED driver

Applications

- Retrofit LED Lamps
- High Voltage DC-DC LED Driver
- General Purpose Constant Current Source

Specifications

Parameter	Value
AC Input Voltage	100-265V
Output Power	8.6W
LED Current	120mA
LED Voltage	72V
Power Factor	>0.97($V_{in}=120V_{AC}$) >0.92($V_{in}=230V_{AC}$)
Efficiency	>88%
XYZ Dimension	45x 24 x 13mm
ROHS Compliance	Yes

Evaluation Board

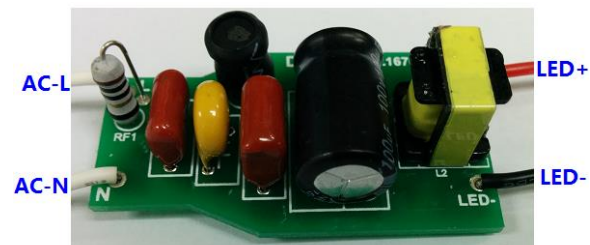


Figure 1: Top View



Figure 2: Bottom View

Connection Instructions:

AC-L Input: White – Hot

AC-N Input: White – Neutral

DC LED+ Output: LED+ (Red)

DC LED- Output: LED- (Black)

Board Layouts

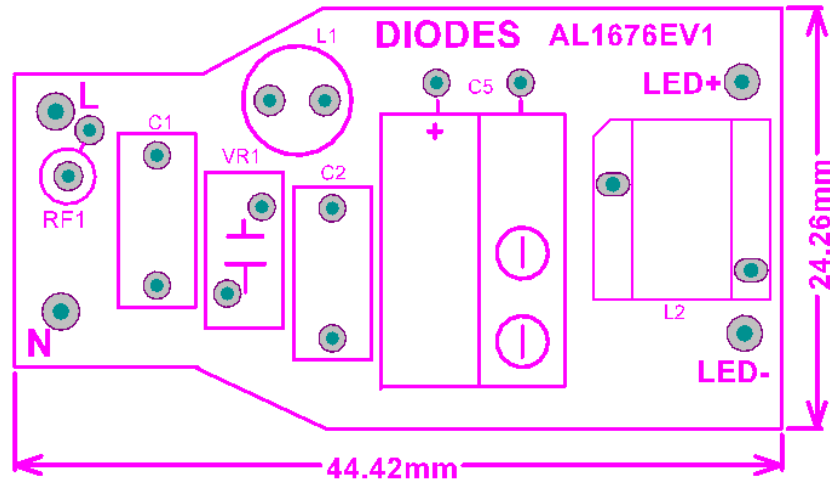


Figure 3: PCB Layout Top View

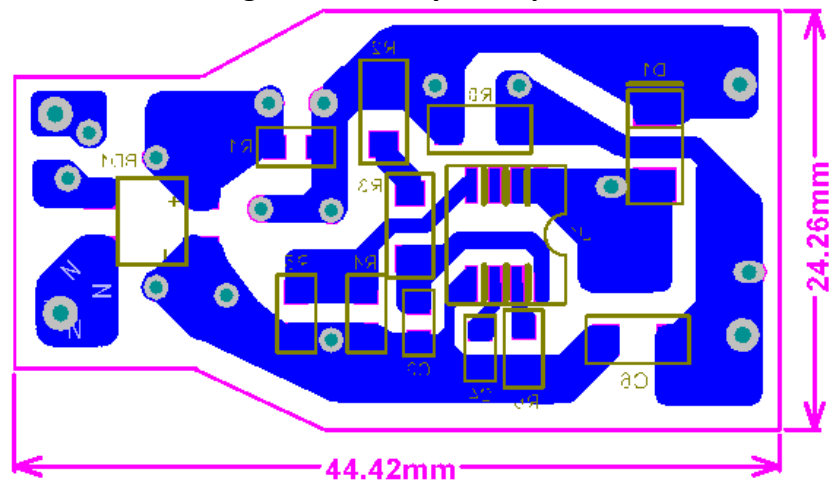


Figure 4: PCB Layout Bottom View

Quick Start Guide

1. Preset the isolated AC source to 120V_{AC}/230V_{AC}.
2. Ensure that the AC source is switched OFF or disconnected.
3. Connect the anode wire of the LED string to the LED+ terminal of the evaluation board.
4. Connect the cathode wire of the LED string to the LED- terminal of the evaluation board.
5. Connect two AC line wires to the AC-L and AC-N terminals on the evaluation board.
6. Ensure that the area around the board is clear and safe, and preferably that the board and LEDs are enclosed in a transparent safety cover.
7. Turn on the main switch. LED string should light up with LED.
DO NOT TOUCH THE BOARD, LEDs OR BARE WIRING.

Caution: The AL1676 is a non-isolated design. All terminals carry high voltage during operation!

Schematic

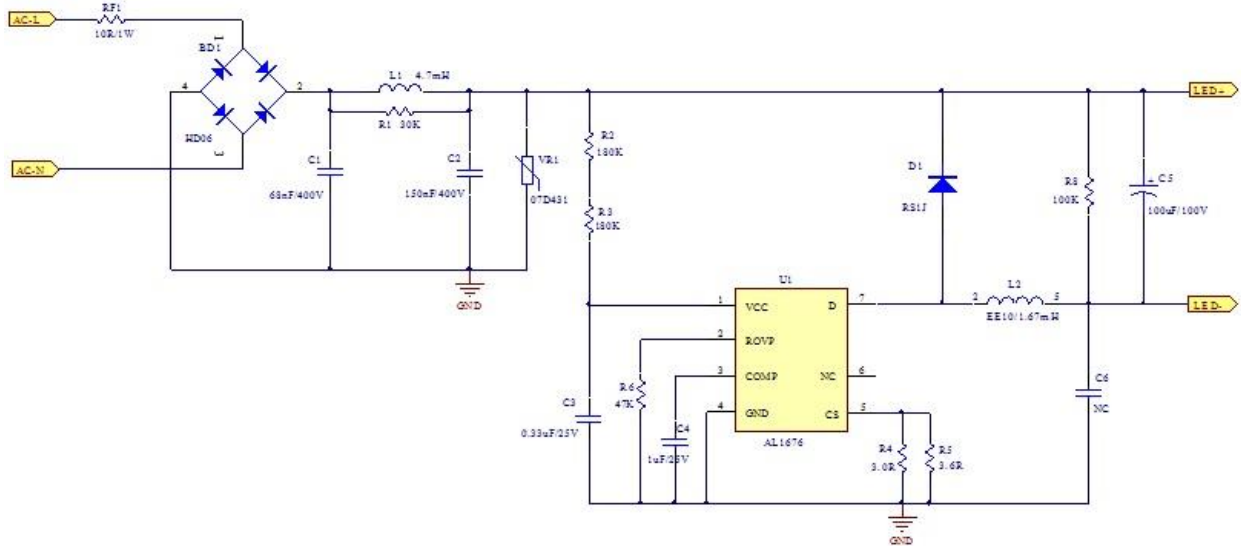


Figure 5: Schematic Circuit

Transformer Design

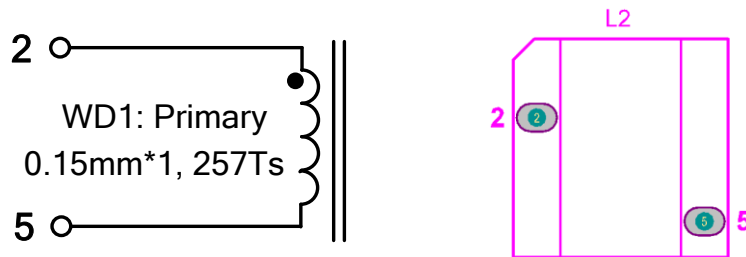
Bobbin and Core

EE10 Vertical 4+4 pin

Transformer Parameters

1. Primary Inductance (Pin2-Pin5, all other windings open): $L_p=1.67\text{mH}$, $\pm 5\% @ 1\text{kHz}$
2. Primary Winding Turns (Pin2-Pin5): $N_p=257\text{Ts}$

Transformer Winding Construction Diagram

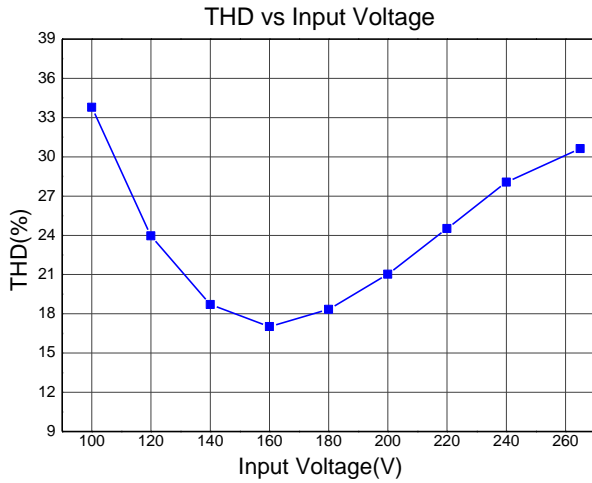
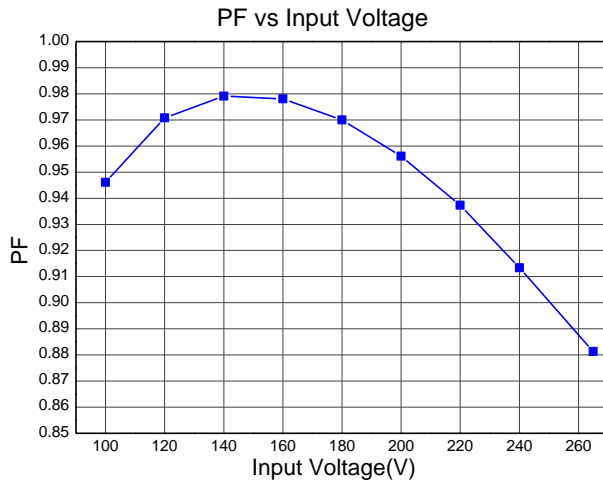
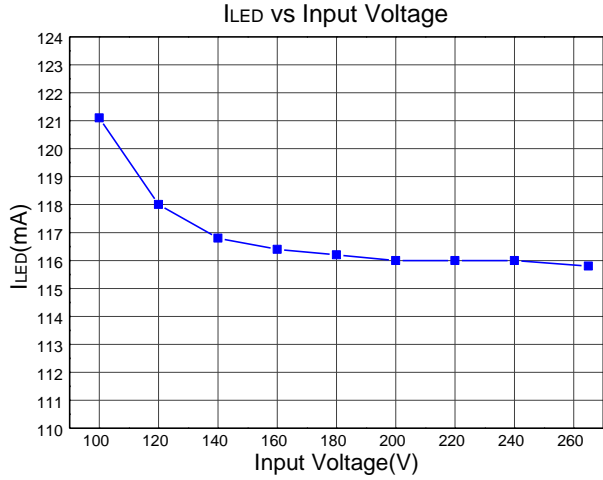
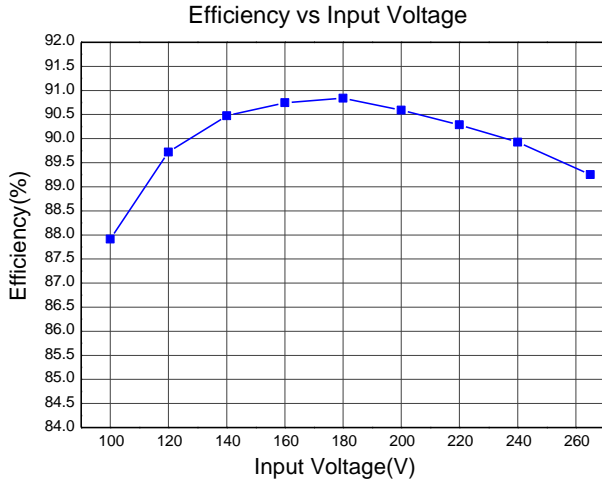


Item	Winding name	Description
1	WD1-Primary Winding	Start at Pin 2, Wind 257turns of $\Phi 0.15\text{mm}$ wire and finish on Pin 5
2	Insulation	2 Layers of insulation tape

Bill of Material

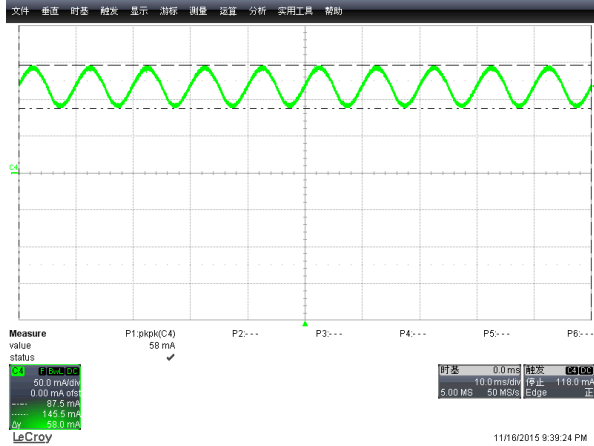
No.	Item	Description	Package	QTY
1	C1	68nF/400V, CL21, Pitch=7.5mm	DIP	1
2	C2	150nF/400V, CL21, Pitch=7.5mm	DIP	1
3	C3	Ceramic Cap, 0.33uF/25V,X7R	0805	1
4	C4	Ceramic Cap, 1uF/25V,X7R	0805	1
5	C5	E-Cap, 130°C,100uF/100V,10*16mm	DIP	1
6	C6	NC	-	0
7	BD1	Rectifier Bridge,HD06,0.8A/600V,Diodes Inc	SOPA-4	1
8	D1	Fast Recovery Diode, RS1J, 1A/600V,Diodes Inc	SMA	1
9	VR1	Varistor, 07D431	DIP	1
10	RF1	Fuse Resistor,10R, 5%, 1W	DIP	1
11	R1	SMD Resistor,30K, 5%, 1/8W	0805	1
12	R2	SMD Resistor,180K, 5%, 1/4W	1206	1
13	R3	SMD Resistor,180K, 5%, 1/4W	1206	1
14	R4	SMD Resistor,3.0R, 1%, 1/8W	0805	1
15	R5	SMD Resistor,3.6R, 1%, 1/8W	0805	1
16	R6	SMD Resistor,47K, 5%, 1/8W	0805	1
17	R8	SMD Resistor,100K, 5%, 1/4W	1206	1
18	L1	Inductor 4.7mH, 6*8mm	DIP	1
19	T1	EE10, Vertical, 4+4 pin,Single Winding,1.67mH	DIP	1
20	U1	AL1676-10B, high PFC Buck IC, Diodes Inc	SOIC-7	1
21	PCB	FR4 Single layer, 45*24mm		
Total				19

Electrical Performance

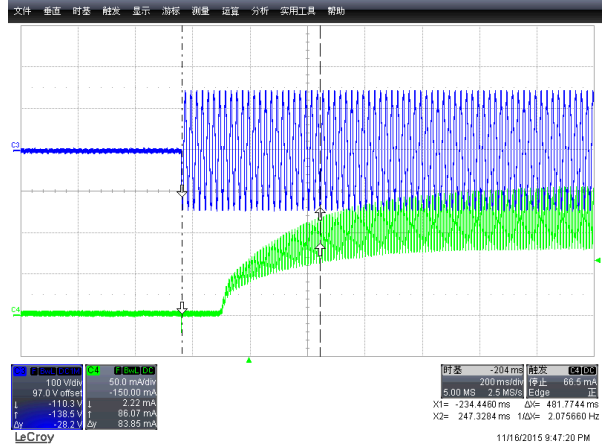


Functional Waveform

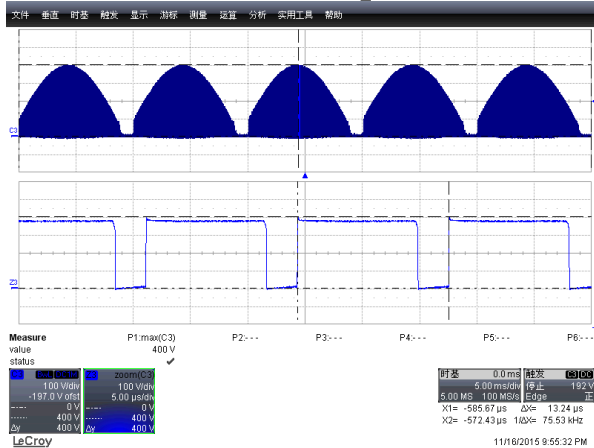
LED Current Ripple
($V_{in}=230V_{AC}$, Ripple=58mA)



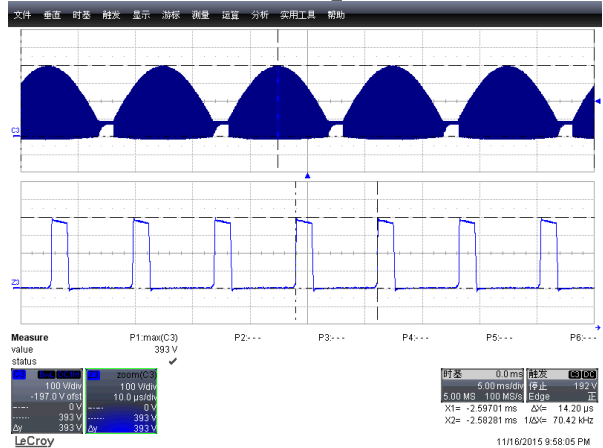
Start-up Time
($V_{in}=100V_{AC}$, Start-up time=481mS)



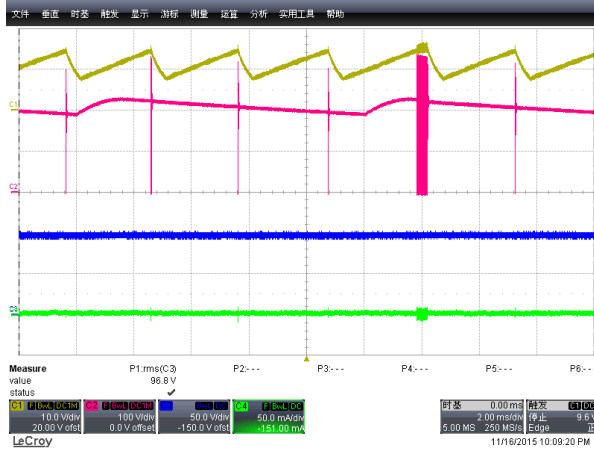
IC V_{DRAIN} Waveform
($V_{in}=265V_{AC}$, $V_{DRAIN_MAX}=400V$)



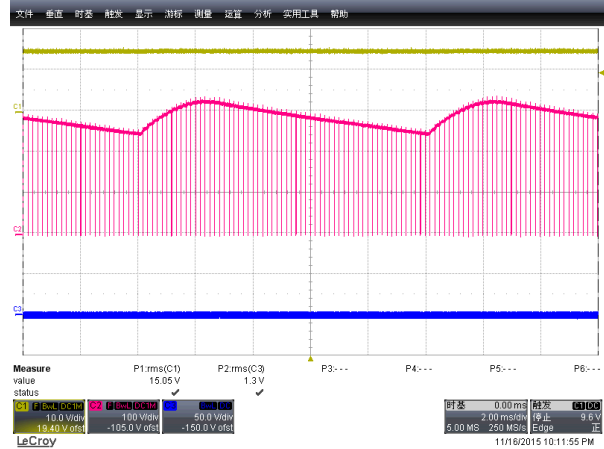
Output Diode V_R Waveform
($V_{in}=265V_{AC}$, $V_{R_MAX}=393V$)



LED Open Protection
($V_{in}=230V_{AC}$, Y-VCC, R-Drain, B-Vout, G-I_{LED})

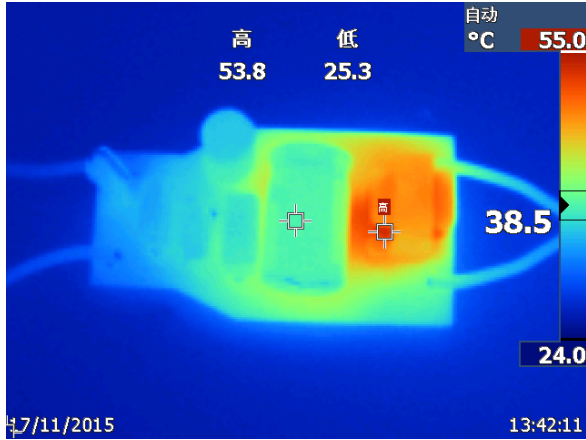


LED Short Protection
($V_{in}=230V_{AC}$, Y-VCC, R-Drain, B-Vout)

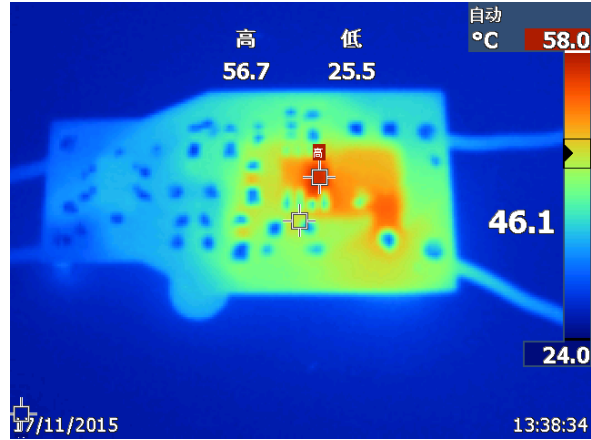


Thermal Test

Top
(Vin=230V_{AC}, Burn-in time=30min)

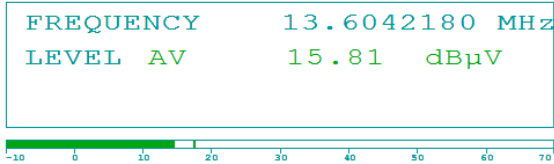


Bottom
(Vin=230V_{AC}, Burn-in time=30min)

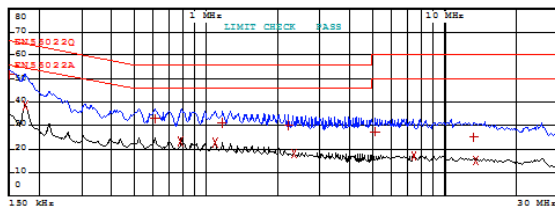
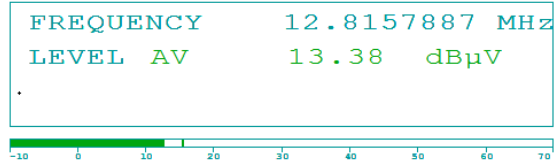


EMI Conduction Test

Line Terminal
(Vin=120V_{AC}, Margin>14dB)

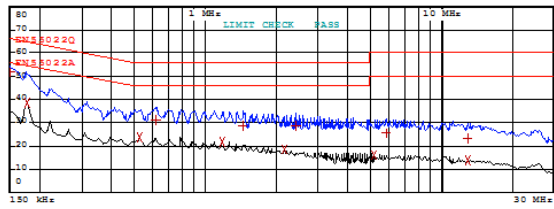


Neutral Terminal
(Vin=120V_{AC}, Margin>14dB)



EDIT PEAK LIST (Final Measurement Results)

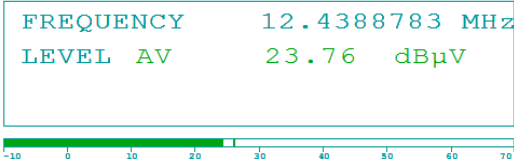
TRACE	FREQUENCY	LEVEL dB μ V	DELTA LIMIT dB
1 Quasi Peak	150 kHz	51.54	-14.45
2 Average	174.145343305 MHz	38.70	-16.05
1 Quasi Peak	610.105531335 MHz	32.88	-23.11
2 Average	774.672132397 MHz	23.27	-23.72
2 Average	1.08553730473 MHz	22.66	-23.33
1 Quasi Peak	1.16491505578 MHz	31.30	-24.69
1 Quasi Peak	2.22424976908 MHz	30.09	-25.90
2 Average	2.33770886123 MHz	18.19	-27.80
1 Quasi Peak	5.13072753076 MHz	27.59	-32.41
2 Average	7.41429363601 MHz	17.12	-32.87
1 Quasi Peak	13.3361611591 MHz	25.10	-34.89
2 Average	13.6042179994 MHz	15.19	-34.80



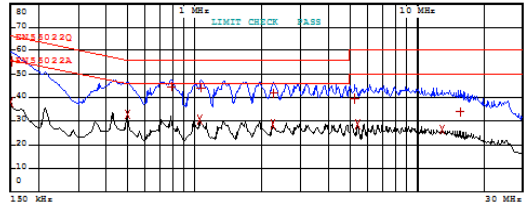
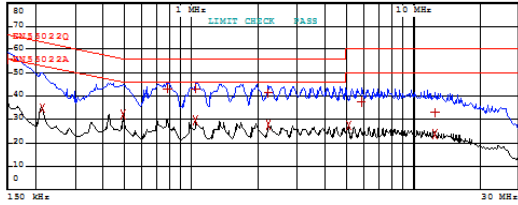
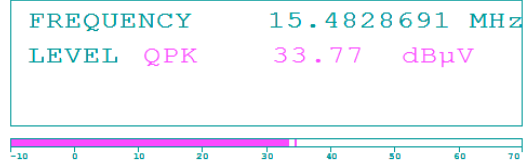
EDIT PEAK LIST (Final Measurement Results)

TRACE	FREQUENCY	LEVEL dB μ V	DELTA LIMIT dB
1 Quasi Peak	150 kHz	51.73	-14.26
2 Average	175.886796739 MHz	38.60	-16.07
2 Average	525.514079005 MHz	23.73	-22.26
1 Quasi Peak	616.206596648 MHz	30.89	-25.10
2 Average	1.17656420634 MHz	21.87	-24.12
1 Quasi Peak	1.43563192593 MHz	28.54	-27.45
2 Average	2.1374603093 MHz	18.31	-27.68
1 Quasi Peak	2.40854377744 MHz	28.89	-27.10
2 Average	5.18203480607 MHz	16.31	-33.69
1 Quasi Peak	5.83924652649 MHz	25.67	-34.32
1 Quasi Peak	12.8157887448 MHz	22.94	-37.05
2 Average	12.8157887448 MHz	13.61	-36.38

Line Terminal (Vin=230V_{AC}, Margin>10dB)



Neutral Terminal (Vin=230V_{AC}, Margin>10dB)



EDIT PEAK LIST (Final Measurement Results)			
TRACE	FREQUENCY	LEVEL dB μ V	DELTA LIMIT dB
Trace1:	EN55022Q		
Trace2:	EN55022A		
Trace3:	---		
1 Quasi Peak	150 kHz	55.79	-10.20
2 Average	212.490413403 kHz	35.05	-18.05
2 Average	490.156469491 kHz	31.92	-14.24
1 Quasi Peak	774.672132397 kHz	43.15	-12.84
1 Quasi Peak	1.04414099339 MHz	43.05	-12.94
2 Average	1.04414099339 MHz	29.59	-16.30
1 Quasi Peak	2.22424976908 MHz	41.41	-14.58
2 Average	2.22424976908 MHz	28.00	-17.99
2 Average	5.13072753076 MHz	27.23	-22.76
1 Quasi Peak	5.83924652649 MHz	37.56	-22.43
1 Quasi Peak	12.4388782936 MHz	33.21	-26.78
2 Average	12.4388782936 MHz	23.76	-26.23

EDIT PEAK LIST (Final Measurement Results)			
TRACE	FREQUENCY	LEVEL dB μ V	DELTA LIMIT dB
Trace1:	EN55022Q		
Trace2:	EN55022A		
Trace3:	---		
2 Average	150 kHz	38.21	-17.78
1 Quasi Peak	151.5 kHz	55.65	-10.26
2 Average	495.058034196 kHz	32.78	-13.30
1 Quasi Peak	782.418853721 kHz	44.49	-11.50
2 Average	1.05458240332 MHz	30.43	-15.56
1 Quasi Peak	1.06512822736 MHz	44.36	-11.63
2 Average	2.24649226677 MHz	28.92	-17.07
1 Quasi Peak	2.26895718944 MHz	42.03	-13.96
1 Quasi Peak	5.23395515413 MHz	39.74	-20.25
2 Average	5.39244619915 MHz	28.84	-21.15
2 Average	12.9157887448 MHz	26.48	-23.51
1 Quasi Peak	15.4828690896 MHz	33.87	-26.12

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