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ON Semiconductor®

LED Driver with Phase-cut Dimmable Function, 8.6 W

LED Driver with Phase-cut Dimmable Function, 8.6 W

The following reference design supports inclusion of FL7734MX in design of an LED Driver with Phase-cut dimmable function. It should be used in conjunction with the FL7734MX datasheet.

Application	ON Semiconductor Device	Input Voltage Range	Rated Output Power	Output Voltage (Rated Current)	Topology
LED Driver	FL7734	108-264 V _{AC}	8.6 W	24 V (360 mA)	Flyback

Key Features

Performance

- $< \pm 2.6\%$ Total Constant Current Tolerance Over All Conditions
- $< \pm 1.8\%$ Over Universal Line Voltage Variation
- $< \pm 1.1\%$ from 70% to 100% Load Voltage Variation
- Excellent Dimmer Compatibility by Active Dimming Control
- Programmable Dimming Curve and Input Current Management
- Fast Startup utilizing Bleeding Circuit
 - < 0.1 s at the Max. Dimmer Phase Angle
 - < 0.5 s at the Min. Dimmer Phase Angle
- Power Factor Correction in Non-dimming Mode
- Constant LED Current Regulation in Large Phase Angle Range

System Protection

- LED Short / Open Protection
- Output Diode Short Protection, Sensing Resistor Short / Open Protection
- VDD Over-Voltage Protection (OVP)
- VDD Under-Voltage Lockout (UVLO)
- Over-Temperature Protection (OTP)
- All Protections are Auto Restart (AR)
- Cycle-by-Cycle Current Limit

1. Schematic

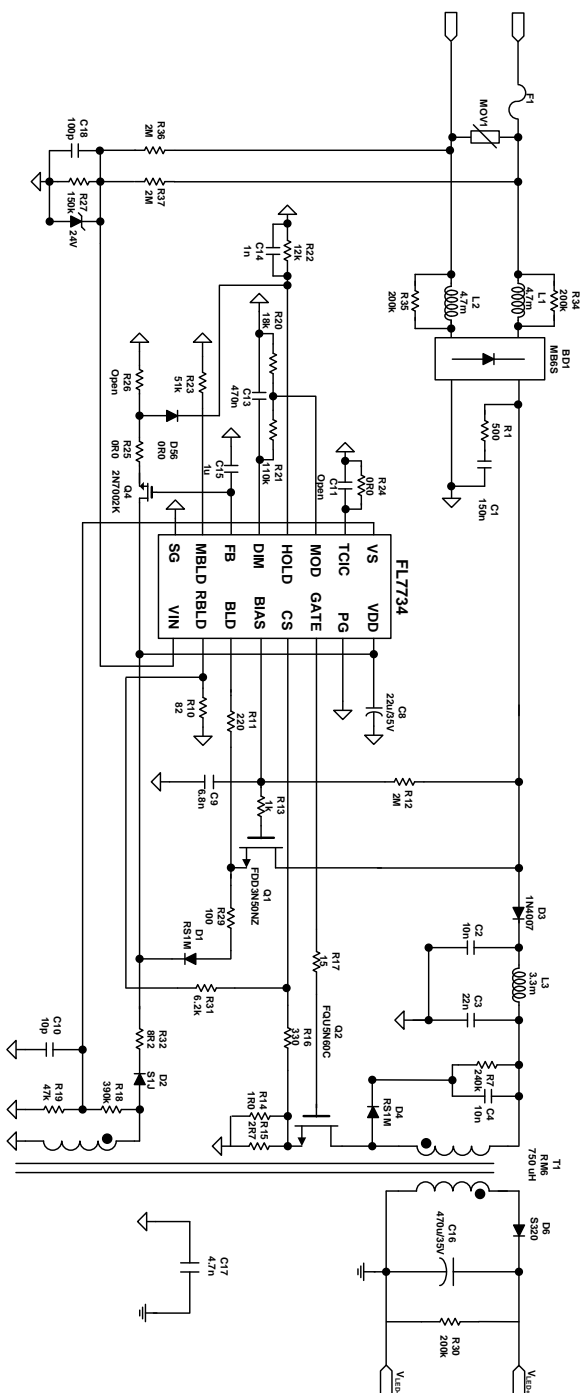


Figure 1. Schematic

2. Transformer

Required Components

MFG: TDK
Material: PC40
Core: RM6
Bobbin: 6-pin
Insulation Tape: Polyester,
.050mm, 3M 1350 or Eq.

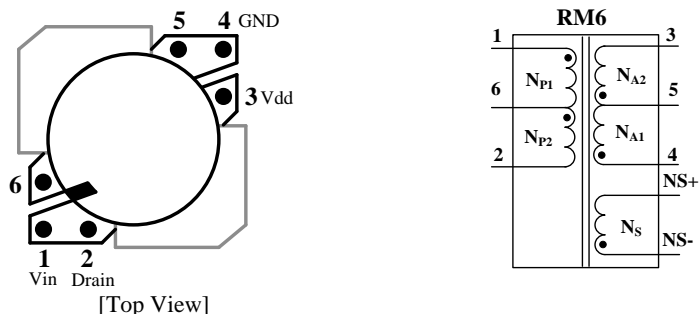


Figure 2. Transformer Bobbin Structure and Pin Configuration

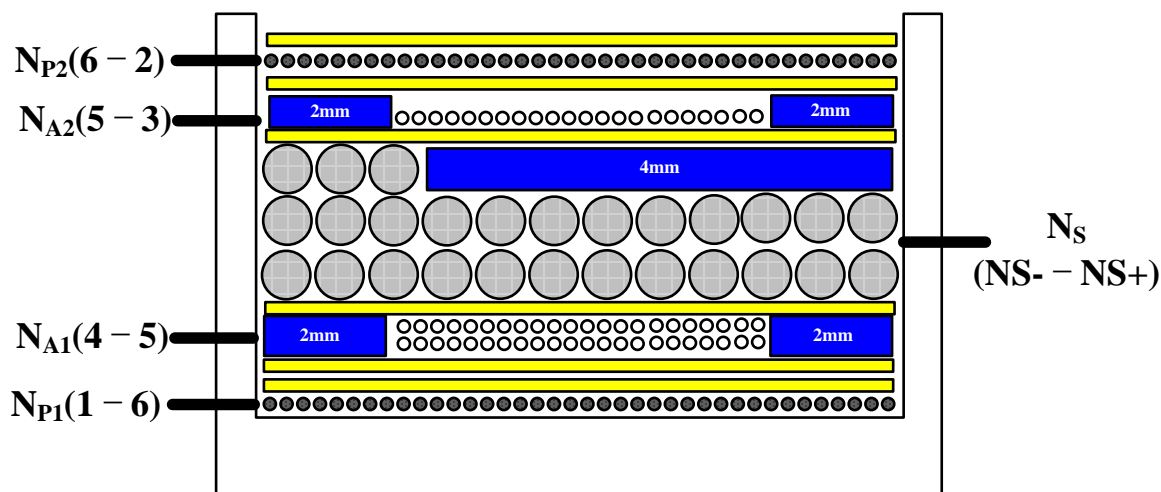


Figure 3. Transformer Winding Structure

2.1. Winding Specification

Winding	Pins (S→F)	Wire (Diameter)	Turns	Layers	Winding Direction	Winding Method
N _{P1}	1→6	0.13 φ	36	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 1 tape layer after winding						
N _{A1}	4→5	0.13 φ	20	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 1 tape layer after winding						
N _S	N _S →N _{S+}	0.2 φ TIW	32	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 1 tape layer after winding						
N _{A2}	5→3	0.13 φ	9	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 1 tape layer after winding						
N _{P2}	6→2	0.13 φ	36	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 3 tape layers after winding						

2.2. Electrical Characteristics

	Pin	Specification	Remarks
Inductance	1→2	750 μ H \pm 5 %	50 kHz, 1 V _{AC}
Leakage	3→1	< 30 μ H	Short all other pins

3. Bill of Material

Item No.	Part Reference	Part Number	Qty.	Description	Manufacturer
1	F1	SS-5-1A		1A/250V Fuse	Busmann
2	MOV1	SVC 471 D-07A		Metal Oxide Varistor	Samwha
3	BD1	MB6S		600V/0.5A SOIC-4	ON Semiconductor
4	R1	MOR 1W TC 500		Metal oxide film resistor RSD type J 500 ohm/1W R-forming	ABC
5	R7	RC1206 JR-07240KL		240kohm SMD Resistor 3216 F 1/4W	Yageo
6	R10	RC1206 JR-0782RL		82ohm SMD Resistor 3216 F 1/4W	Yageo
7	R11	RC1206 JR-07150RL		220ohm SMD Resistor 3216 F 1/4W	Yageo
8	R12	RC1206 JR-072ML		2Mohm SMD Resistor 3216 F 1/4W	Yageo
9	R13	RC0805 JR-071KL		1kohm SMD Resistor 2012 F 1/8W	Yageo
10	R14	RC0805 JR-071R0L		1R0 ohm SMD Resistor 2012 1/4W F	Yageo
11	R15	RC0805 JR-072R7L		2R7ohm SMD Resistor 2012 1/4W F	Yageo
12	R16	RC0805 JR-07330RL		330ohm SMD Resistor 2012 F 1/4W	Yageo
13	R17	RC0805 JR-0715RL		15ohm SMD Resistor 2012 F 1/4W	Yageo
14	R18	RC0603 JR-07390KL		390kohm SMD Resistor 1608 F 1/16W	Yageo
15	R19	RC0603 JR-0747KL		47kohm SMD Resistor 1608 F 1/16W	Yageo
16	R20	RC0603 JR-0718KL		18kohm SMD Resistor 1608 F 1/16W	Yageo
17	R21	RC0603 JR-07110KL		110kohm SMD Resistor 1608 F 1/16W	Yageo
18	R22	RC0603 JR-0712KL		12kohm SMD Resistor 1608 F 1/16W	Yageo
19	R23	RC0603 JR-0751KL		51kohm SMD Resistor 1608 F 1/16W	Yageo
20	R24	RC0603 JR-070R0KL		0 ohm SMD Resistor 1608 F 1/16W	Yageo
21	R25	RC0603 JR-070R0KL		0 ohm SMD Resistor 1608 F 1/16W	Yageo
22	R27	RC0805 JR-07150KL		150kohm SMD Resistor 2012 F 1/4W	Yageo
23	ZD			24V zener diode is parallel with R27	
24	R29	RC0805 JR-0751RL		51ohm SMD Resistor 2012 1/4W F	Yageo
25	R30	RC0805 JR-07200KL		200kohm SMD Resistor 2012 F 1/4W	Yageo
26	R31	RC0603 JR-076.2KL		6.2kohm SMD Resistor 1608 F 1/16W	Yageo
27	R32	RC0805 JR-078R2L		8.2ohm SMD Resistor 2012 F 1/4W	Yageo
28	R36	RC1206 JR-072ML		2Mohm SMD Resistor 3216 F 1/4W	Yageo
29	R37	RC1206 JR-072ML		2Mohm SMD Resistor 3216 F 1/4W	Yageo
30	C1	B32671P6154K		MK 0.15uF/630V 13.0X 6.0 X 12.0 mm (P10.0mm)	EPCOS
31	C2	B32529C6103J289		MKT 10nF/400V 7.2 X 3.0 X 6.5 mm(P5.0mm)	EPCOS
32	C3	B32529C6223J		MKT 22nF/400V 7.3 X 4.5 X 9.5 mm(P5.0mm)	EPCOS
33	C4	C1206C103KDRCTU		10nF/1kV SMD Capacitor 3216	Kemet

Item No.	Part Reference	Part Number	Qty.	Description	Manufacturer
34	C8	KMG 22uF35V		KMG series 22μF/35V D5 X H11 105°C Electrolytic Capacitor	Samyoung
35	C9	GRM2192C1H682JA01#		6.8nF/50V SMD Capacitor 2012 CH	Murata
36	C10	C0603C100K8GACTU		10pF/10V SMD Capacitor 1608 NP0	Kemet
37	C11	GRM21A1X1H333JA39#		33nF/50V SMD Capacitor 2012 SL	Murata
38	C13	GRM188B11A474KA61#		470nF/10V SMD Capacitor 1608 B	Murata
39	C14	GRM1881X1E102JA01#		1nF/10V SMD Capacitor 1608 SL	Murata
40	C15	GRM185D71A105KE36#		1uF/10V SMD Capacitor 1608 X7T	Murata
41	C16	KMG 470uF35V		KMG series 470μF/35V D10 X H16 105°C Electrolytic Capacitor	Samyoung
42	C17	SCF2E472M14DW7		Y cap 4700pF	Samwha capacitor
43	C18	GRM1882C1H101JA01#		SMD Capacitor CH 100pF/50V	
44	T1	RM6 core		Core RM6 PC40 Bobbin BRM6-716CPFR	TDK
45	D1	RS1M		1000V/1.0A SMA package fast recovery diode	ON Semiconductor
46	D2	S1J		600V/1.0A SMA package general purpose diode	ON Semiconductor
47	D3	1N4007		1000V/1.0A SMA Genenral purpose diode	ON Semiconductor
48	D4	RS1M		1000V/1.0A SMA package fast recovery diode	ON Semiconductor
49	D56	1N4148WS		100V/0.3A SOD-323 package general purpose diode	ON Semiconductor
50	D6	S320		200V/3.0A SMB package Schottky Rectifier	ON Semiconductor
51	Q1	FDD3N50NZ		N-ch mosfet 500V/3A D-pak	ON Semiconductor
52	Q2	FQU5N60C		N-ch mosfet 600V/5A I-pak	ON Semiconductor
53	Q4	2N7002K		N-ch mosfet 60V/0.3A SOT-23	ON Semiconductor
54	U	FL7734MX		Phase cut dimmable LED driver IC	ON Semiconductor
55	L1	R06472KT00		Radial inductor 4.7mH size Φ6.5 mm X H7.5 mm Molding color Green	Bosung
56	L2	R06472KT00		Radial inductor 4.7mH size Φ6.5 mm X H7.5 mm Molding color Green	Bosung
57	L3	R06332KT00		Radial inductor 3.3mH size Φ6.5 mm X H7.5 mm Molding color Green	Bosung

4. Performance

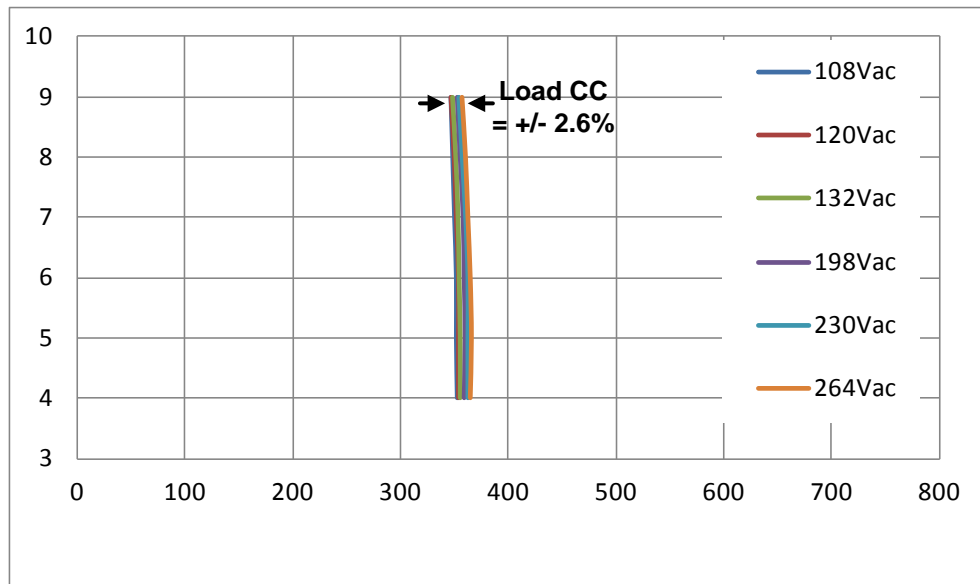


Figure 4. Output Current Regulation Data plotted against Output Voltage Change

Table 1. Output Current Regulation by Output Voltage Change (12-27 V)

Input Voltage	I _{OUT} Minimum (mA)	I _{OUT} Maximum (mA)	Tolerance (±%)
108 V _{AC} [60 Hz]	346	353	1.0
120 V _{AC} [60 Hz]	347	354	0.9
230 V _{AC} [60 Hz]	348	355	0.9
264 V _{AC} [60 Hz]	352	360	1.1

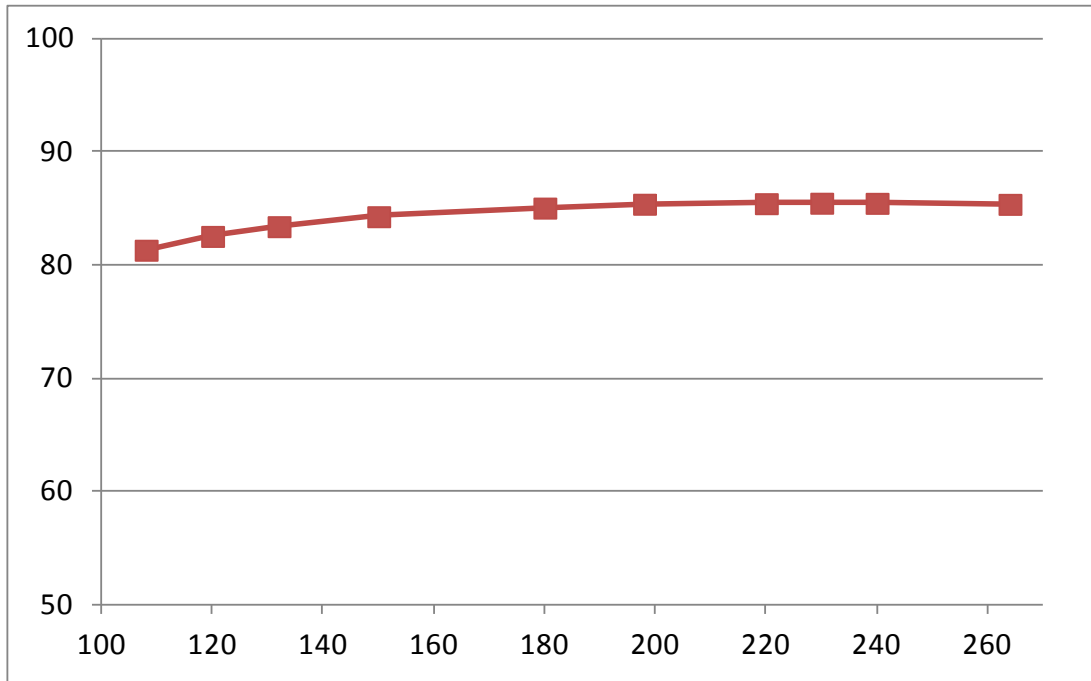


Figure 5. System Efficiency Data plotted against Line Variation

Table 2. System Efficiency – 24 V Nominal Load

Input Voltage	Input Power (W)	Output Current (mA)	Output Voltage (V)	Output Power (W)	Efficiency (%)
108 V _{AC} [60 Hz]	10.3	348	24	8.4	81.4
120 V _{AC} [60 Hz]	10.2	350	24	8.4	82.6
132 V _{AC} [60 Hz]	10.1	351	24	8.4	83.5
198 V _{AC} [60 Hz]	10.0	355	24	8.5	85.4
230 V _{AC} [60 Hz]	10.0	357	24	8.6	85.5
264 V _{AC} [60 Hz]	10.1	360	24	8.6	85.4

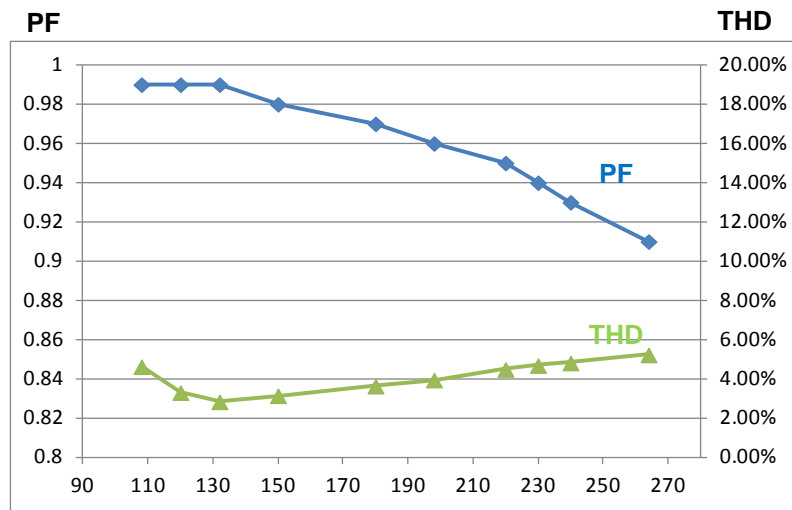


Figure 6. PF and THD data plotted against Line Variation – 24 V Nominal Load

Table 3. Power Factor and Input Current THD

Input Voltage	Output Current (mA)	Output Voltage (V)	Power Factor	THD (%)
108 V _{AC} [60 Hz]	348	24	0.99	4.6
120 V _{AC} [60 Hz]	350	24	0.99	3.3
132 V _{AC} [60 Hz]	351	24	0.99	2.8
198 V _{AC} [60 Hz]	355	24	0.96	3.9
230 V _{AC} [60 Hz]	357	24	0.94	4.6
264 V _{AC} [50 Hz]	360	24	0.91	5.2

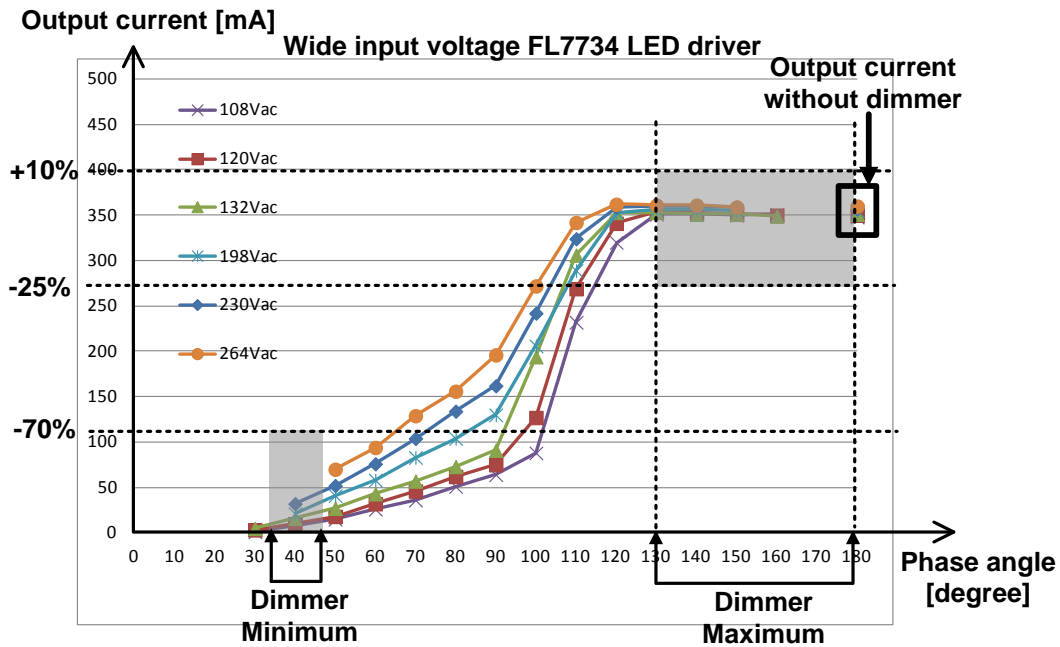


Figure 7. Dimming curve

Figure 7 shows a dimming curve which is obtained by rotating the dimmer switch. Regardless of input line voltage $\pm 10\%$ variation, LED current is constantly regulated from 180° to 130° dimmer phase angle. When the phase angle is below 130° , LED current decreases linearly according to internal dimming reference modulation.

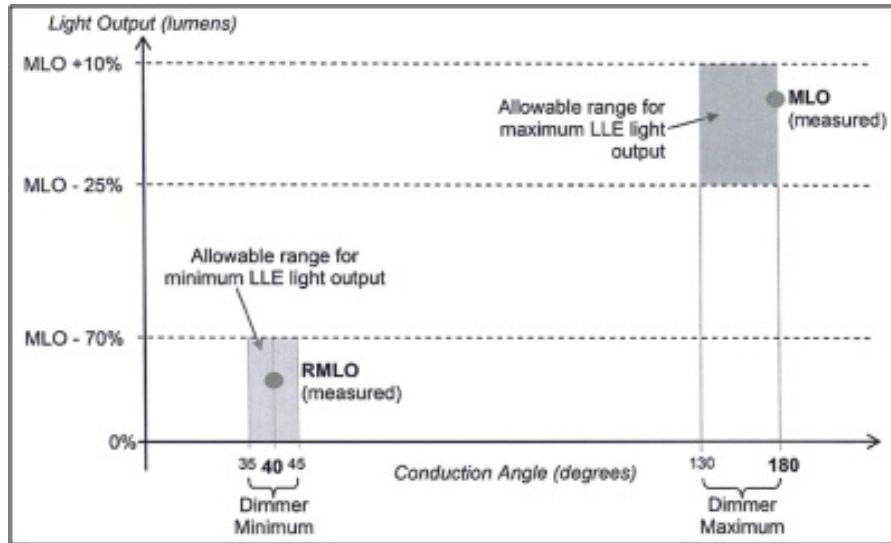


Figure 8. NEMA SSL-7A Specification

FL7734 dimming control method can meet NEMA SSL-7A specification. Figure 8 indicates the maximum and minimum dimmed output range as specified by NEMA SSL-7A.

5. Electromagnetic Interference(EMI)

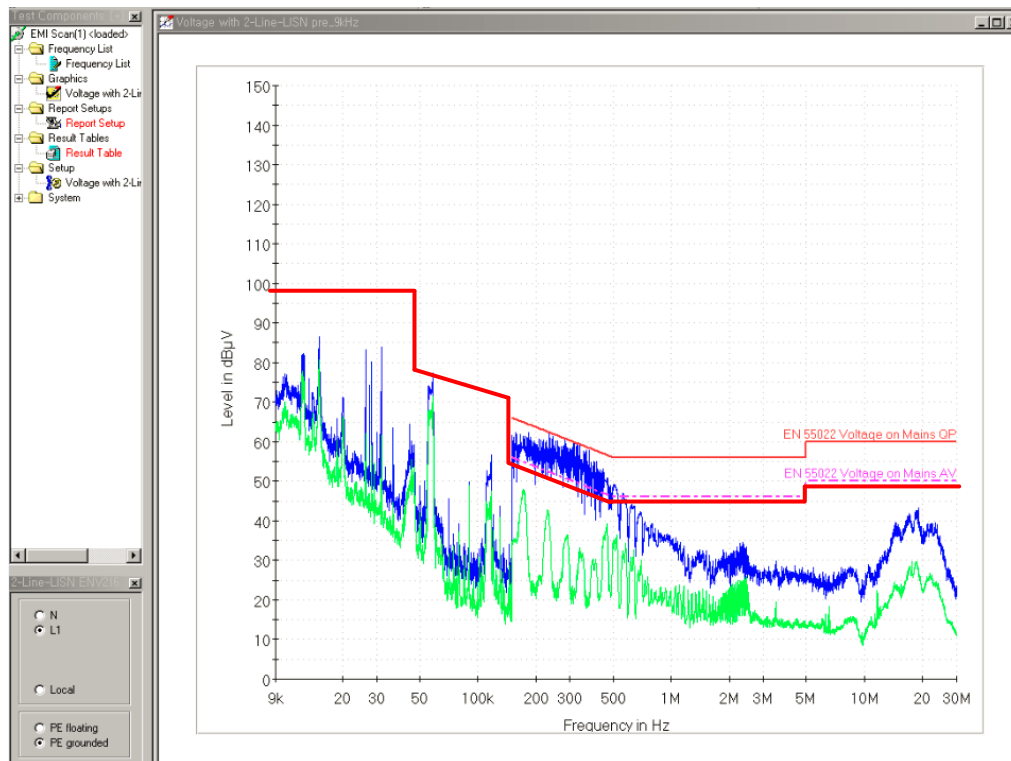


Figure 9. HV Live

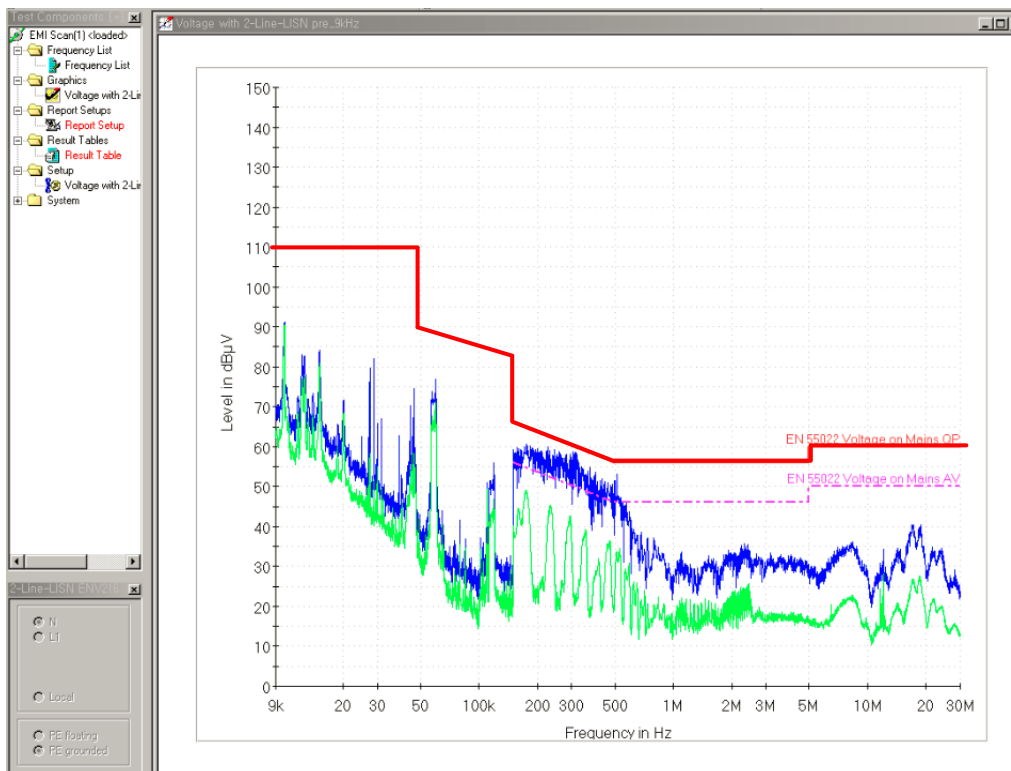


Figure 10. HV Neutral

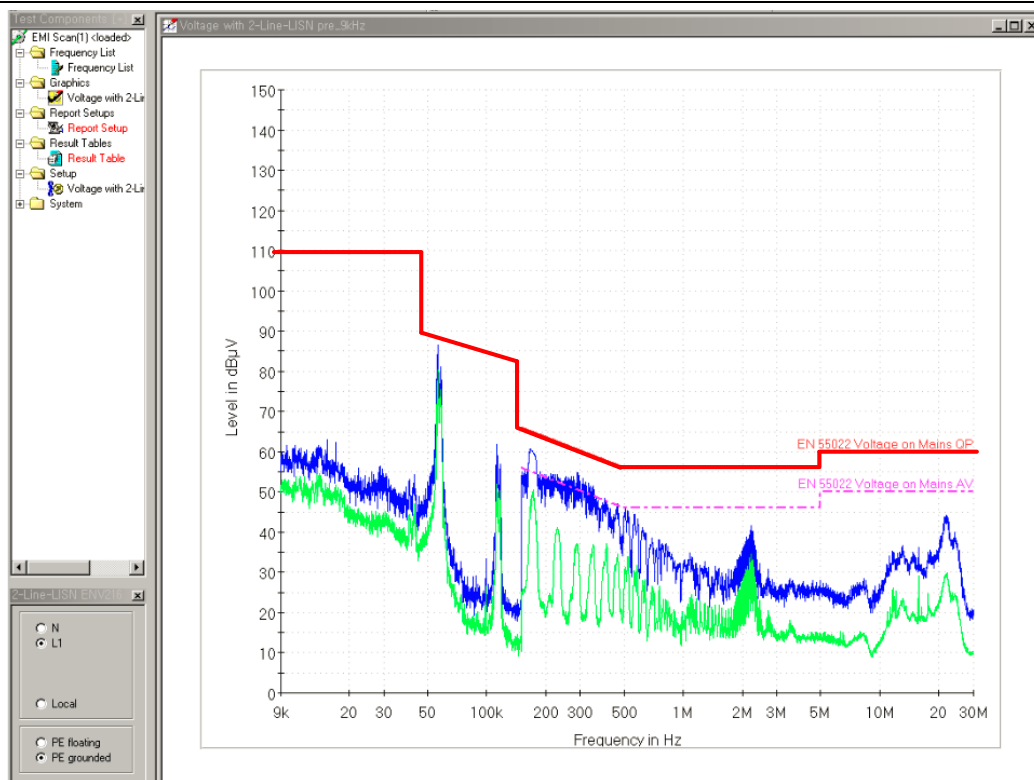


Figure 11. LL Live

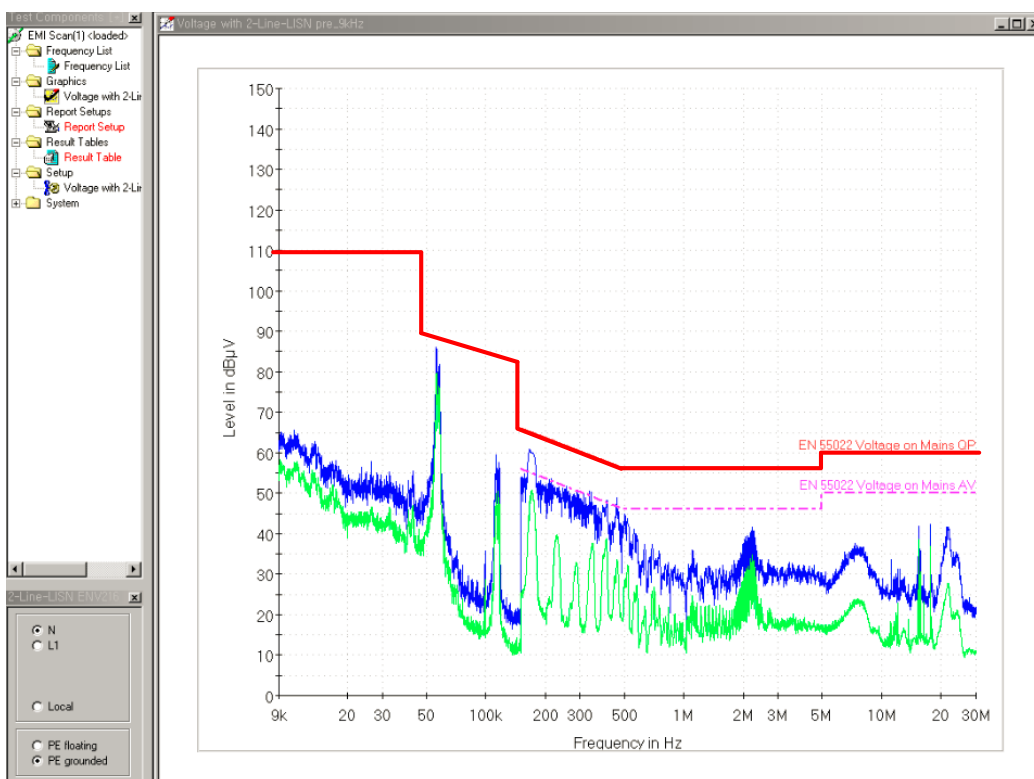



Figure 12. LL Neutral

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