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ON Semiconductor®

LED Driver with Phase–cut Dimmable Function, 40 W

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Publication Order Number:
TND6252/D

LED Driver with Phase-cut Dimmable Function, 40 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	108-305 V_{AC}	40 W	40 V (1000 mA)	Flyback

Key Features

Performance

- < ±2.0% Total Constant Current Tolerance Over All Conditions
- < ±1.8% Over Universal Line Voltage Variation
- < 0.7% 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

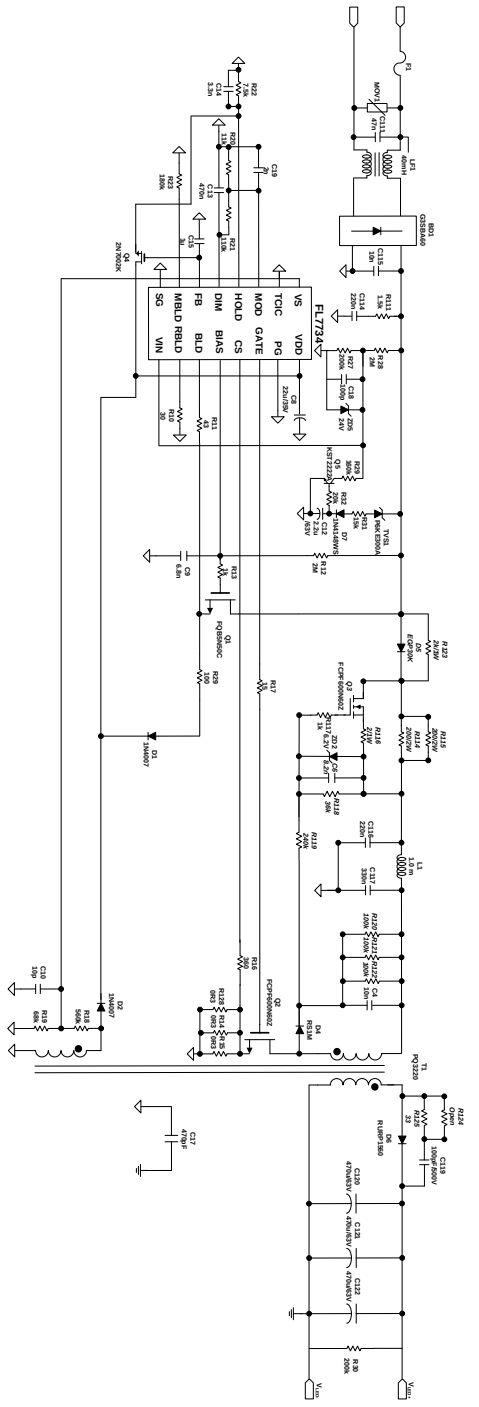

Figure 1. Schematic

2. Transformer

Required Components

MFG: TDK
Material: PC40
Core: PQ3220
Bobbin: 12-pin, remove pins 2,3,10
Insulation Tape: Polyester,
.050mm, 3M 1350 or Eq.

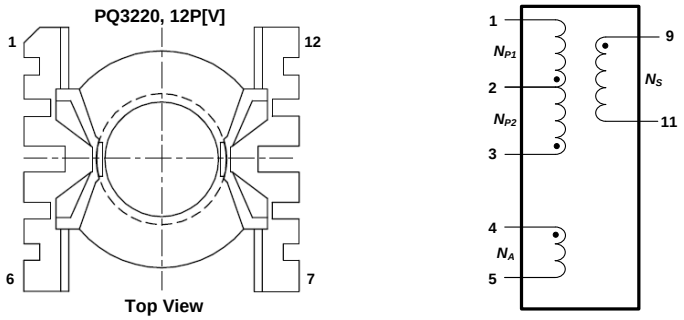

Figure 2. Transformer Bobbin Structure and Pin Configuration

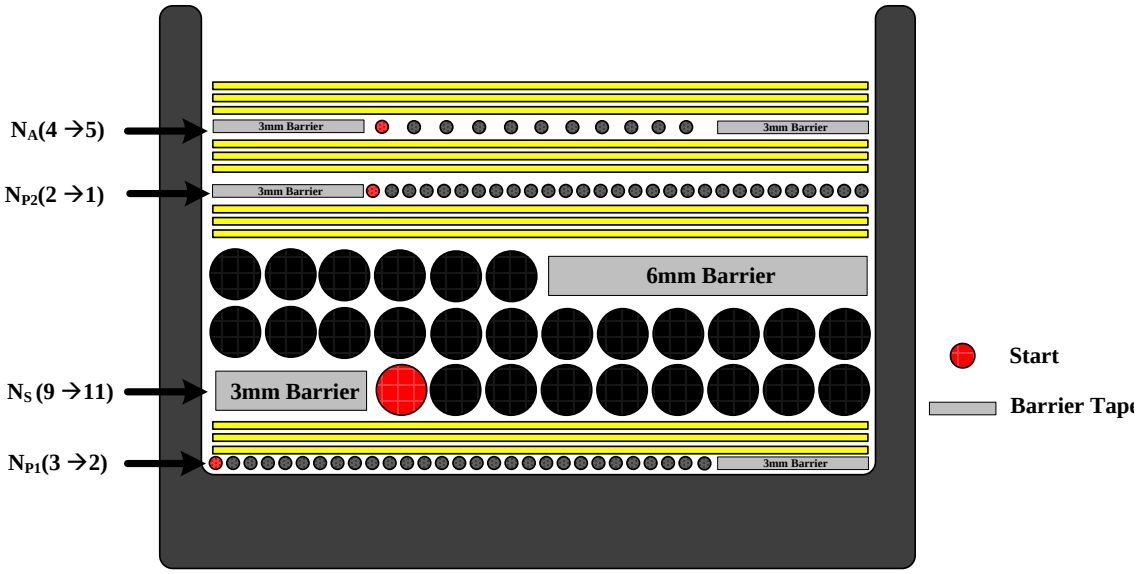

Figure 3. Transformer Winding Structure

2.1. Winding Specification

Winding	Pins (S→F)	Wire (Diameter)	Turns	Layers	Winding Direction	Winding Method
N_{P1} (1)	3→2	0.5 φ	8	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 1 tape layer after winding						
N_S	9→11	0.7 φ TIW	14	1	▲ Forward	Solenoid
Insulation: 1 tape layer after winding						
N_{P2}	2→1	0.5 φ	5	1	▲ Forward	Solenoid
Insulation: 1 tape layer between coil and finish lead, 1 tape layer after winding						
N_A	4→5	0.2 φ	8	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	3→1	150 µH ± 5 %	50 kHz, 1 V_{AC}
Leakage	3→1	< 10 µH	Short all other pins

3. Bill of Material

Item No.	Part Reference	Part Number	Description	Manufacturer
1	F1	SS-5-2A	2 A/250 V Fuse	Bussmann
2	MOV1	SVC471D-10A	Metal Oxide Varistor	Samwha
3	BD1	G3SBA60	4 A / 600 V, Bridge Diode	Vishay
4	R111	MOR 1W TC 1R5K	Metal oxide film resistor RSD type J 1.5 kOhm/1W R-forming	ABC
5	R114	MOR 2W TC 200R	Metal oxide film resistor RSD type J 200 Ohm/2W R-forming	ABC
6	R115	MOR 2W TC 200R	Metal oxide film resistor RSD type J 200 Ohm/2W R-forming	ABC
7	R116	MOR 2W TC 2R	Metal oxide film resistor RSD type J 2 Ohm/2W R-forming	ABC
8	R117	RC0805 JR-071KL	1 kOhm SMD Resistor 2012 F 1/8W	Yageo
9	R118	RC0603 JR-0736KL	36 kOhm SMD Resistor 1608 F 1/16W	Yageo
10	R119	RC0603 JR-07240KL	240 kOhm SMD Resistor 1608 F 1/16W	Yageo
11	R120	RC1206JR-07100KL	100 kOhm SMD Resistor 3216 F 1/4W	Yageo
12	R121	RC1206JR-07100KL	100 kOhm SMD Resistor 3216 F 1/4W	Yageo
13	R122	RC1206JR-07100KL	100 kOhm SMD Resistor 3216 F 1/4W	Yageo
14	R123	MOR 1W TC 2R0K	Metal oxide film resistor RSD type J 2.0 kOhm/1W R-forming	ABC
15	R125	RC1206 JR-0733RL	33 Ohm SMD Resistor 3216 F 1/4W	Yageo
16	R128	RC1206 JR-070R3RL	0.3 Ohm SMD Resistor 3216 F 1/4W	Yageo
17	R10	RC1206 JR-0730RL	30 Ohm SMD Resistor 3216 F 1/4W	Yageo
18	R11	RC1206 JR-0743RL	43 Ohm SMD Resistor 3216 F 1/4W	Yageo
19	R12	RC1206 JR-072ML	2 MOhm SMD Resistor 3216 F 1/4W	Yageo
20	R13	RC0805 JR-071KL	1 kOhm SMD Resistor 2012 F 1/8W	Yageo
21	R14	RC1206 JR-070R3RL	0.3 Ohm SMD Resistor 3216 F 1/4W	Yageo
22	R15	RC1206 JR-070R3RL	0.3 Ohm SMD Resistor 3216 F 1/4W	Yageo
23	R16	RC0805 JR-07360RL	360 Ohm SMD Resistor 2012 F 1/4W	Yageo
24	R17	RC0805 JR-0715RL	15 Ohm SMD Resistor 2012 F 1/4W	Yageo
25	R18	RC0603 JR-07560KL	560 kOhm SMD Resistor 1608 F 1/16W	Yageo
26	R19	RC0603 JR-0768KL	68 kOhm SMD Resistor 1608 F 1/16W	Yageo
27	R20	RC0603 JR-0711KL	11 kOhm SMD Resistor 1608 F 1/16W	Yageo
28	R21	RC0603 JR-07110KL	110 kOhm SMD Resistor 1608 F 1/16W	Yageo
29	R22	RC0603 JR-077R5KL	7.5 kOhm SMD Resistor 1608 F 1/16W	Yageo
30	R23	RC0603 JR-07180KL	180 kOhm SMD Resistor 1608 F 1/16W	Yageo
31	R25	RC0603 JR-070R0L	0 Ohm SMD Resistor 1608 F 1/16W	Yageo
32	R26	RC0603 JR-070R0L	0 Ohm SMD Resistor 1608 F 1/16W	Yageo
33	R27	RC0805 JR-07200KL	200 kOhm SMD Resistor 2012 F 1/4W	Yageo
34	R28	RC1206 JR-072MKL	2 MOhm SMD Resistor 3216 F 1/4W	Yageo
35	R29	RC0805 JR-07160KRL	160 kOhm SMD Resistor 2012 F 1/4W	Yageo
36	R30	RC0805 JR-07200KL	200 kOhm SMD Resistor 2012 F 1/8W	Yageo

Item No.	Part Reference	Part Number	Description	Manufacturer
37	R31	RC0805 JR-0715KL	15 kOhm SMD Resistor 2012 F 1/8W	Yageo
38	R32	RC0805 JR-0720KL	20 kOhm SMD Resistor 2012 F 1/8W	Yageo
39	C111	MPE 630V473	MPE 47 nF/630 V	Sungho electronics
40	C114	TF224*2*10B	MTF 220 nF/450 V	CARLI
40	C115	MPE 630V103	MPE 10 nF/630 V	Sungho electronics
41	C116	TF224*2*10B	MK 0.22uF/450V	CARLI
42	C117	TF334*2*10B	MK 0.33uF/450V	CARLI
43	C119	C1206C101KCRACTU	100 pF / 500 V, SMD Capacitor 3216	Kemet
44	C120	KMG 470 µF / 63 V	470 µF / 63 V, Electrolytic Capacitor	Samyoung
45	C121	KMG 470 µF / 63 V	470 µF / 63 V, Electrolytic Capacitor	Samyoung
46	C122	KMG 470 µF / 63 V	470 µF / 63 V, Electrolytic Capacitor	Samyoung
47	C4	C1206C103KDRACTU	10 nF/1 kV SMD Capacitor 3216	Kemet
49	C6	GRM1885C1E822JA01#	8.2 nF/16 V SMD Capacitor 1608 COG	Murata
50	C8	KMG 22uF35V	KMG series 22 µF/35 V D5 X H11 105℃ Electrolytic Capacitor	Samyoung
51	C9	GRM2192C1H682JA01#	6.8 nF/50 V SMD Capacitor 2012 CH	Murata
52	C10	C0603C100K8GACTU	10 pF/10 V SMD Capacitor 1608 NP0	Kemet
53	C12	KMG 2.2uF63V	KMG series 2.2 µF/63 V D5 X H11 105℃ Electrolytic Capacitor	Samyoung
54	C13	GRM188B11A474KA61#	470 nF/10 V SMD Capacitor 1608 B	Murata
55	C14	GRM1881X1E332JA01#	3.3 nF/10 V SMD Capacitor 1608 SL	Murata
56	C15	GRM185D71A105KE36#	1 uF/10 V SMD Capacitor 1608 X7T	Murata
57	C17	SCF2E471M14DW7	Y cap 470pF	SAMWHA
58	C18	GRM1882C1H101JA01#	100 pF/50 V SMD Capacitor CH	Murata
59	C19	GRM1881X1E202JA01#	2 nF/10 V SMD Capacitor 1608 SL	Murata
60	LF1	B82733F	40 mH Common Inductor	EPCOS
61	L1	R06102KT00	Radial inductor 1.0 mH size Φ10 mm X H11 mm P 8mm	BOSUNG
62	T1	PQ3220 core	PQ Core, 12-Pin Transformer	TDK
63	D1	1N4007	1000 V/1.0 A DO-41 package general purpose diode	ON Semiconductor
64	D2	1N4007	1000 V/1.0 A DO-41 package general purpose diode	ON Semiconductor
65	D4	RS1M	1000 V/1.0 A SMA package fast recovery diode	ON Semiconductor
66	D5	EGP30K	800 V/3.0 A DO-201AD package	ON Semiconductor
67	D6	RURP1560	600 V / 15 A, Ultrafast Rectifier	ON Semiconductor
68	D7	1N4148WS	100V/0.3A SOD-323 package general purpose diode	ON Semiconductor
69	TVS1	P6KE300A	TVS diode Vc=414 V	ON Semiconductor
70	ZD2	MM3Z6V2B	6.2 V zener diode SOD-323	ON Semiconductor
71	ZD5	MM3Z24VB	24 V zener diode SOD-323	ON Semiconductor
72	Q1	FQB5N50C	N-ch mosfet 500 V/5.0 A D2-Pak	ON Semiconductor
73	Q2	FCPF600N60Z	N-ch mosfet 600 V/7.4 A TO-220	ON Semiconductor
74	Q3	FCPF600N60Z	N-ch mosfet 600 V/7.4 A TO-220	ON Semiconductor
75	Q4	2N7002K	N-ch mosfet 60 V/0.3 A SOT-23	ON Semiconductor
76	Q5	KST2222A	NPN General purpose transistor	ON Semiconductor
77	U	FL7734MX	Phase cut dimmable LED driver IC	ON Semiconductor

4. Performance

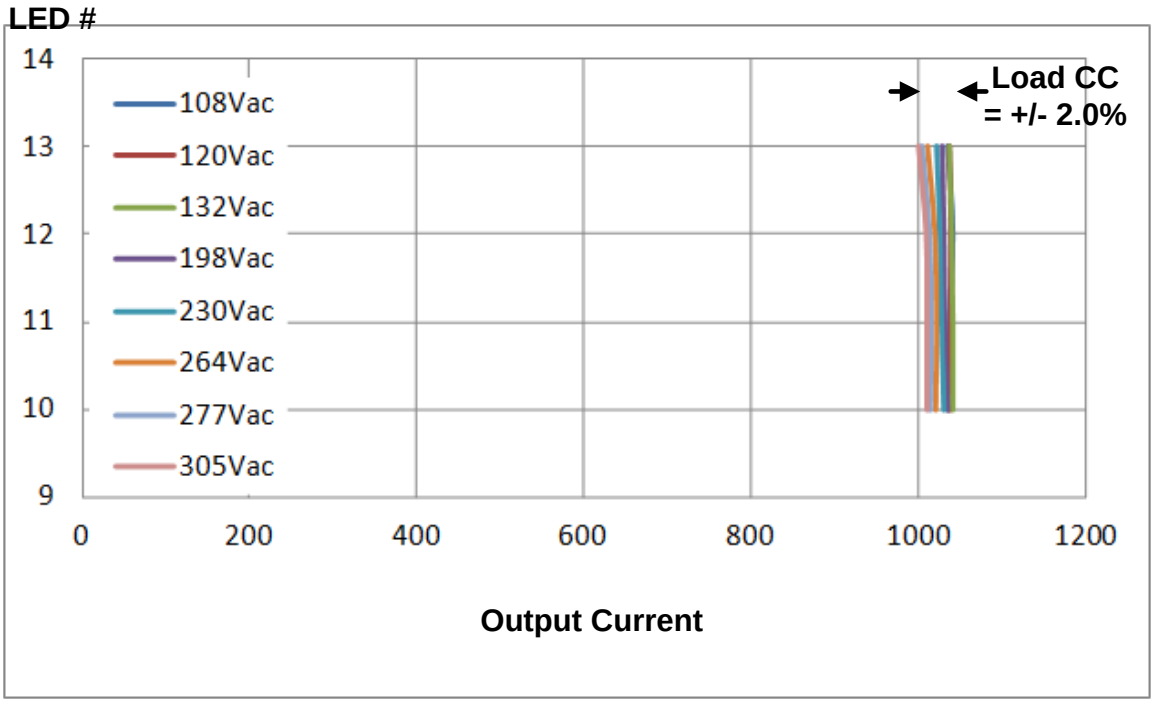

Figure 4. **Output Current Regulation Data plotted against Output Voltage Change**

Table 1. Output Current Regulation by Output Voltage Change (30-40 V)

Input Voltage	I_{OUT} Minimum (mA)	I_{OUT} Maximum (mA)	Tolerance (±%)
108 V_{AC} [60 Hz]	1036	1042	0.28
120 V_{AC} [60 Hz]	1037	1040	0.1
230 V_{AC} [60 Hz]	1021	1030	0.4
264 V_{AC} [60 Hz]	1011	1022	0.5
277 V_{AC} [60 Hz]	1004	1015	0.5
305 V_{AC} [60 Hz]	1000	1010	0.4

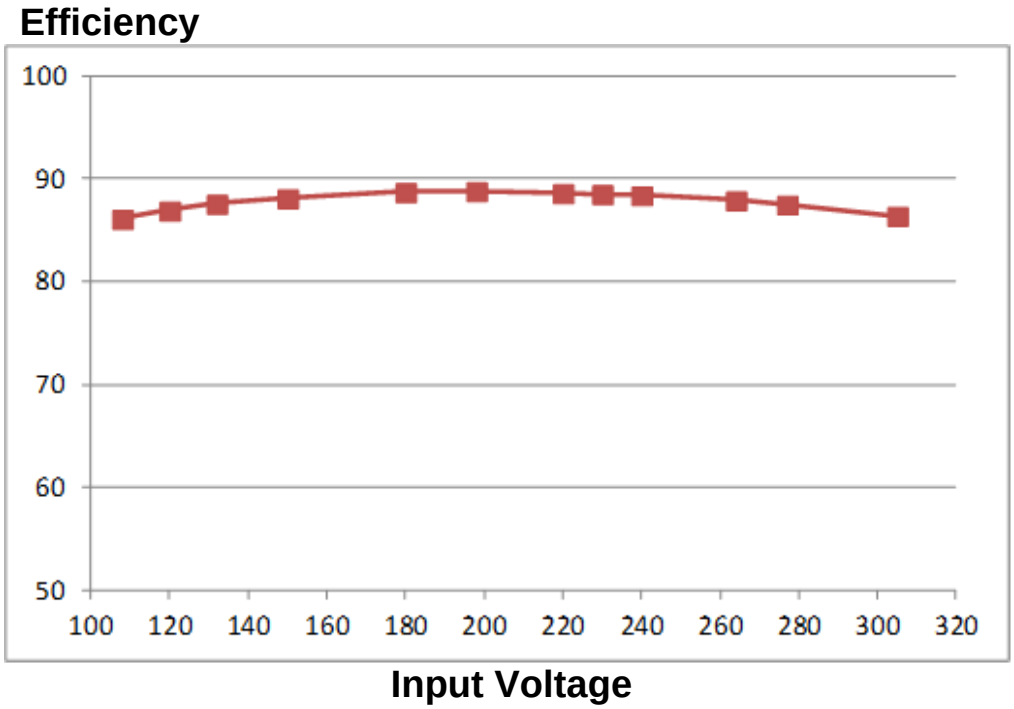

Figure 5. System Efficiency Data plotted against Line Variation

Table 2. System Efficiency – 40 V Nominal Load

Input Voltage	Input Power (W)	Output Current (mA)	Output Voltage (V)	Output Power (W)	Efficiency (%)
108 V_{AC} [60 Hz]	48.4	1042	40	41.68	86.1
120 V_{AC} [60 Hz]	47.8	1040	40	41.6	86.9
230 V_{AC} [60 Hz]	46.2	1025	40	41	88.5
264 V_{AC} [60 Hz]	46.4	1020	40	40.8	87.9
277 V_{AC} [60 Hz]	46.3	1013	40	40.5	87.5
305 V_{AC} [60 Hz]	46.7	1009	40	40.3	86.4

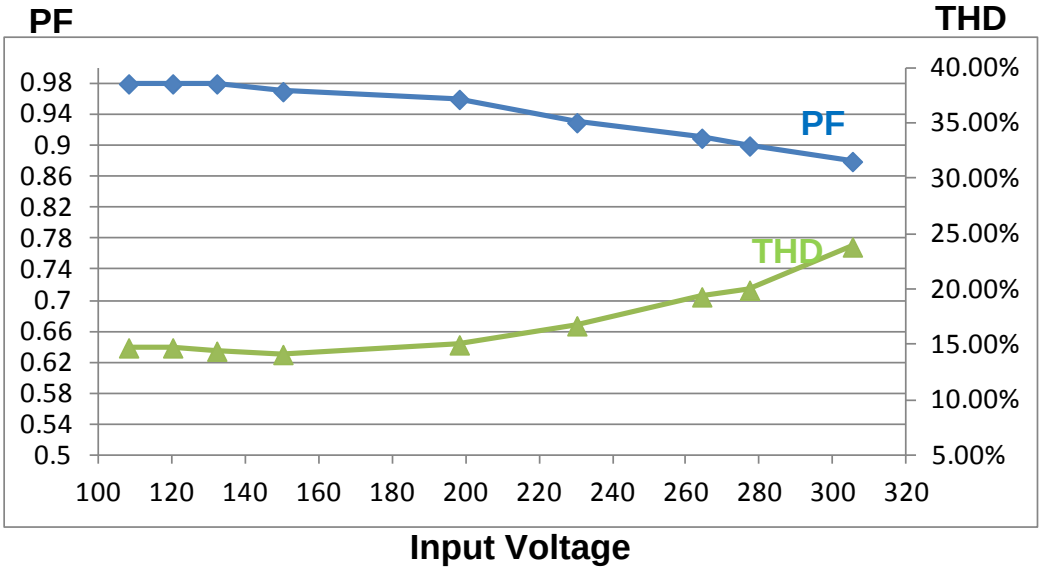

Figure 6. **PF and THD data plotted against Line Variation – 40 V Nominal Load**

Table 3. Power Factor and Input Current THD

Input Voltage	Output Current (mA)	Output Voltage (V)	Power Factor	THD (%)
108 V_{AC} [60 Hz]	1042	40	0.99	14.80
120 V_{AC} [60 Hz]	1040	40	0.99	14.80
230 V_{AC} [60 Hz]	1025	40	0.93	16.70
264 V_{AC} [60 Hz]	1020	40	0.91	19.40
277 V_{AC} [60 Hz]	1013	40	0.90	20.00
305 V_{AC} [60 Hz]	1009	40	0.88	23.90

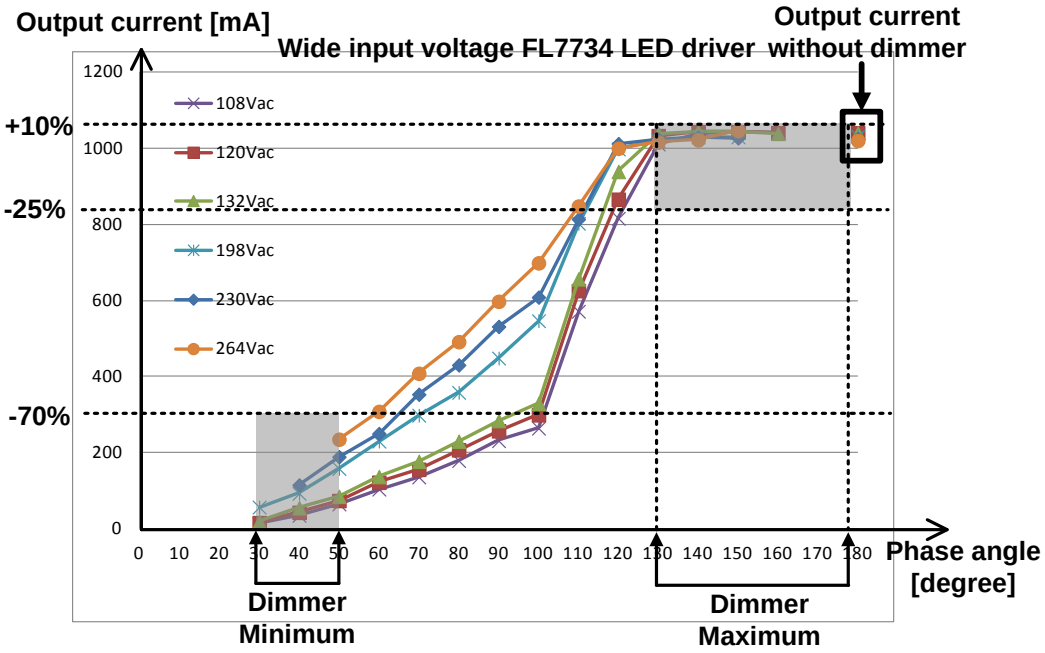

Figure 7. Dimming curve

Figure 7 shows a dimming curve which is obtained by rotating the dimmer switch. Regardless of input line voltage ±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.

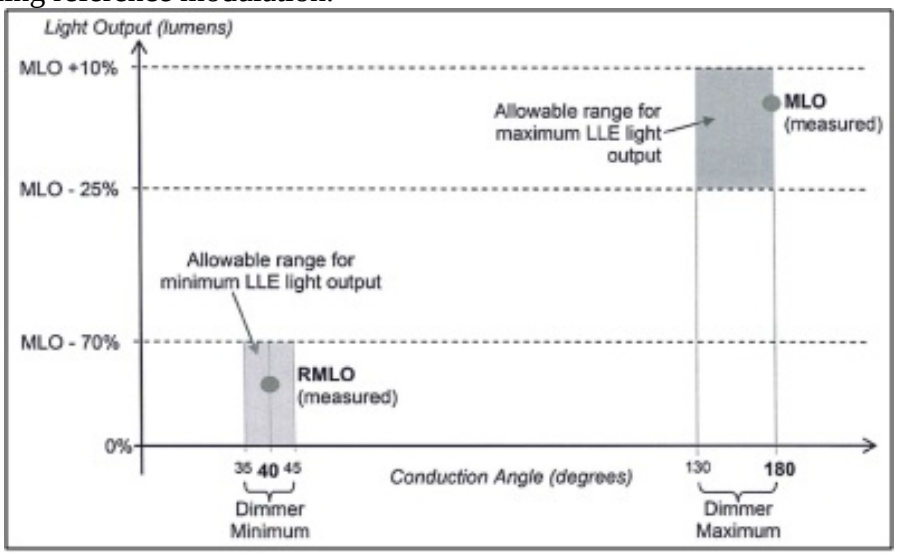

Figure 8. NEMA SSL-7A Specification

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)

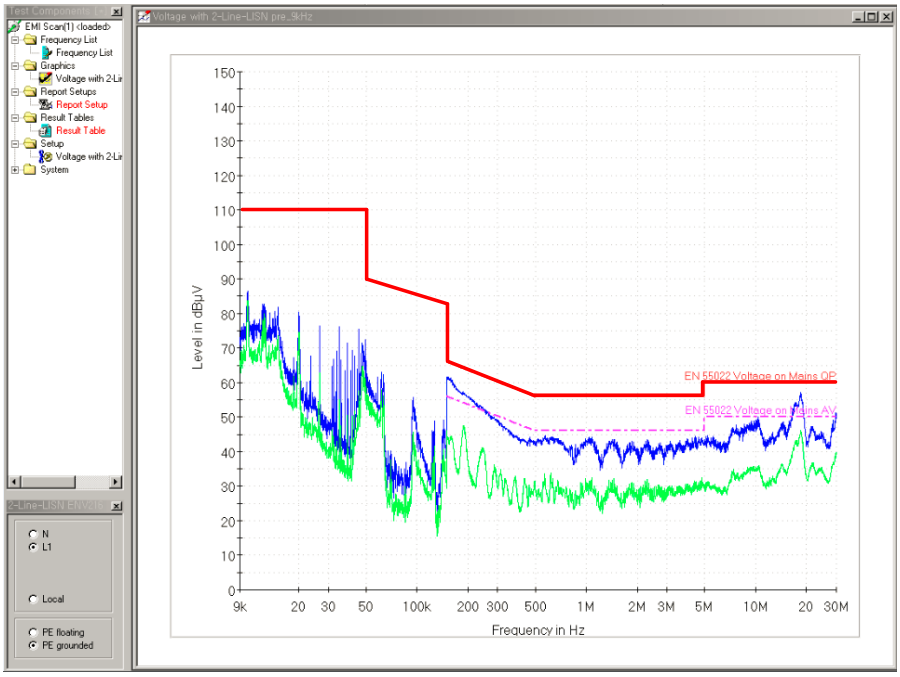

Figure 9. **HV Live**

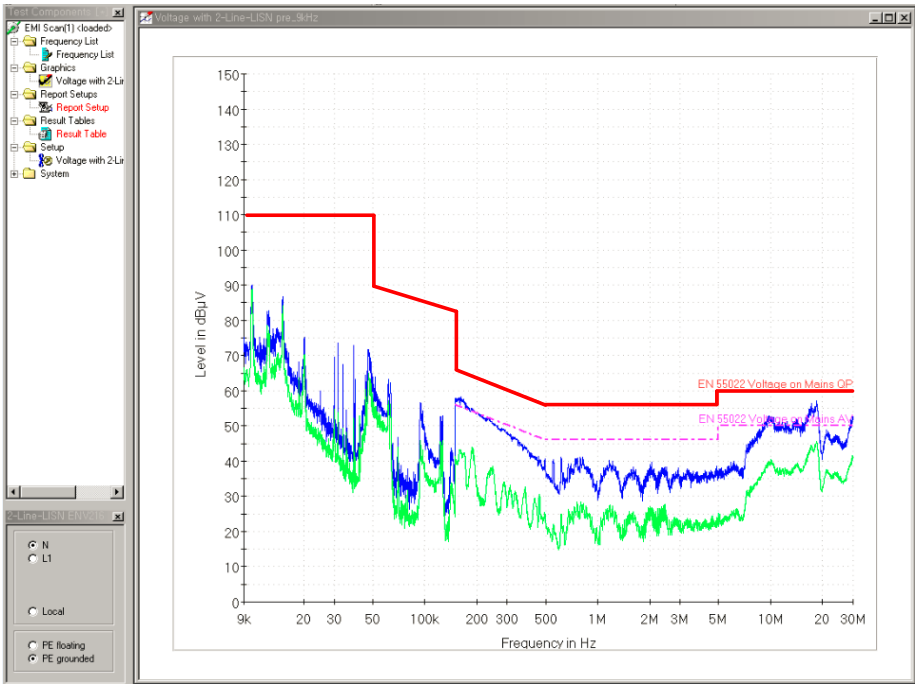

Figure 10. **HV Neutral**

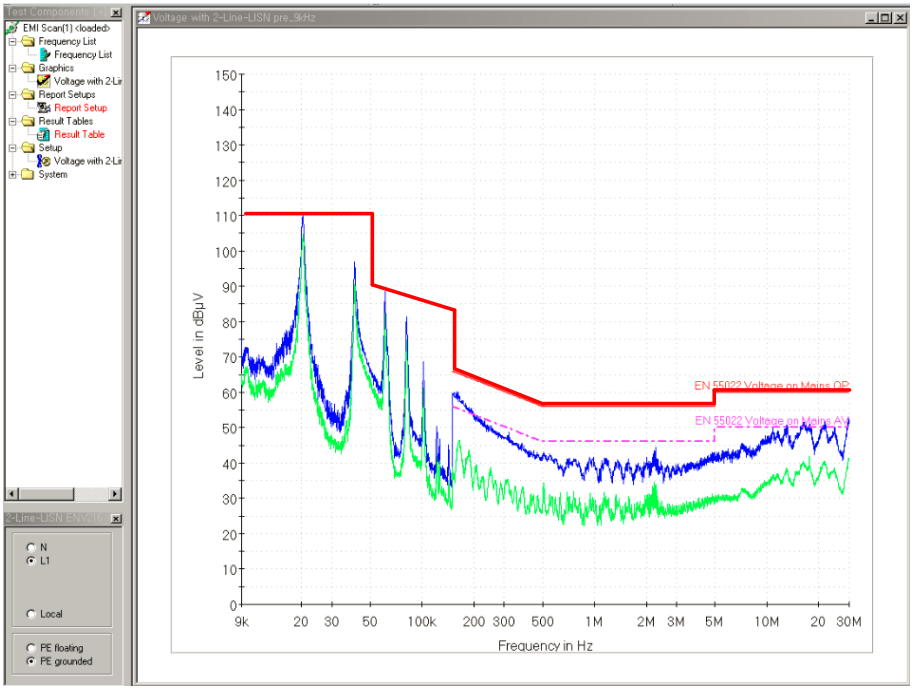

Figure 11. **LL Live**

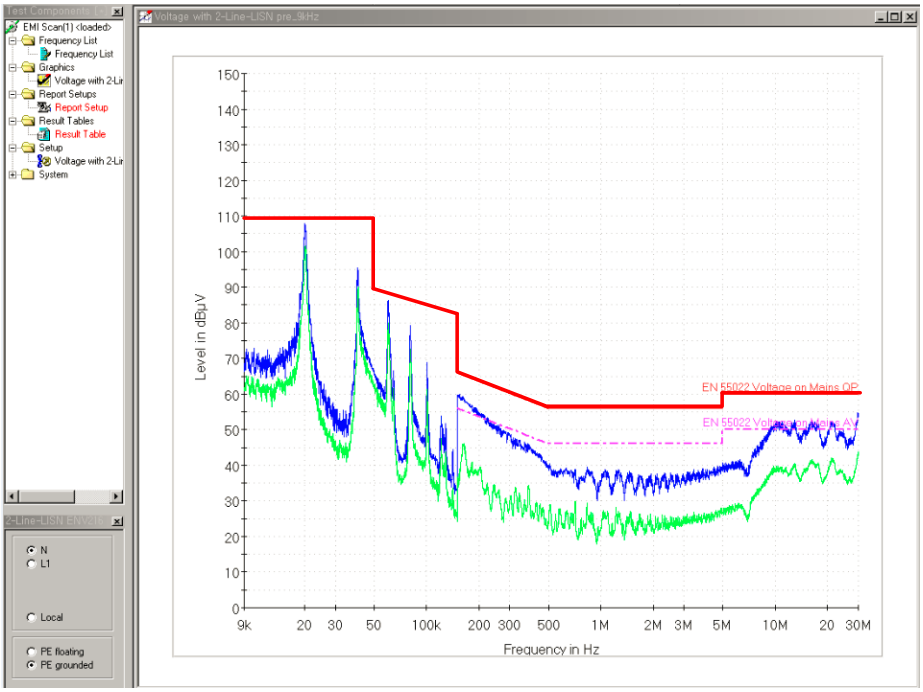

Figure 12. **LL Neutral**

6. Related Resources

[FL7734 Product Page]

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