FAIRCHILD™

User Guide for

FEBFL77944_L80H012A

FEBFL77944_L80H012B

Evaluation Board

12 W Down Light ACLED Driver at High-Line

Featured Fairchild Product:

FL77944

Direct questions or comments about this evaluation board to: "Worldwide Direct Support"

Fairchild Semiconductor.com

Table of Contents

This user guide supports the evaluation kit for the FL77944. It should be used in conjunction with the FL77944 datasheet as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

1. Introduction

This document describes a direct AC line LED driver with a minimal number of external components. The input voltage range of the LED driver board is classed as high-line application for 198 V_{AC} ~ 242 $V_{AC,}$ with a single DC output, constant current depends on the Rcs value. This document contains a general description of the FL77944, the normal configuration specification, schematic, bill of materials, and typical operating characteristics.

1.1. General Description of FL77944MX

The FL77944 is a direct AC line LED driver with a minimal number of external RC passive components. In normal configuration, one resistor is to adjust LED power, and one capacitor is to provide a stable voltage to an internal biasing shunt regulator.

The FL77944 provides phase-cut dimming with wide dimming range, smooth dimming control and good dimmer compatibility. It achieves the high efficiency with high PF and low THD which makes the FL77944 suitable for high-efficiency LED lighting systems. The FL77944 has dedicated DIM pin which can be used with analog or digital PWM dimming. The FL77944 can also be used with a rheostat dimmer switch which is suitable for desktop or indoor lamps.

High wattage design of the FL77904 can be implemented with multiple IC embedded in parallel for street lighting and down lighting applications.

1.2. Controller Features

- The simplest Direct AC LED Driver with Only Two External RC Passive Component
- Wide AC Input Range : 90~305 V_{AC}
- Four Integrated High-Voltage LED Constant Current Sinks of up to 150 mA (RMS) Capability
- TRIAC Dimmable (Leading/Trailing Edge)
- Rheostat Dimmable
- Analog/digital PWM Dimming Function
- High Power Factor (above 0.98 in normal configuration)
- Adjustable LED Power with an External Current Sense Resistor
- Low Harmonic Content (THD under 20% in normal configuration)
- SOP16 EP Package
- Flexible LED Forward Voltage Configuration
- Power Scalability with Multiple Driver ICs
- Over Temperature Protection (OTP)

1.3. Controller Internal Block Diagram

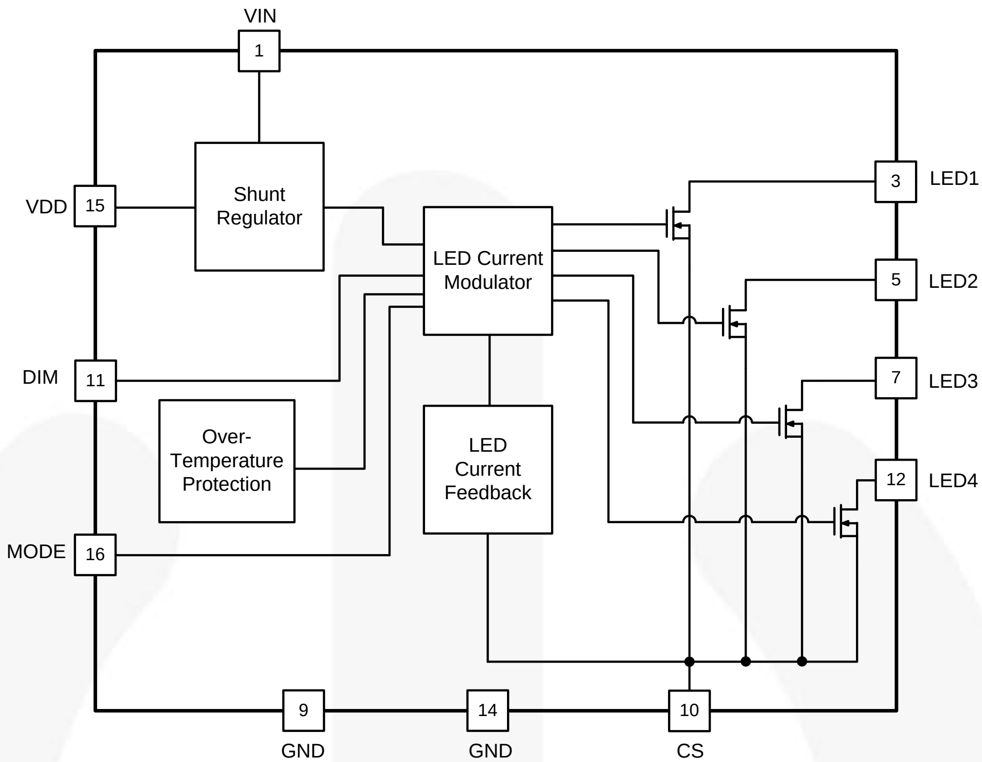


Figure 1. Simplified FL77944 Block Diagram

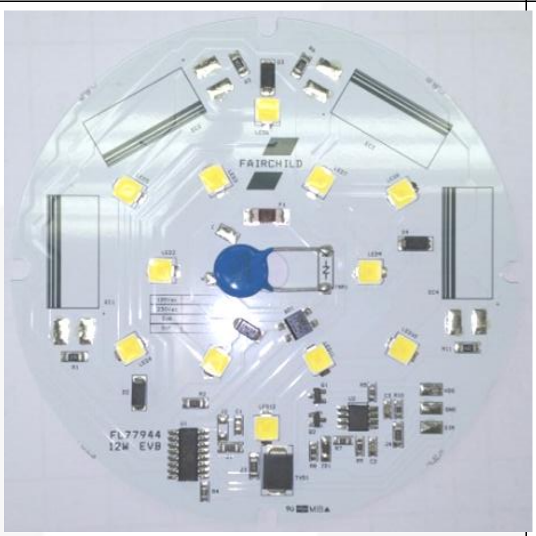
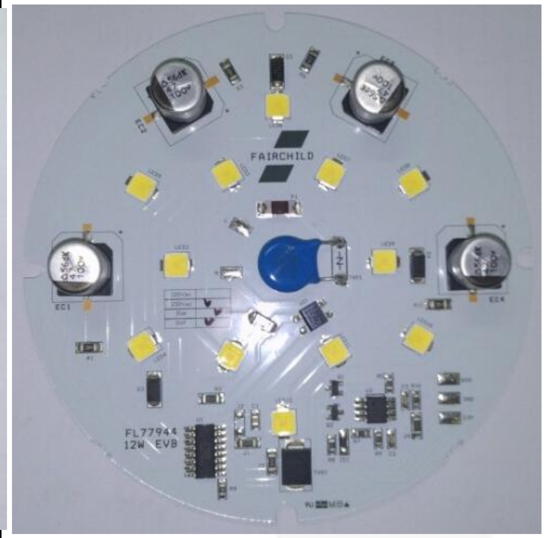
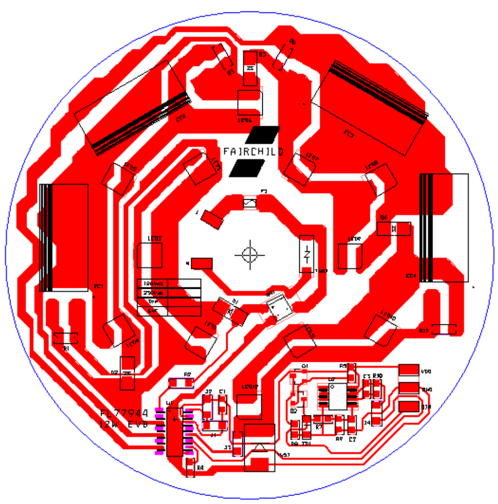
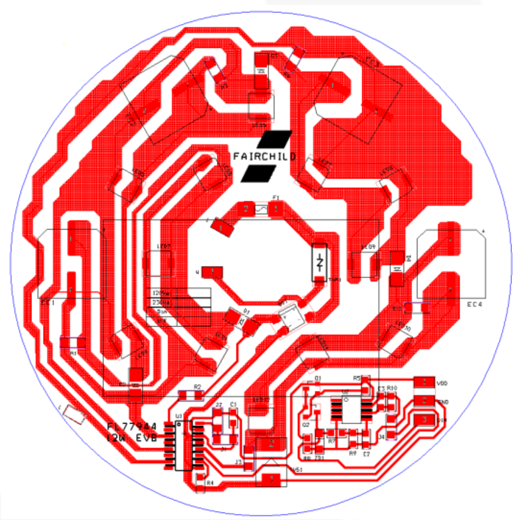
2. Evaluation Board Test Outline

Table 1. **Evaluation Board Test Condition & Equipment List**

Evaluation Board #	**FEBFL77944_L80H012A**	**High-Line, 12 W, without SVF**
	FEBFL77944_L80H012B	**High-Line, 12 W, with SVF**
Test Date	APRIL 2016	
Test Equipment	AC Source: 6800 Series Oscilloscope: LeCroy 104Xi-A Power Meter: Yokogawa PZ4000 Multimeter: FLUKE 87 V OL770: LED Test and Measurement System for Efficacy Photo Sensor: Hamamatsu for Flicker Index	
Test Items	1. Startup Performance 2. Normal Operation 3. Efficacy 4. Flicker Index 5. Power Factor 6. Total Harmonic Distortion(THD) 7. Dimming Performance 8. Conduction EMI	

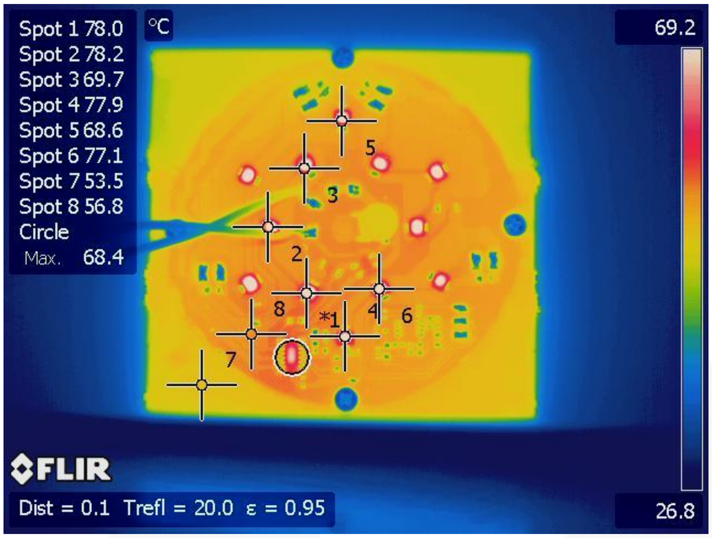
3. Evaluation Board Specifications

Table 2. **Evaluation Board Specifications**

	Version A	**Version B**
SVF Cap.	**For Normal Electrolytic Capacitors**	**For SMD Electrolytic Capacitors**
EVB PHOTO		
PCB		
Diameter	100 mm	
Material	Metal	
Thickness	1.6 t	
Input	High-line: 198 ~ 242 V_{AC}	

4. Evaluation Board Operating Temperature

Table 3. **Evaluation Board Operating Temperature**

Without SVF	
Test Condition	With heat sink: 110 mm * 105 mm * 5mm Ambient temperature: 25°C
Spot	Spot 1 = LED 1(78.0 °C), Spot 2= LED 2(78.2°C) Spot 3 = LED 3(69.7 °C), Spot 4= LED 12(77.9°C) Spot 5 = LED 6(68.6 °C), Spot 6= LED 11(77.1°C) Spot 7 = Heat sink(53.5 °C), Spot 8= PCB(56.8°C) Circle = IC (68.4°C)

5. Evaluation Board Bill of Materials (BOM)

No.	Description	Specification	Type	Location No.	Qty.	Vender	Remark
Common Parts							
1	PCB	100Φ	Metal		1		
2	IC	FL77944	SOIC16	U1	1	Fairchild	
3	Bridge Diode	MB6S (1.0 A 600 V)	MBS	BD1	1	Fairchild	
4	CHIP- CAP	0.1 µF 50 V	2012	C1	1		
5	CHIP-RES	2 KΩ	3216	R2	1		
6	CHIP-RES	200 KΩ	2012	R1, R3, R6, R11	4		
7	CHIP-RES	0 OΩ	3216	J3	3		
8	REC DIODE	1000 V, 1 A: S1M	DO214AC(SMA)	D1, D2, D3, D4	4	Fairchild	
9	FUSE	2 A 250 V_{AC} MF2410F1.000TM	SMD	F1	1	AEM	
10	CHIP-RES	0 Ω	3216	J4	1		
11	CHIP-RES	0 Ω	3216	J1, J2	1		
12	LED 1~12	67 VF 20 mA	5250	LED 1~12	12	LGIT	
13	Sensing R	12R4 Ω F(1%)	2012	R4	1		SVF only
14	E-CAP	47 µF 100 V	DIP	EC 1,2,3,4	4		
15	Varistor	10D391	10Φ, 250 V	TNR1	1		
Without SVF Option							
A	TVS DIODE	SMCJ100CA	DO214AA(SMB)	TVS1	1	Fairchild	
With SVF Option							
B	TVS DIODE	SMCJ120A	DO214AA(SMB)	TVS1	1	Fairchild	
Dimming Option							
DIM-1	CHIP-RES	4.7M Ω	2012	R10	1		
DIM-2	CHIP-RES	1M Ω	2012	R7, R9	2		
DIM-3	CHIP-RES	470K Ω	2012	R8	1		
Dim-4	IC	LM258	SOIC8	U2	1	Fairchild	
Dim-5	CHIP- CAP	15 nF/K 25 V	1608 (0603)	C2, C3	2		
Dim-6	Zener Diode	10 V, MM3Z10VB	SOD323F	ZD1	1	Fairchild	
Dim-7	OP Amp	KSP2907		Q1, Q2	2	Fairchild	
Dim-8	CHIP-RES	576 Ohm 1%	2012	R5	1		

6. High-Line without SVF Evaluation Board

6.1. Evaluation Board Schematic

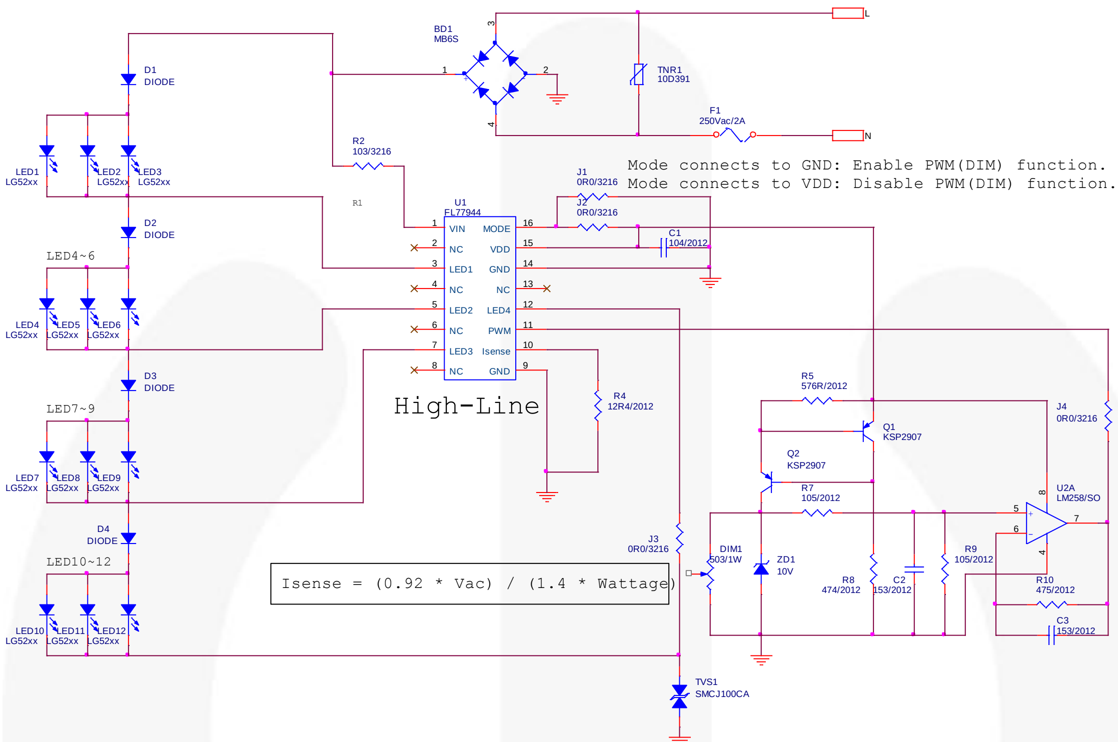


Figure 2. Typical Application Circuit of the 12 W Down Light for High-Line without SVF Condition

Note:

1. The diode D1, D2, D3, D4 can be removed for the without SVF application.

Table 4. **Evaluation Board Circuit Parameters for High-Line without SVF**

Parameter			**Value**		**Unit**
Evaluation Board #			FEBFL77944_L80H012A		-
Input Voltage			198 ~ 242		V_{AC}
Output Power			12		W
LED					
CCT	If(mA)	Vf(V)	Power(W)	Φv(lm)	Lm/W
5700K(G)	20 (Typ.)	65.4	1.31	167	127
Option					
Dimming		0 V – 10 V			
Dimmer		SF 10p-W by Cooper Wiring Devices			

6.2. Key Performance Measurements

Table 5. **Key Performance Measurements for High-Line without SVF**

Input Condition	50 Hz			60 Hz		
	198 V_{AC}	220 V_{AC}	242 V_{AC}	198 V_{AC}	220 V_{AC}	242 V_{AC}
Power Factor	0.98	0.99	0.99	0.98	0.99	0.99
THD (%)	14.32	11.91	11.54	14.33	11.91	11.53
Pin (W)	10.20	12.40	14.40	10.30	12.50	14.40
IIN.RMS (A)	0.052	0.056	0.060	0.052	0.057	0.060
Lumen (lm)	970.03	1117.03	1196.52	956.63	1110.15	1197.55
Efficacy(lm/W)	95.10	90.08	83.09	93.75	88.81	83.16
Flicker Index	0.359	0.339	0.312	0.377	0.359	0.332

Note:

2. Lumen (lm) : Measured after one minute by initial turn-on * 0.955 (temperature saturation factor).

Table 5 shows the key performance measurements for high-line without Self Valley Fill (SVF) condition according to the input voltage (min: 198 V_{AC}, typical: 220 V_{AC}, max: 242 V_{AC}) and 50 Hz / 60 Hz. Power factor is higher than 0.98 at the input voltage range from 198 to 242 Vac. THD is reduced by an increased input voltage. THD is reduced by an increased input voltage. However the efficacy is decreased by increasing the input voltage. The input power rate should be larger than the rise of the lumen.

6.3. Startup

Table 6. **Startup Waveform According to Variable Input Voltage and Frequency**

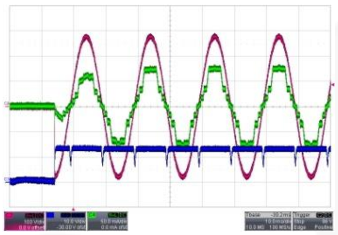
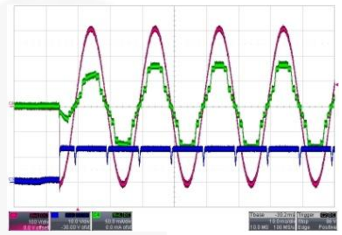
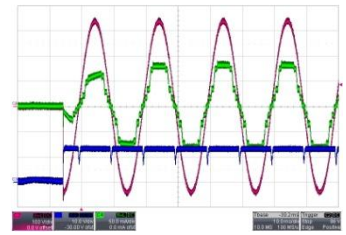
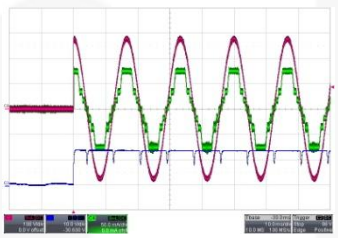
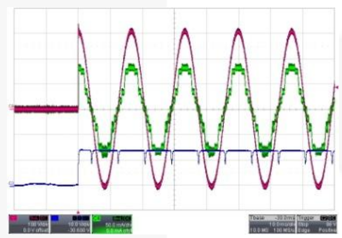
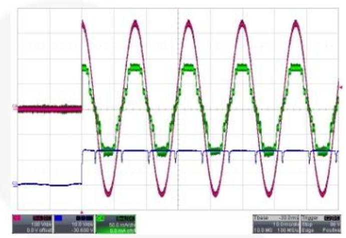
	198 V_{AC}	**220 V_{AC}**	**242 V_{AC}**
50 Hz			
60 Hz			

Figure 3. Ch1: VDD 10.0 V/div, Ch2: $V_{IN.ac}$ 100 V/div, Ch3: $I_{IN.ac}$ 50.0 mA/div

Table 6 shows the overall startup performance of low-line without SVF evaluation board at the variable input voltage with 50 / 60 Hz when no dimmer is connected. The input current starts flowing at least 2 ms after the AC input power switch turns-on for all condition.

6.4. Normal Operation

Table 7. **Normal Operation Waveform According to Variable Input Voltage and Frequency**

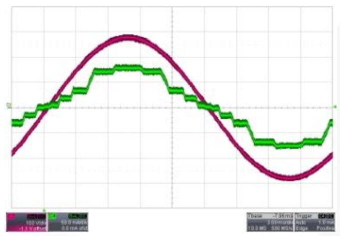
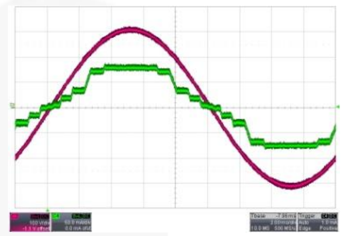
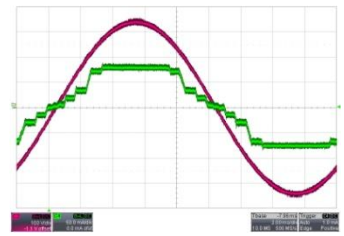
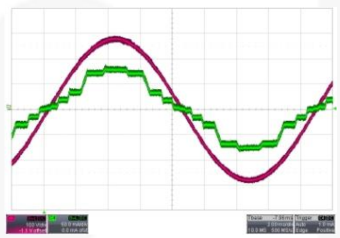
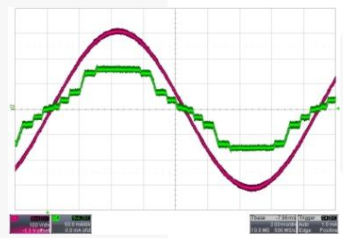
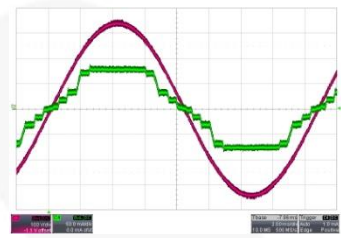
	198 V_{AC}	**220 V_{AC}**	**242 V_{AC}**
50 Hz			
60 Hz			
Figure 4. Ch2: $V_{IN.ac}$, 100 V/div, Ch4: $I_{IN.ac}$ 50.0 mA/div			

Table 7 shows the normal operation waveform of high-line without SVF evaluation board at the variable input voltage with 50 / 60 Hz when no dimmer is connected. The condition of the LED 4 pin is turned on when the input voltage larger than at least all string LED forward voltage (67 V * 4 ea = 268 V). Also the conduction time of the LED 4 pin is depend on the input voltage.

6.5. Dimming Operation & Performance

Table 8. **Dimming Operation Waveform According to Variable Dimming Voltage**

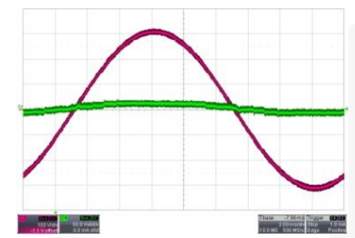
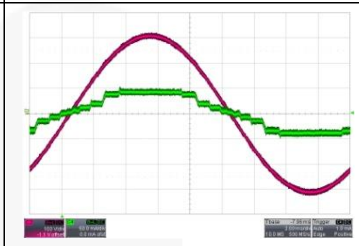
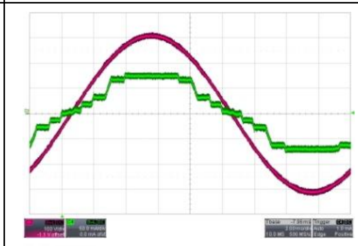
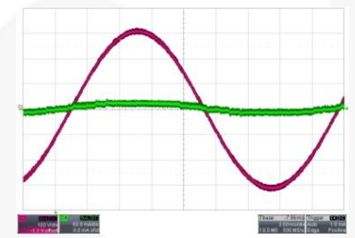
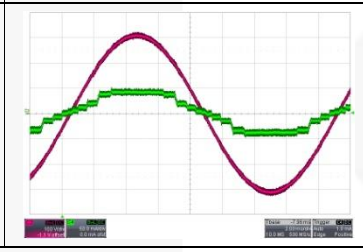
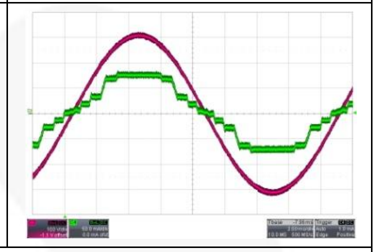
	DIM: 1 V	DIM: 5 V	DIM: 9 V
50 Hz at 220 V_{AC}			
60 Hz at 220 V_{AC}			

Figure 5. Ch2: $V_{IN.ac}$, 100 V/div, Ch4: $I_{IN.ac}$ 50.0 mA/div Dimmer: SF 10p-W by Cooper Wiring Devices

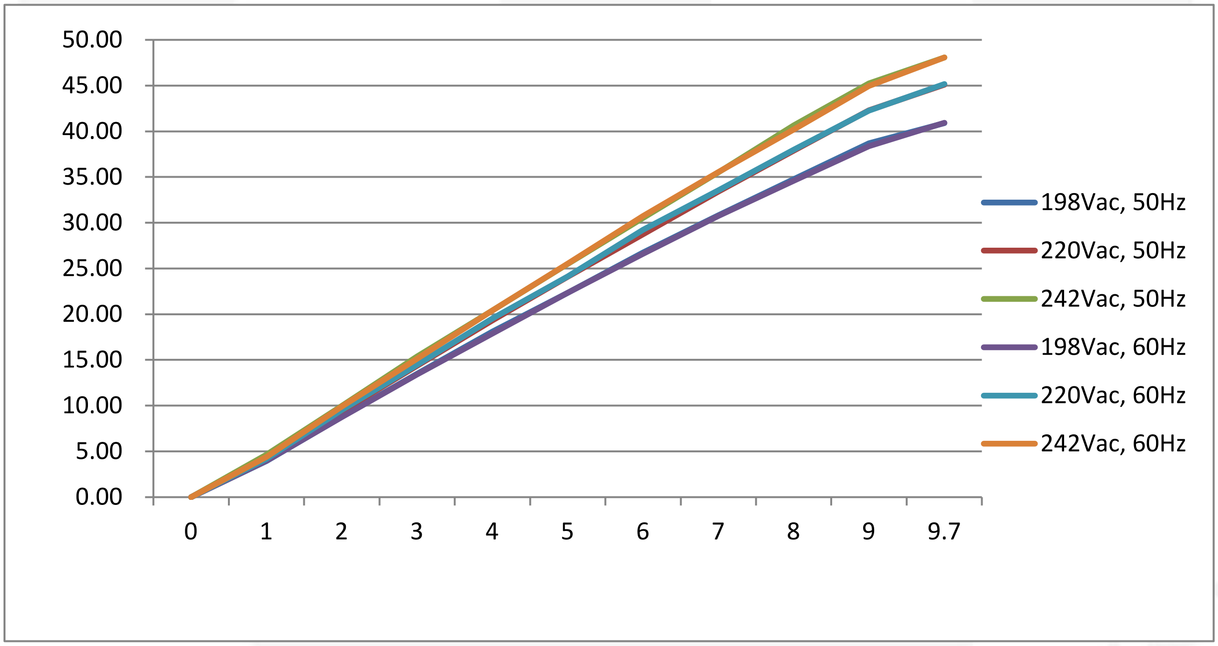


Figure 6. [High-Line w/o SVF] Dimming Performance: Output Current vs. Analog Dimming

The FL77944 analog dimming function can be implemented with a few external component.

The converter output current at the rated line voltage can be adjusted within the range of 8.2% to 100% of the nominal current value through 0 to 10 V A-DIM signal.

6.6. Electromagnetic Interference (EMI)

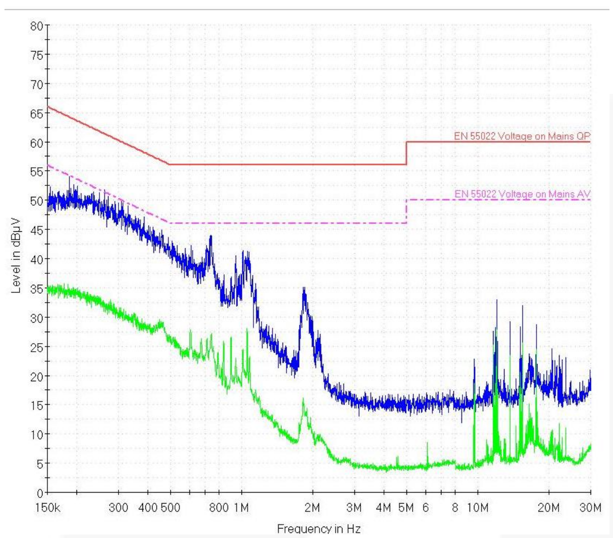


Figure 7. 220 V_{AC}, 60 Hz, <L>, At least 10 dB Margin, Blue Trace: Peak Scan, Green Trace: Average Scan

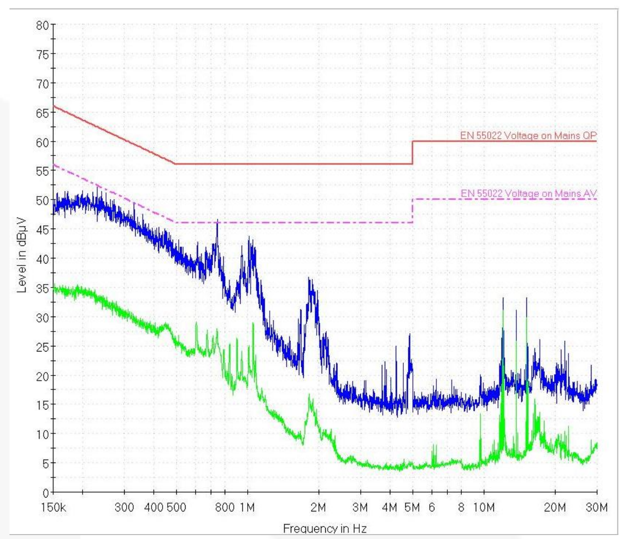


Figure 8. 220 V_{AC}, 60 Hz, <N>, At least 10 dB Margin, Blue Trace: Peak Scan, Green Trace: Average Scan

7. High-Line with SVF Evaluation Board

7.1. Evaluation Board Schematic

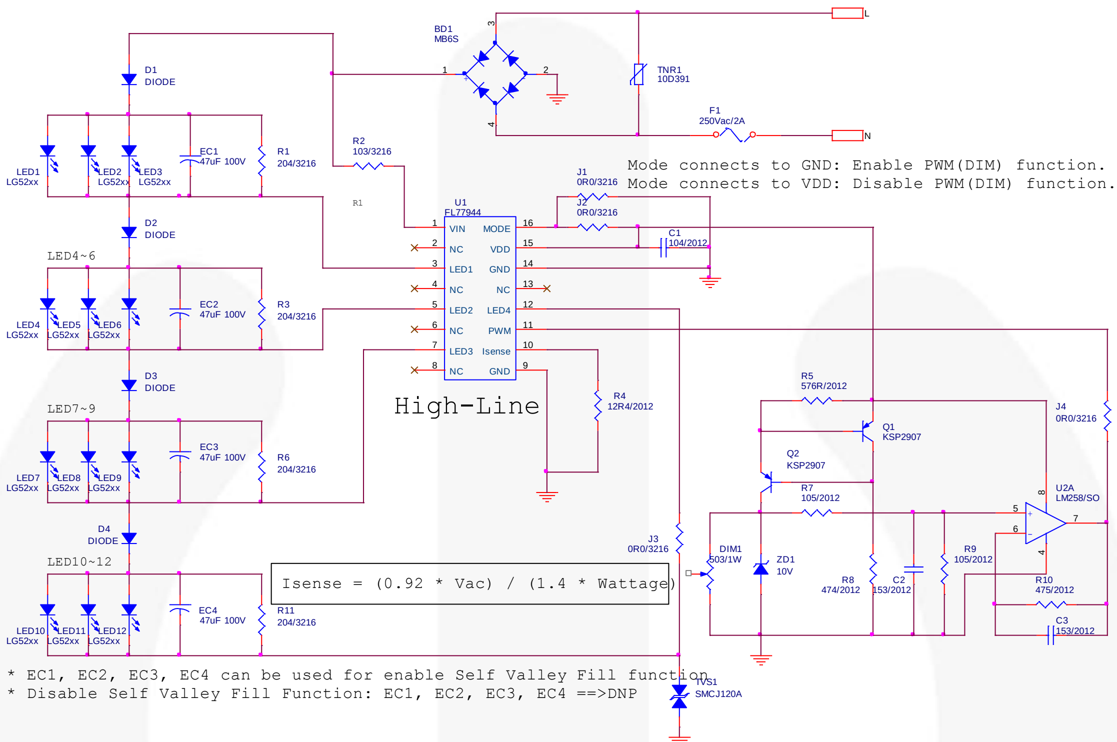


Figure 9. Typical Application Circuit of the 12 W Down Light for High-Line with SVF Condition

Table 9. **Evaluation Board Circuit Parameters for High-Line with SVF**

Parameter			**Value**		**Unit**
Evaluation Board #			FEBFL77944_L80H012B		-
Input Voltage			198 ~ 242		V_{AC}
Output Power			12		W
LED					
CCT	If(mA)	Vf(V)	Power(W)	Φv(lm)	Lm/W
5700K(G)	20 (Typ.)	65.4	1.31	167	127
Option					
Dimming		0 V – 10 V			
Dimmer		SF 10p-W by Cooper Wiring Devices			

7.2. Key Performance Measurements

Table 10. **Key Performance Measurements for High-Line with SVF**

Input Condition	50 Hz			60 Hz		
	198 V_{AC}	220 V_{AC}	242 V_{AC}	198 V_{AC}	220 V_{AC}	242 V_{AC}
Power Factor	0.98	0.98	0.99	0.98	0.98	0.99
THD (%)	17.80	14.96	13.75	17.79	14.97	13.78
Pin (W)	9.80	11.50	13.20	9.80	11.60	13.20
IIN.RMS (A)	0.050	0.053	0.055	0.050	0.053	0.055
Lumen (lm)	889.46	989.86	1051.52	889.46	989.86	1050.14
Efficacy (lm/W)	90.76	86.07	79.66	90.99	84.78	79.56
Flicker Index	0.070	0.062	0.056	0.061	0.061	0.056

Note:
3. Lumen (lm) : Measured after one minute by initial turn-on * 0.955 (temperature saturation factor).

Table 10 shown the key performance measurements for high-line with Self Valley Fill (SVF) condition according to the input voltage (min: 198 V_{AC}, typical: 220 V_{AC}, max: 242 V_{AC}) and 50 Hz / 60 Hz. Power factor is higher than 0.98 at the input voltage range from 198 to 242 Vac. THD is reduced by an increased input voltage. However the efficacy is decreased by increasing the input voltage. The input power rate should be larger than the rise of the lumen.

7.1. Dimming Performance

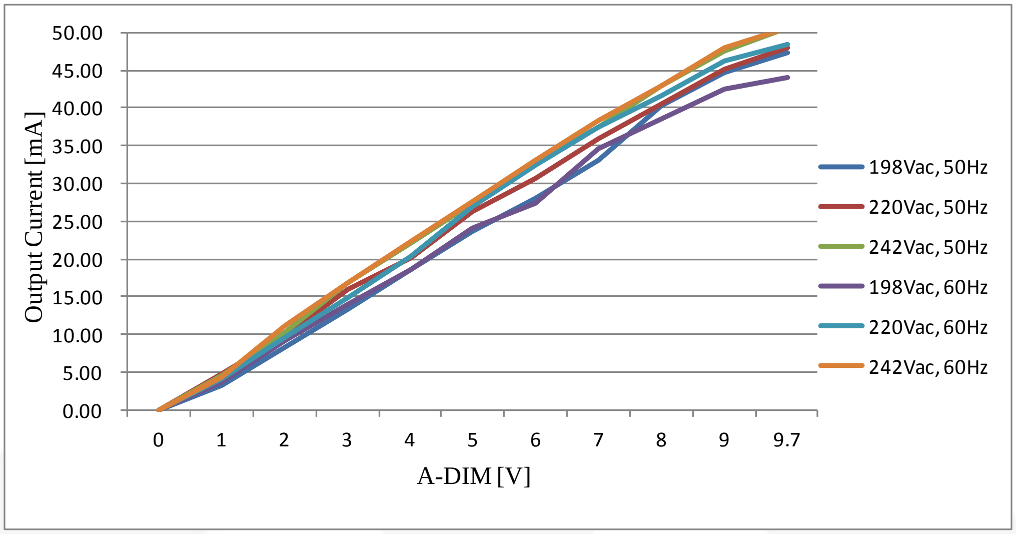


Figure 10. [High-line with SVF] Dimming Performance: Output Current vs. Analog Dimming

The FL77944 analog dimming function can be implemented with a few external component

The converter output current at the rated line voltage can be adjusted within the range of 8.8% to 100% of the nominal current value through 0 to 10 V A-DIM signal.

7.2. Electromagnetic Interference (EMI)

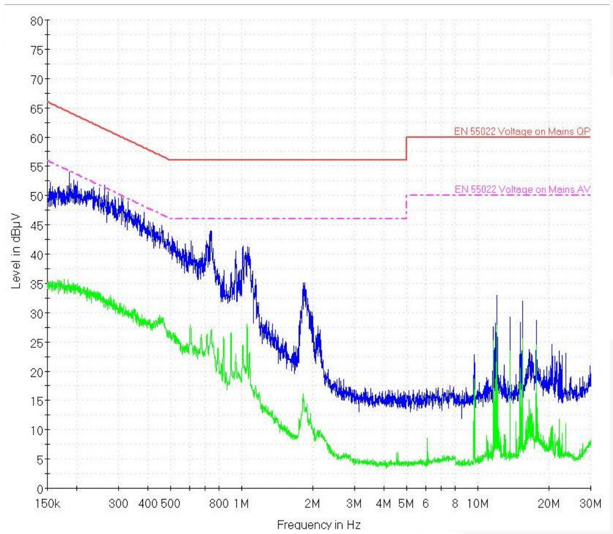


Figure 11. 220 V_{AC}, 60 Hz, <L>, At least 10 dB Margin, Blue Trace: Peak Scan, Green Trace: Average Scan

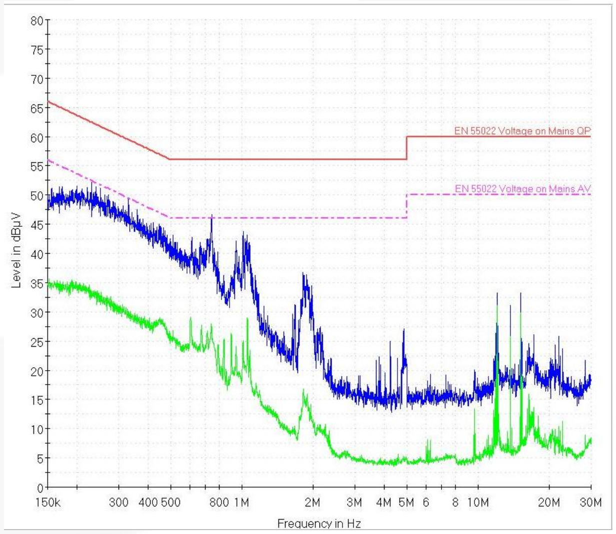


Figure 12. 220 V_{AC}, 60 Hz, <N>, At least 10 dB Margin, Blue Trace: Peak Scan, Green Trace: Average Scan

8. Revision History

Rev.	Date	Description
1.0	April. 2016	Initial Release

WARNING AND DISCLAIMER

Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Users' Guide. Contact an authorized Fairchild representative with any questions.

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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