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User Guide for

FEBFDD850N10LD_CS001

35 W Boost Converter for LED Drive using BoostPak

Featured Fairchild Product:

FDD850N10LD

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 FDD850N10LD. It should be used in conjunction with the FDD850N10LD datasheets 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 the proposed solution for a driving of LED application using the BoostPak (FDD850N10LD) for boost topology. The input voltage range is 20.4 V – 27.6 V and there is a single-channel DC output with a constant current of 640 mA at 55 V. This document contains a general description of FDD850N10LD, the converter specification, a schematic, the bill of materials, and the typical operating characteristics.

1.1. Description

The N-channel MOSFET and NP diode are combined in one 5-lead D-Pak package produced using Fairchild Semiconductor's PowerTrench® process tailored to minimize on-state resistance while maintaining superior switching performance. The diode is a hyper-fast rectifier with low forward-voltage drop and excellent switching performance. Using the BoostPak FDD850N10LD in low-power LED backlight driving applications results in lower profile and cost savings by reducing part count, weight, and PCB size as well as improving reliability due to lower leakage current than Schottky Barrier Diode (SBD).

1.2. Features

- Lower Conduction Resistance :
  - $R_{DS(on)}$ = 61 mΩ (Typ.) at V_{GS} = 10 V, I_D = 12 A
  - $R_{DS(on)}$ = 64 mΩ (Typ.) at V_{GS} = 5.0 V, I_D = 12 A
- Low Gate Charge (Typ. 22.2 nC)
- Low C_{rss} (Typ. 42 pF)
- Fast Reverse Recovery Time: t_{rr} (Typ.) = 11 ns at I_F = 5 A, di/dt = 200 A/µs
- Fast Switching
- 100% Avalanche Tested
- Improved dv/dt Capability
- RoHS Compliant

1.3. FDD850N10LD Diagrams

Figure 1. Pin Descriptions

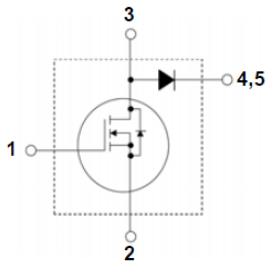


Figure 2. Block Diagram

2. Evaluation Board Specifications

All data was measured under the condition, T_A=25°C.

Table 1. Summary of Features and Performance

Description	Symbol	Value	Comments
Input Voltage	$V_{IN, MIN.}$	20.4 V	
	$V_{IN, TYP.}$	24.0 V	
	$V_{IN, MAX.}$	27.6 V	
Switching Frequency	f_{sw}	200 kHz	R35 (kΩ)=15000/f_{sw} (kHz)
Output Voltage / Current	V_{OUT}	55 V	
	I_{OUT}	0.64 A	
Output Power	P_{OUT}	35 W	
Efficiency		> 92%	
Temperature	$T_{BoostPak}$ $T_{Inductor}$ T_{MOSFET}	< 65°C	
Initial Application			LED Backlight

3. Photographs

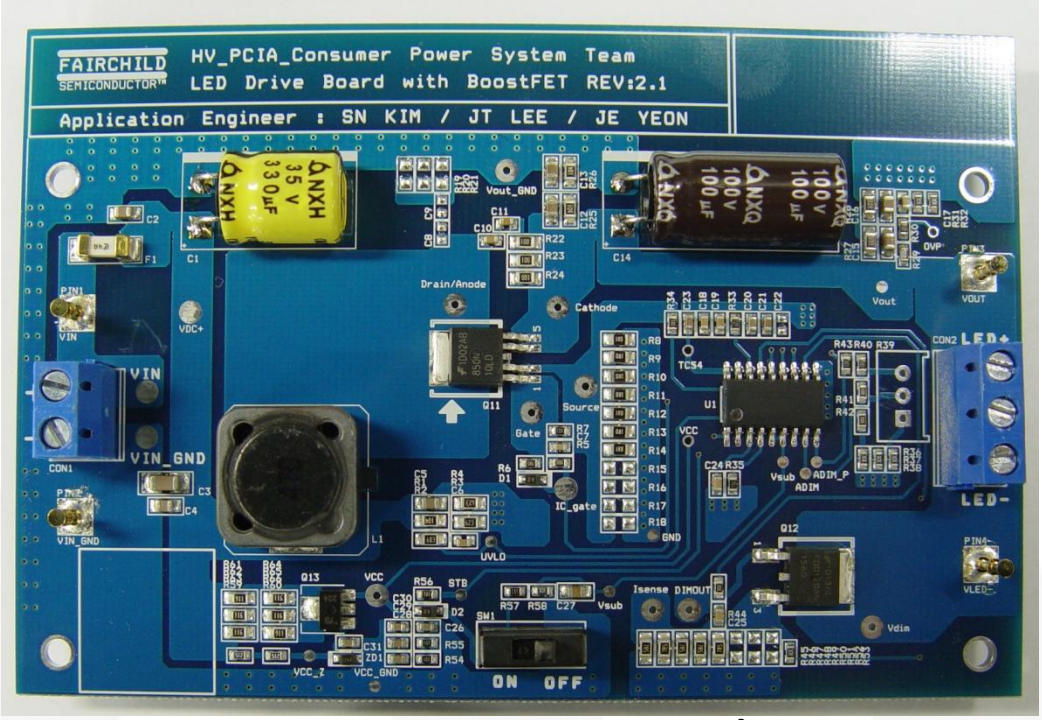


Figure 3. Top View (114 x 76 mm^2)

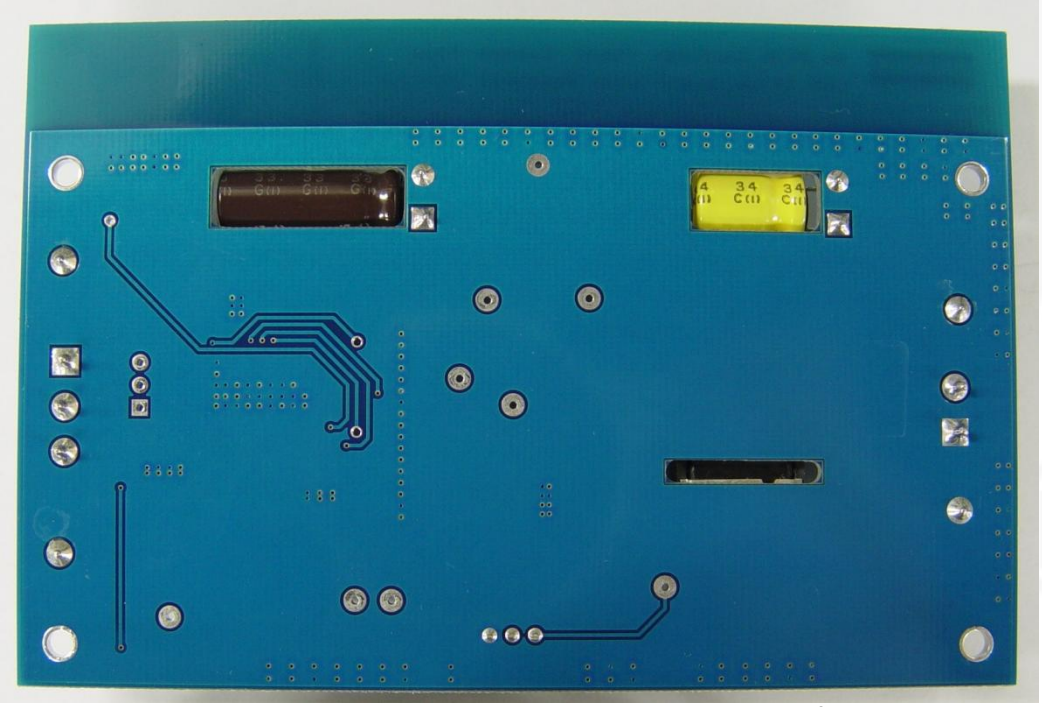


Figure 4. Bottom View (114 x 76 mm^2)

4. Printed Circuit Board

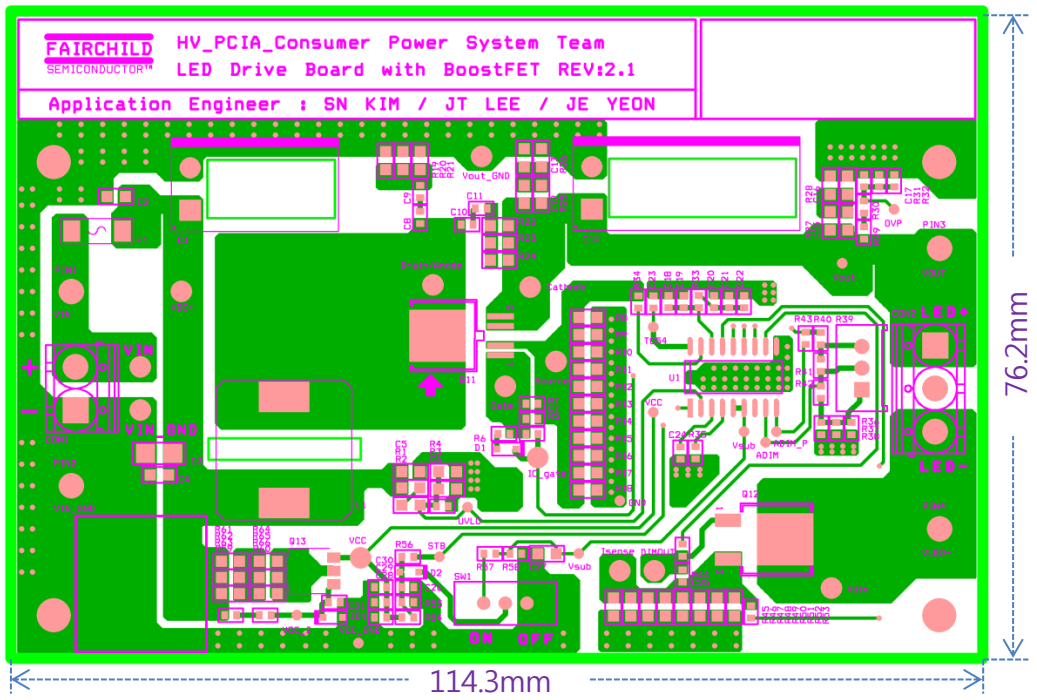


Figure 5. Top Side

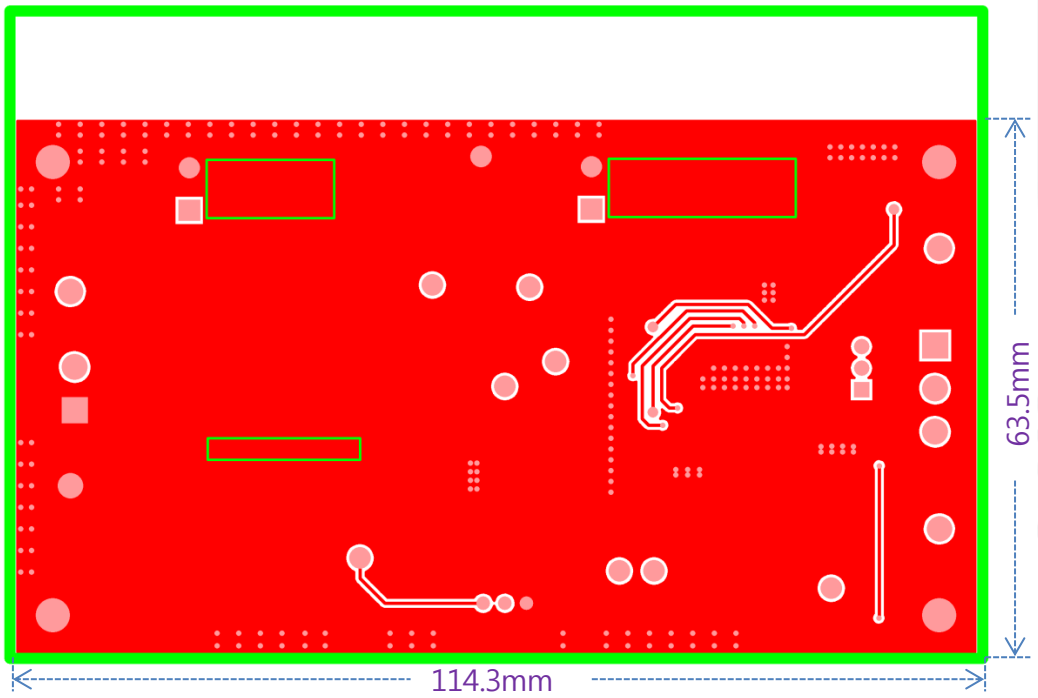


Figure 6. Bottom Side

5. Schematic

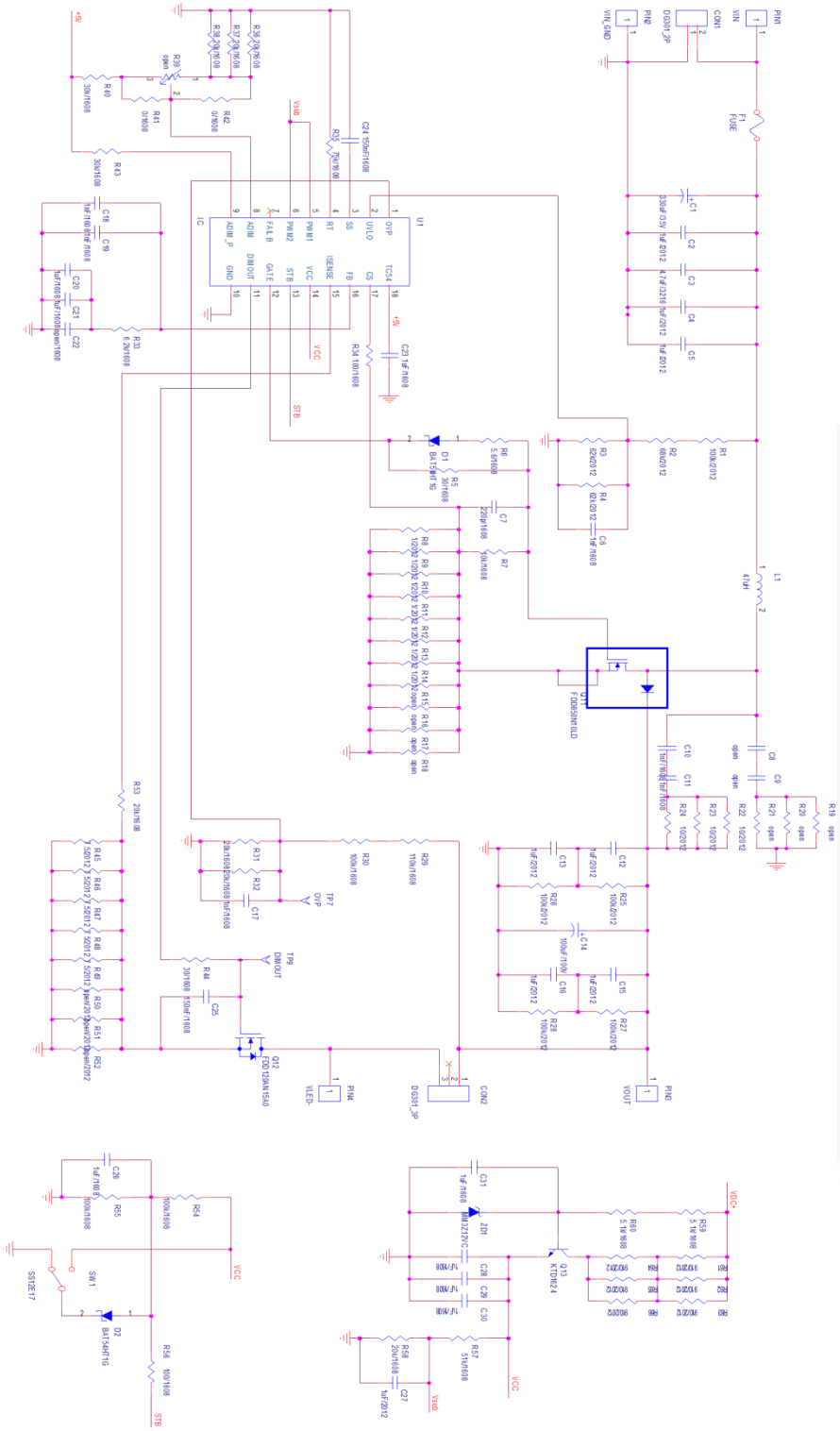


Figure 7. Evaluation Board Schematic

6. Bill of Materials

Item No.	Reference	Part No.	Qty.	Description	Manufacturer
1	Q11	FDD850N10LD	1	BoostPak, D-Pak 5L	Fairchild Semiconductor
2	Q12	FDD120AN15A0	1	150 V / 14 A / 120 Ω, D-Pak	Fairchild Semiconductor
3	Q13	KTD1624	1	3 A / 60 V / NPN BJT, SOT-89	KEC
4	L1	DYCP1580-470	1	47µH / 0.073 Ω / 5 A, SMD Inductor	DONGYANG TELECOM
5	U1		1	Main Controller	
6	D1,D2	BAT54HT1G	2	0.2 A / 30 V Small Signal Diode, SOD-323	Fairchild Semiconductor
7	ZD1	MM3Z12VC	1	12 V / 200 mW Zener Diode, SOD-323F	Fairchild Semiconductor
8	C1	NXH35VB330MTPRB	1	330 µF / 35 V Electrolytic Capacitor	Samyoung
9	C2, C4, C5, C12, C13, C15, C16, C27	GRM21BR71H105KA12	8	1 µF / 50 V SMD Capacitor 2012	Murata
10	C3	GRM31CR71H475KA12	1	4.7 µF / 50 V SMD Capacitor 3216	Murata
11	C6, C10, C11, C17, C18, C19	GRM188R71H102KA01	6	1 nF / 50 V SMD Capacitor 1608	Murata
12	C7	GRM188R71E221KA01	1	220 pF / 25 V SMD Capacitor 1608	Murata
13	C14	NXQ100VB100MTPRB	1	100 µF / 100 V Electrolytic Capacitor	Samyoung
14	C20, C21, C23, C26, C28, C29, C30, C31	GRM188R71E105KA12	8	1 µF / 25 V SMD Capacitor 1608	Murata
15	C24, C25	GRM188R71E154KA01	2	150 nF / 25 V SMD Capacitor 1608	Murata
16	R1, R25, R26, R27, R28	MCR10ERTJ104	5	100 kΩ SMD Resistor 2012	Rhom
17	R2	MCR10ERTJ683	1	68 kΩ SMD Resistor 2012	Rhom
18	R3, R4	MCR10ERTJ623	2	62 kΩ SMD Resistor 2012	Rhom
19	R5, R44	MCR03ERTF30R0	2	30 Ω SMD Resistor 1608	Rhom
20	R6	MCR03ERTJ5R6	1	5.6 Ω SMD Resistor 1608	Rhom
21	R7	MCR03ERTF1002	1	10 kΩ SMD Resistor 1608	Rhom
22	R8, R9, R10, R11, R12, R13, R14	MCR10ERTJ1R0	7	1 Ω SMD Resistor 2012	Rhom
23	R22, R23, R24	MCR10ERTJ100	3	10 Ω SMD Resistor 2012	Rhom
24	R29	MCR03ERTF1103	1	110 kΩ SMD Resistor 1608	Rhom
25	R30, R54, R55	MCR03ERTF1003	3	100 kΩ SMD Resistor 1608	Rhom
26	R31, R32, R36, R37, R38, R53, R58	MCR03ERTF2002	7	20 kΩ SMD Resistor 1608	Rhom
27	R33	MCR03ERTF6201	1	6.2 kΩ SMD Resistor 1608	Rhom
28	R34, R56	MCR03ERTF1000	2	100 Ω SMD Resistor 1608	Rhom
29	R35	MCR03ERTF7502	1	75 kΩ SMD Resistor 1608	Rhom

Item No.	Reference	Part No.	Qty.	Description	Manufacturer
30	R40, R43	MCR03ERTF3002	2	30 kΩ SMD Resistor 1608	Rhom
31	R41, R42	MCR03ERTF0000	2	0 Ω SMD Resistor 1608	Rhom
32	R45, R46, R47, R48, R49	MCR10ERTJ7R5	5	7.5 Ω SMD Resistor 2012	Rhom
33	R57	MCR03ERTF5102	1	51 kΩ SMD Resistor 1608	Rhom
34	R59, R60	MCR03ERTF5101	2	5.1 kΩ SMD Resistor 1608	Rhom
35	R61, R62, R63, R64, R65, R66	MCR10ERTJ911	6	910 Ω SMD Resistor 2012	Rhom
36	CON1	DG301_5.0_2P	1	2-Pin Terminal Block for Vin	DEGSON ELECTRONICS
37	CON2	DG301_5.0_3P	1	3-Pin Terminal Block for LED	DEGSON ELECTRONICS
38	SW1	SS12E17	1	1P2T Switch	VIMEX
39	F1		1	I_F=4 A	

7. Inductor Specifications

- Manufacturer: DONGYANG TELECOM CO., LTD.

HEAD OFFICE & FACTORY	942-5, Dohwa-Dong, Nam-gu, Incheon, Korea	TEL : 032-584-0100 FAX : 032-584-0101
China Factory	No.28 Feng Huang Street, Weifang Shandong, CHINA	TEL : 86-536-790-2048 FAX : 86-536-760-2046
Thailand Factory	3/3 Moo. 1 T. Napradoo A.Phantong Chonburi	TEL : 66-81-933-5740 FAX : 66-38-451-573

- Part No : DYCP1580-470

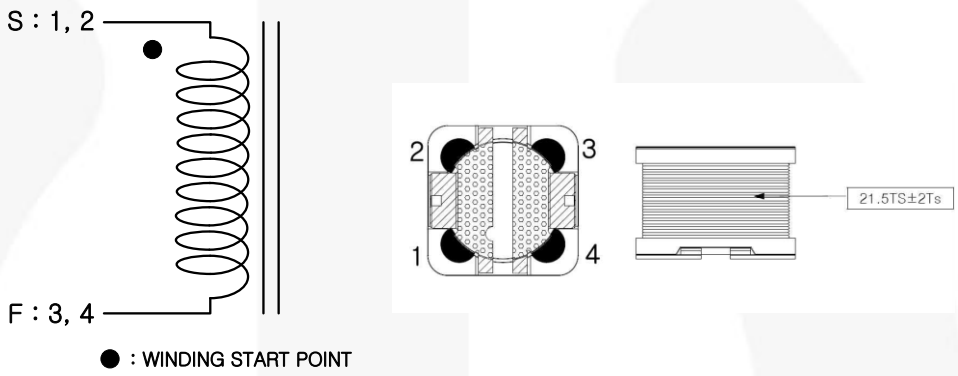
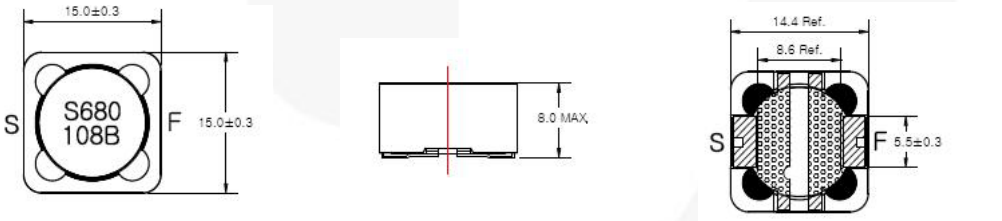


Figure 8. Inductor Specification & Construction

(unit : mm)



Top view **Front view** **Bottom view**

Figure 9. Dimension Specification

Table 2. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
P1		1 → 3	0.35 Φ * 2	21.5 ± 2.0	Solenoid Winding
		2 → 4			

Table 3. Electrical Characteristics

	Pin	Specification
Inductance	1, 2 – 3, 4	47.0 μH
Resistance		0.073 Ω
Maximum Current		5.0 A

8. Test Conditions & Test Equipment

Table 4. Test Conditions & Test Equipment

Evaluation Board #	FEBFDD850N10LD_CS001
Test Date	
Test Temperature	T_A=25°C
Test Equipments	DC Power Supply: H-3005D by FinePower Power Analyzer: PM3000A by Voltech Load: 100 W 100 ΩJ Adjustable Resistor Oscilloscope: DPO7104 by Tectronix Passive voltage probe - P6139 Differential high voltage probe - P5205 Current probe : TCP0030 Thermometer: Therma CAM SC640 by FLIR SYSTEMS

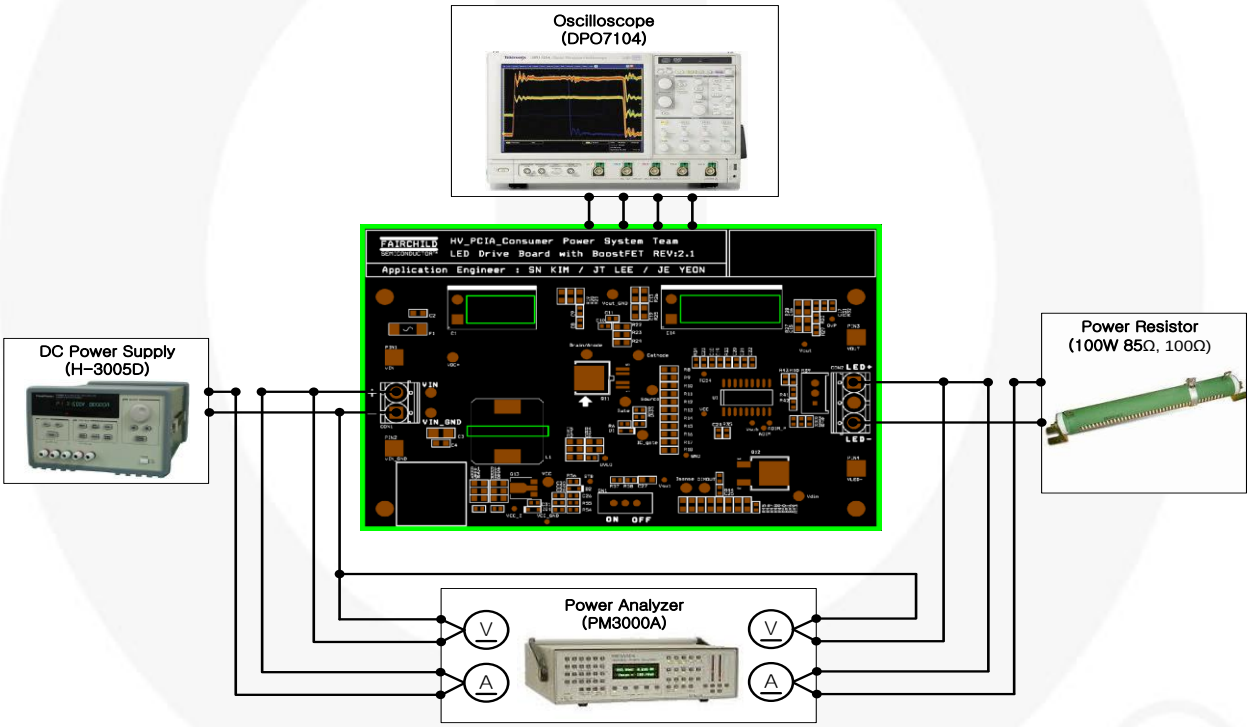


Figure 10. Test Block Diagram

9. Performance of Evaluation Board

9.1. Switching Waveforms

Test Conditions

Connect the power resistor (85 Ω) to CON2 and measure the voltage and current stress on the BoostPak (FDD850N10LD) under the specified conditions below.

Table 5. Test Result

			Input Voltage (V)			Remarks
			20.4	**24**	**27.6**	
Power On	MOSFET	V_{ds} (V)	62.4	62.4	63.2	
	Diode	V_{ca} (V)	69.6	69.6	68.8	
	Inductor	I_{L_max} (A)	2.56	2.36	2.20	
		I_{L_min} (A)	0.00	0.08	0.04	
Normal	MOSFET	V_{ds} (V)	64.0	64.0	64.0	
	Diode	V_{ca} (V)	76.8	74.4	72.0	
	Inductor	I_{L_max} (A)	2.60	2.36	2.20	
		I_{L_min} (A)	0.96	0.68	0.48	
Power Off	MOSFET	V_{ds} (V)	64.8	63.2	63.2	
	Diode	V_{ca} (V)	75.2	73.6	72.0	
	Inductor	I_{L_max} (A)	2.68	2.48	2.24	
		I_{L_min} (A)	-0.20	-0.20	-0.24	

9.1.1. Power On

Waveforms: C1 (V_{gs}: 5 V/div), C2 (V_{ds}: 20 V/div), C3 (I_L: 1 A/div), C4 (V_{ka}: 20 V/div), Time (20 ms/div)

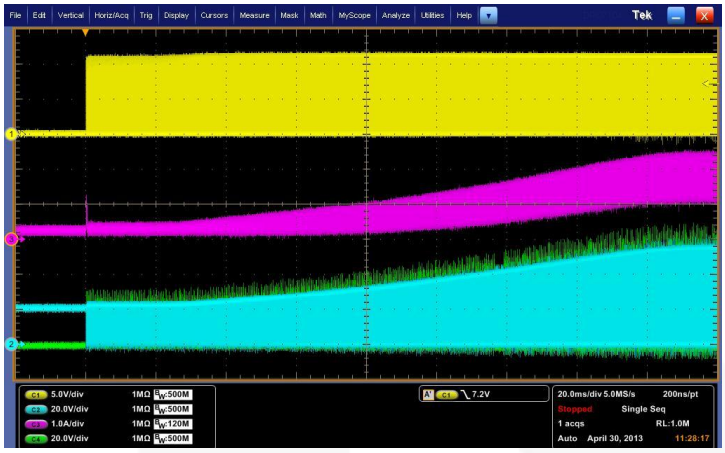


Figure 11. V_{IN}=20.4 V

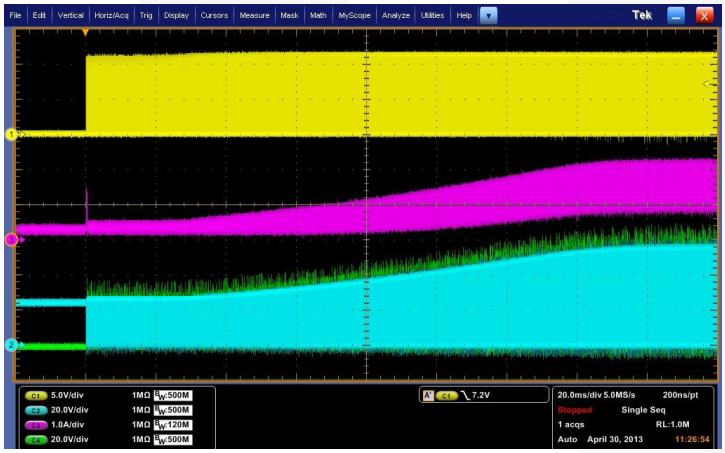


Figure 12. V_{IN}=24 V

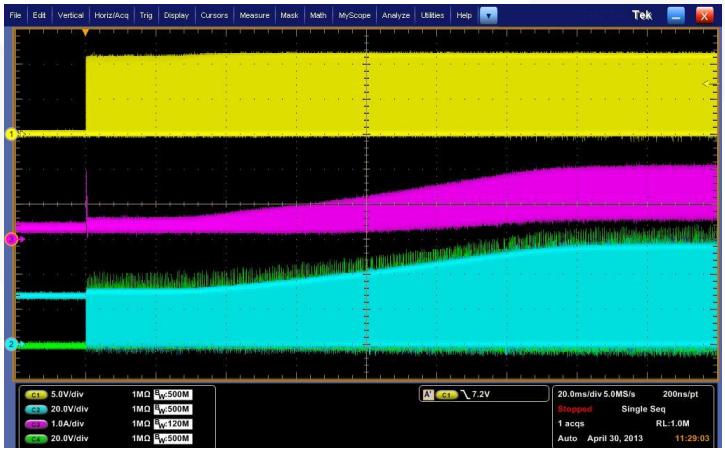


Figure 13. V_{IN}=24 V

9.1.2. Normal

Waveforms: C1 (V_{gs}: 5 V/div), C2 (V_{ds}: 20 V/div), C3 (I_L: 1 A/div), C4 (V_{ka}: 20 V/div), Time (10 µs/div)

Figure 14. V_{IN}=20.4 V

Figure 15. V_{IN}=24 V

Figure 16. V_{IN}=24 V

9.1.3. Power Off

Waveforms: C1 (V_{gs}: 5 V/div), C2 (V_{ds}: 20 V/div), C3 (I_L: 1 A/div), C4 (V_{ka}: 20 V/div), Time (50 ms/div)

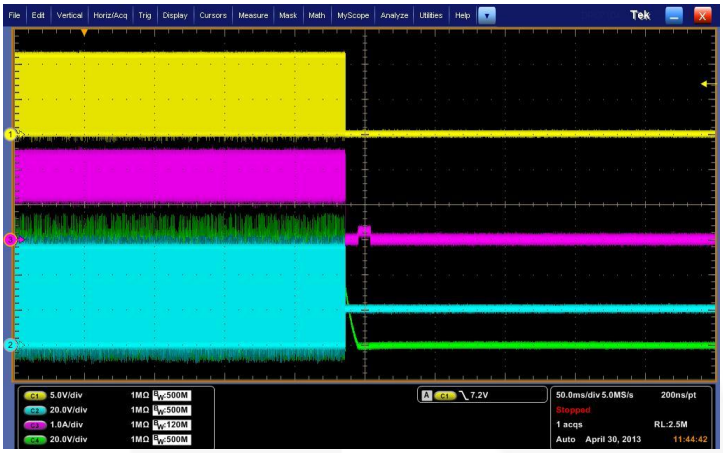


Figure 17. V_{IN}=20.4 V

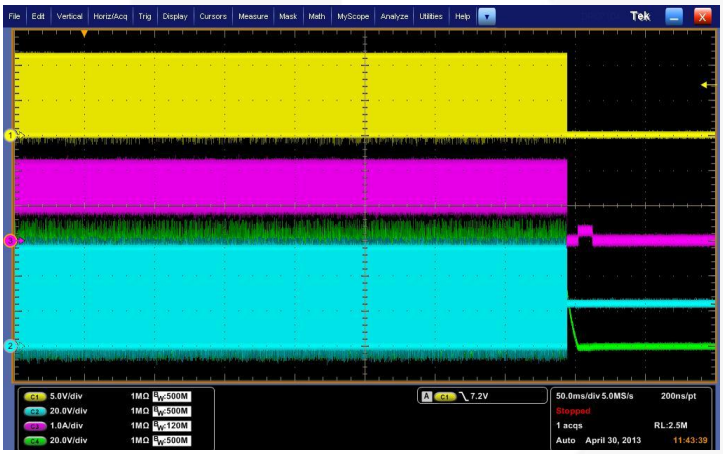


Figure 18. V_{IN}=24 V

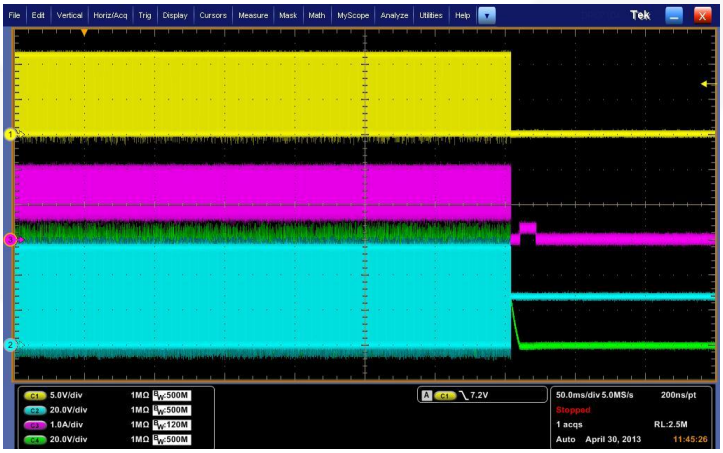


Figure 19. V_{IN}=24 V

9.2. Output Regulation Characteristics

Test Conditions

Connect the power resistor (85 Ω, 100 Ω) to the CON2 and measure the output voltage and current on the BoostPak (FDD850N10LD) after 30 minutes aging.

Table 6. Test Results

Input Voltage (V)	P_{out}=35 W		P_{out}=45 W		Remarks
	V_{OUT} (V)	I_{OUT} (A)	V_{OUT} (V)	I_{OUT} (A)	
20.4	55.39	0.639	64.83	0.640	
24.0	55.42	0.639	64.97	0.639	
27.6	55.43	0.639	65.04	0.642	

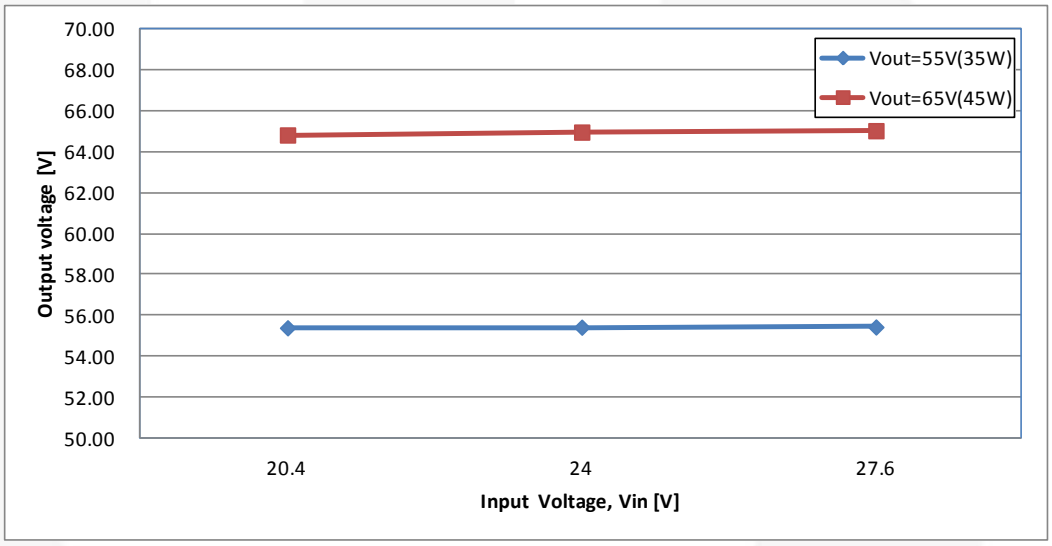


Figure 20. Output Regulation Characteristics

9.3. Loss Analysis

Test Conditions

Connect the power resistor (85 Ω) to the CON2 and measure the output voltage and current on the BoostPak (FDD850N10LD) after 30 minutes aging.

Table 7. Test Results

Input Voltage (V)	MOSFET				Diode				Total P_D (W)
	P_{ON} (W)	P_{OFF} (W)	P_{COND} (W)	P_{TOT} (W)	P_{ON} (W)	P_{OFF} (W)	P_{COND} (W)	P_{TOT} (W)	
20.4	0.17	0.11	0.14	0.42	0.02	0.38	0.53	0.93	1.34
24	0.15	0.09	0.09	0.34	0.02	0.37	0.52	0.91	1.24
27.6	0.13	0.09	0.07	0.28	0.02	0.36	0.52	0.90	1.18

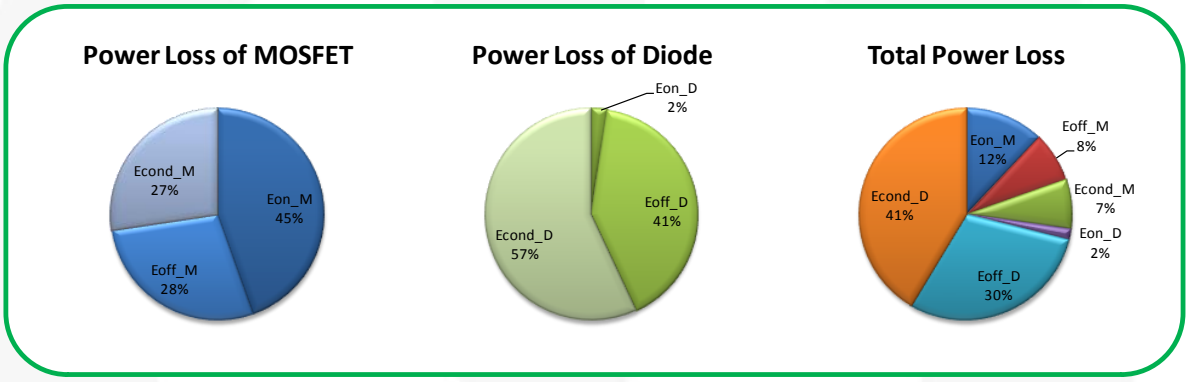


Figure 21. Loss Analysis for V_{IN}=24 V

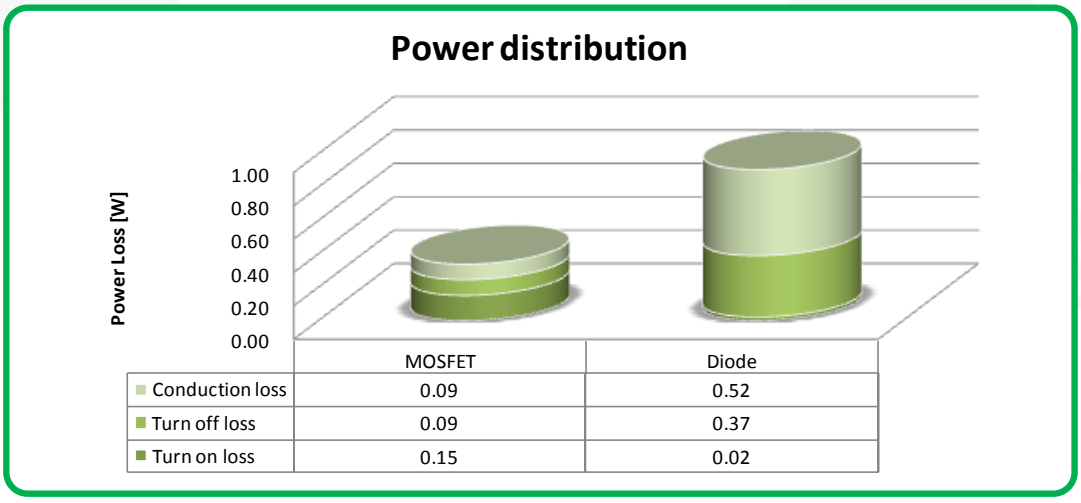


Figure 22. Loss Distribution for V_{IN}=24 V

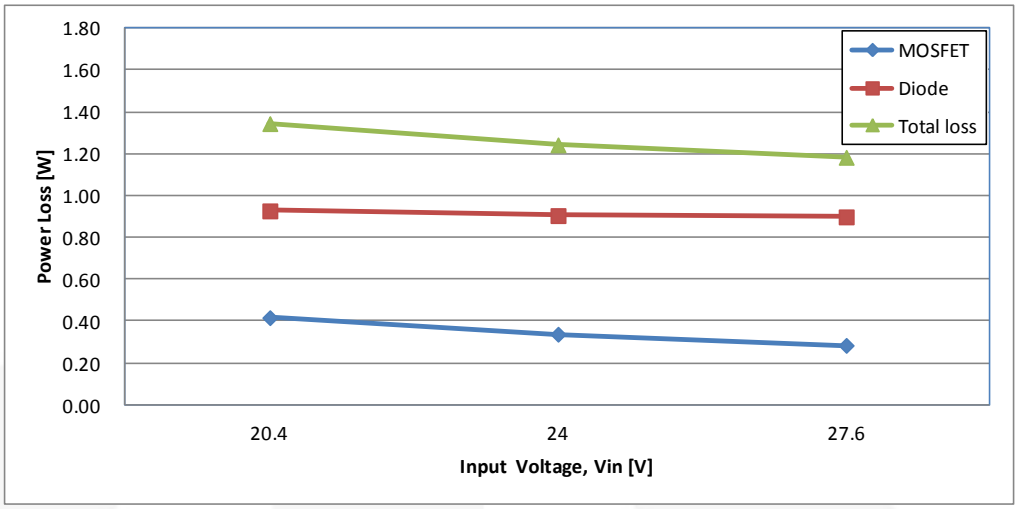
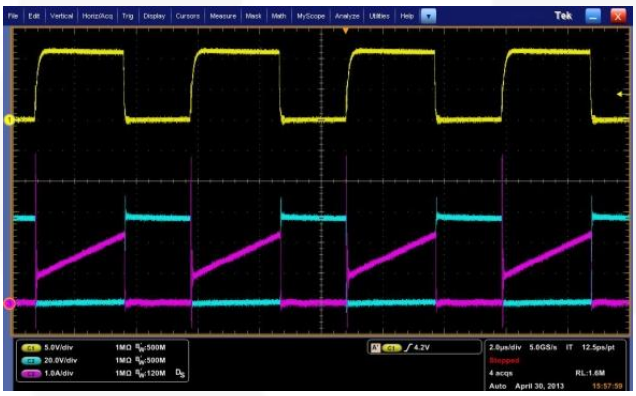
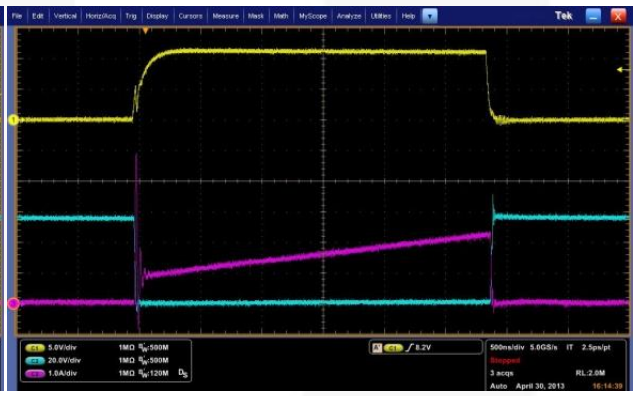


Figure 23. Loss Comparison for Input Voltage, V_{IN}

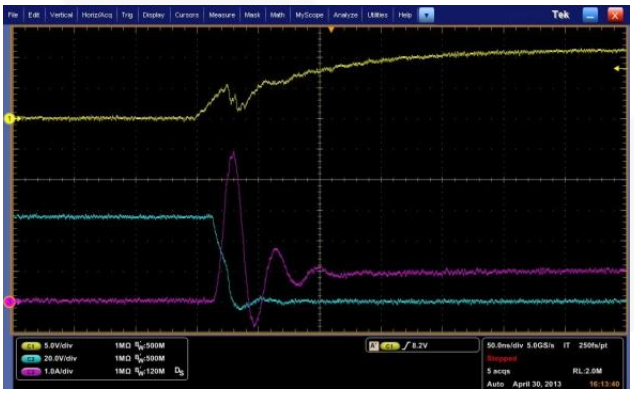
Waveforms: C1 (V_{gs}: 5 V/div), C2 (V_{ds}: 20 V/div), C3 (I_d: 1 A/div)



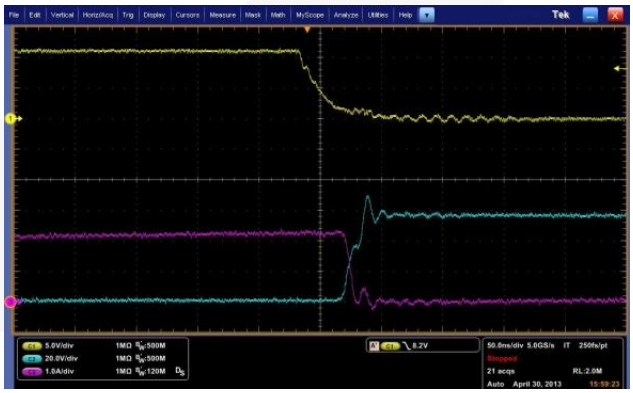
4-Period Waveforms, Time (2 µs/div)



Conduction Waveforms, Time (500 ns/div)



Turn-On Waveforms, Time (50 ns/div)

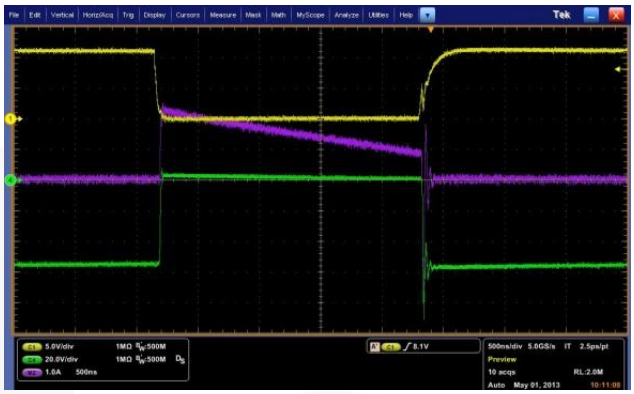


Turn-Off Waveforms, Time (50 ns/div)

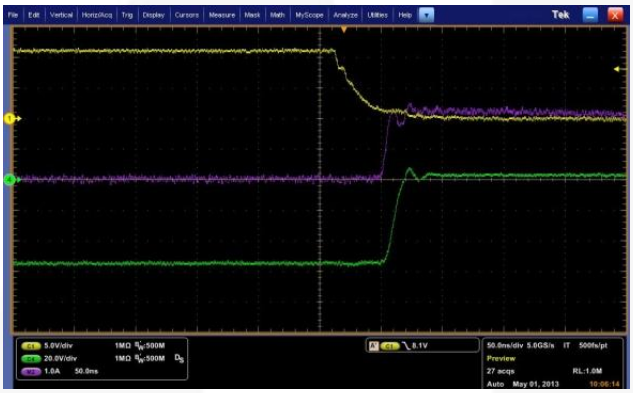
Figure 24. MOSFET Waveforms for V_{IN}=24 V

Waveforms : C1(V_{gs}:5V/div), C4(V_{ak}:20V/div), M2(I_a:1A/div)

4-Period Waveforms, Time (2 µs/div)



Conduction Waveforms, Time (500 ns/div)



Turn-On Waveforms, Time (50 ns/div)

Turn-Off Waveforms, Time (50 ns/div)

Figure 25. Diode Waveforms for V_{IN}=24 V

9.4. Efficiency

Test Conditions

Connect the power resistor (85 Ω, 100 Ω) to the CON2 and measure the output voltage and current on the BoostPak (FDD850N10LD) after 30 minutes aging.

Table 8. Test Results of V_{OUT} = 55 V (35 W)

Input Voltage	Input Power	Output Power	Efficiency	Remark
20.4 V	37.75 W	35.39 W	93.75%	
24.0 V	37.54 W	35.42 W	94.36%	
27.6 V	37.38 W	35.43 W	94.78%	

Table 9. Test Results of V_{OUT} = 65 V (45 W)

Input Voltage	Input Power	Output Power	Efficiency	Remark
20.4 V	44.48 W	41.47 W	93.23%	
24.0 V	44.20 W	41.52 W	93.92%	
27.6 V	44.14 W	41.73 W	94.54%	

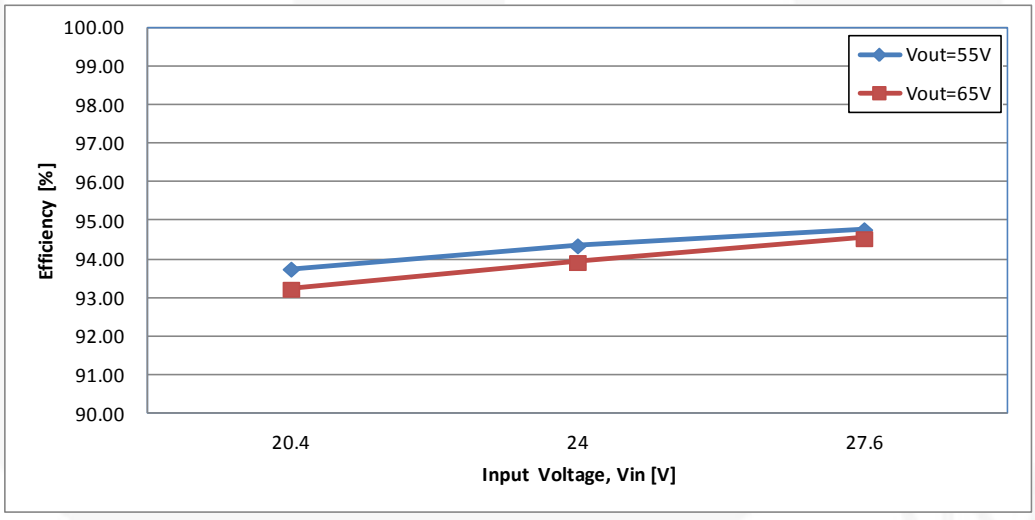


Figure 26. Efficiency Curve

9.5. Temperature

Test Conditions

Connect the power resistor (85 Ω) to the CON2 and measure the saturated temperature.

Table 10. Test Result of V_{OUT} = 55 V (35 W)

	V_{IN}=20.4 V	V_{IN}=24 V	V_{IN}=27.6 V	Remark
BoostPak (Q11)	**66.9°C**	**61.5°C**	**59.3°C**	PKG Top
Inductor	63.7°C	59.6°C	56.6°C	
R8~R14	57.6°C	52.8°C	49.8°C	
MOSFET (Q12)	50.8°C	50.0°C	52.1°C	
R45~R49	58.9°C	57.3°C	60°C	

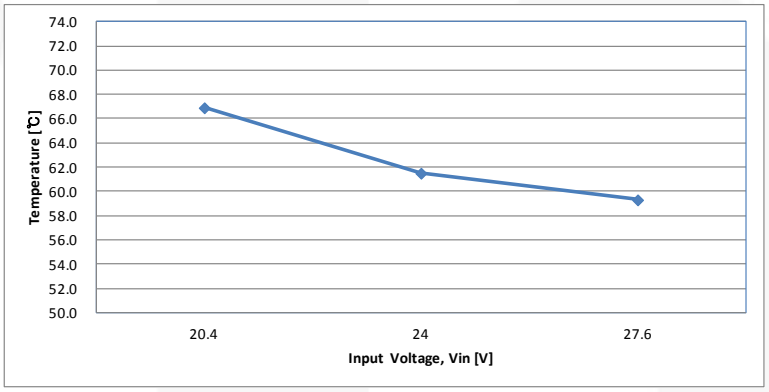


Figure 27. Temperature Curve

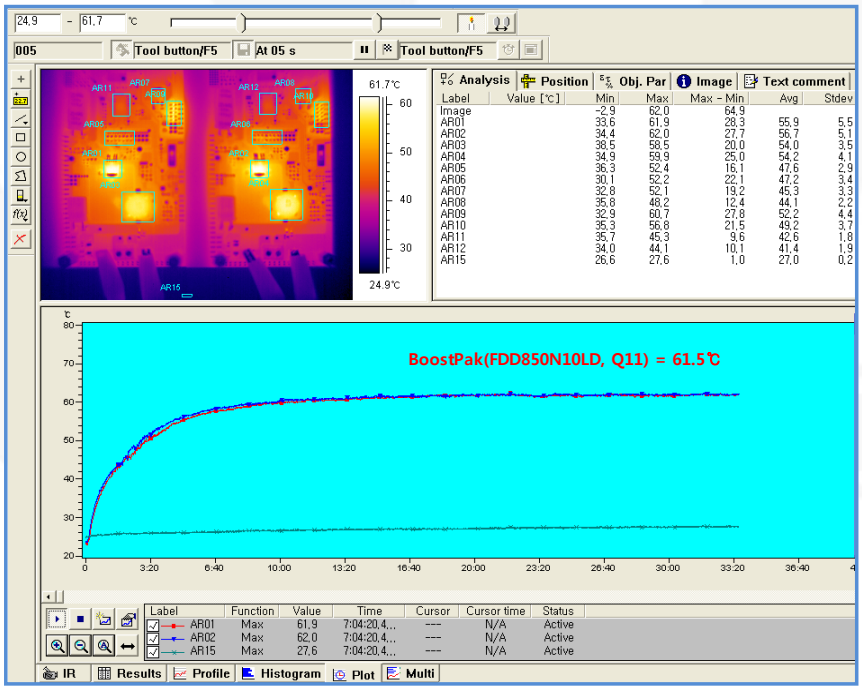


Figure 28. IR Image for V_{IN}=24 V

9.6. EMI

Test Conditions

Frequency Sub-Range: 30 MHz ~ 1000 MHz

Load is five strings of LEDs.

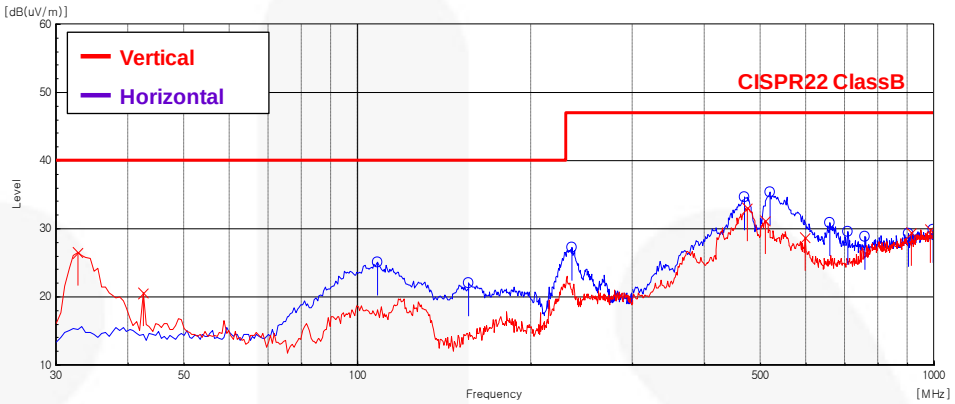


Figure 29. Radiated Emissions: V_{IN}=24 V

10. Revision History

Rev.	Date	Description
1.0.0	May 2013	Initial Release

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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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