

FEB100-001 User's Guide

5V/1A Flyback Converter For Auxiliary Power and Charging Applications

Featured FSC Products: FSDM311, FOD2741B

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Contents

1. General Board Description	3
1.1 The contents of the FSDM311 Evaluation Kit	3
1.2 Power Supply Specification Table	3
2. Circuit Description	3
2.1 Auxiliary Supply Implementation.....	4
2.2 Lithium-Ion Charger Implementation.....	5
3. Evaluation Board Connection.....	6
4. Test Procedure.....	6
5. Test Results	7
5.1 Start-up	7
5.2 Operation.....	8
6. Parts List.....	11
7. Printed Circuit Board	12
8. Featured Products.....	13
8.1 FSDM311 Controller Details	13
8.1.1 Description	13
8.1.2 Main Features of the FSDM311	13
8.1.3 FSDM311 Functional Block Diagram.....	14
8.2 FOD2741 Details	14
8.2.1 Description	14
8.2.2 Features	14
9. References/Resources	15
9.1 Application Notes	15

1. General Board Description

The FEB100-001 Evaluation Board is a 5V/1A Flyback converter for auxiliary power and Lithium-Ion battery charging power supplies. The design uses the FSDM311 Fairchild Power Switch technology. It operates over a universal input range of 85 Vac to 265 Vac.

1.1 The Contents of the FEB100-001 Evaluation Kit

- FEB100-001 evaluation board
- FEB100-001 evaluation board user's guide
- CD ROM containing the following:
 - FEB100-001 User's Guide
 - FSDM311 Data Sheet
 - FOD2741 Data Sheet
 - 2N3904 Data Sheet
 - IN4148 Data Sheet
 - SB360 Data Sheet
 - UF4007 Data Sheet
 - AN-4137 Design Guidelines for Off-line Flyback Converters Using FPS
 - AN-4138 Design Considerations for Battery Charger Using Green Mode FPS
 - AN-4141 Troubleshooting and Design Tips for FPS Flyback Applications
 - AN-4145 Electromagnetic Compatibility for Power Converters

1.2 Power Supply Specification Table

- 74% efficiency

Table 1. Power supply specifications.

	Voltage (V)			Voltage Ripple	Current (A)		
	Min	Typ	Max		Min	Typ	Max
Output 1	4.95	5.0	5.05	120mV	–	1	1.2

2. Circuit Description

This circuit demonstrates the ability of the FSDM311 in an auxiliary or charging application. The circuit is shipped standard as an auxiliary power supply producing 5V at 1A. The secondary side can be changed by the addition of Q1, TH1, R15, R16, R17, & R19 to operate as a Lithium-Ion battery charger. A detailed design procedure including calculations can be found in AN-4138.

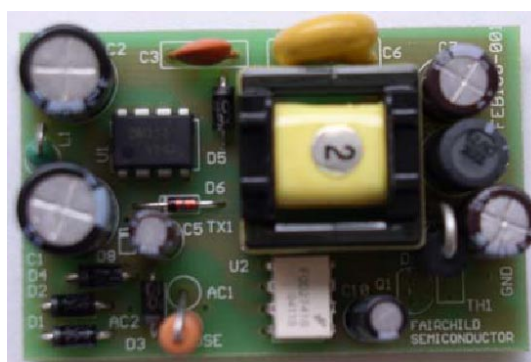


Figure 1. Photograph of evaluation board.

2.2 Lithium-Ion Charger Implementation

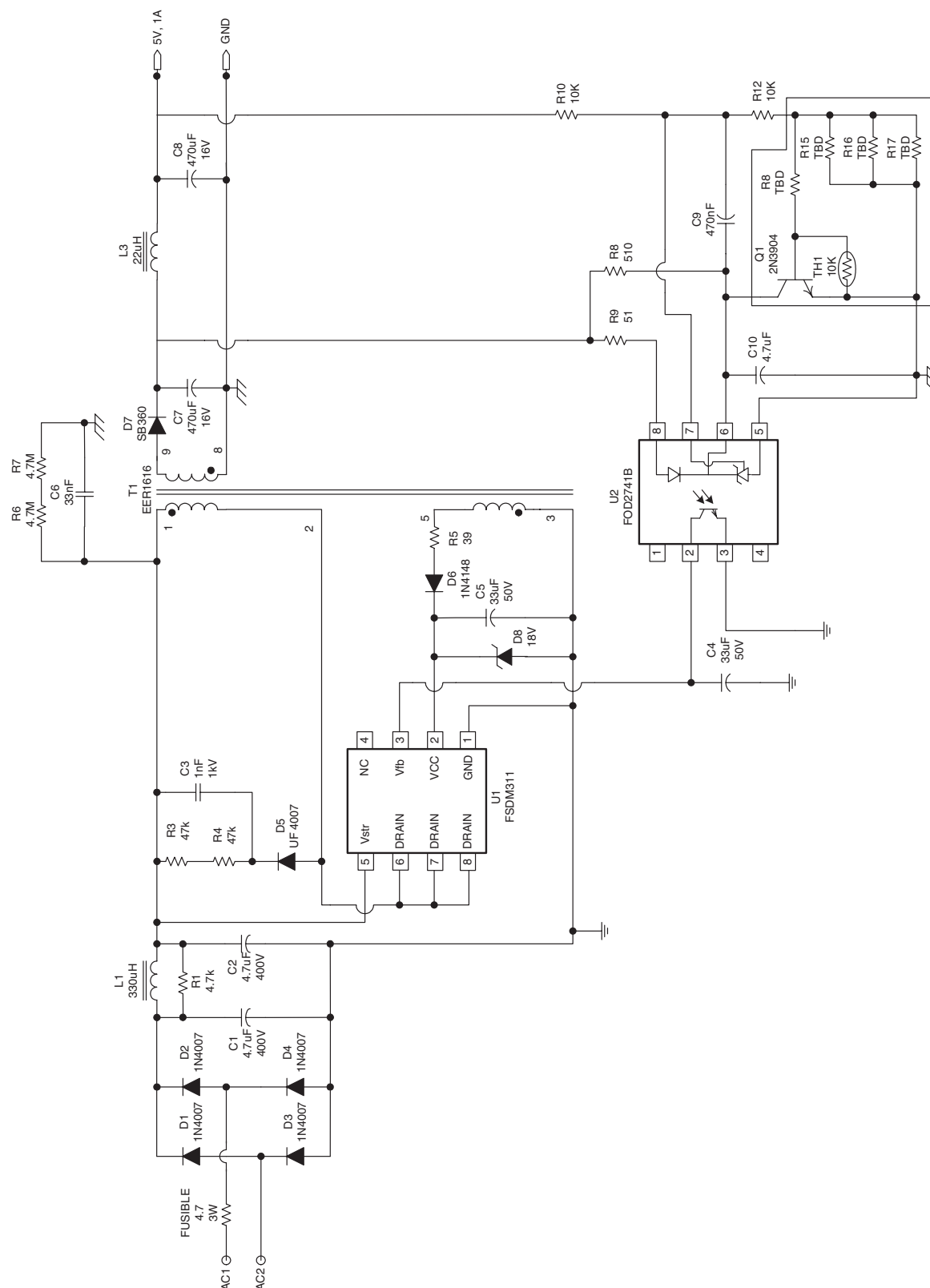


Figure 3. Lithium-Ion charger schematic.

3. Evaluation Board Connection

Great care should be taken when connecting the ac mains to this board. It is recommended that an isolated ac power source or a variable transformer and isolation transformer be used to provide the high voltage input. A variable load or a 5Ω, 25W power resistor can be connected to the dc output to fully load the converter.

A high voltage or differential probe should be connected across the Drain-to-Source to reproduce the V_{ds} waveform represented in the “Test Results” section. A standard voltage probe can be placed on the V_{cc} and V_{fb} pins to reproduce the waveforms. The Drain-to-Source current can be captured with the use of a current probe. The copper pour connecting the drain pins and the transformer primary can be cut and replaced with a short wire from the drain pins of the FPS to the transformer primary. Then the current probe can be placed around the short wire to measure the current waveform through the wire.

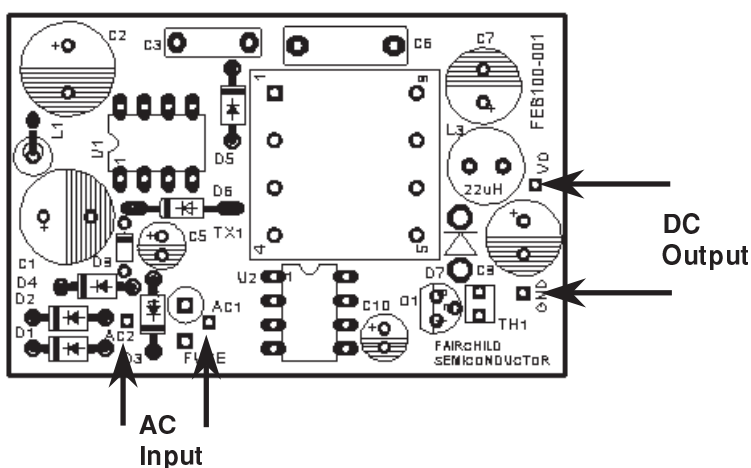


Figure 4. Graphical explanation of evaluation board connection.

4. Test Procedure

Once the board connections are made to ac mains and the desired load, the waveforms found in section 5, “Test Results” can be evaluated. The startup waveforms found in figures 5 and 6 can be reproduced by setting the appropriate trigger level and single trigger to your oscilloscope. The time per division and amplitude levels may need to be adjusted to get waveforms that match.

5. Test Results

5.1 Start-up

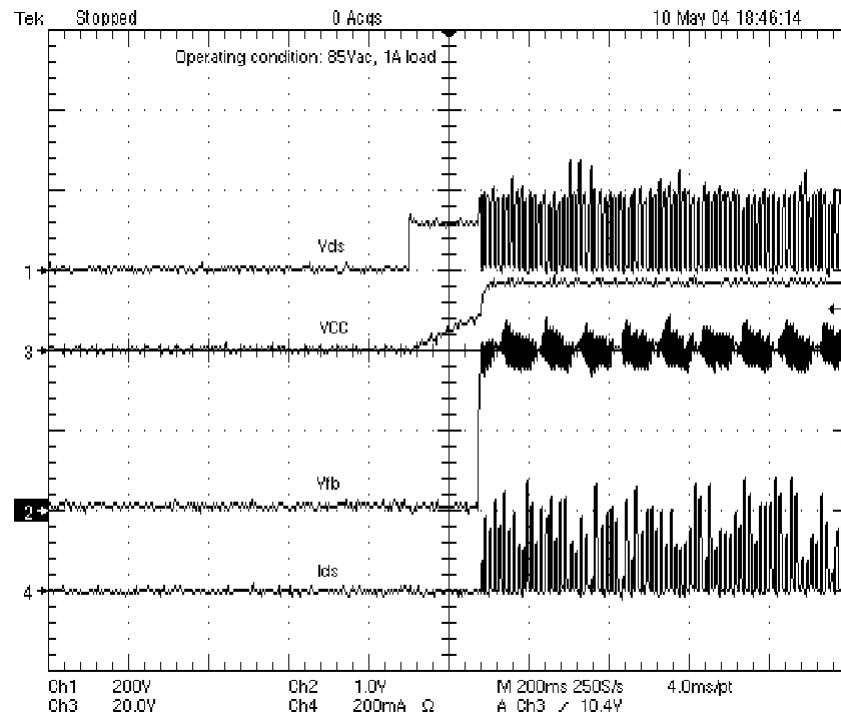


Figure 5. Start-up waveform at 85V and full load.

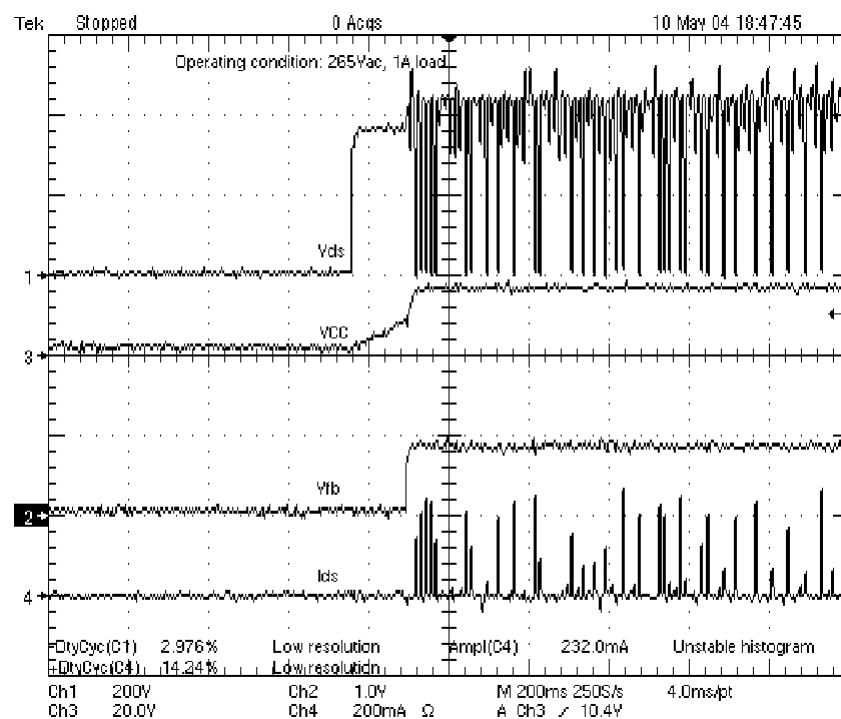


Figure 6. Start-up waveform at 265V and full load.

The “four corner” operating condition waveforms are found in figures 7, 8, 9, and 10.



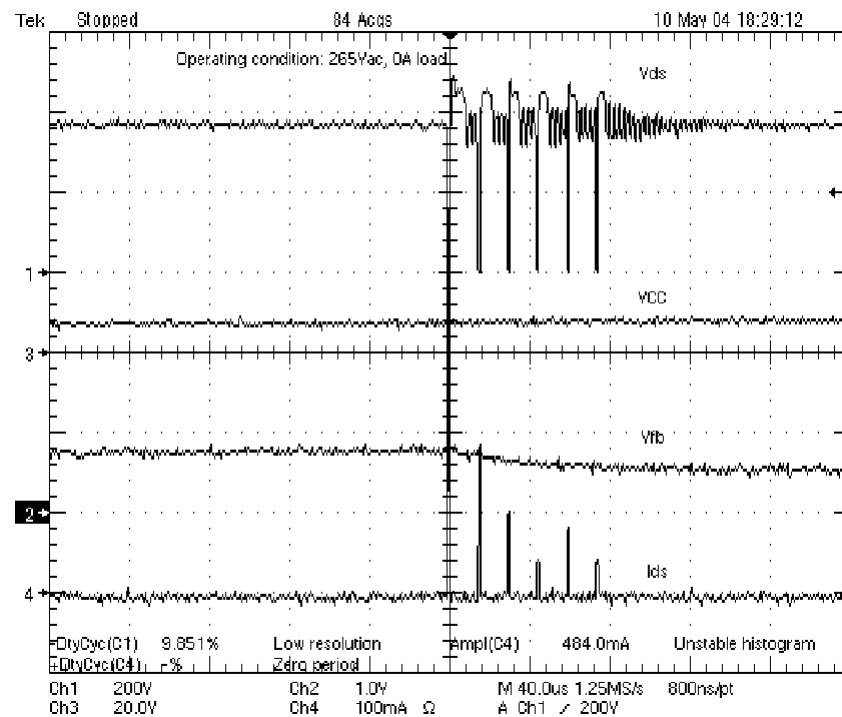


Figure 9. Vds, Vcc, Vfb, Ids at high line, no load condition.

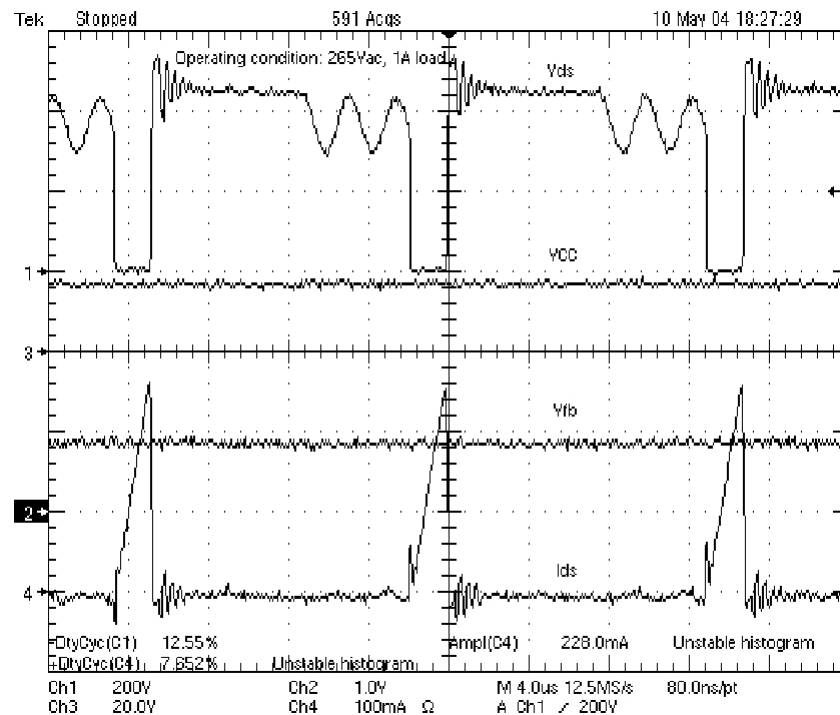


Figure 10. Vds, Vcc, Vfb, Ids at high line, full load condition.

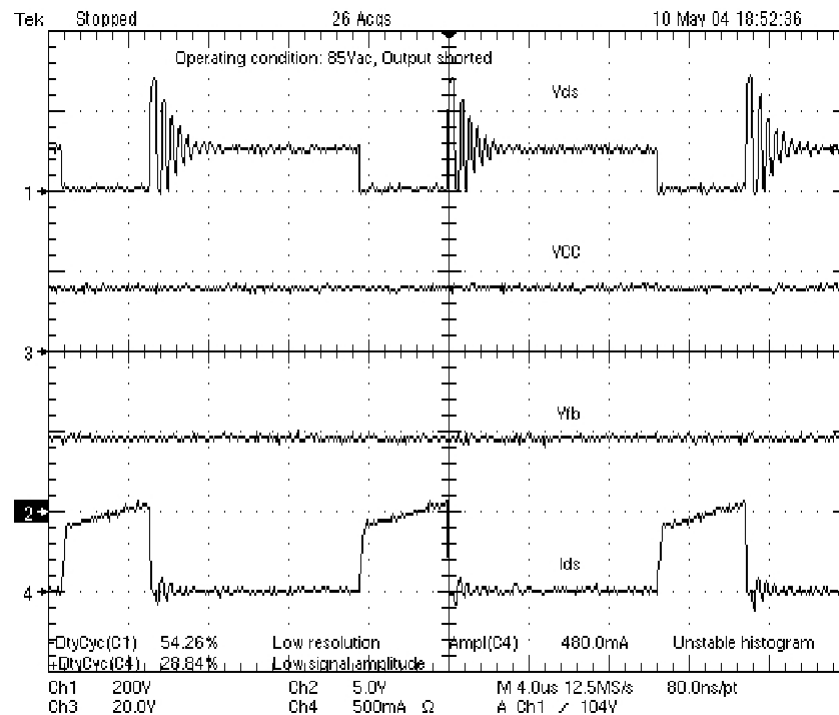


Figure 11. Vds, Vcc, Vfb, Ids at low line, output shorted.

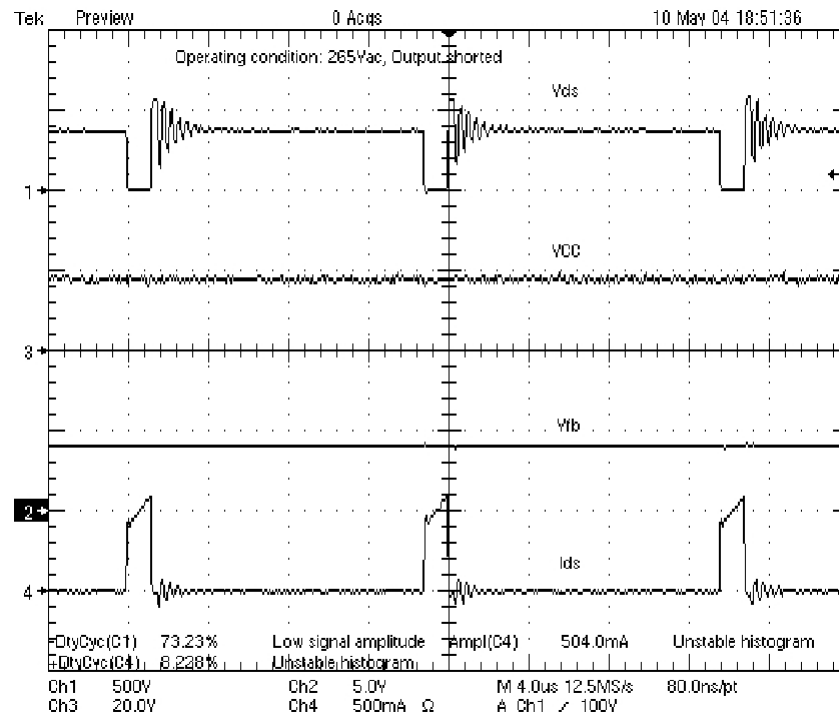


Figure 12. Vds, Vcc, Vfb, Ids at high line, output shorted.

6. Parts List

The selected components for the evaluation board are shown in Table 2.

Ref	Qty	Description	P/N	Mfg
C1, C2	2	4.7µF/400VElectrolytic cap		Any
C3	1	1nF/1kV, Safety cap		Any
C4	1	0.1µF, 0603 chip cap		Any
C5	1	10µF/50V, Electrolytic cap		Any
C6	1	3.3nF/1kV, Safety cap		Any
C7,C8	2	470µF/10V, Electrolytic cap, low esr		Any
C9	1	470nF/16V, 0603 chip cap		Any
C10	1	4.7µF/50V, Electrolytic cap		Any
D1,D2,D3,D4,D5	5	1A/1000V, Ultra Fast Recovery Rectifier	UF4007	Fairchild
D6	1	General diode	1N4148	Fairchild
D7	1	3A/60V, Schottky rectifier	SB360	Fairchild
D8	1	Do not install		Any
FUSE	1	4.7Ω, 3W, fusible resistor		Vishay
L1	1	330µH, power inductor	77F331J	JW Miller
L3	1	22µH, power inductor	R622LY-220K	Toko
*Q1	1	NPN transistor	2N3904	Fairchild
R1	1	4.7K, 0805 chip resistor		Any
R3,R4	2	47K, 0805 chip resistor		Any
R5	1	10Ω, 0603 chip resistor		Any
R6,R7	2	4.7M, 0805 chip resistor		Any
R8	1	510Ω, 1206 chip resistor		Any
R9	1	51Ω, 0603 chip resistor		Any
R10, R11	2	10K, 1206 chip resistor		Any
*R15,*R16,R17	3	0Ω, 0805		Any
*R19	1	Do not install		Any
*TH1	1	10K, NTC Thermistor	2322 640 55103	BC
TX1	1	2.3mH, custom transformer	G044104	GCI
U1	1	Power switch	FSDM311	Fairchild
U2	1	Integrated opto-coupler	FOD2741B	Fairchild

* Needed only for battery charger

Table 2. Bill of materials used for evaluation board.

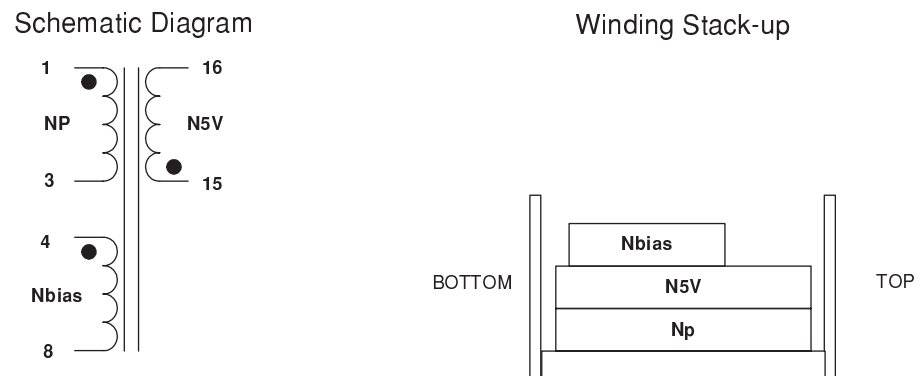


Figure 13. Transformer specification.

7. Printed Circuit Board

The PCB was constructed of FR4 material with a thickness of 0.062 inches. A 1 oz. copper weight was used for the copper traces.

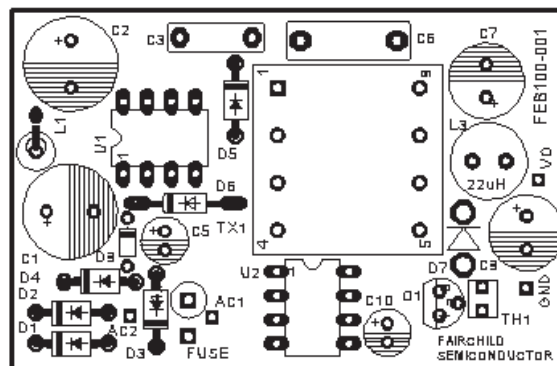


Figure 14. Silkscreen screenshot of the evaluation board.

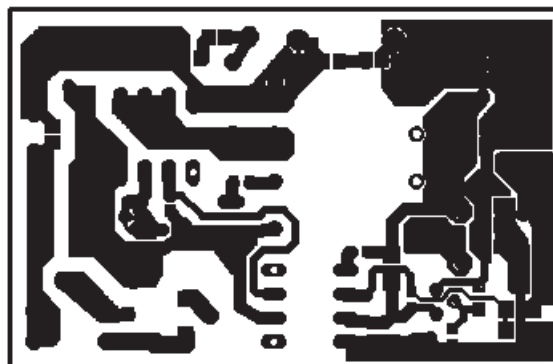


Figure 15. Copper screenshot of the evaluation board.

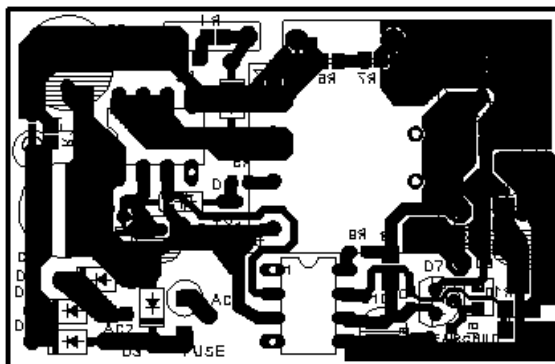


Figure 16. Complete screenshot of the evaluation board.

8. Featured Products

8.1 FSDM311 Controller Details

8.1.1 Description

The FSDM311 is an integrated Pulse Width Modulators (PWM) and Sense FET specially designed for high performance off-line Switch Mode Power Supplies (SMPS) with minimal external components. This device is monolithic high voltage power switching regulator which combines an VDMOS Sense FET with a voltage mode PWM control block. The integrated PWM controller features include: a fixed oscillator, Under Voltage Lock Out (UVLO) protection, Leading Edge Blanking (LEB), optimized gate turn-on/turn-off driver, thermal shut down protection (TSD), temperature compensated precision current sources for loop compensation and fault protection circuitry. When compared to a discrete MOSFET and controller or RCC switching converter solution, the FSDM311 reduces total component count, design size, weight and at the same time increases efficiency, productivity, and system reliability. This device is a basic platform well suited for cost effective designs of flyback converters.

8.1.2 Main Features of the FSDM311

- Internal Avalanche Rugged Sense FET
- Precision Fixed Operating Frequency (67kHz)
- Advanced Burst-Mode operation Consumes under 0.2W at 265Vac and no load
- Internal Start-up Switch and Soft Start
- Under Voltage Lock Out (UVLO) with Hysteresis
- Pulse by Pulse Current Limit
- Over Load Protection (OLP)
- Over Voltage Protection (OVP)
- Internal Thermal Shutdown Function (TSD)
- Auto-Restart Mode

8.1.3 FSDM311 Functional Block Diagram

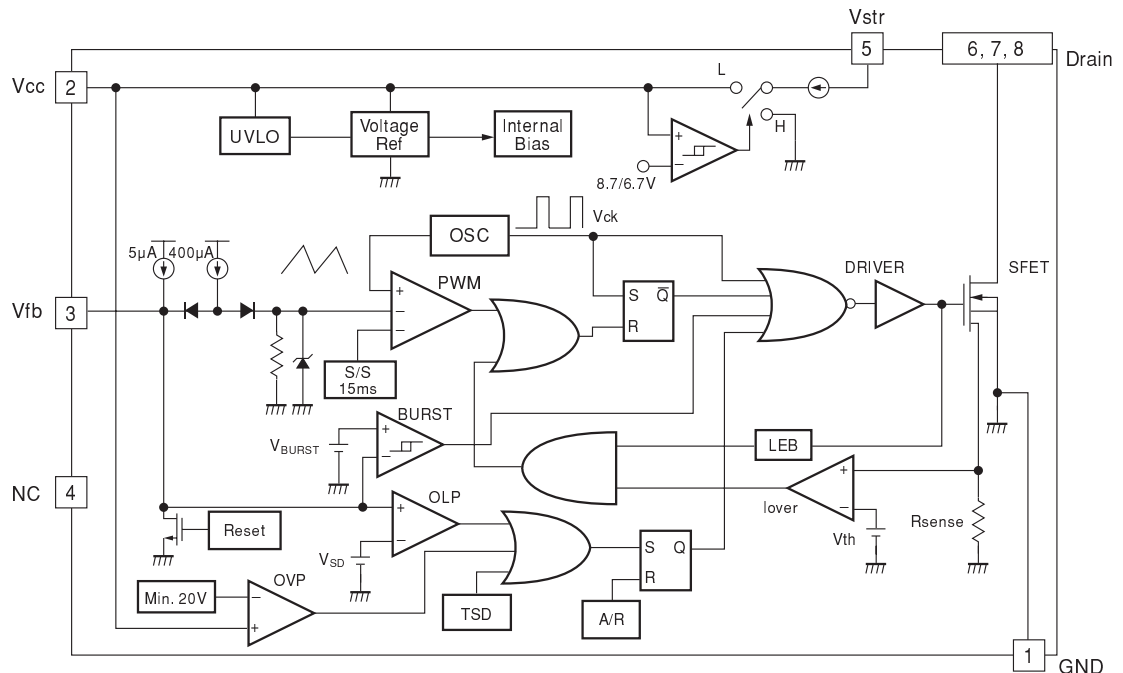


Figure 17. Functional block diagram of the FSDM311.

8.2 FOD2741 Details

8.2.1 Description

The FOD2741 Optically Isolated Amplifier consists of the popular KA431 precision programmable shunt reference and an optocoupler. The optocoupler is a gallium arsenide (GaAs) light emitting diode optically coupled to a silicon phototransistor. It comes in 3 grades of reference voltage tolerance = 2%, 1%, and 0.5%.

The Current Transfer Ratio (CTR) ranges from 100% to 200%. It also has an outstanding temperature coefficient of 50 ppm/°C. It is primarily intended for use as the error amplifier/reference voltage/optocoupler function in isolated ac to dc power supplies and dc/dc converters.

When using the FOD2741, power supply designers can reduce the component count and save space in tightly packaged designs. The tight tolerance reference eliminates the need for adjustments in many applications. The device comes in a 8-pin dip white package.

8.2.2 Features

- Optocoupler, precision reference and error amplifier in single package
- 2.5V reference
- CTR 100% to 200%
- 5,000V RMS isolation
- UL approved E90700, Volume 2; CSA approval 1296837; VDE approval 40002463; BSI approval 8702, 8703
- Low temperature coefficient 50 ppm/°C max
- FOD2741A: tolerance 0.5%; FOD2741B: tolerance 1%; FOD2741C: tolerance 2%

9. References / Resources

9.1 Application Notes

Application note AN-4137 is a full design procedure for flyback converters. Application note AN4138 is a full design procedure for a flyback charger circuit.

- AN-4137 Design Guidelines for Off-line Flyback Converters Using FPS
- AN-4138 Design Considerations for Battery Charger Using Green Mode FPS
- AN-4141 Troubleshooting and Design Tips for FPS Flyback Applications
- AN-4145 Electromagnetic Compatibility for Power Converters

WARNING AND DISCLAIMER

This Evaluation Board may employ high voltages so appropriate safety precautions should be used when operating this board. Replace components on the Evaluation Board only with those parts shown on the parts list in the User's Guide. Contact an authorized Fairchild representative with any questions.

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