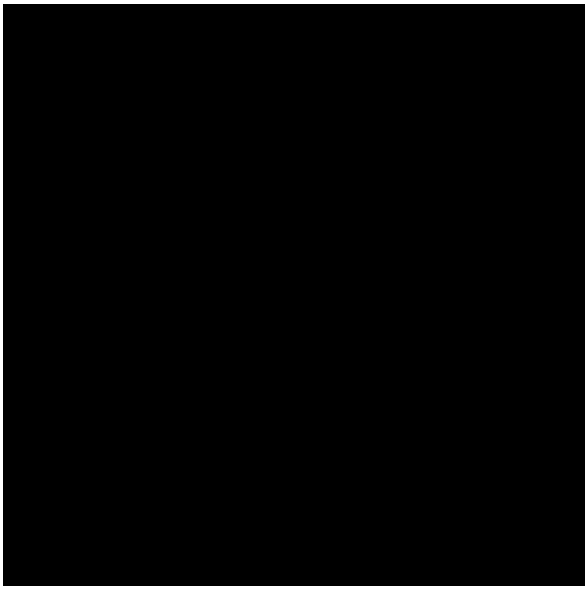
## Is Now Part of



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Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.

FAIRCHILD SEMICONDUCTOR®

October 2011

# FSD146MRBN
# Green-Mode Fairchild Power Switch (FPS™)

## Features

- Advanced Soft Burst-Mode Operation for Low Standby Power and Low Audible Noise
- Random Frequency Fluctuation for Low EMI
- Pulse-by-Pulse Current Limit
- Various Protection Functions: Overload Protection (OLP), Over-Voltage Protection (OVP), Abnormal Over-Current Protection (AOCP), Internal Thermal Shutdown (TSD) with Hysteresis, Output-Short Protection (OSP), and Under-Voltage Lockout (UVLO) with Hysteresis
- Low Operating Current (0.4mA) in Burst Mode
- Internal Startup Circuit
- Internal High-Voltage SenseFET: 650V
- Built-in Soft-Start: 15ms
- Auto-Restart Mode

## Applications

- Power Supply for LCD Monitor, STB, and DVD Combination

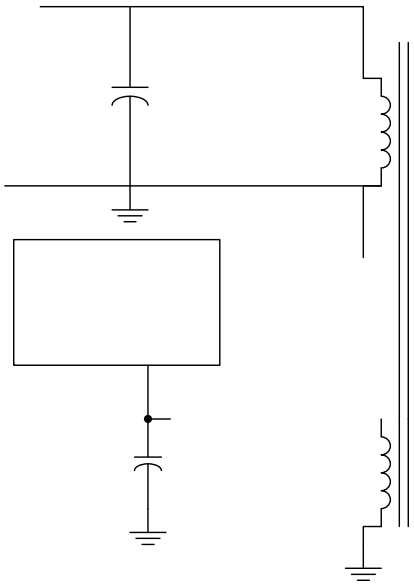
## Description

The FSD146MRBN is an integrated Pulse Width Modulation (PWM) controller and SenseFET designed for offline Switch-Mode Power Supplies (SMPS) with minimal external components. The PWM controller includes an integrated fixed-frequency oscillator, Under-Voltage Lockout (UVLO), Leading-Edge Blanking (LEB), optimized gate driver, internal soft-start, temperature-compensated precise current sources for loop compensation, and self-protection circuitry. Compared with a discrete MOSFET and PWM controller solution, the FSD146MRBN can reduce total cost, component count, size, and weight; while simultaneously increasing efficiency, productivity, and system reliability. This device provides a basic platform that is well suited for cost-effective design of a flyback converter.

## Ordering Information

| Part Number | Package | Operating Junction Temperature | Current Limit | $R_{DS(ON)}$ (Max.) | Output Power Table[2] |
|---|---|---|---|---|---|

## Application Circuit



## Pin Configuration

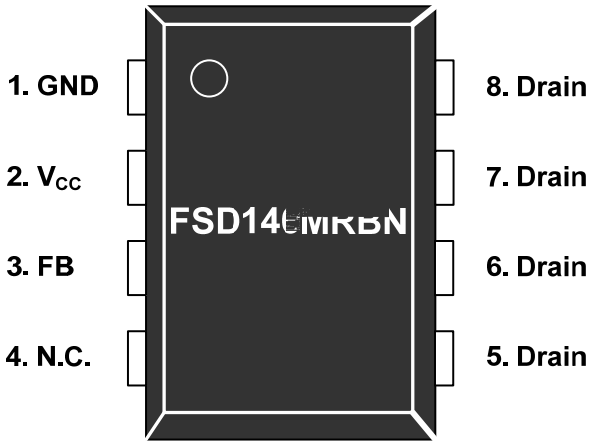



**Figure 3. Pin Configuration (Top View)**

## Pin Definitions

| Pin # | Name | Description |
|---|---|---|
| 1 | GND | **Ground**. This pin is the control ground and the SenseFET source. |
| 2 | $V_{CC}$ | **Power Supply**. This pin is the positive supply input, which provides the internal operating current for both startup and steady-state operation. |
| 3 | FB | **Feedback**. This pin is internally connected to the inverting input of the PWM comparator. The collector of an opto-coupler is typically tied to this pin. For stable operation, a capacitor |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{DS}$ | Drain Pin Voltage | | 650 | V |
| $V_{CC}$ | $V_{CC}$ Pin Voltage | | 26 | V |
| $V_{FB}$ | Feedback Pin Voltage | -0.3 | 10.0 | V |
| $I_{DM}$ | Drain Current Pulsed | | 3.4 | A |

$I_{DS}$ Continuous Switching Drain Current

## Electrical Characteristics

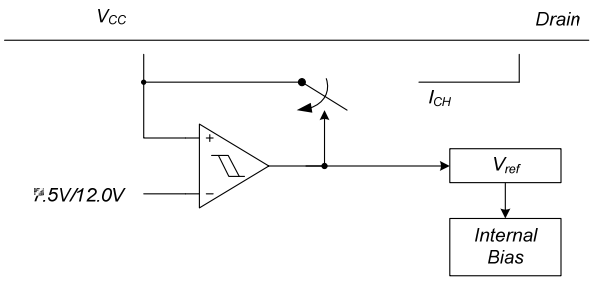
$T_J$ = 25 C unless otherwise specified.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **SenseFET Section** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{CC}$ = 0V, $I_D$ = 250 A | 650 | | | V |
| $I_{DSS}$ | Zero-Gate-Voltage Drain Current | $V_{DS}$ = 650V, $T_A$ = 25 C | | | 250 | A |
| $R_{DS(ON)}$ | Drain-Source On-State Resistance | $V_{GS}$=10V, $I_D$ =1A | | 2.1 | 2.6 | Ω |
| $C_{ISS}$ | Input Capacitance[12] | $V_{DS}$ = 25V, $V_{GS}$ = 0V, f=1MHz | | 436 | | pF |
| $C_{OSS}$ | Output Capacitance[12] | $V_{DS}$ = 25V, $V_{GS}$ = 0V, f=1MHz | | 65 | | pF |
| $t_r$ | Rise Time | $V_{DS}$ = 325V, $I_D$ = 4A, $R_G$=25Ω | | 24 | | ns |
| $t_f$ | Fall Time | $V_{DS}$ = 325V, $I_D$ = 4A, $R_G$=25Ω | | 24 | | ns |
| $t_{d(on)}$ | Turn-On Delay | $V_{DS}$ = 325V, $I_D$ = 4A, $R_G$=25Ω | | 13 | | ns |
| $t_{d(off)}$ | Turn-Off Delay | $V_{DS}$ = 325V, $I_D$= 4A, $R_G$=25Ω | | 30 | | ns |
| **Control Section** | | | | | | |
| $f_S$ | Switching Frequency[12] | $V_{CC}$ = 14V, $V_{FB}$ = 4V | 61 | 67 | 73 | kHz |

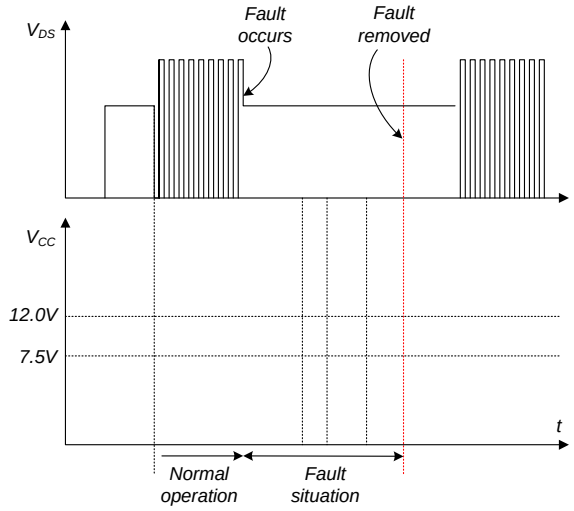
## Typical Performance Characteristics

## Functional Description

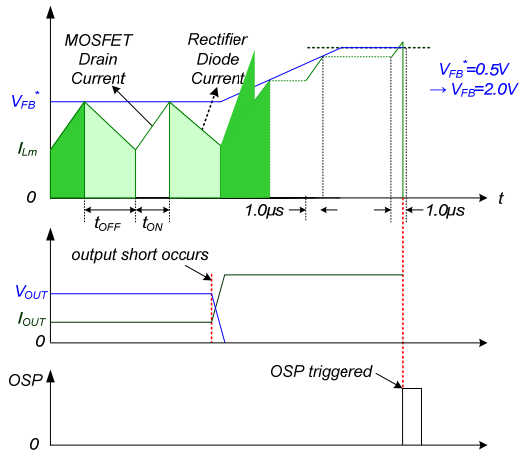
**1. Startup:** At startup, an internal high-voltage current source supplies the internal bias and charges the external capacitor ($C_{Vcc}$) connected to the $V_{CC}$ pin, as illustrated in Figure 17. When $V_{CC}$ reaches 12V, the FSD146MRBN begins switching and the internal high-voltage current source is disabled. The FSD146MRBN continues normal switching operation and the power is supplied from the auxiliary transformer winding unless $V_{CC}$ goes below the stop voltage of 7.5V.



**4. Protection Circuits**: The FSD146MRBN has several self-protective functions, such as Overload Protection (OLP), Abnormal Over-Current Protection (AOCP), Output-Short Protection (OSP), Over-Voltage Protection (OVP), and Thermal Shutdown (TSD). All the protections are implemented as auto-restart. Once the fault condition is detected, switching is terminated and the SenseFET remains off. This causes $V_{CC}$ to fall. When $V_{CC}$ falls to the Under-Voltage Lockout (UVLO) stop voltage of 7.5V, the protection is reset and the startup circuit charges the $V_{CC}$ capacitor. When $V_{CC}$ reaches the start voltage of 12.0V, the FSD146MRBN resumes normal operation. If the fault condition is not removed, the SenseFET remains off and $V_{CC}$ drops to stop voltage again. In this manner, the auto-restart can alternately enable and disable the switching of the power SenseFET until the fault condition is eliminated. Because these protection circuits are fully integrated into the IC without external components, the reliability is improved without increasing cost.



**4.3. Output-Short Protection (OSP)**: If the output is shorted, steep current with extremely high di/dt can flow through the SenseFET during the minimum turn-on time. Such a steep current brings high-voltage stress on the drain of the SenseFET when turned off. OSP protects the device from this abnormal condition. It is comprised of detecting $V_{FB}$ and SenseFET turn-on time. When the $V_{FB}$ is higher than 2.0V and the SenseFET turn-on time is lower than 1.0μs, this condition is recognized as an abnormal error and PWM switching shuts down until $V_{CC}$ reaches $V_{START}$ again. An abnormal condition output short is shown in Figure 22.



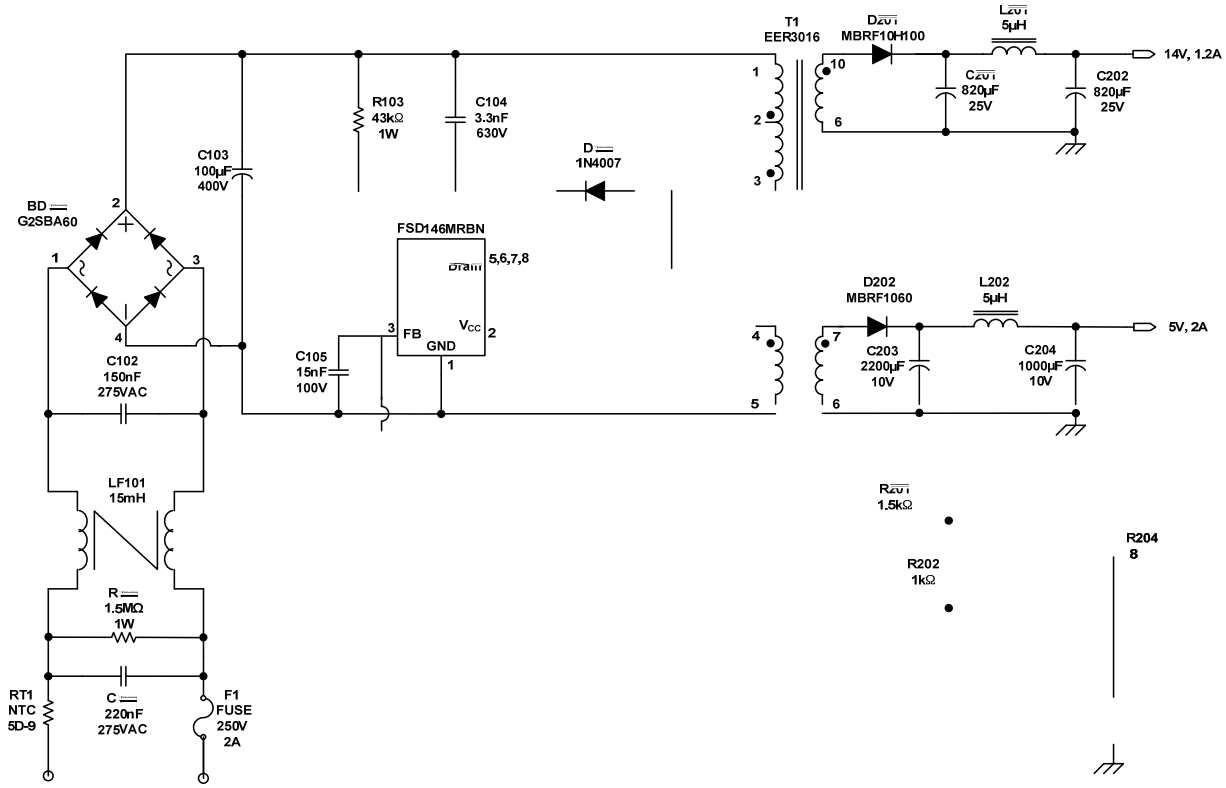
## Typical Application Circuit

| Application | Input Voltage | Rated Output | Rated Power |
|---|---|---|---|
| LCD Monitor Power Supply | 85 ~ 265$V_{AC}$ | 5.0V(2A)<br>14.0V(1.2A) | 26.8W |

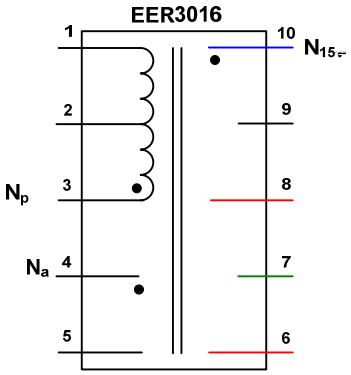
### Key Design Notes:

1. The delay for overload protection is designed to be about 30ms with C105 (8.2nF). OLP time between 39ms (12nF) and 46ms (15nF) is recommended.
2. The SMD-type capacitor (C106) must be placed as close as possible to the $V_{CC}$ pin to avoid malfunction by abrupt pulsating noises and to improve ESD and surge immunity. Capacitance between 100nF and 220nF is recommended.

### Schematic



## Transformer



## Bill of Materials

| Part # | Value | Note | Part # | Value | Note |
|---|---|---|---|---|---|
| **Fuse** | | | **Capacitor** | | |
| F101 | 250V 2A | | C101 | 220nF/275V | Box (Pilkor) |
| **NTC** | | | C102 | 150nF/275V | Box (Pilkor) |
| NTC101 | 5D-9 | DSC | C103 | 100 F/400V | Electrolytic (SamYoung) |
| **Resistor** | | | C104 | 3.3nF/630V | Film (Sehwa) |
| R101 | 1.5MΩ, J | 1W | C105 | 15nF/100V | Film (Sehwa) |
| R103 | 43kΩ, J | 1W | C106 | 100nF | SMD (2012) |
| R201 | 1.5kΩ, F | 1/4W, 1% | C107 | 47 F/50V | Electrolytic (SamYoung) |
| R202 | 1.0kΩ, F | 1/4W, 1% | C201 | 820 F/25V | Electrolytic (SamYoung) |
| R203 | 18kΩ, F | 1/4W, 1% | C202 | 820 F/25V | Electrolytic (SamYoung) |
| R204 | 8kΩ, F | 1/4W, 1% | C203 | 2200 F/10V | Electrolytic (SamYoung) |
| R205 | 8kΩ, F | 1/4W, 1% | C204 | 1000 F/16V | Electrolytic (SamYoung) |
| | | | C205 | 47nF/100V | Film (Sehwa) |
| | | | C301 | 2.2nF/Y2 | Y-cap (Samhwa) |
| **IC** | | | **Inductor** | | |
| FPS | FSD146MRBN | Fairchild | LF101 | 20mH | Line filter 0.5Ø |
| IC201 | KA431LZ | Fairchild | L201 | 5 H | 5A Rating |
| IC301 | FOD817B | Fairchild | L202 | 5 H | 5A Rating |
| **Diode** | | | **Transformer** | | |
| D101 | 1N4007 | Vishay | T101 | 826 H | |
| D102 | UF4007 | Vishay | | | |
| ZD101 | 1N4750 | Vishay | | | |
| D201 | MBRF10H100 | Fairchild | | | |
| D202 | MBRF1060 | Fairchild | | | |
| BD101 | G2SBA60 | Vishay | | | |

## Physical Dimensions

**Figure 27. 8-Lead, MDIP, JEDEC MS-001, .300" Wide**

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