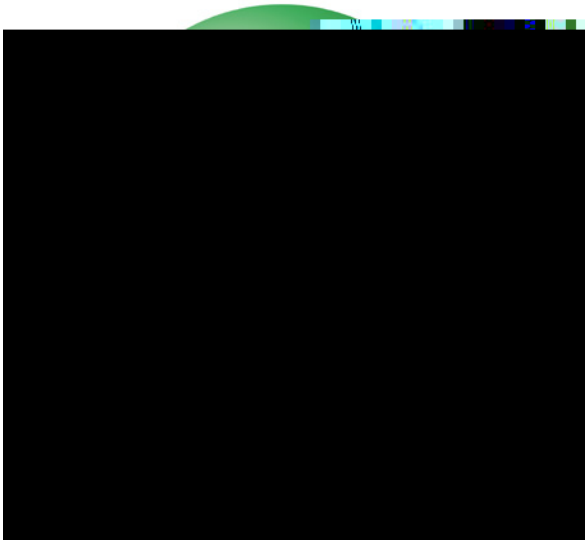
Is Now Part of



To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

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®

January 2014

FSD176MRT
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 (0.4 mA) in Burst Mode
- Internal Startup Circuit
- Internal High-Voltage SenseFET: 650 V
- Built-in Soft-Start: 15 ms
- Auto-Restart Mode

Applications

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

Description

The FSD176MRT is an integrated Pulse Width Modulation (PWM) controller and SenseFET specifically designed for offline Switch-Mode Power Supplies (SMPS) with minimal external components. The PWM controller includes an integrated fixed-frequency

Application Circuit

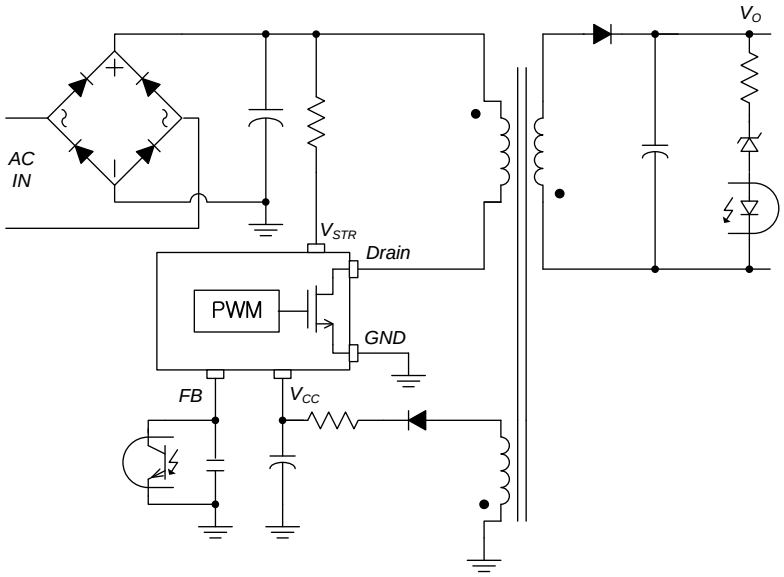
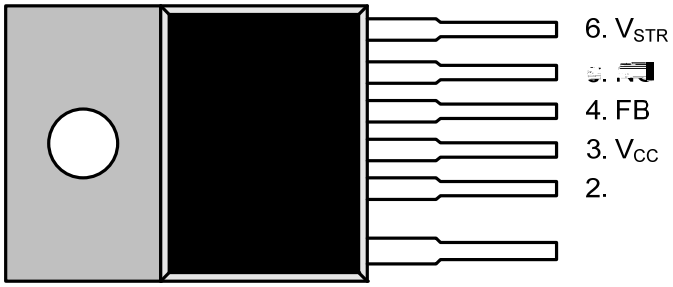


Figure 1. Typical Application Circuit

Pin Configuration



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_{STR}	V_{STR} Pin Voltage			650	V
V_{DS}	Drain Pin Voltage			650	V
V_{CC}	V_{CC} Pin Voltage			26	V
V_{FB}	Feedback Pin Voltage		-0.3	12.0	V
I_{DM}	Drain Current Pulsed			12.8	A
I_{DS}	Continuous Switching Drain Current[6]	T_C=25°C		6.4	A
		T_C=100°C		4.0	A

Electrical Characteristics

T_J = 25°C unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit

Electrical Characteristics (Continued)

Typical Performance Characteristics

Characteristic graphs are normalized at T_A=25°C.

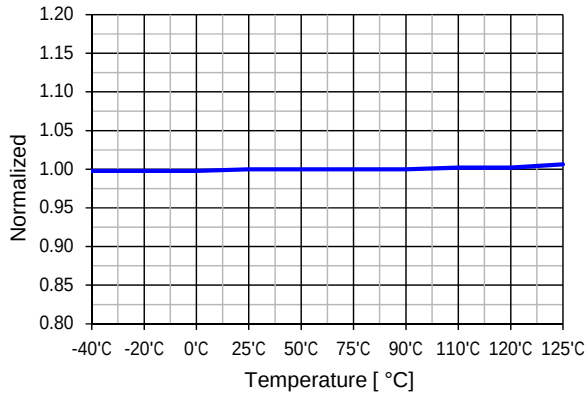


Figure 11. UVLO Threshold Voltage (V_{START}) vs. T_A

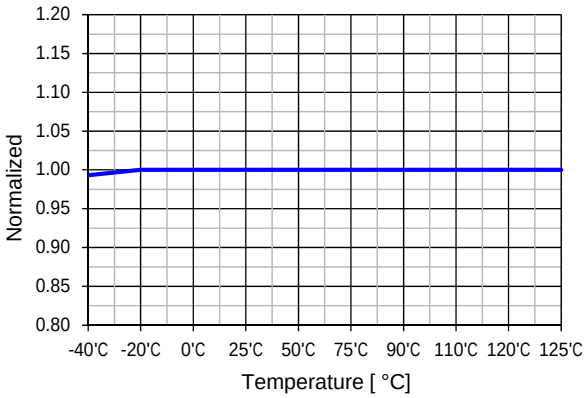


Figure 12. UVLO Threshold Voltage (V_{STOP}) vs. T_A

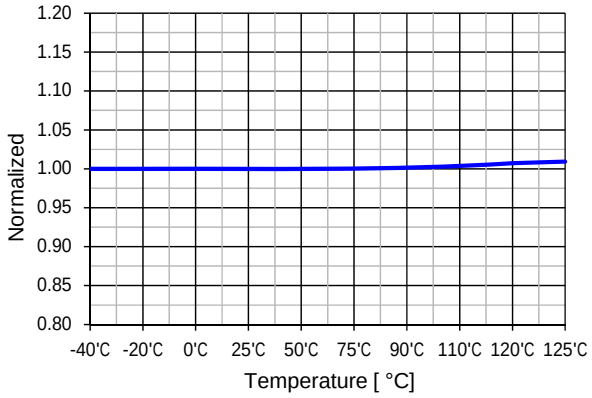


Figure 13. Shutdown Feedback Voltage (V_{SD}) vs. T_A

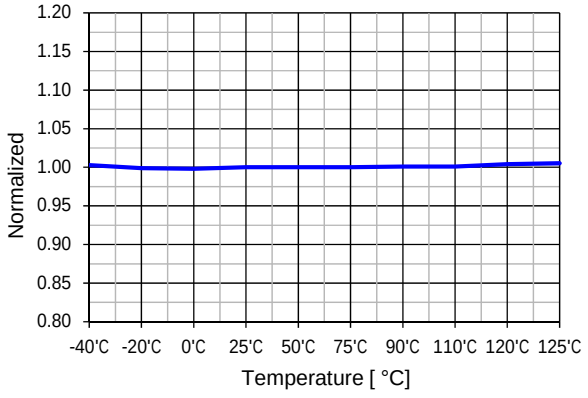


Figure 14. Over-Voltage Protection (V_{OVP}) vs. T_A

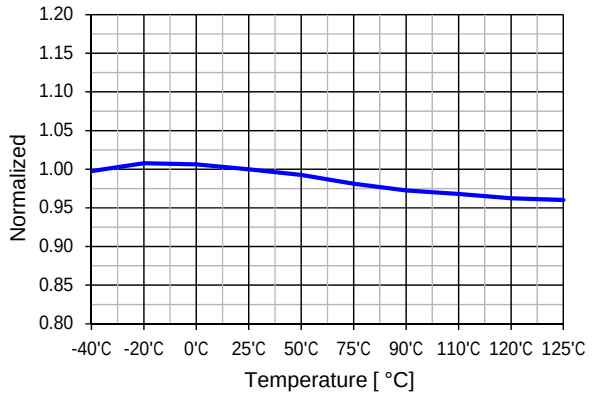


Figure 15. Switching Frequency (f_S) vs. T_A

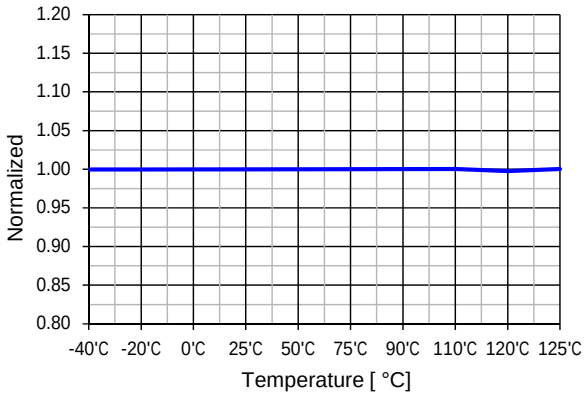


Figure 16. Maximum Duty Ratio (D_{MAX}) vs. T_A

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 12 V, the FSD176MRT begins switching and the internal high-voltage current source is disabled. The FSD176MRT continues normal switching operation and the power is supplied from the auxiliary transformer winding unless V_{CC} goes below the stop voltage of 7.5 V.

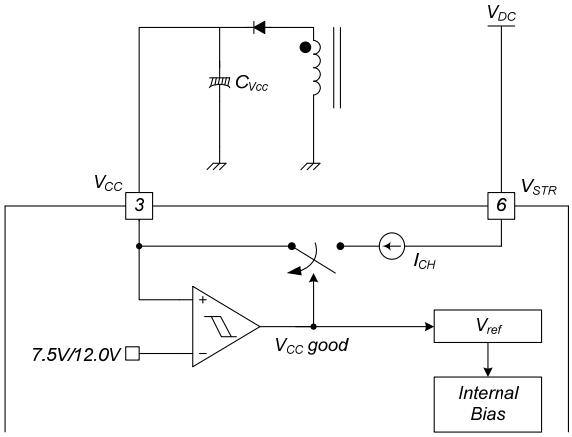


Figure 17. Startup Block

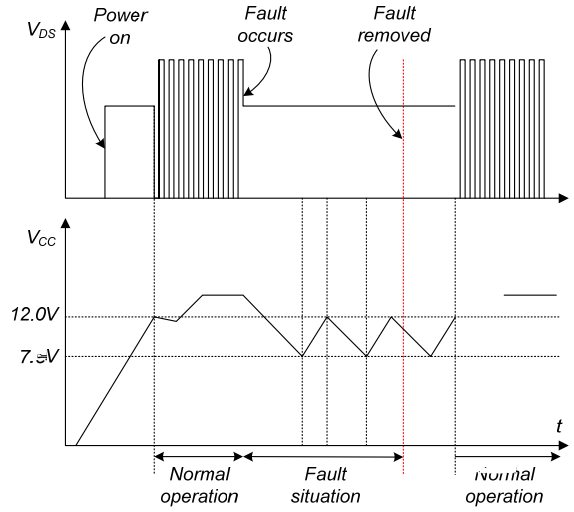
2. Soft-Start: The internal soft-start circuit increases the PWM comparator inverting input voltage, together with the SenseFET current, slowly after startup. The typical soft-start time is 15ms. The pulse width to the power switching device is progressively increased to establish the correct working conditions for transformers, inductors, and capacitors. The voltage on the output capacitors is progressively increased to smoothly establish the required output voltage. This helps prevent transformer saturation and reduces stress on the secondary diode during startup.

3. Feedback Control: This device employs current-mode control, as shown in Figure 18. An opto-coupler (such as the FOD817) and shunt regulator (such as the KA431) are typically used to implement the feedback network. Comparing the feedback voltage with the voltage across the R_{SENSE} resistor makes it possible to control the switching duty cycle. When the reference pin voltage of the shunt regulator exceeds the internal reference voltage of 2.5 V, the opto-coupler LED current increases, pulling down the feedback voltage and reducing drain current. This typically occurs when the input voltage is increased or the output load is decreased.

3.1 Pulse-by-Pulse Current Limit: Because current-mode control is employed, the peak current through the SenseFET is limited by the inverting input of the PWM comparator (V_{FB}*), as shown in Figure 18. Assuming that the 90 µA current source flows only through the internal resistor (3R + R = 27 kΩ), the cathode voltage of diode D2 is about 2.5 V. Since D1 is blocked when the feedback voltage (V_{FB}) exceeds 2.5 V, the maximum voltage of the cathode of D2 is clamped at this voltage. Therefore, the peak value of the current through the SenseFET is limited.

3.2 Leading-Edge Blanking (LEB): At the instant the internal SenseFET is turned on, a high-current spike usually occurs through the SenseFET, caused by primary-side capacitance and secondary-side rectifier reverse recovery. Excessive voltage across the R_{SENSE} resistor leads to incorrect feedback operation in the current-mode PWM control. To counter this effect, the leading-edge blanking (LEB) circuit inhibits the PWM comparator for t_{LEB} (300 ns) after the SenseFET is turned on.

4. Protection Circuits: The FSD176MRT 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 a 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 7.5 V, the protection is reset and the startup circuit charges the V_{CC} capacitor. When V_{CC} reaches the start voltage of 12.0 V, the FSD176MRT 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. To protect the device from this abnormal condition, OSP is included. It is comprised of detecting V_{FB} and SenseFET turn-on time. When the V_{FB} is higher than 2.0 V and the SenseFET turn-on time is lower than 1.0 µs, the FSD176MRT recognizes this condition as an abnormal error and shuts down PWM switching until V_{CC} reaches V_{START} again. An abnormal condition output short is shown in Figure 22.

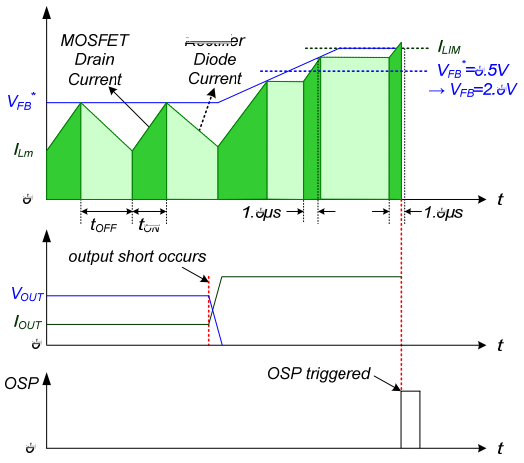


Figure 22. Output-Short Protection

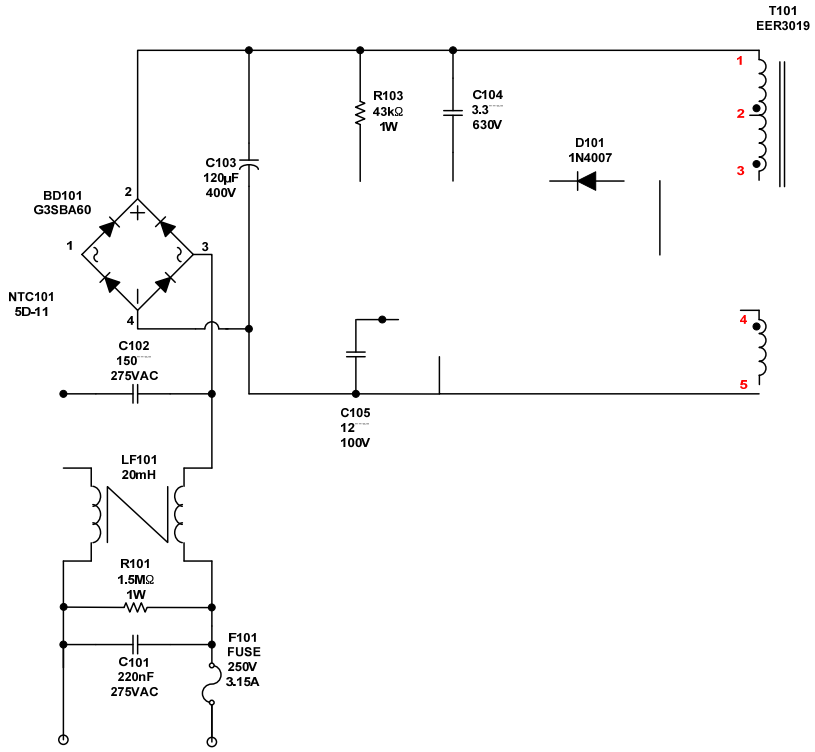
4.4 Over-Voltage Protection (OVP): If the secondary-side feedback circuit malfunctions or a solder defect causes an opening in the feedback path, the current through the opto-coupler transistor becomes almost zero. Then V_{FB} climbs up in a similar manner to the overload situation, forcing the preset maximum current to be supplied to the SMPS until the overload protection is triggered. Because more energy than required is provided to the output, the output voltage may exceed the rated voltage before the overload protection is triggered, resulting in the breakdown of the devices in the secondary side. To prevent this situation, an OVP circuit is employed. In

Typical Application Circuit

Application	Input Voltage	Rated Output	Rated Power
LCD Monitor	85 ~ 265 V_{AC}	5.0 V (3 A)	64 W
Power Supply		14.0 V (3.5 A)	

Key Design Notes:

1. The delay for overload protection is designed to be about 30 ms with C105 (8.2 nF). OLP time between 39 ms (12 nF) and 46 ms (15 nF) 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 100 nF and 220 nF is recommended.



Transformer Specification

Core: EER3019 (A_e=134 mm^2)

Bobbin: EER3019

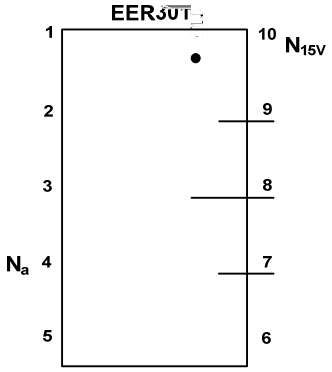
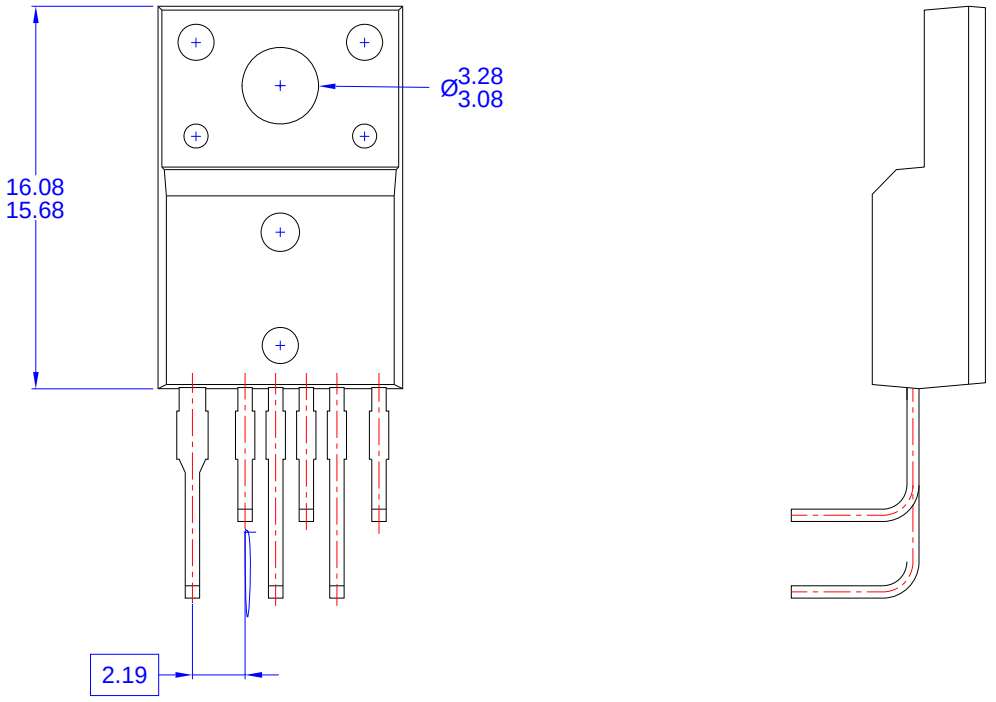
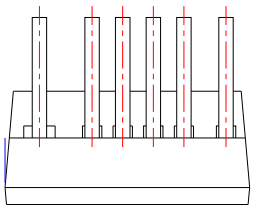


Table 3. Bill of Materials

Part #	Value	Note	Part #	Value	Note
Fuse			**Capacitor**		
F101	250 V 3.15 A		C101	220 nF / 275 V	Box (Pilkor)
NTC			C102	150 nF / 275 V	Box (Pilkor)
NTC101	5D-11	DSC	C103	120 µF / 400 V	Electrolytic (SamYoung)
Resistor			C104	3.3 nF / 630 V	Film (Sehwa)
R101	1.5 MΩ, J	1 W	C105	12 nF / 100 V	Film (Sehwa)
R103	43 kΩ, J	1 W	C106	220 nF	SMD (2012)
R201	1 kΩ, F	1/4 W, 1%	C107	47 µF / 50 V	Electrolytic (SamYoung)
R202	1.2 kΩ, F	1/4 W, 1%	C201	1000 µF / 25 V	Electrolytic (SamYoung)

Physical Dimensions





NOTES:

A) NO PACKAGE STANDARD APPLIES.
B) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
C) DIMENSIONS ARE IN MILLIMETERS.
D) DRAWING FILENAME : MKT-TO220E06REV2

FAIRCHILD

CorePLUS™ Green FPS™ Programmable Active Droop™ TinyBuck®

SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative