FSDM0465RE, FSDM0565RE, FSDM07652RE
Green Mode Power Switch

Features

- Internal Avalanche-Rugged SenseFET
- Advanced Burst-Mode Operation Consumes Under 1W at 240V_{AC} & 0.5W load
- Precision Fixed Operating Frequency (66kHz)
- Internal Start-up Circuit
- Improved Pulse-by-Pulse Current Limiting
- Over-Voltage Protection (OVP)
- Overload Protection (OLP)
- Internal Thermal Shutdown Function (TSD)
- Auto-Restart Mode
- Under-Voltage Lockout (UVLO) with hysteresis
- Low Operating Current (2.5mA)
- Built-in Soft-Start

Applications

- SMPS for LCD monitor and STB
- Adaptor

Description

The FSDM0465RE, FSDM0565RE and FSDM07652RE are an integrated Pulse Width Modulator (PWM) and SenseFET specifically designed for high-performance offline Switch Mode Power Supplies (SMPS) with minimal external components. This device is an integrated high-voltage power-switching regulator that combines an avalanche-rugged SenseFET with a

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Publication Order Number:
FSDM0465RE/D

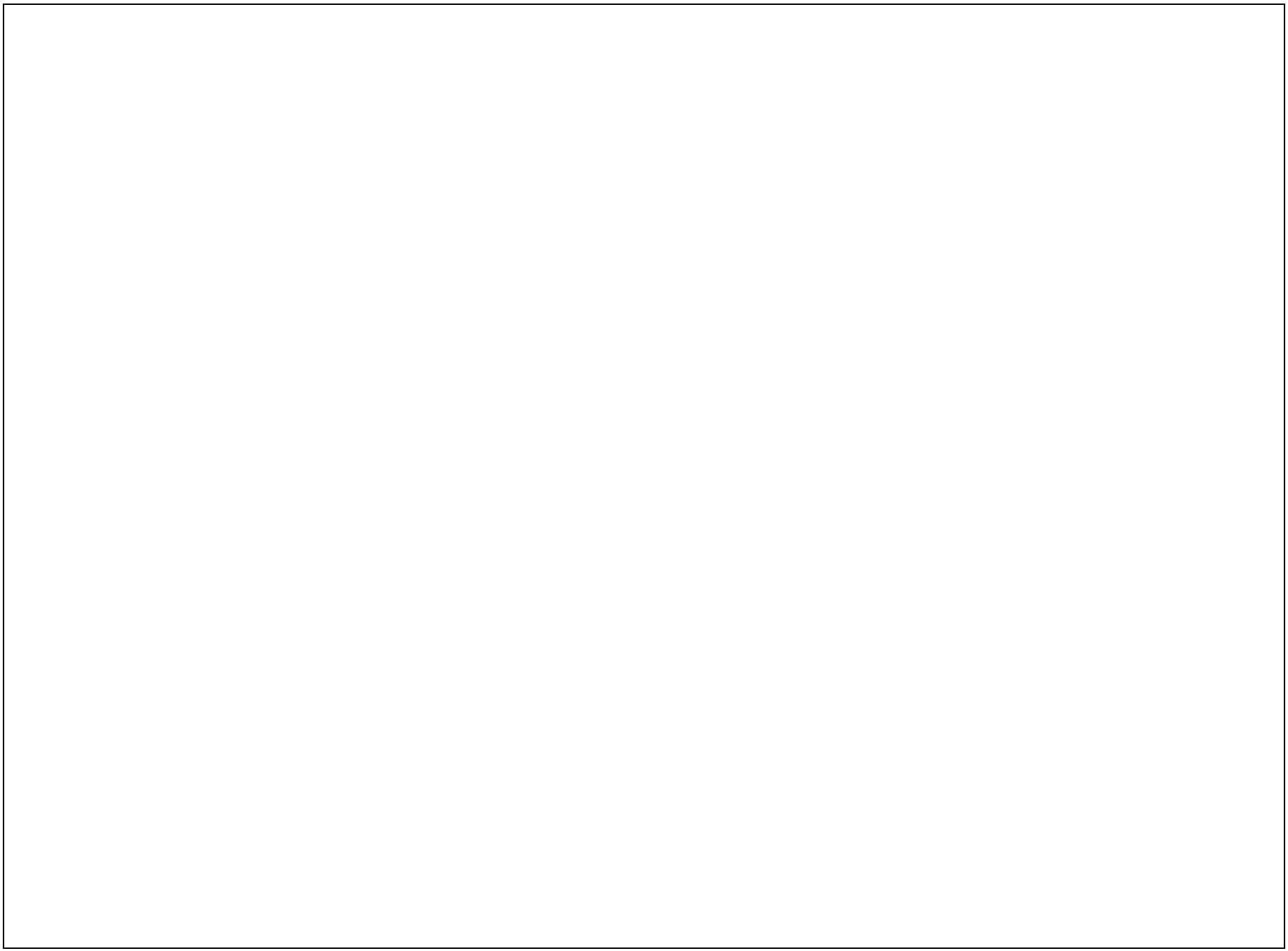
Typical Circuit

Figure 1. Typical Flyback Application

Output Power Table

Notes:

2. Typical continuous power in a non-ventilated enclosed adapter measured at 50°C ambient.
3. Maximum practical continuous power in an open-frame design at 50°C ambient.
4. 230VJQUBGHBÀÀqt6Ea%Ñ±Bn9d10UGHLX



Absolute Maximum Ratings

The “Absolute Maximum Ratings” are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. T_A = 25°C, unless otherwise specified.

Symbol	Parameter			Value	Unit
BV_{DSS}	Drain Source Breakdown Voltage			650	V
V_{str}	Max. Voltage at Vstart pin			650	V
I_{DM}	Drain Current Pulsed(5)	FSDM0465RE	T_C=25°C	9.6	A_{DC}
		FSDM0565RE	T_C=25°C	11	
		FSDM07652RE	T_C=25°C	15	
I_D	Continuous Drain Current	FSDM0465RE	T_C=25°C	2.2	A
			T_C=100°C	1.4	
		FSDM0565RE	T_C=25°C	2.8	
			T_C=100°C	1.7	
		FSDM07652RE	T_C=25°C	3.8	
			T_C=100°C	2.4	
E_{AS}	Single Pulsed Avalanche Energy(6)		FSDM0465RE		mJ
			FSDM0565RE	190	
			FSDM07652RE	370	
V_{CC}	Supply Voltage			20	V
V_{FB}	Input Voltage Range			-0.3 to V_{CC}	V
P_D(Watt H/S)	Total Power Dissipation (T_C=25°C)			45	W
T_J	Operating Junction Temperature			Internally limited	°C
T_A	Operating Ambient Temperature			-25 to +85	°C
T_{STG}	Storage Temperature			-55 to +150	°C
	ESD Capability, HBM Model (All pins except V_{str} and FB)			2.0 ($GND-V_{str}/V_{FB}$=1.5kV)	kV
	ESD Capability, Machine Model (All pins except V_{str} and FB)			300 ($GND-V_{str}/V_{FB}$=225V)	V

Notes:

5. Repetitive rating: Pulse width limited by maximum junction temperature.
6. L=14mH, starting T_J=25°C.

Thermal Impedance

T_A=25°C, unless otherwise specified.

Symbol	Parameter	Value	Unit
θ_{JA}(7)	Junction-to-Ambient Thermal Resistance	49.90	°C/W
θ_{JC}(8)	Junction-to-Case Thermal Resistance	2.78	°C/W

Notes:

7. Free-standing, with no heat-sink, under natural convection.
8. Infinite cooling condition - refer to the SEMI G30-88.

Electrical Characteristics

T_A = 25°C unless otherwise specified.

Symbol	Parameter		Condition	Min.	Typ.	Max.	Unit
SenseFET SECTION							
I_{DSS}	Zero Gate Voltage Drain Current	FSDM0465RE	V_{DS} = 650V, V_{GS} = 0V			250	μA
			V_{DS} = 520V, V_{GS} = 0V, T_C = 125°C			250	
		FSDM0565RE	V_{DS} = 650V, V_{GS} = 0V			500	
			V_{DS} = 520V, V_{GS} = 0V, T_C = 125°C			500	
		FSDM07652RE	V_{DS} = 650V, V_{GS} = 0V			500	
			V_{DS} = 520V, V_{GS} = 0V, T_C = 125°C			500	
$R_{DS(ON)}$	Static Drain Source on Resistance[9]	FSDM0465RE	V_{GS} = 10V, I_D = 2.5A		2.20	2.60	Ω
		FSDM0565RE			1.76	2.20	
		FSDM07652RE			1.40	1.60	
C_{OSS}	Output Capacitance	FSDM0465RE	V_{GS} = 0V, V_{DS} = 25V, f = 1MHz		60		pF
		FSDM0565RE			78		
		FSDM07652RE			100		
$t_{d(on)}$	Turn-On Delay Time	FSDM0465RE	V_{DD} = 325V, I_D = 5A		23		ns
		FSDM0565RE			22		
		FSDM07652RE			22		
t_r	Rise Time	FSDM0465RE	V_{DD} = 325V, I_D = 5A		20		ns
		FSDM0565RE			52		
		FSDM07652RE			60		
$t_{d(off)}$	Turn-Off Delay Time	FSDM0465RE	V_{DD} = 325V, I_D = 5A		65		ns
		FSDM0565RE			95		
		FSDM07652RE			115		
t_f	Fall Time	FSDM0465RE	V_{DD} = 325V, I_D = 5A		27		ns
		FSDM0565RE			50		
		FSDM07652RE			65		
CONTROL SECTION							
f_{OSC}	Switching Frequency		V_{FB} = 3V	60	66	72	kHz
Δf_{STABLE}	Switching Frequency Stability		13V ≤ V_{CC} ≤ 18V	0	1	3	%
Δf_{OSC}	Switching Frequency Variation[10]		-25°C ≤ T_A ≤ 85°C	0	±5	±10	%
I_{FB}	Feedback Source Current		V_{FB} = GND	0.7	0.9	1.1	mA
D_{MAX}	Maximum Duty Cycle	FSDM0465RE		77	82	87	%
		FSDM0565RE		77	82	87	%
		FSDM07652RE		75	80	85	%
D_{MIN}	Minimum Duty Cycle					0	%
V_{START}	UVLO Threshold Vo1(e)]TJ41.054 0 TdlLOV(g.0044 Tw 9 0 0 9 126.24 1610ta1 Tc°)-9.6(C)-8634(0)-229484 221.5201 Tn						

Electrical Characteristics (Continued)

T_A = 25°C unless otherwise specified.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
BURST MODE SECTION						
V_{BURH}						

Notes:

9. Pulse test: Pulse width ≤ 300μS, duty cycle ≤ 2%.
10. These parameters, although guaranteed at the design, are not tested in production.
11. These parameters indicate the inductor current.
12. This parameter is the current flowing into the control IC.

Comparison Between FS6M0765RTC and FSDM0x65RE

Function	FS6M0765RTC	FSDM0x65RE	FSDM0x65RE Advantages
Soft-Start			

Typical Performance Characteristics

These characteristic graphs are normalized at T_A= 25°C.

Figure 4. Operating Current vs. Temp.

Figure 5. Start Threshold Voltage vs. Temp.

Figure 6. Stop Threshold Voltage vs. Temp.

Figure 7. Operating Frequency vs. Temp.

Typical Performance Characteristics (Continued)

These characteristic graphs are normalized at T_A= 25°C.

Typical Performance Characteristics (Continued)

These characteristic graphs are normalized at T_A= 25°C.

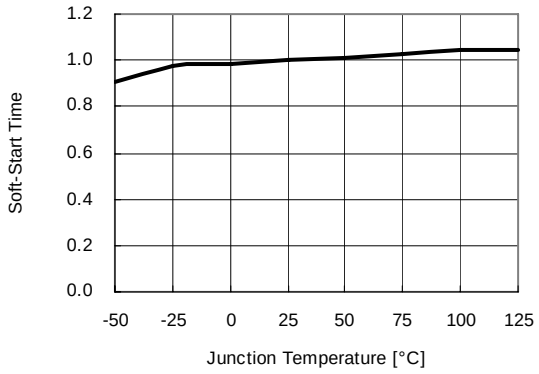


Figure 16. Soft-Start Time vs. Temp.

Functional Description

1. Start-up: In previous generations of Power Switches the V_{CC} pin had an external start-up resistor to the DC input voltage line. In this generation, the start-up resistor is replaced by an internal high-voltage current source. At start-up, the 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 FSDM0x65RE begins switching and the internal high-voltage current source is disabled. The FSDM0x65RE continues normal switching operation and the power is supplied from the auxiliary transformer winding unless V_{CC} goes below the stop voltage of 8V.

Figure 17. Internal Start-up Circuit

2. Feedback Control: FSDM0x65RE employs current-

Figure 19. Auto Restart Operation

3.1 Overload Protection (OLP): Overload is defined as the load current exceeding a pre-set level due to an unexpected event. In this situation, the protection circuit should be activated to protect the SMPS. Even when the SMPS is in normal operation, the overload protection circuit can be activated during the load transition. To avoid this undesired operation, the overload protection circuit is designed to be activated after a specified time to determine whether it is a transient situation or a true overload situation. Because of the pulse-by-pulse current limit capability, the maximum peak current through the SenseFET is limited, and therefore the maximum input power is restricted with a given input voltage. If the output consumes beyond this maximum power, the output voltage (V_O) decreases below the set voltage. This reduces the current through the opto-coupler LED, which also reduces the opto-coupler transistor current, thus increasing the feedback voltage (V_{FB}). If V_{FB} exceeds 2.5V, D1 is blocked and the 3.5μA current source starts to charge C_B slowly up to V_{CC}. In this condition, V_{FB} continues increasing until it reaches 6V, when the switching operation is terminated, as shown in Figure 20. The delay time for shutdown is the time required to charge C_B from 2.5V to 6.0V with 3.5μA. A 10 ~ 50ms delay time is typical for most applications.

Figure 20. Overload Protection

3.2 Over-Voltage Protection (OVP): If the secondary side feedback circuit were to malfunction or a solder defect caused an opening in the feedback path, the current through the opto-coupler transistor becomes almost zero. In this event, V_{FB} climbs in a similar manner to the overload situation, forcing the preset maximum current to be supplied to the SMPS until the overload protection is activated. Because more energy than required is provided to the output, the output voltage may exceed the rated voltage before the overload protection is activated, resulting in the breakdown of the devices in the secondary side. To prevent this situation, an over-8uat insvat7ovat7ovat7ov ins s>h i in8a (i)12.3amn.ov in5ovat7ovnotecnu

5. Burst Operat r dissipation in standby mode, t ers burst-mode operation. As the edback voltage decreases. As 1, the device automatically ent the feedback voltage drops b At this point, switching stops a tart to drop at a rate dependent o This causes the feedback voltage $_{BURH}$ (700mV), switching resume then falls and the process repe tion alternately enables and disa wer SenseFET, thereby reducing y mode.

Figure 21. Waveforms of Burst Operation

Application Information

Features

- High efficiency (>81% at $85V_{AC}$ input)
- Low zero load power consumption (<300mW at $240V_{AC}$ input)
- Low standby mode power consumption (<800mW at $240V_{AC}$ input and 0.3W load)
- Low component count
- Enhanced system reliability through various protection functions
- Internal soft-start (10ms)

Key Design Notes

- Resistors R102 and R105 are employed to prevent start-up at low input voltage. After start-up, there is no power loss in these resistors since the start-up pin is internally disconnected after start-up.
- The delay time for overload protection is designed to be about 50ms with C106 of 47nF. If a faster triggering of OLP is required, C106 can be reduced to 10nF.
- Zener diode ZD102 is used for a safety test, such as UL. When the drain pin and feedback pin are shorted, the zener diode fails and remains short, which causes the fuse (F1) to be blown and prevents explosion of the opto-coupler (IC301). This zener diode also increases the immunity against line surge.

1. Schematic

Figure 22. Demo Circuit

7. Layout

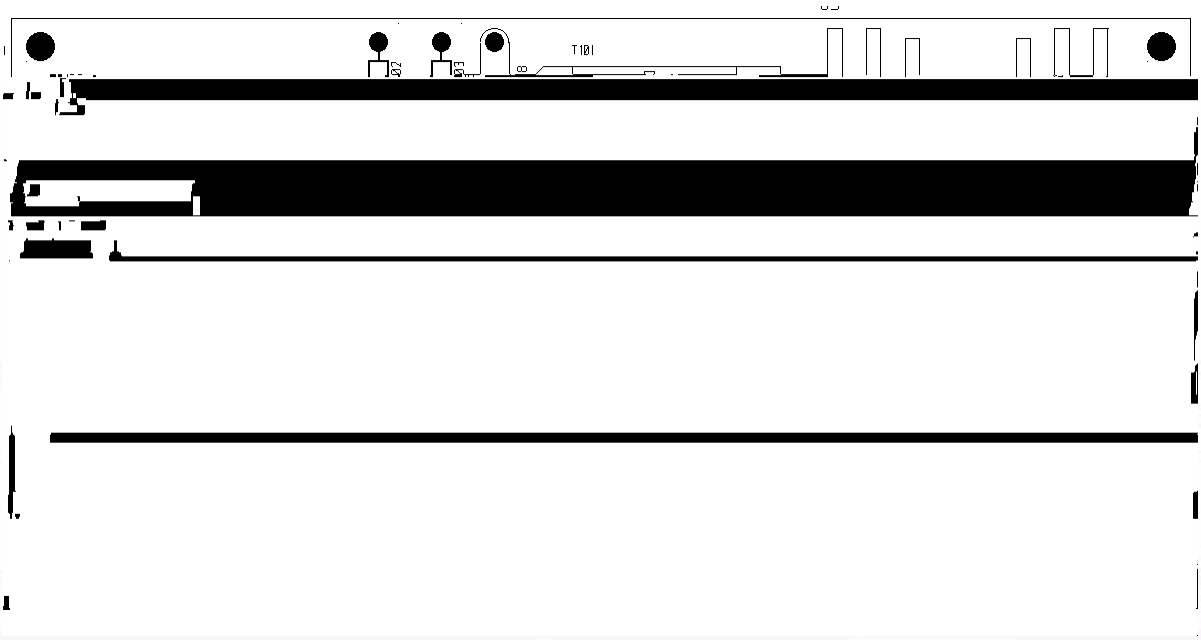


Figure 24. Layout Considerations for FSDM0565RE (Top View)

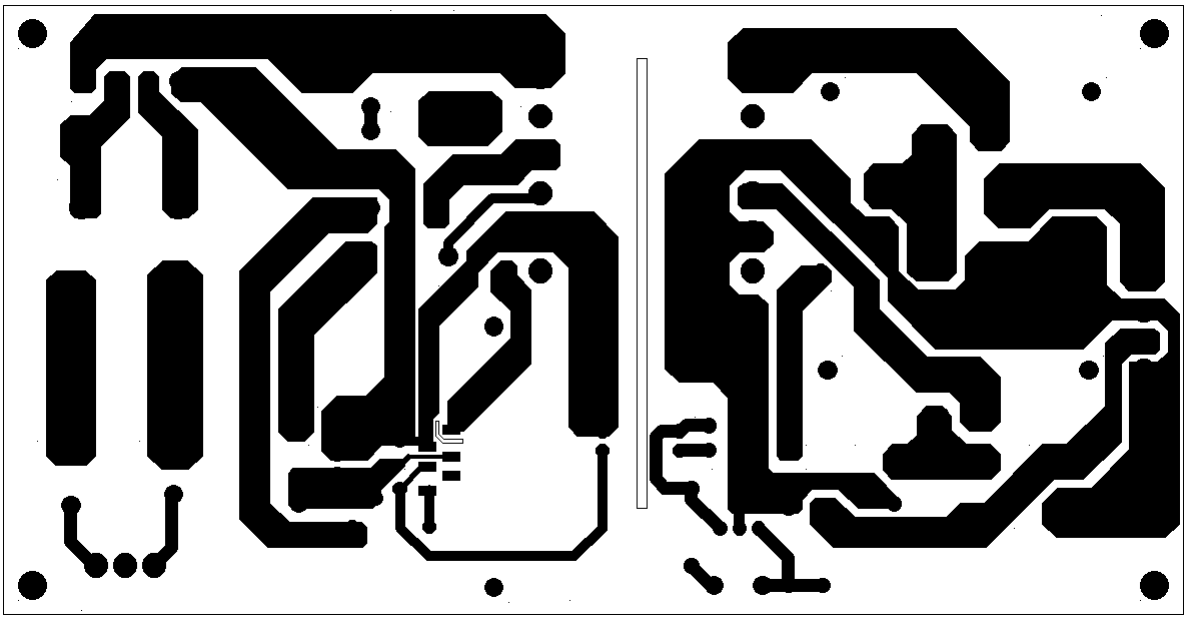


Figure 25. Layout Considerations for FSDM0565RE (Bottom View)