SGM2525
Programmable Current Limit Switch
with Output Voltage Clamping

GENERAL DESCRIPTION

The SGM2525 is a compact electronic fuse (eFuse) with a complete set of protection functions. The wide operating voltage range is specifically designed for many popular DC buses. Extremely low $R_{DS(ON)}$ of the integrated protection N-channel MOSFET helps to reduce power loss during the normal operation. The programmable soft-start time controls the slew rate of the output voltage during the power-up procedure. Independent enable control allows complex system sequencing control. Internal over-temperature protection turns off the MOSFET when T_J is more than +150℃. The SGM2525 latches off the internal FET. During the thermal shutdown, the fault pin is pulled low to signal a fault condition.

The SGM2525 is available in a Green TDFN-3×3-10L package and operates over a temperature range of -40℃ to +85℃.

FEATURES

- **Wide Input Voltage Range from 4.5V to 18V with Surge up to 30V**
- **Extremely Low $R_{DS(ON)}$ for the Integrated Protection Switch: 23mΩ**
- **Programmable Soft-Start Time**
- **Programmable Current Limit up to 5A**
- **Thermal Shutdown Protection & Latch-Off**
- **Selectable Input Range and Output Clamp Voltage Threshold**
- **Enable Interface Pin**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in a Green TDFN-3×3-10L Package**

APPLICATIONS

Notebook PC
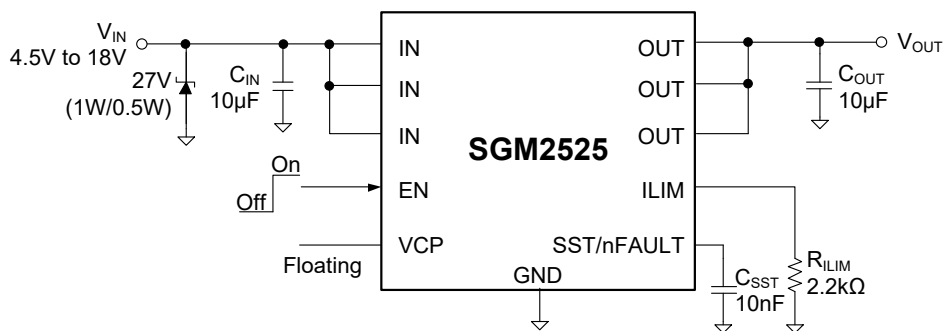iPad mini
Server
Service PC

## TYPICAL APPLICATION

Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2525	TDFN-3×3-10L	-40℃ to +85℃	SGM2525YTD10G/TR	SGM 2525D XXXXX	Tape and Reel, 4000

MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

X X X X X
— Vendor Code
— Date Code - Week
— Date Code - Year
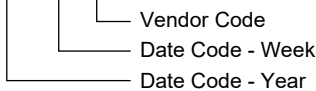
Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

IN, OUT, EN, VCP to GND .... -0.3V to 20V
ILIM, SST/nFAULT to GND.................................. -0.3V to 6V
Package Thermal Resistance
TDFN-3×3-10L, θ_{JA} .... 62℃/W
Junction Temperature ....+150℃
Storage Temperature Range.........................-65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃
ESD Susceptibility
HBM.. 4000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Supply Input Voltage...4.5V to 18V
Operating Ambient Temperature Range........-40℃ to +85℃
Operating Junction Temperature Range......-40℃ to +125℃

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.
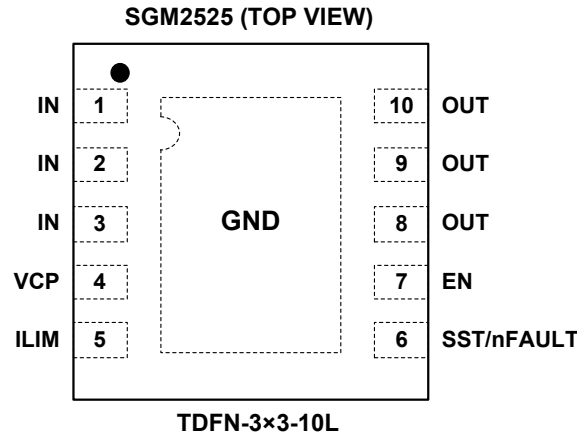
DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION

SGM2525 (TOP VIEW)

IN	1		10	OUT
IN	2		9	OUT
IN	3	GND	8	OUT
VCP	4		7	EN
ILIM	5		6	SST/nFAULT

TDFN-3×3-10L

PIN DESCRIPTION

PIN	NAME	FUNCTION
1, 2, 3	IN	Power Input Pin. Power input and supply voltage of the device. Decouple high frequency noise by connecting at least a 0.1µF ceramic capacitor to ground.
4	VCP	Output Clamp Voltage Selection Based on the Input Voltage. Pull VCP pin high by connecting a resistor to IN pin, or float VCP pin to select different output clamp voltage thresholds, as shown in Table 1. Recommend to place a 0.1µF decoupling capacitor as close as this pin.
5	ILIM	Current Limit Program Pin. Program the current limit by connecting a resistor to ground.
6	SST/nFAULT	Soft-Start Time Program or Fault Event Indicator Pin. Connect a capacitor to ground to program the soft-start time. nFAULT event indicator, goes low to indicate fault condition due to under-voltage or thermal shutdown event.
7	EN	Enable Interface Pin. Pull it high to enable the IC.
8, 9, 10	OUT	Power Output Pin.
Exposed Pad	GND	Ground Pin.

Table 1. Output Clamp Voltage Selection

VCP Pin	V_{IN} (V)		Output Clamp Voltage Threshold (V)		
			MIN	TYP	MAX
High	5	Over 6	5.5	5.7	5.9
Floating	12	Over 14	12.8	13.3	13.6

ELECTRICAL CHARACTERISTICS

(T_J = +25℃, V_{IN} = 5V, R_{ILIM} = 10kΩ, C_{SST} = 10nF, C_{IN} = 10µF and C_{OUT} = 10µF, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}		4.5		18	V
Input UVLO Threshold Voltage	V_{UVLO}	VCP = High	3.4	3.6	3.8	V
		VCP = Floating	8.2	8.6	9.0	V
UVLO Hysteresis	V_{UVHYS}	VCP = High		0.1		V
		VCP = Floating		0.2		
Bias Current	I_{BIAS}			170	200	µA
Shutdown Current	I_{SHDN}	EN = 0V		0.7	1.2	µA
FET On-Resistance	$R_{DS(ON)}$			23	29	mΩ
Output Clamp Voltage	V_{CLP}	VCP = High	5.5	5.7	5.9	V
		VCP = Floating	12.8	13.2	13.6	V
Soft-Start Time [1]	t_{SST}	C_{SST} = 0F		1.4		ms
		C_{SST} = 10nF		2.6		ms
Soft-Start Time Accuracy [1]		C_{SST} = 10nF		±30% t_{SST}		
Current Limit		R_{ILIM} = 11kΩ	0.92	1.0	1.09	A
Current Limit Program Range [2]	I_{LIM}		1		5	A
EN Turn-On Threshold Voltage	V_{EN_ON}	T_J = -40℃ to +85℃	1.2			V
EN Turn-Off Threshold Voltage	V_{EN_OFF}	T_J = -40℃ to +85℃			0.4	V
Thermal Shutdown Temperature	T_{SD}			150		℃
Thermal Shutdown Hysteresis	T_{HYS}			20		℃

NOTES:

1. Refers to the Equations:

$$t_{SST} = t_{SST\_DLT} \text{ (No External } C_{SST})$$
(1)

$$t_{SST} = \frac{C_{SST}}{I_{INT}} \times 1.2 \ (t_{SST} > t_{SST\_DLY})$$
(2)

where t_{SST_DLT} is the internally fixed default soft-start time, about 1.4ms, which means there's no any external C_{SST}; I_{INT} is the internal current source, about 4.6µA. A capacitor (C_{SST}) of less than 10nF is recommended.
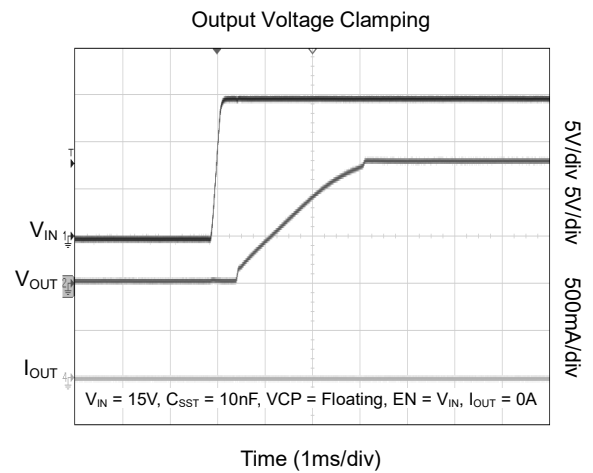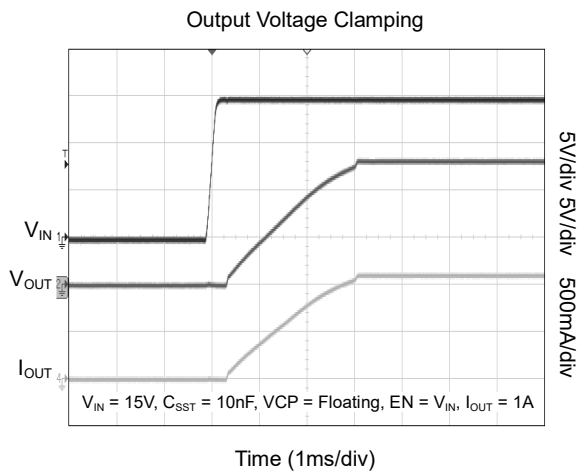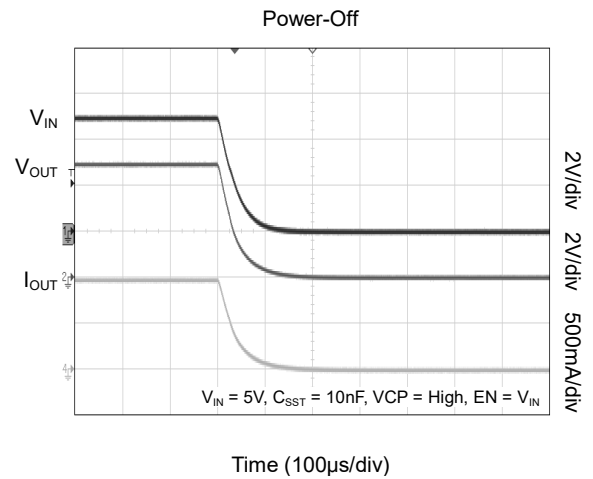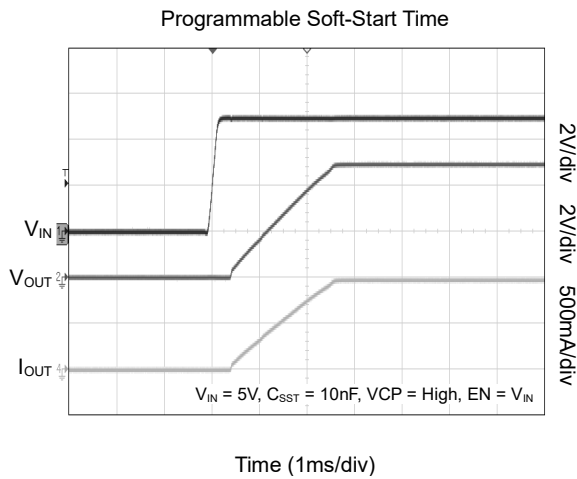
2. Recommended current limit program table.

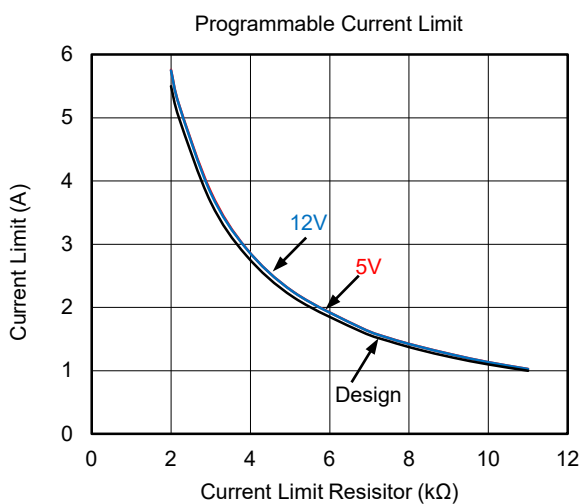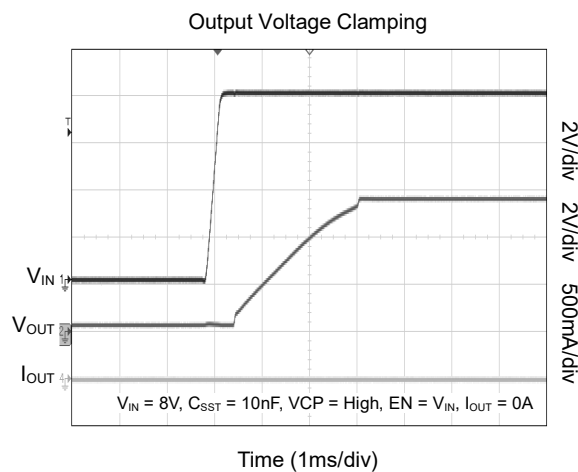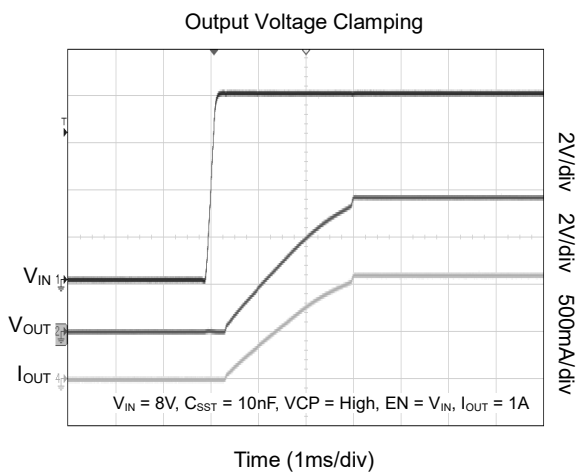| R_{ILIM} (kΩ)	11	5.5	4.4	3.7	3.1	2.8	2.4	2.2
Current Limit (A)	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0

Calculate the R_{ILIM} and current limit as in Equation 3.

$$R_{ILIM} = \frac{11}{I_{LIM}} (k\Omega)$$
(3)

TYPICAL PERFORMANCE CHARACTERISTICS

Programmable Soft-Start Time

V_{IN} = 12V, C_{SST} = 10nF, VCP = Floating, EN = V_{IN}

Time (1ms/div)

Power-Off

V_{IN} = 12V, C_{SST} = 10nF, VCP = Floating, EN = V_{IN}

Time (50μs/div)

Programmable Soft-Start Time

V_{IN} = 5V, C_{SST} = 10nF, VCP = High, EN = V_{IN}

Time (1ms/div)

Power-Off

V_{IN} = 5V, C_{SST} = 10nF, VCP = High, EN = V_{IN}

Time (100μs/div)

Output Voltage Clamping

V_{IN} = 15V, C_{SST} = 10nF, VCP = Floating, EN = V_{IN}, I_{OUT} = 1A

Time (1ms/div)

Output Voltage Clamping

V_{IN} = 15V, C_{SST} = 10nF, VCP = Floating, EN = V_{IN}, I_{OUT} = 0A

Time (1ms/div)

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Output Voltage Clamping

V_{IN} = 8V, C_{SST} = 10nF, VCP = High, EN = V_{IN}, I_{OUT} = 1A

Time (1ms/div)

Output Voltage Clamping

V_{IN} = 8V, C_{SST} = 10nF, VCP = High, EN = V_{IN}, I_{OUT} = 0A

Time (1ms/div)

Programmable Current Limit

FUNCTIONAL BLOCK DIAGRAM
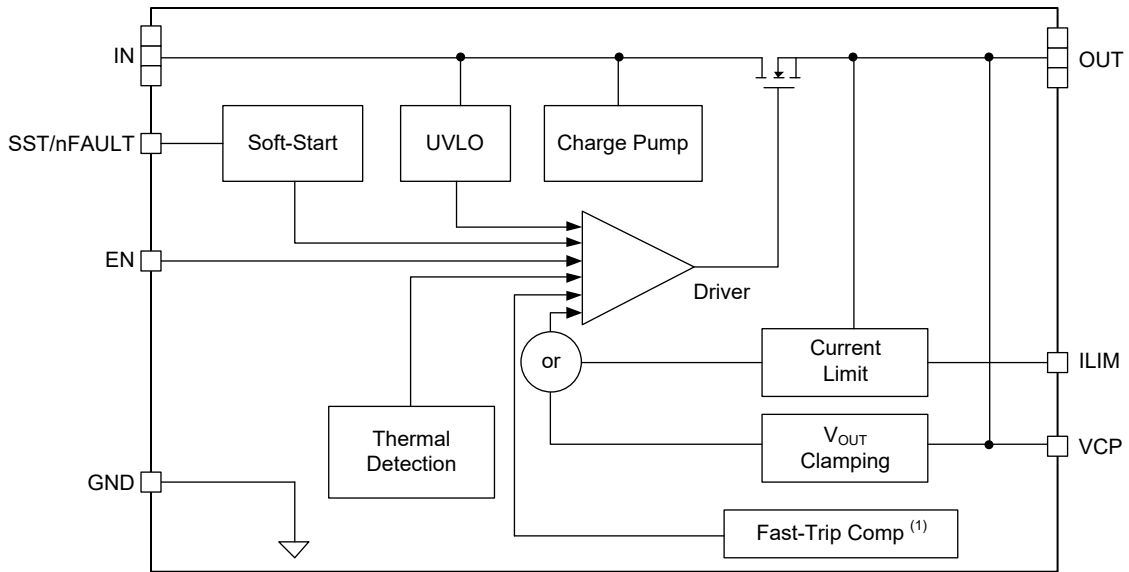
Figure 2. SGM2525 Block Diagram

NOTE:

1. During the operating of SGM2525, its output may short to ground in some abnormal conditions. As a result, the current through the device increases very rapidly. The internal current limit amplifier provides the accurate current limit control while its bandwidth is limited. So it cannot respond quickly enough to this event. Therefore, the SGM2525 offers a dedicate fast-trip comparator, which shuts down the pass device very quickly when $I_{OUT} > I_{FAST-TRIP}$ ($I_{FAST-TRIP} = 1.8 \times I_{LIM}$), and terminates the rapid short-circuit peak current. After the output short peak current has been terminated by the fast-trip comparator, the current limit amplifier smoothly regulates the output current to I_{LIM}.
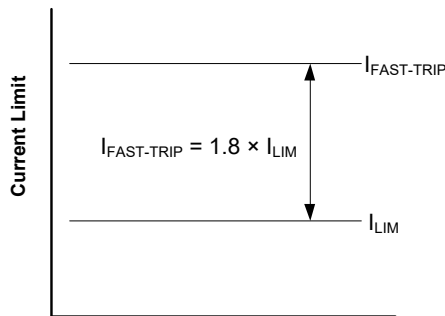

Figure 3. Over-Current Protection Levels

APPLICATION EXAMPLES

The SGM2525 provides simple solutions for current limit, in-rush current control and supervision of power rails for wide range of applications operating at 4.5V to 18V and delivering up to 5A.

Protection and Current Limit for Primary-Side Regulated Power Supplies

Primary-side regulated power supplies and adapters are dominant today in many of the applications such as LCD-TV, fast charger, set-top boxes and gaming consoles.

• No secondary-side protection for immediate termination of critical faults such as short-circuit and over-voltage.
• Do not provide precision current limit for overload transients.
• Have poor output voltage regulation for sudden change in AC input voltages, triggering output over-voltage condition.

Many of the above applications require precision output current limit and secondary-side protection, driving the demand for secondary-side current detection. This requires other circuits using precision operational amplifiers. This increases the complexity of the solution and also results in sensing losses. The SGM2525 with its integrated low-ohmic N-channel MOSFET provides a simple and efficient solution.
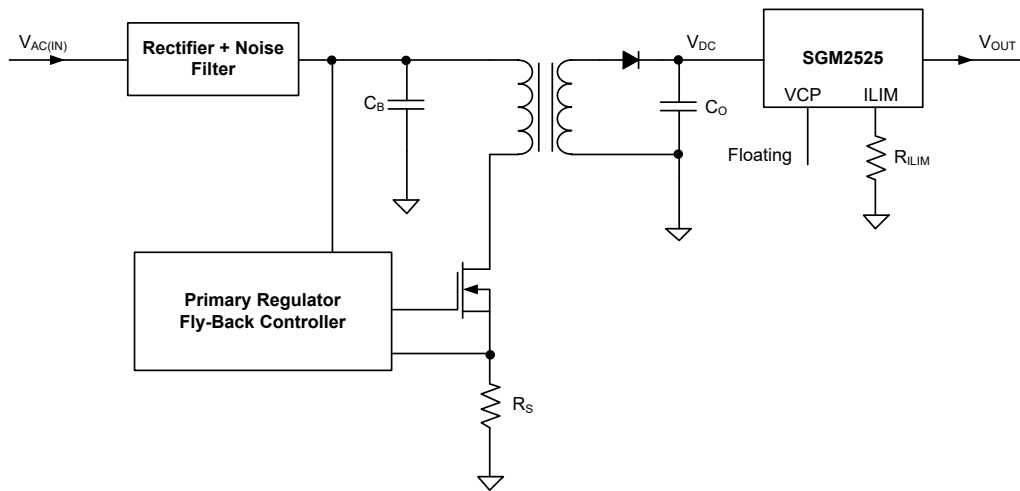

Figure 4. Current Limit and Protection for AC-DC Power Supplies

APPLICATION EXAMPLES (continued)

Precision Current Limit in Intrinsic Safety Applications

Intrinsic Safety (IS) is becoming prominent requirement for safe operation of electrical and electronic equipment in hazardous areas. IS requires that equipment is designed such that the total amount of energy available in the apparatus is simply not enough to ignite an explosive atmosphere. The energy can be electrical, in the form of a spark, or heat in the form of a hot surface.

This requires precision current limit and precision shutdown of the circuit for over-voltage conditions ensuring that set voltage and current limits are not exceeded for wide operating temperature range and variable environmental conditions. Applications such as gas analyzers, medical equipment (such as electrocardiographs), portal industrial equipment, cabled power distribution systems and hand-held motor-operated tools need to meet these critical safety standards.
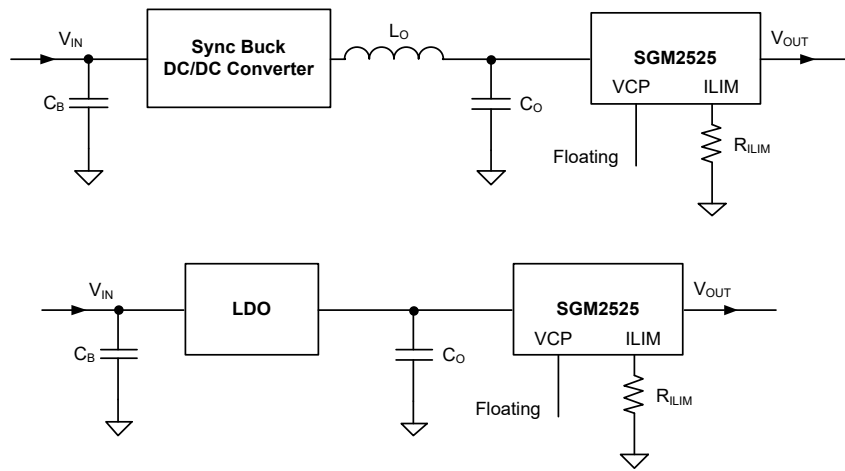

Figure 5. Precision Current Limit and Protection of Internal Rails

APPLICATION EXAMPLES (continued)

Smart Load Switch

A smart load switch is a series of MOSFETs used for switching of the load (resistive or inductive). It also provides protection during fault conditions. Typical discrete implementation is shown in Figure 6. Discrete solutions have higher component count and require complex circuitry to implement each of the protection fault needs.

SGM2525 can be used as a smart power switch for applications operating range from 4.5V to 18V. SGM2525 provides programmable soft-start, programmable current limits, over-temperature protection, a fault flag and under-voltage lockout.
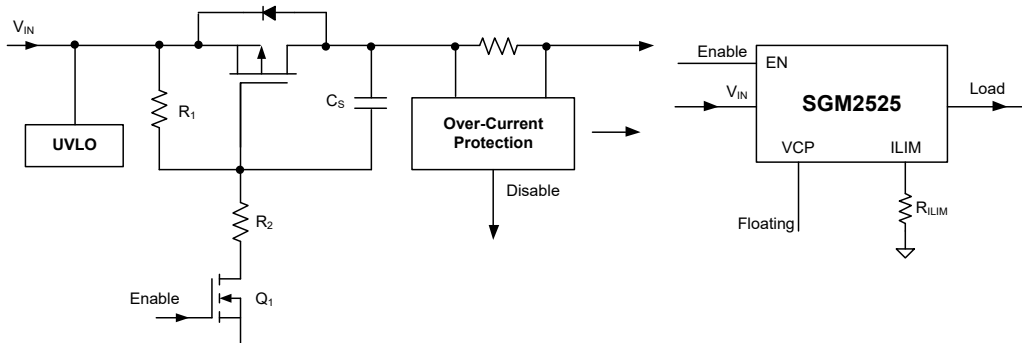

Figure 6. Smart Load Switch Implementation

Figure 6 shows typical implementation and usage of the SGM2525 as a load switch. This configuration can be used for driving a solenoid and fan control. It is recommended to use a freewheeling diode across the load when load is highly inductive.
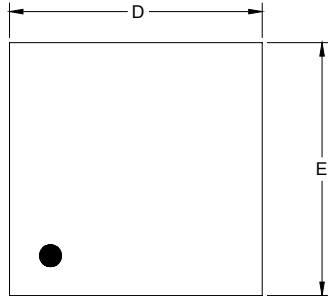
REVISION HISTORY

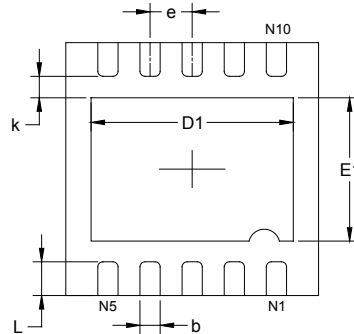NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (NOVEMBE 2020) to REV.A   **Page**
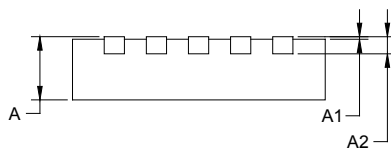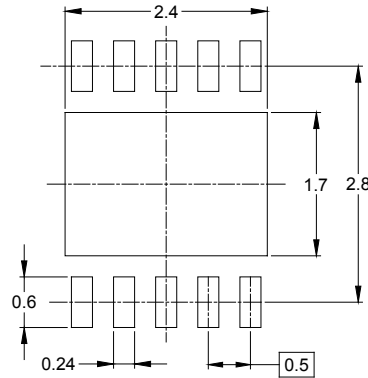
Changed from product preview to production data...All

PACKAGE OUTLINE DIMENSIONS

TDFN-3×3-10L

TOP VIEW

BOTTOM VIEW

SIDE VIEW

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	2.900	3.100	0.114	0.122
D1	2.300	2.600	0.091	0.103
E	2.900	3.100	0.114	0.122
E1	1.500	1.800	0.059	0.071
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.300	0.500	0.012	0.020

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS

DIRECTION OF FEED

NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
TDFN-3×3-10L	13″	12.4	3.35	3.35	1.13	4.0	8.0	2.0	12.0	Q1
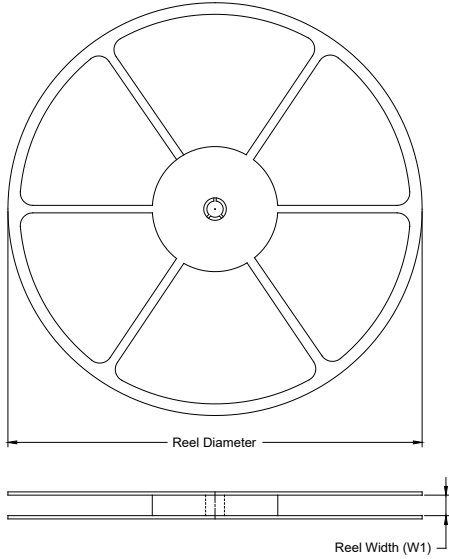
CARTON BOX DIMENSIONS

NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton	
13″	386	280	370	5	DD0002