SGM2521/SGM2521A SGM2522/SGM2522A Programmable Current Limit Switches

GENERAL DESCRIPTION

The SGM2521/SGM2521A/SGM2522/SGM2522A are compact, feature rich eFuse with a full suite of protection functions. The wide operating voltage allows control of many popular DC buses. The precision ±10% current limit, at room temperature, provides excellent accuracy making the SGM2521/1A/2/2A well suited for many system protection applications.

Load, source and device protection are provided with multiple programmable features including over-current (OC), over-voltage (OV) and under-voltage (UV). 3% threshold accuracy for UV and OV, ensures tight supervision of bus voltages, eliminating the need for supervisor circuitry. Fault flag output (nFLT) is provided for system status monitoring and downstream load control.

The SGM2521/1A/2/2A are available in Green SOIC-8 and TDFN-2×3-8BL packages and operate over a temperature range of -40℃ to +85℃.

TYPICAL APPLICATION

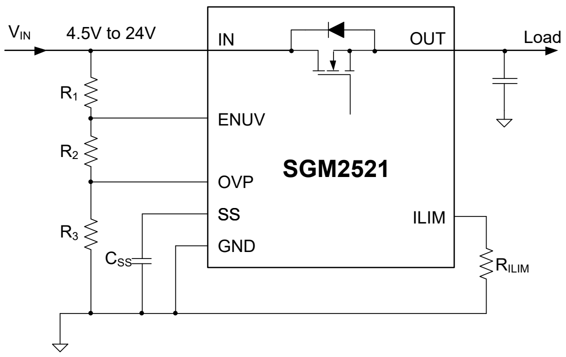


Figure 1. Typical Application Circuit

FEATURES

- **Wide Input Voltage Range from 4.5V to 24V with Surge up to 30V**
- **Extremely Low $R_{DS(ON)}$ for the Integrated Protection Switch:**
  55mΩ (SOIC-8 Package)
  61mΩ (TDFN-2×3-8BL Package)
- **Programmable Soft-Start Time**
- **Programmable Current Limit from 260mA to 2A**
- **±7% I_{LIMIT} Accuracy at 280mA (SGM2521A/SGM2522A)**
- **±8% I_{LIMIT} Accuracy at 1A (SGM2521/SGM2522)**
- **Enable Interface Pin**
- **Short-Circuit Protection**
- **Over-Voltage Protection**
- **Fault Output for Thermal Shutdown, Short-Circuit, UVLO and OVP**
- **Thermal Shutdown Protection**
  SGM2521/SGM2521A: Auto-Recovery
  SGM2522/SGM2522A: Latched-Off
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in Green SOIC-8 and TDFN-2×3-8BL Packages**

APPLICATIONS

White Goods, Appliances
Set-Top Boxes, DVD and Gaming Consoles
HDD and SSD Drives
Smart Meters, Gas Analyzers
Smart Load Switches/USB Switches
Adapter Power Devices

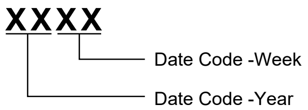
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2521	TDFN-2×3-8BL	-40℃ to +85℃	SGM2521YTDC8G/TR	2521 XXXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +85℃	SGM2521YS8G/TR	SGM 2521YS8 XXXXX	Tape and Reel, 4000
SGM2521A	TDFN-2×3-8BL	-40℃ to +85℃	SGM2521AYTDC8G/TR	ML6 XXXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +85℃	SGM2521AYS8G/TR	SGM 2521AYS8 XXXXX	Tape and Reel, 4000
SGM2522	TDFN-2×3-8BL	-40℃ to +85℃	SGM2522YTDC8G/TR	2522 XXXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +85℃	SGM2522YS8G/TR	SGM 2522YS8 XXXXX	Tape and Reel, 4000
SGM2522A	TDFN-2×3-8BL	-40℃ to +85℃	SGM2522AYTDC8G/TR	ML7 XXXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +85℃	SGM2522AYS8G/TR	SGM 2522AYS8 XXXXX	Tape and Reel, 4000

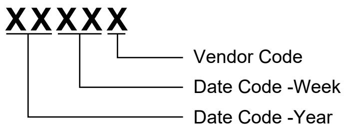
MARKING INFORMATION

NOTE: XXXX = Date Code. XXXXX = Date Code and Vendor Code.

TDFN-2×3-8BL



SOIC-8



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, ENUV, nFLT, OVP to GND................. -0.3V to 30V
SS, ILIM to GND .... -0.3V to 6V
Package Thermal Resistance
SOIC-8, θ_{JA}... 107.8℃/W
TDFN-2×3-8BL, θ_{JA}... 87.4℃/W
Junction Temperature ....+150℃
Storage Temperature Range........................-65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃
ESD Susceptibility
HBM...4000V

RECOMMENDED OPERATING CONDITIONS

Supply Input Voltage...4.5V to 24V
Operating Ambient Temperature Range........-40℃ to +85℃
Operating Junction Temperature Range......-40℃ to +125℃

OVERSTRESS CAUTION

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

ESD SENSITIVITY CAUTION

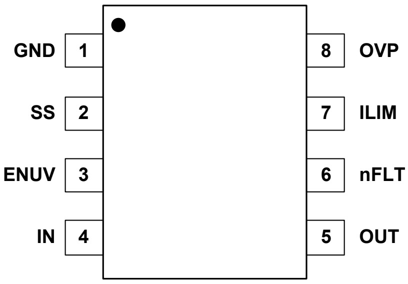
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time.

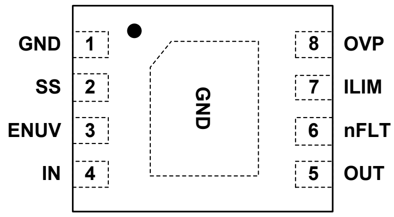
PIN CONFIGURATIONS

SGM2521/1A/2/2A (TOP VIEW)



SOIC-8

SGM2521/1A/2/2A (TOP VIEW)



TDFN-2×3-8BL

PIN	NAME	DESCRIPTION
1	GND	Ground.
2	SS	Soft-Start Pin. A capacitor from this pin to GND sets the ramp rate of output voltage at device turn-on.
3	ENUV	Enable and Under-Voltage Lockout Input. Input for setting programmable under-voltage lockout threshold. An under-voltage event will open internal FET and assert nFLT to indicate power-failure. When pulled to GND, resets the thermal fault latch in SGM2522/SGM2522A.
4	IN	Power Input Pin. Power input and supply voltage of the device.
5	OUT	Power Output Pin.
6	nFLT	Fault Event Indicator Pin. Fault event indicator, goes low to indicate fault condition due to under-voltage, over-voltage, short-circuit and thermal shutdown event. A nuisance fast trip does not trigger fault. It is an open drain output.
7	ILIM	Current Limit Program Pin. A resistor from this pin to GND will set the over-load and short-circuit limit.
8	OVP	Over-Voltage Protection Pin. Input for setting programmable over-voltage protection threshold. An over-voltage event will open the internal FET and assert nFLT to indicate over-voltage.

FUNCTIONAL BLOCK DIAGRAM

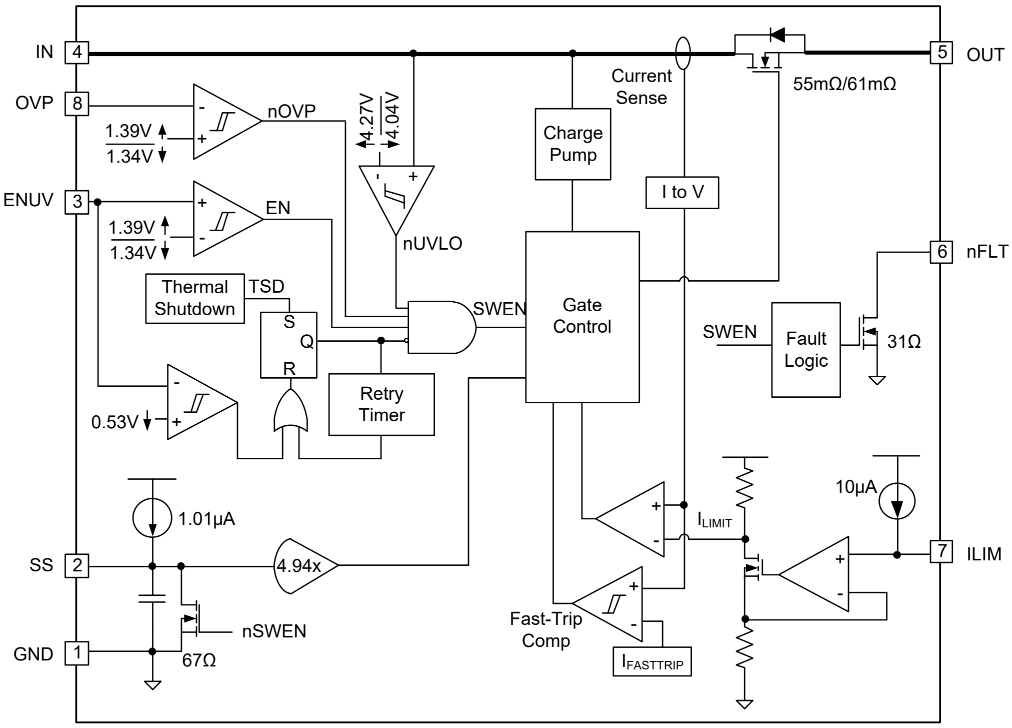


Figure 2. Functional Block Diagram

ELECTRICAL CHARACTERISTICS

(T_A = +25℃, 4.5V ≤ V_{IN} ≤ 24V, V_{ENUV} = 2V, V_{OVP} = 0V, R_{ILIM} = 95.3kΩ, C_{SS} = OPEN, nFLT = OPEN, unless otherwise noted.)

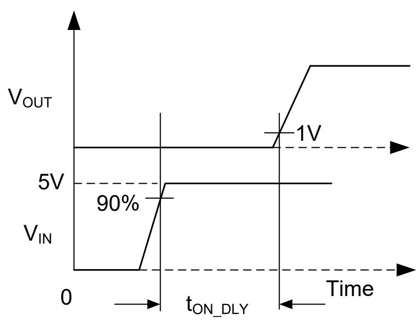
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY VOLTAGE AND INTERNAL UNDER-VOLTAGE LOCKOUT						
Operating Input Voltage	V_{IN}		4.5		24	V
UVLO Threshold Voltage, Rising	V_{UVR}			4.27		V
UVLO Hysteresis	V_{UVHYS}			230		mV
Supply Current, Enabled	I_{Q_ON}	V_{ENUV} = 2V, V_{IN} = 12V		0.17		mA
Supply Current, Disabled	I_{Q_OFF}	V_{ENUV} = 0V, V_{IN} = 12V		0.75		μA
OVER-VOLTAGE PROTECTION (OVP) INPUT						
Over-Voltage Threshold Voltage, Rising	V_{OVPR}			1.39		V
Over-Voltage Threshold Voltage, Falling	V_{OVPF}			1.34		V
OVP Input Leakage Current	I_{OVP}	0V ≤ V_{OVP} ≤ 18V		±100		nA
ENABLE AND UNDER-VOLTAGE LOCKOUT (ENUV) INPUT						
ENUV Threshold Voltage, Rising	V_{ENR}			1.39		V
ENUV Threshold Voltage, Falling	V_{ENF}			1.34		V
ENUV Threshold Voltage to Reset Thermal Fault, Falling	V_{ENF_RST}		0.53	0.73		V
EN Input Leakage Current	I_{EN}	0 ≤ V_{ENUV} ≤ 18V		±100		nA
SOFT-START: OUTPUT RAMP CONTROL (SS)						
SS Charging Current	I_{SS}	V_{SS} = 0V		1.01		μA
SS Discharging Resistance	R_{SS}	V_{ENUV} = 0V, I_{SS} = 10mA sinking		67		Ω
SS Maximum Capacitor Voltage	V_{SSMAX}			5.3		V
SS to OUT Gain	$GAIN_{SS}$	$\Delta V_{OUT}/\Delta V_{SS}$		4.94		V/V
CURRENT LIMIT PROGRAMMING (I_{LIM})						
ILIM Pin Bias Current	I_{ILIM}			10		μA
Current Limit	I_{LIMIT}	R_{ILIM} = 95.3kΩ, V_{IN} - V_{OUT} = 1V, SGM2521/2 Only		1		A
		R_{ILIM} = 27kΩ, V_{IN} - V_{OUT} = 1V, SGM2521A/2A Only		0.28		
		R_{ILIM} = Short, shorted resistor current limit, R_{ILIM} = Open, open resistor current limit		0.216		
Fast-Trip Comparator Threshold	$I_{FASTTRIP}$	R_{ILIM} in kΩ		1.8 × I_{LIMIT}		A
ILIM Open Resistor Detect Threshold	V_{ILIM_OPEN}	V_{ILIM} rising, R_{ILIM} = Open		3.0		V
MOSFET-POWER SWITCH						
FET On-Resistance (2)	$R_{DS(ON)}$	SOIC-8		55		mΩ
		TDFN-2×3-8BL		61		
PASS FET OUTPUT (OUT)						
OUT Bias Current in Off State	I_{LKG_OUT}	V_{ENUV} = 0V, V_{OUT} = 0V (Sourcing)		0.1		μA
	I_{SINK_OUT}	V_{ENUV} = 0V, V_{OUT} = 300mV (Sinking)		0.24		
FAULT FLAG (nFLT): ACTIVE LOW						
nFLT Pull-Down Resistance	R_{nFLT}	Device in fault condition, V_{ENUV} = 0V, I_{nFLT} = 100mA		31		Ω
nFLT Input Leakage Current	I_{nFLT}	Device not in fault condition, V_{nFLT} = 0V, 18V		±0.5		μA
THERMAL SHUTDOWN (TSD)						
Thermal Shutdown Threshold, Rising	T_{TSD}			150		℃
Thermal Shutdown Hysteresis	T_{TSDHYS}			20		℃

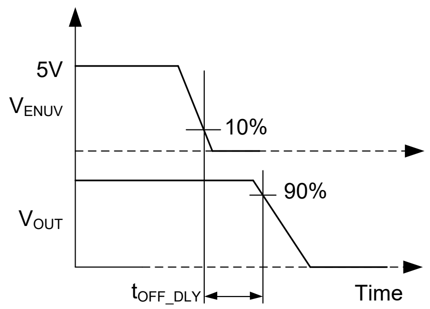
TIMING REQUIREMENTS

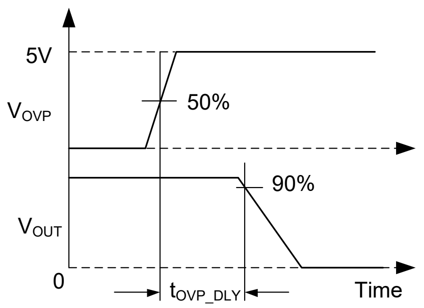
(T_A = +25℃, V_{IN} = 12V, V_{ENUV} = 2V, V_{OVP} = 0V, R_{ILIM} = 95.3kΩ, C_{SS} = OPEN, nFLT = OPEN, unless otherwise noted.)

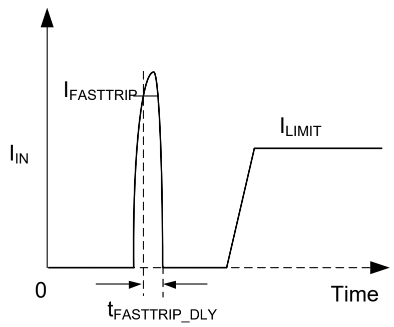
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
ENABLE AND UNDER-VOLTAGE LOCKOUT (ENUV) INPUT						
Turn-Off Delay	t_{OFF_DLY}	ENUV↓ to V_{OUT} = 10.8V, C_{OUT} = 2.2μF		8		μs
Turn-On Delay	t_{ON_DLY}	ENUV↑ to V_{OUT} = 1V, C_{SS} = OPEN, C_{OUT} = 2.2μF		92		μs
OVER-VOLTAGE PROTECTION (OVP) INPUT						
OVP Disable Delay	t_{OVP_DLY}	OVP↑ to V_{OUT} = 10.8V, C_{OUT} = 2.2μF		25		μs
SOFT-START: OUTPUT RAMP CONTROL (SS)						
Output Ramp Time	t_{SS}	ENUV↑ to V_{OUT} = 11V, with C_{SS} = open, C_{OUT} = 2.2μF		0.26		ms
		ENUV↑ to V_{OUT} = 11V, with C_{SS} = 1.2nF, C_{OUT} = 2.2μF		2.78		
CURRENT LIMIT PROGRAMMING (I_{LIM})						
Fast-Trip Comparator Delay	$t_{FASTTRIP\_DLY}$	I_{OUT} > $I_{FASTTRIP}$		3		μs
THERMAL SHUTDOWN (TSD)						
Retry Delay after Thermal Shutdown Recovery, T_J < [T_{TSD} - 20℃]	t_{TSD_DLY}	SGM2521/SGM2521A only, V_{IN} = 12V		120		ms
		SGM2521/SGM2521A only, V_{IN} = 4.5V		100		ms

PARAMETRIC MEASUREMENT INFORMATION





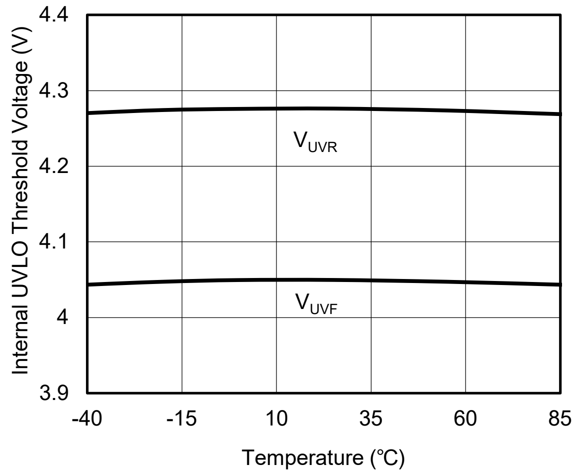




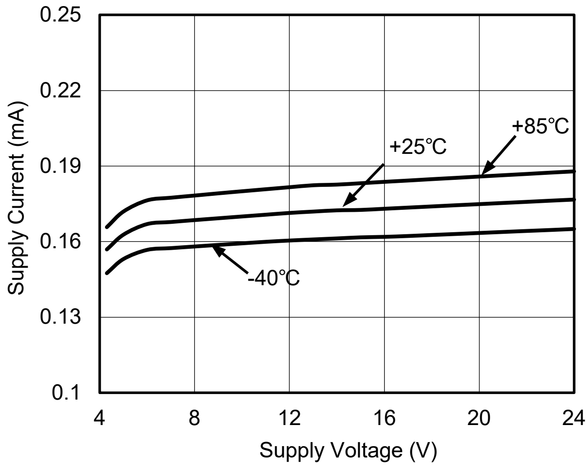
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, 4.5V ≤ V_{IN} ≤ 24V, V_{ENUV} = 2V, V_{OVP} = 0V, R_{ILIM} = 95.3kΩ, C_{SS} = OPEN, nFLT = OPEN, unless otherwise noted.

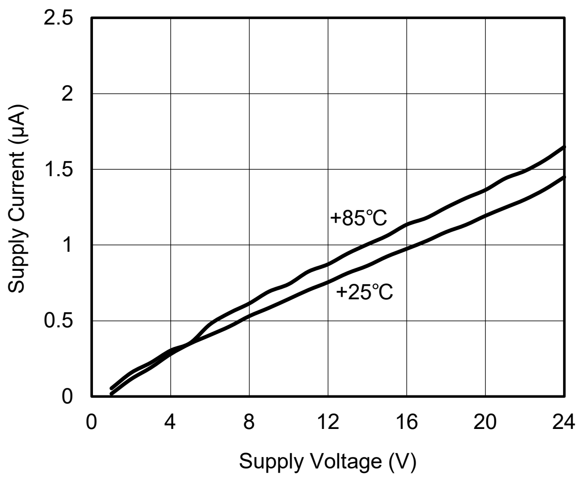
UVLO Threshold Voltage vs. Temperature



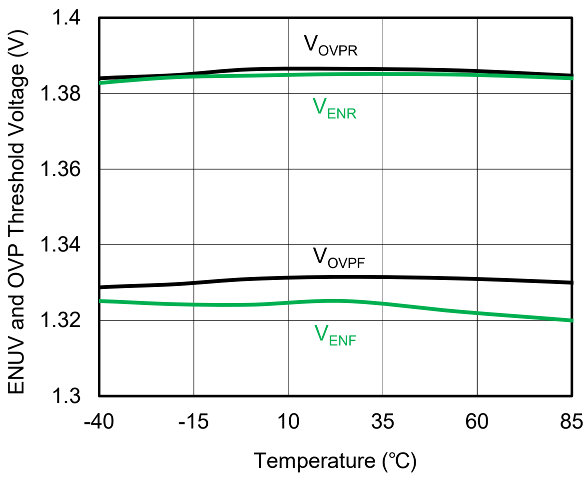
Input Supply Current vs. Supply Voltage during Normal Operation



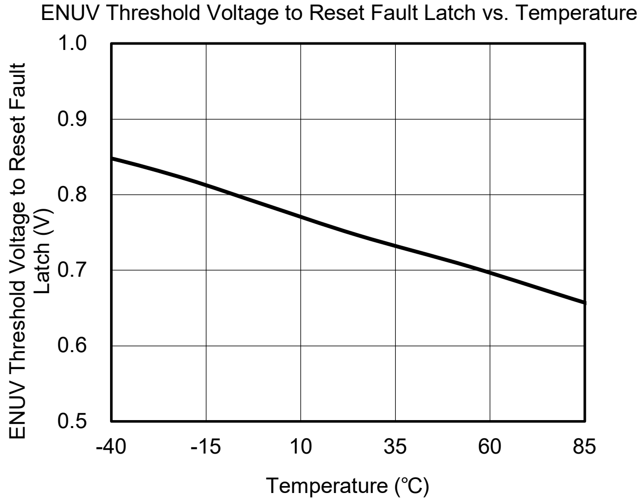
Input Supply Current vs. Supply Voltage at Shutdown



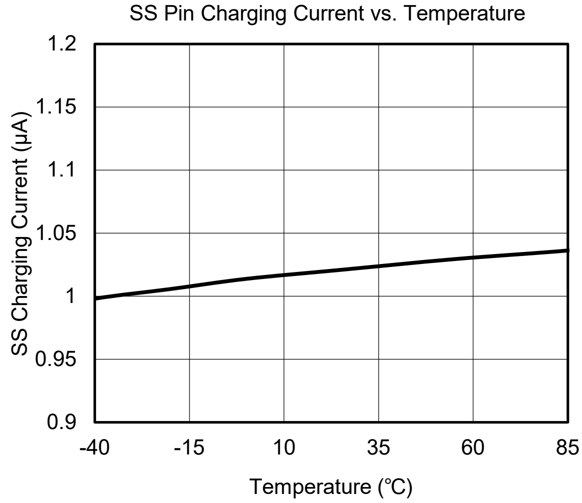
ENUV and OVP Threshold Votage vs. Temperature



ENUV Threshold Voltage to Reset Fault Latch vs. Temperature

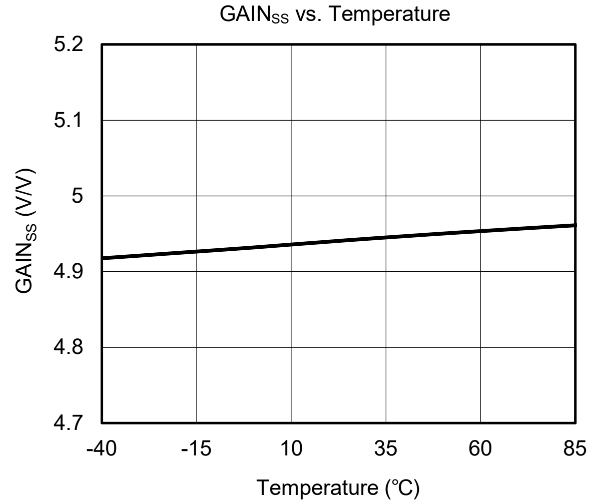


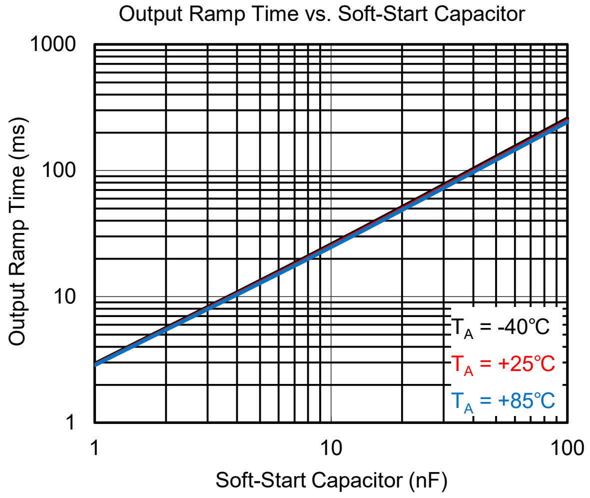
SS Pin Charging Current vs. Temperature

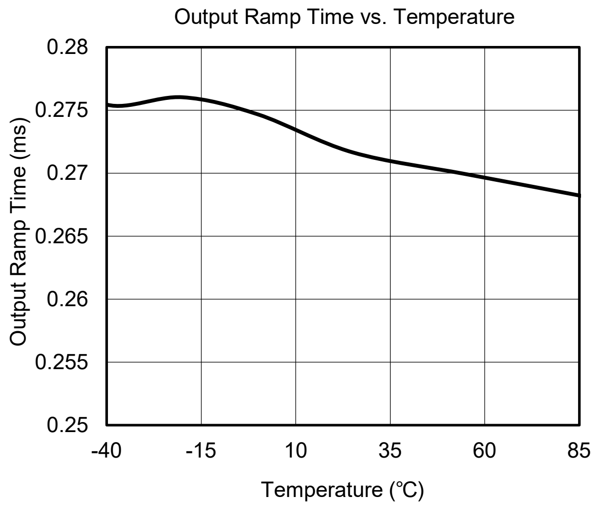


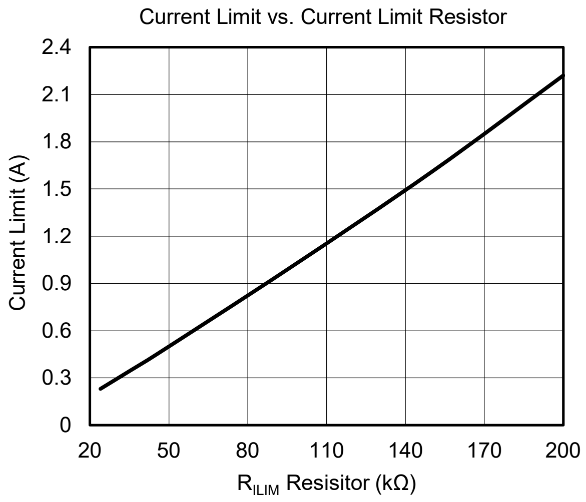
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

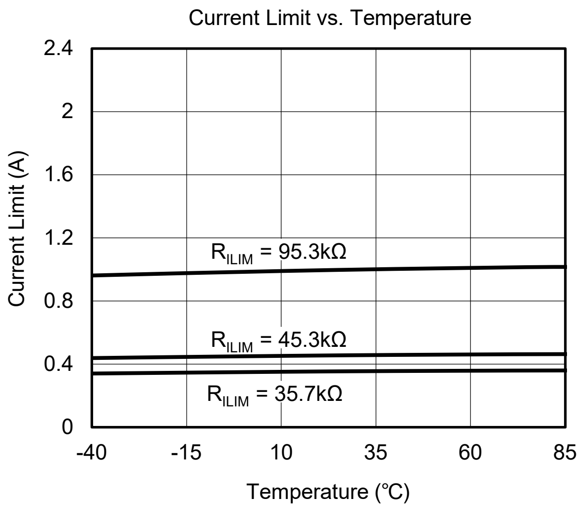
T_A = +25℃, 4.5V ≤ V_{IN} ≤ 24V, V_{ENUV} = 2V, V_{OVP} = 0V, R_{ILIM} = 95.3kΩ, C_{SS} = OPEN, nFLT = OPEN, unless otherwise noted.

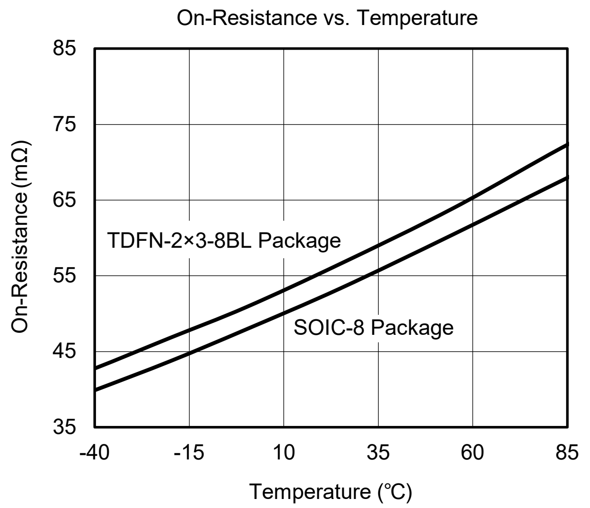








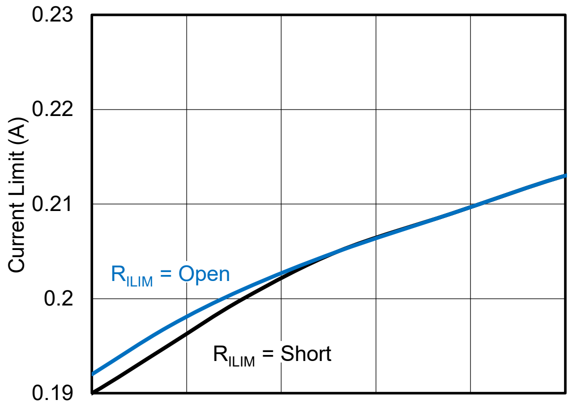




TYPICAL PERFORMANCE CHARACTERISTICS (continued)

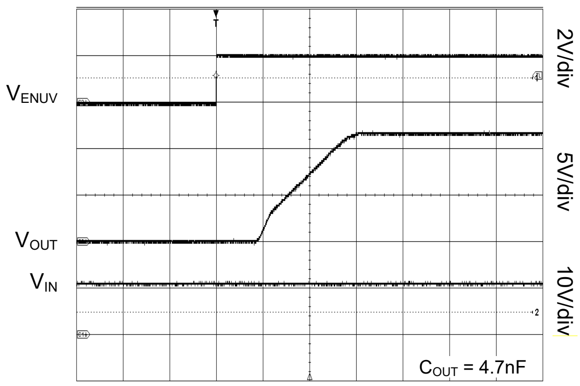
T_A = +25℃, 4.5V ≤ V_{IN} ≤ 24V, V_{ENUV} = 2V, V_{OVP} = 0V, R_{ILIM} = 95.3kΩ, C_{SS} = OPEN, nFLT = OPEN, unless otherwise noted.

Current Limit for R_{ILIM} = Open and Short vs. Temperature



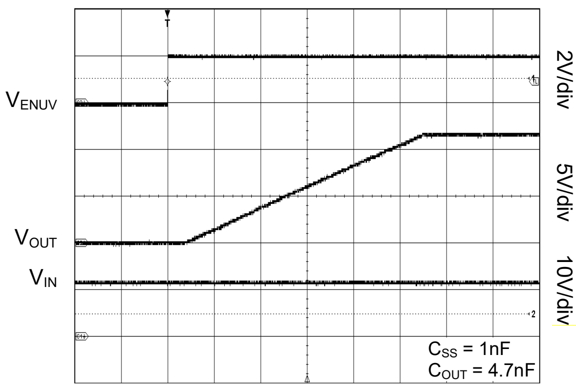
Temperature (℃)

Turn-On with Enable



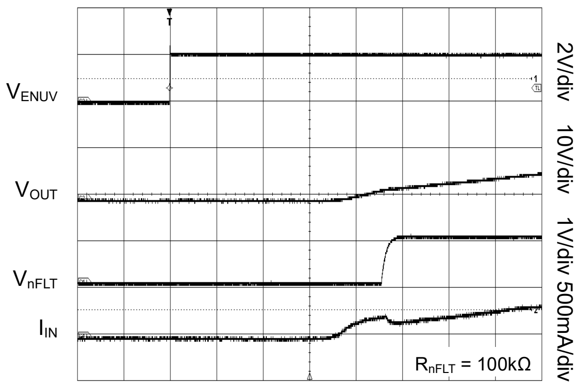
Time (100μs/div)

Turn-On with Enable



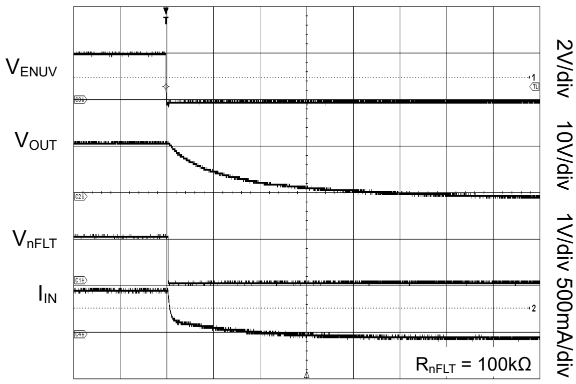
Time (500μs/div)

ENUV Turn-On Delay: ENUV↑ to Output Ramp↑



Time (20μs/div)

ENUV Turn-Off Delay: ENUV↓ to Fault↓

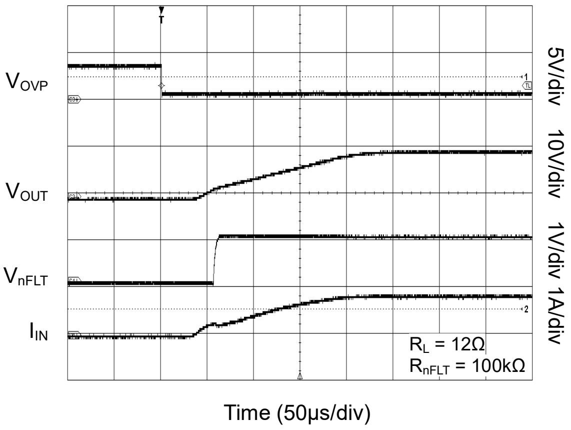


Time (20μs/div)

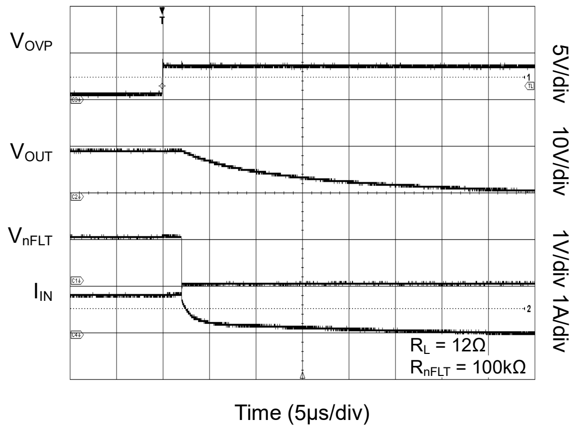
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, 4.5V ≤ V_{IN} ≤ 24V, V_{ENUV} = 2V, V_{OVP} = 0V, R_{ILIM} = 95.3kΩ, C_{SS} = OPEN, nFLT = OPEN, unless otherwise noted.

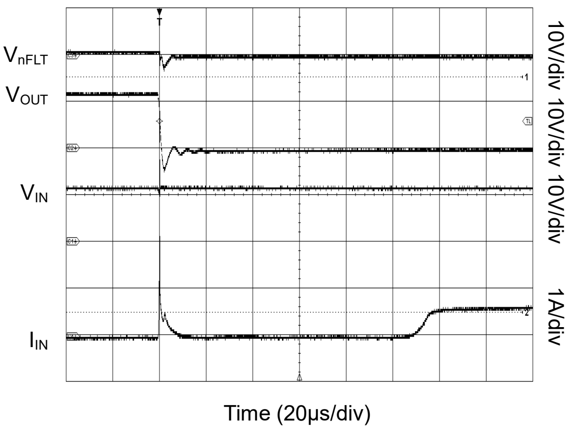
OVP Turn-On Delay: OVP↓ to Output Ramp↑



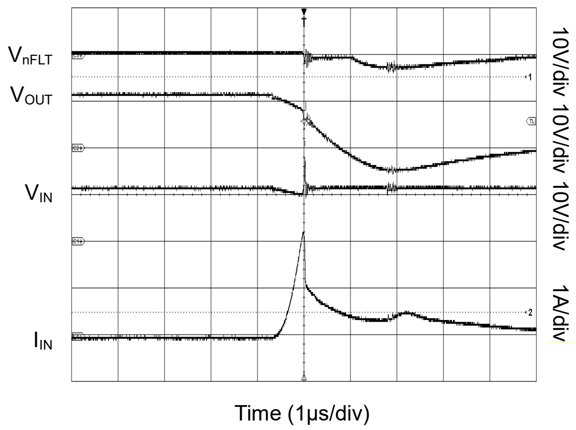
OVP Turn-Off Delay: OVP↑ to Fault↓



Hot-Short: Fast-Trip Response and Current Regulation



Hot-Short: Fast-Trip Response (Zoomed)



DETAILED DESCRIPTION

Overview

SGM2521/1A/2/2A family is a smart eFuse with enhanced built-in protection circuitry. It provides robust protection for all systems and applications powered from 4.5V to 24V.

For hot-plug-in boards, the device provides in-rush current control and programmable output ramp rate. SGM2521/1A/2/2A integrate over-current and short-circuit protection. The precision over-current limit helps to minimize over design of the input power supply, while the fast response short-circuit protection immediately isolates the load from input when a short-circuit is detected. The device allows the user to program the over-current limit threshold between 0.26A and 2A via an external resistor. The device provides precision monitoring of voltage bus for brown-out and over-voltage conditions and asserts fault for downstream system. Its threshold accuracy of 3% ensures tight supervision of bus, eliminating the need for a separate supply voltage supervisor chip. SGM2521/1A/2/2A are designed to protect systems such as White Goods, STBs, DTVs, Smart Meters and Gas Analyzers.

The additional features include:

- Over-temperature protection to safely shutdown in the event of an over-current event
- Fault reporting for brown-out and over-voltage faults
- A choice of latched-off or auto-recovery restart mode

Enable and Adjusting Under-Voltage Lockout (UVLO)

The ENUV pin controls the on/off state of the internal FET. A voltage $V_{ENUV} < V_{ENF}$ on this pin turns off the internal FET, thus disconnecting IN from OUT.

Toggling the ENUV pin below V_{ENF_RST} resets the SGM2522/SGM2522A that has latched-off due to a fault condition. The internal de-glitch delay on ENUV falling edge is kept low for quick detection of power failure. For applications where a higher de-glitch delay on ENUV is desired, or when the supply is particularly noisy, it is recommended to use an external filter capacitor from the ENUV terminal to GND.

The under-voltage lockout threshold can be programmed by using an external resistor divider from the supply IN terminal to the ENUV terminal to GND as shown in Figure 3. When an under-voltage or input power fail event is detected, the internal FET is quickly turned off, and nFLT is asserted. If the under-voltage lockout function is not needed, the ENUV pin should be connected to the IN terminal. The ENUV terminal should not be left floating.

SGM2521/1A/2/2A also implement internal under-voltage lockout (UVLO) circuitry on the IN pin. The devices get disabled when the IN terminal voltage falls below internal UVLO threshold V_{UVF}.

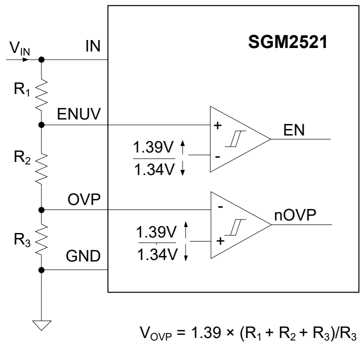


Figure 3. UVLO and OVP Thresholds Set by R_1, R_2 and R_3

Over-Voltage Protection (OVP)

SGM2521/1A/2/2A incorporate circuits to protect the system during over-voltage conditions. A resistor divider, connected from the supply to OVP terminal to GND (as shown in Figure 3), programs the over-voltage threshold. A voltage more than V_{OVPR} on the OVP pin turns off the internal FET and protects the downstream load. This pin should be tied to GND when not used.

Hot-Plug-In and In-Rush Current Control

SGM2521/1A/2/2A are designed to control the in-rush current upon insertion of a card into a live backplane or other "hot" power source. This limits the voltage sag on the backplane's supply voltage and prevents unintended resets of the system power. A slew rate controlled start-up (SS) also helps to eliminate conductive and radiated interference. An external capacitor from the SS pin to GND defines the slew rate of the output voltage at power-on (as shown in Figure 4). The equation governing slew rate at start-up is shown in Equation 1:

$$I_{SS} = \frac{C_{SS}}{GAIN_{SS}} \times \frac{dV_{OUT}}{dt} \quad (1)$$

where:

I_{SS} = 1.01μA (TYP)

$\frac{dV_{OUT}}{dt}$ = Desired output slew rate

$GAIN_{SS} = \Delta V_{OUT}/\Delta V_{SS}$ gain = 4.94

DETAILED DESCRIPTION (continued)

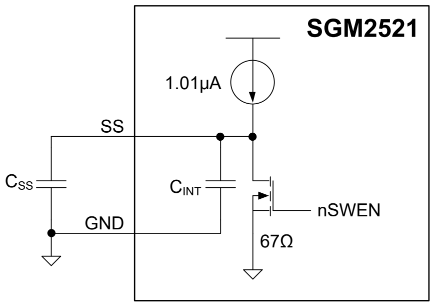


Figure 4. Output Ramp Time t_{dVdT} is Set by C_{dVdT}

The total ramp time (t_{SS}) of V_{OUT} for 0 to V_{IN} can be calculated using Equation 2:

$$t_{SS} = 20.04 \times 10^4 \times V_{IN} \times C_{SS} \quad (2)$$

where C_{SS} is in Farad.

The in-rush current, $I_{IN\text{-}RUSH}$ can be calculated as

$$I_{IN\text{-}RUSH} = C_{OUT} \times \frac{V_{IN}}{t_{SS}} \quad (3)$$

The SS pin can be left floating to obtain a predetermined slew rate (t_{SS}) on the output. When terminal is left floating, the device sets an internal ramp rate of ~50V/ms for output (V_{OUT}) ramp.

For systems where load is present during start-up, the current never exceeds the over-current limit set by R_{ILIM} resistor for the application.

Over-Load and Short-Circuit Protection

At all times load current is monitored by sensing voltage across an internal sense resistor. During over-load events, current is limited to the current limit (I_{LIMIT}) programmed by R_{ILIM} resistor:

$$I_{LIMIT} = 10.95 \times 10^{-3} \times R_{ILIM} - 0.043 \quad (4)$$

$$R_{ILIM} = \frac{I_{LIMIT} + 0.043}{10.95 \times 10^{-3}} \quad (5)$$

where:

I_{LIMIT} is over-load current limit in Ampere

R_{ILIM} is the current limit programming resistor in kΩ

SGM2521/1A/2/2A incorporate two distinct over-current protection levels: the current limit (I_{LIMIT}) and the fast-trip threshold ($I_{FASTTRIP}$). The fast-trip and current-limit operations are shown in Figure 5.

Bias current on ILIM pin directly controls current-limiting behavior of the device, and PCB routing of this node must be kept away from any noisy (switching) signals.

Over-Load Protection

For over-load conditions, the internal current-limit amplifier regulates the output current to I_{LIMIT}. The output voltage droops during current limit regulation, resulting in increased power dissipation in the device. If the device junction temperature reaches the thermal shutdown threshold (T_{TSD}), the internal FET is turned off. Once in thermal shutdown, each of the SGM2522/ SGM2522A stays latched-off, whereas each of the SGM2521/SGM2521A commences an auto-recovery cycle t_{TSD_DLY} millisecond after $T_J < [T_{TSD} - 20℃]$. During thermal shutdown, the fault pin nFLT pulls low to signal a fault condition.

Short-Circuit Protection

During a transient short-circuit event, the current through the device increases very rapidly. As current-limit amplifier cannot respond quickly to this event due to its limited bandwidth, the device incorporates a fast-trip comparator, with a threshold $I_{FASTTRIP}$. When the current through the internal FET exceeds $I_{FASTTRIP}$ ($I_{OUT} > I_{FASTTRIP}$), this comparator shuts down the pass device within 3μs and terminates the rapid short-circuit peak current. The $I_{FASTTRIP}$ threshold is dependent on programmed over-load current limit and function of R_{ILIM}. See Equation 6 for the calculation.

$$I_{FASTTRIP} = 1.8 \times I_{ILIMIT} \quad (6)$$

where:

$I_{FASTTRIP}$ is fast-trip current limit in Ampere

The fast-trip circuit holds the internal FET off for only a few microseconds, after which the device attempts to turn back on normally, allowing the current-limit loop to regulate the output current to I_{LIMIT}. Then, device behaves similar to over-load condition.

DETAILED DESCRIPTION (continued)

Start-Up with Short on Output

During start-up into a short-circuit current is limited to I_{LIMIT}. This feature helps in quick fault isolation and hence ensures stability of the DC bus.

Constant Current Limit Behavior during Over-Current Faults

When T_J > 120℃, there is about 1% to 20% thermal fold back in the current limit value so that the regulated current drops from I_{LIMIT} to I_{OS}. Eventually, the device shuts down due to over temperature.

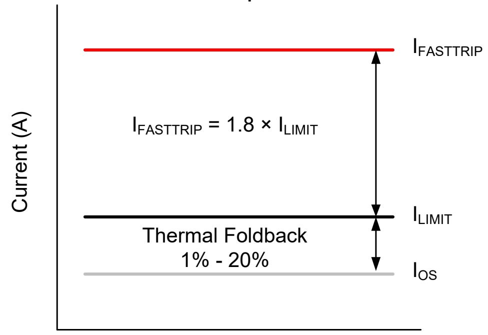


Figure 5. Over-Current Protection Levels

Fault Response

The nFLT pin open-drain output is asserted (active low) during under-voltage, over-voltage and thermal shutdown conditions. The nFLT signal remains asserted until the fault condition is removed and the device resumes normal operation. During thermal shutdown, each of the SGM2522/SGM2522A stays latched-off, whereas each of the SGM2521/SGM2521A commences an auto-recovery cycle t_{TSD_DLY} millisecond after T_J < [T_{TSD} - 20℃]. For SGM2522/SGM2522A, thermal fault latch can be reset by cycling the ENUV pin below V_{ENF_RST} threshold. A nuisance fast trip does not trigger fault.

Connect nFLT pin with a pull-up resistor to input or output voltage rail. The nFLT pin may be left open or tied to GND when not used.

IN, OUT and GND Pins

The IN pin should be connected to the power source. A ceramic bypass capacitor close to the device from IN to GND is recommended to alleviate bus transients. The recommended operating voltage range is 4.5V to 24V. The OUT pin should be connected to the load. V_{OUT} in the ON condition, is calculated using the Equation 7:

$$V_{OUT} = V_{IN} - (R_{DS(ON)} \times I_{OUT}) \quad (7)$$

where, $R_{DS(ON)}$ is the on-resistance of the internal FET. GND terminal is the most negative voltage in the circuit and is used as a reference for all voltage reference unless otherwise specified.

Thermal Shutdown

Internal over-temperature shutdown disables/turns off the FET when T_J > 150℃ (TYP). Each of the SGM2522/SGM2522A latches off the internal FET, whereas each of the SGM2521/SGM2521A commences an auto-recovery cycle t_{TSD_DLY} millisecond after T_J drops below [T_{TSD} - 20℃]. During the thermal shutdown, the fault pin nFLT is pulled low to signal a fault condition.

Shutdown Control

The internal FET and hence the load current can be remotely switched off by taking the ENUV pin below its 1.34V threshold with an open collector or open drain device as shown in Figure 6. Upon releasing the ENUV pin the device turns on with soft-start cycle.

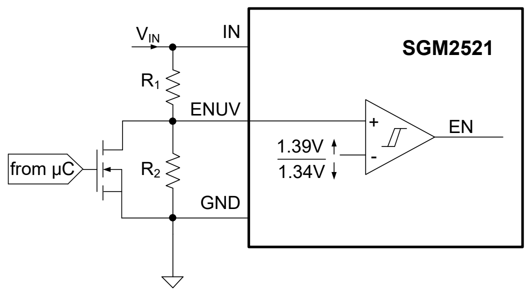


Figure 6. Shutdown Control

Operational Overview of Device Functions

The device functionality for various conditions are shown in Table 1.

Table 1. Operational Overview of Device Functions

Device	SGM2521/SGM2521A/SGM2522/SGM2522A
Start-Up	In-rush ramp controlled by capacitor at SS pin
	In-rush limited to I_{LIMIT} level as set by R_{ILIM}
	If T_J > T_{TSD} device shuts off
Over-Current Response	Current is limited to I_{LIMIT} level as set by R_{ILIM}
	Power dissipation increases as V_{IN} - V_{OUT} grows
	Device turns off when T_J > T_{TSD}
	SGM2522/SGM2522A remain off
	SGM2521/SGM2521A will attempt restart t_{TSD_DLY} millisecond after T_J < [T_{TSD} -20℃]
Short-Circuit Response	Fast shut off when I_{LOAD} > $I_{FASTTRIP}$
	Quick restart and current limited to I_{LIMIT}, follows standard start-up cycle

SYSTEM EXAMPLES

The SGM2521/1A/2/2A provide simple solutions for current limiting, in-rush current control and supervision of power rails for wide range of applications operating at 4.5V to 24V and delivering up to 2A.

Protection and Current Limiting for Primary-Side Regulated Power Supplies

Primary-side regulated power supplies and adapters are dominant today in many of the applications such as Smart Phones, Portable Hand-Held Devices, White Goods, Set-Top Boxes and Gaming Consoles. These supplies provide efficient, low cost and low component count solutions for power needs ranging from 5W to 30W. But, these come with drawbacks of:

•No secondary side protection for immediate termination of critical faults such as short-circuit and over-voltage
•Do not provide precision current limiting for over-load 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 limiting and secondary side protection, driving the need for current sensing in the secondary side. This needs additional circuit implementation using precision operational amplifiers. This increases the complexity of the solution and also results in sensing losses. The SGM2521/1A/2/2A with their integrated low-ohmic N-channel FET provide a simple and efficient solution. Figure 7 shows the typical implementation using SGM2521/1A/2/2A.

During short-circuit conditions, the internal fast comparator of SGM2521/1A/2/2A turn off the internal FET in less than 3μs (TYP) as soon as current exceeds $I_{FASTTRIP}$, set by the current limit R_{ILIM} resistor. The OVP comparator with 3% precision helps in quick isolation of the load from the input when inputs exceed the set V_{OVPR}.

In addition to above, the SGM2521/1A/2/2A provide in-rush current limit when output is hot-plugged into any of the system loads.

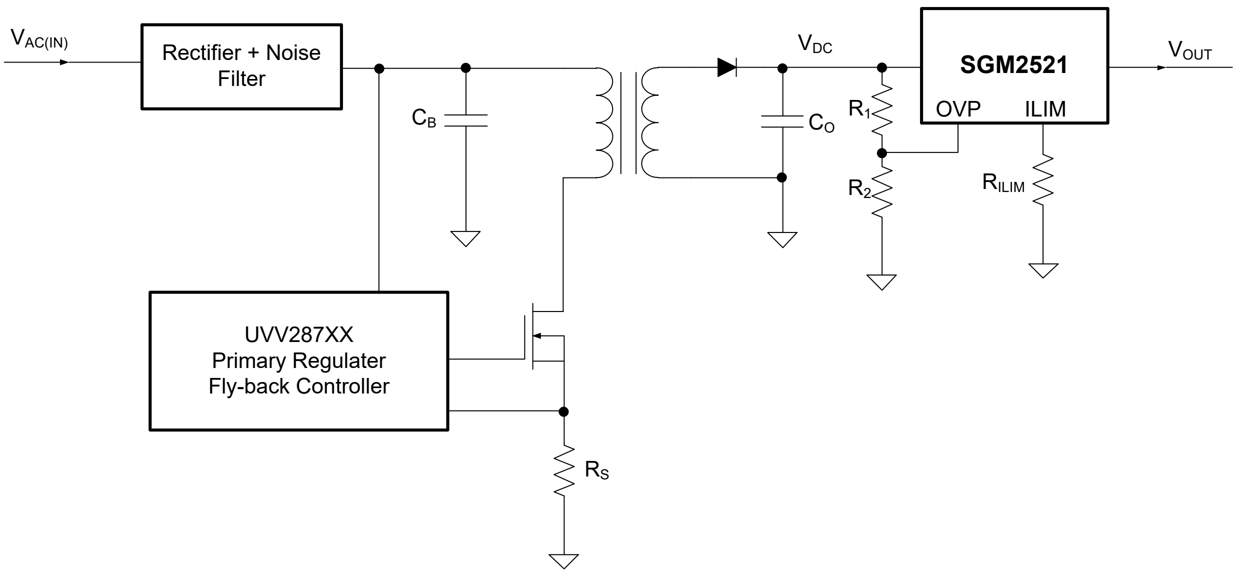


Figure 7. Current Limiting and Protection for AC-DC Power Supplies

SYSTEM EXAMPLES (continued)

Precision Current Limiting in Intrinsic Safety Applications

Intrinsic Safety (IS) is becoming prominent need for safe operation of electrical and electronic equipment in hazardous areas. Intrinsic Safety 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 thermal, in the form of a hot surface.

This calls for precision current limiting 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.

The SGM2521/1A/2/2A devices can be used as simple protection solution for each of the internal rails. Figure 8 shows the typical implementation using SGM2521/1A/2/2A.

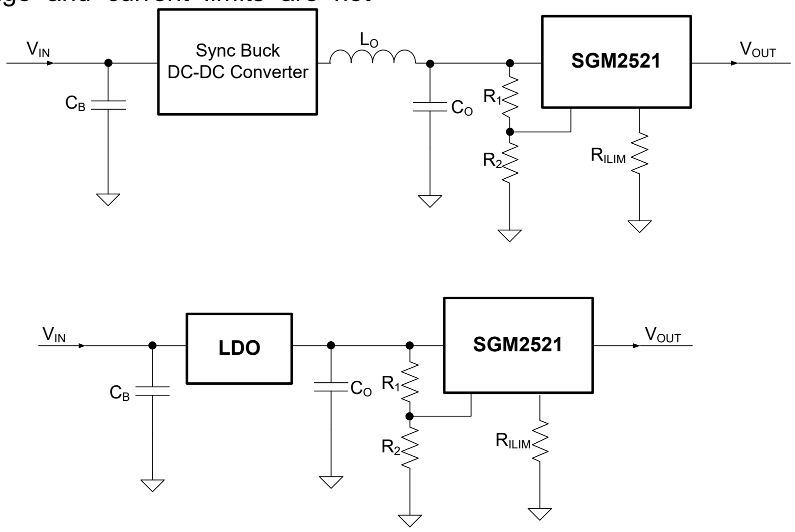


Figure 8. Precision current Limit and Protection of Internal Rails

Smart Load Switch

A smart load switch is a series FET used for switching of the load (resistive or inductive). It also provides protection during fault conditions. Typical discrete implementation is shown in Figure 9. Discrete solutions have higher component count and require complex circuitry to implement each of the protection fault needs.

SGM2521/1A/2/2A can be used as a smart power switch for applications ranging from 4.5V to 24V. SGM2521/1A/2/2A provide programmable soft-start, programmable current limits, over-temperature protection, a fault flag, and under-voltage lockout.

Figure 9 shows typical implementation and usage as 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.

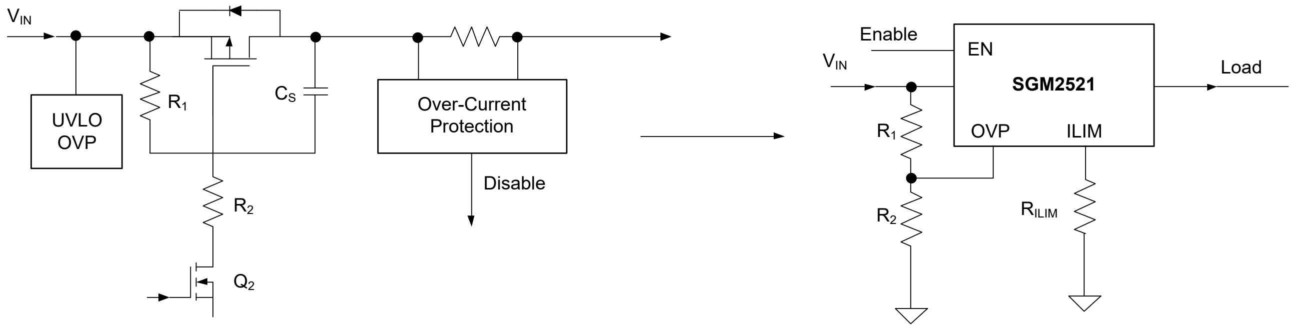
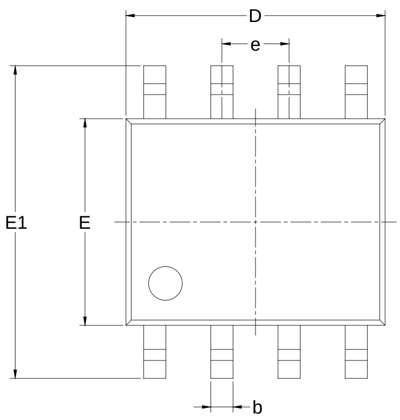
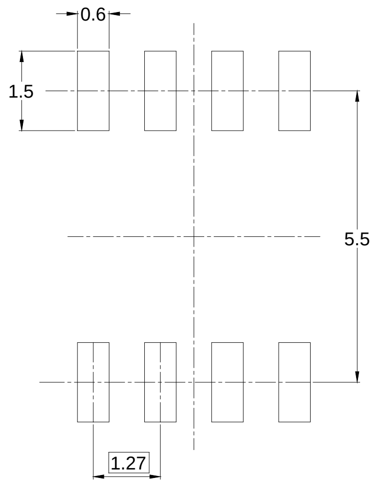


Figure 9. Smart Load Switch Implementation

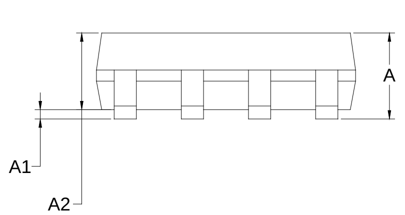
PACKAGE OUTLINE DIMENSIONS

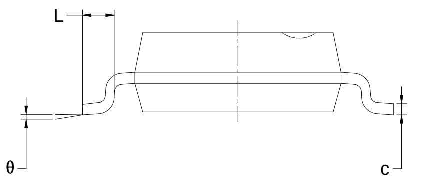
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

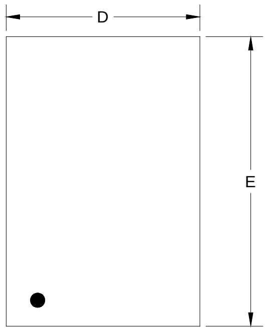




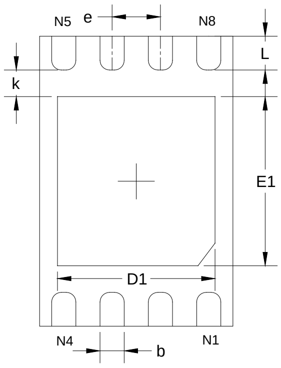
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

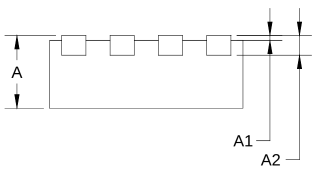
TDFN-2×3-8BL



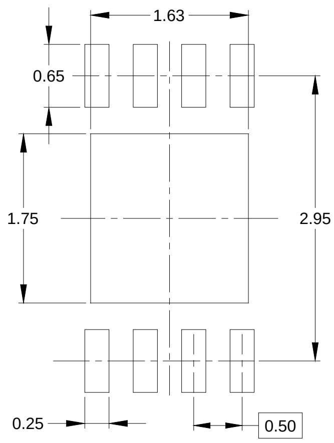
TOP VIEW



BOTTOM VIEW



SIDE VIEW

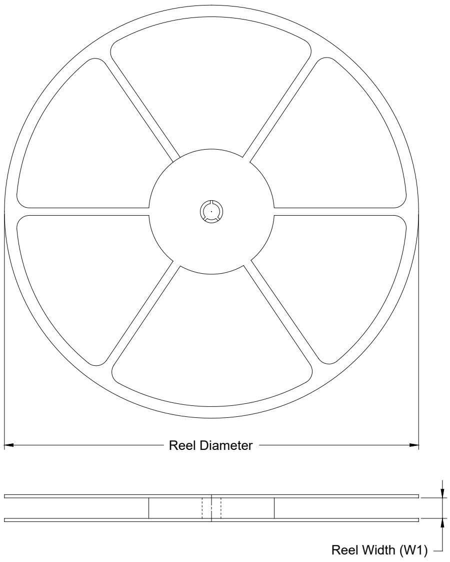


RECOMMENDED LAND PATTERN (Unit: mm)

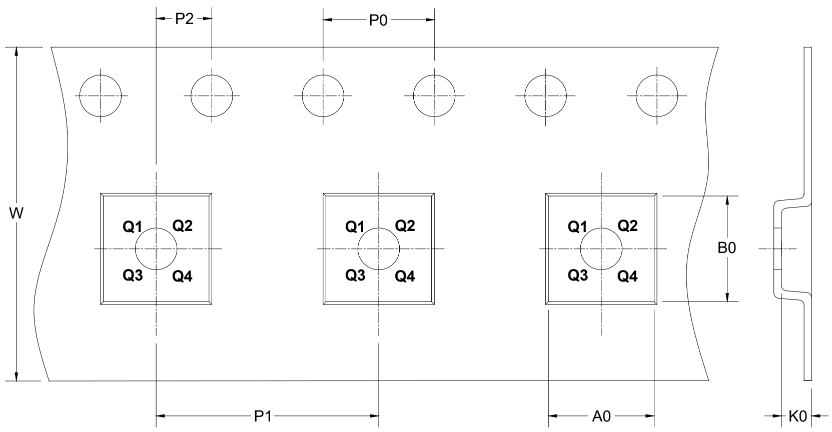
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	1.950	2.050	0.077	0.081
D1	1.530	1.730	0.060	0.068
E	2.950	3.050	0.116	0.120
E1	1.650	1.850	0.065	0.073
b	0.200	0.300	0.008	0.012
e	0.500 BSC		0.020 BSC	
k	0.250 REF		0.010 REF	
L	0.300	0.450	0.012	0.018

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

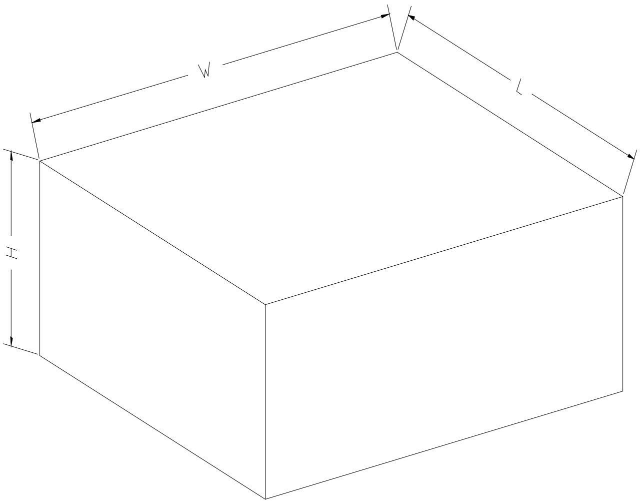
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOIC-8	13″	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
TDFN-2×3-8BL	7″	9.5	2.30	3.30	1.10	4.0	4.0	2.0	8.0	Q2

DD0001

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
7″ (Option)	368	227	224	8
7″	442	410	224	18
13″	386	280	370	5

DD0002