SGM25007
5.5V, 7A Low R_{DSON} Load Switch Device with Current Monitoring

GENERAL DESCRIPTION

The SGM25007 is an N-MOSFET power switch with 7A load protection function. The switch operates from a wide range of 0.5V to 5.5V supply voltage. The small package and low R_{DSON} make the device very suitable for space limited, and battery powered applications, such as notebook, tablet computer or other portable devices.

The SGM25007 provides very accurate current monitoring through the IMON pin. The current monitor gain can be scaled according to different applications. An integrated soft-start function is designed to avoid inrush current during startup stage.

A number of protection features are provided in the device including programmable soft-start time, over-current protection and over-temperature shutdown. The device also provides the quick output discharge function in disable status.

The SGM25007 is available in a Green TQFN-2×2-12CL package.

FEATURES

- **Input Voltage Range: 0.5V to 5.5V**
- **On-Resistance: 6.3mΩ (TYP)**
- **Shutdown Current: 1.5μA (MAX)**
- **Load Current Limit: 7A (TYP)**
- **High Output Current Monitoring Accurate**
- **Built-in PG Indicator**
- **Built-in Soft-Start Function**
- **Built-in Output Discharge Function**
- **Fast Short-Circuitry Response: < 200ns**
- **Thermal Shutdown Protection**
- **Available in a Green TQFN-2×2-12CL Package**

APPLICATIONS

Notebook
Tablet PC
Portable Devices
Solid State Drivers
Handheld Devices

TYPICAL APPLICATION

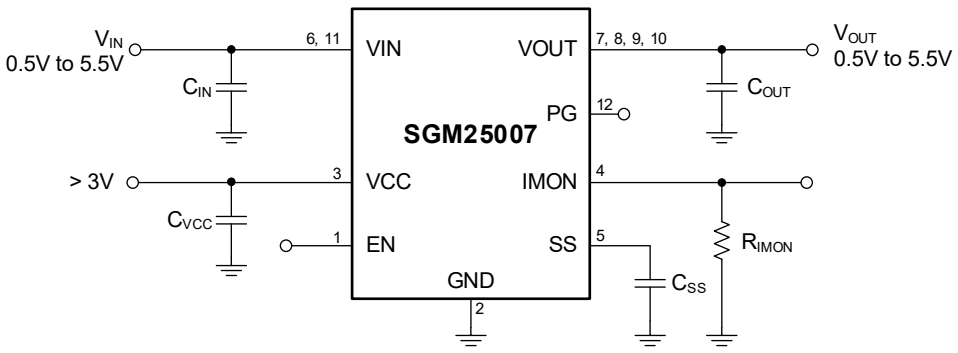


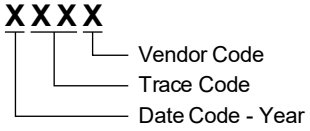
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM25007	TQFN-2×2-12CL	-40℃ to +125℃	SGM25007XTVS12G/TR	15Q XXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.



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

V_{IN} ..... -0.3V to 6.5V
V_{CC} ..... -0.3V to 6.5V
V_{OUT} ..... -0.3V to 6.5V
EN, SS, IMON ..... -0.3V to 6.5V
Package Thermal Resistance
TQFN-2×2-12CL, θ_{JA} ..... 75℃/W
TQFN-2×2-12CL, θ_{JB} ..... 11.2℃/W
TQFN-2×2-12CL, θ_{JC} ..... 64.3℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility (1) (2)
HBM ..... ±4000V
CDM ..... ±1000V

NOTES:

1. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.

2. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

RECOMMENDED OPERATING CONDITIONS

V_{IN} ..... 0.5V to 5.5V
V_{CC} ..... 3V to 5.5V
All Other Pins ..... 0V to 5.5V
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

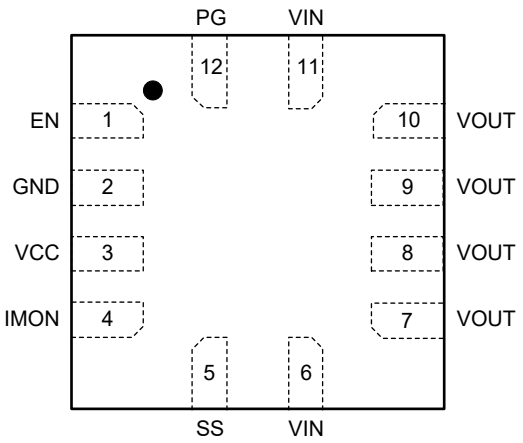
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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

(TOP VIEW)



TQFN-2×2-12CL

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	EN	Enable Input. Logic high to enable the device.
2	GND	GND.
3	VCC	Supply Voltage to Controller.
4	IMON	Output Current Monitor. This pin is used to monitor the output current. Connect an external resistor between this pin and GND. The voltage of the resistor is proportional to the current flowing through the power device.
5	SS	Soft-Start Time Program Pin. The capacitor between SS and GND pins will set the slew rate according to the application requirements.
6, 11	VIN	Switch Input.
7, 8, 9, 10	VOUT	Switch Output.
12	PG	Power Good Indicator Pin.

ELECTRICAL CHARACTERISTICS

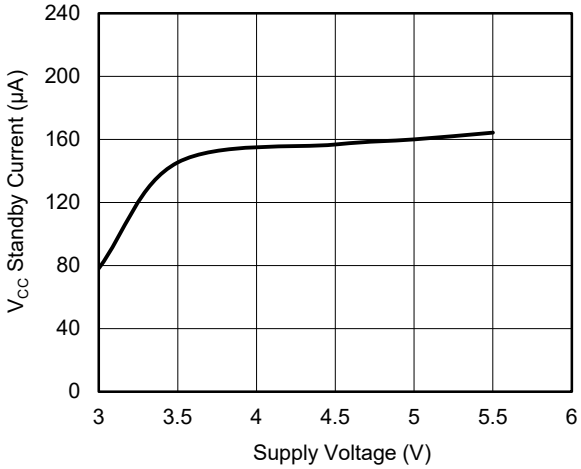
(V_{IN} = 3.6V, V_{CC} = 3.6V, T_J = -40℃ to +125℃, typical values are measured at T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input and Supply Voltage (VIN, VCC)							
Input Voltage	V_{IN}			0.5		5.5	V
Supply Voltage	V_{CC}			3		5.5	V
Off-State Leakage Current	I_{OFF}	T_J = +25℃, V_{IN} = 5V, V_{EN} = low				1	μA
V_{CC} Standby Current	I_{STBY}	V_{CC} = 5V, V_{EN} = low			0.2	1.5	μA
		V_{CC} = 5V, enable, no load			172	260	
Power FET (VIN - VOUT)							
On-Resistance	R_{DSON}	V_{CC} = 5V			6.3	13	mΩ
		V_{CC} = 3.3V			6.4	13	
Under-Voltage Protection							
V_{CC} Under-Voltage Lockout Threshold	V_{CC_UVLO}	Rising			2.6	2.7	V
UVLO Hysteresis	V_{UVLO_HYS}				185		mV
Soft-Start (SS)							
SS Pull-Up Current	I_{SS}	Fixed slew rate			9		μA
Enable (EN)							
EN Threshold	V_{ENH}	Rising		1.43	1.56	1.68	V
EN Hysteresis	V_{EN_HYS}				400		mV
Current Monitor Output (IMON)							
Current Limit	I_{OUT}	R_{IMON} = 50kΩ, ramp I_{OUT} record peak current limit	T_J = +25℃	1.31	1.41	1.50	A
			T_J = -40℃ to +125℃	1.11	1.41	1.70	
Current Monitor Accuracy	I_{MON}	I_{OUT} = 3.75A	V_{IN} = 3.6V, T_J = +25℃	42.36	44.58	46.81	μA
		I_{OUT} = 3A		34.20	35.81	37.42	
		I_{OUT} = 1.5A		17.55	18.28	19.02	
		I_{OUT} = 3.75A	V_{IN} = 3.6V, T_J = -40℃ to +125℃	41.01	44.58	48.16	
		I_{OUT} = 3A		32.94	35.81	38.68	
		I_{OUT} = 1.5A		16.82	18.28	19.75	
		I_{OUT} = 3.75A	V_{IN} = 1.2V, T_J = +25℃	42.38	45.09	47.79	
		I_{OUT} = 3A		33.99	36.2	38.33	
		I_{OUT} = 1.5A		17.24	18.35	19.45	
		I_{OUT} = 3.75A	V_{IN} = 1.2V T_J = -40℃ to +125℃	41.02	45.09	49.15	
		I_{OUT} = 3A		32.9	36.2	39.42	
		I_{OUT} = 1.5A		16.69	18.35	20.00	
Discharge Resistance							
Discharge Resistance	R_{DIS}				200		Ω
Power Good (PG) Indication							
Power Good Rising Threshold	V_{PG_R}	Voltage gap between V_{OUT} and V_{IN}		95	150	205	mV
Power Good Hysteresis	V_{PG_HYS}				84		mV
Power Good Delay Time	t_{PG_D}				84		μs
Power Good High	V_{PG_H}	V_{CC} = 3.3V		3.2			V
Power Good Low	V_{PG_L}	Sink 1mA				0.2	V
Thermal Shutdown and Recovery							
Thermal Shutdown Rising Threshold	T_{SD}				150		℃
Thermal Shutdown Hysteresis	T_{HYS}				20		℃

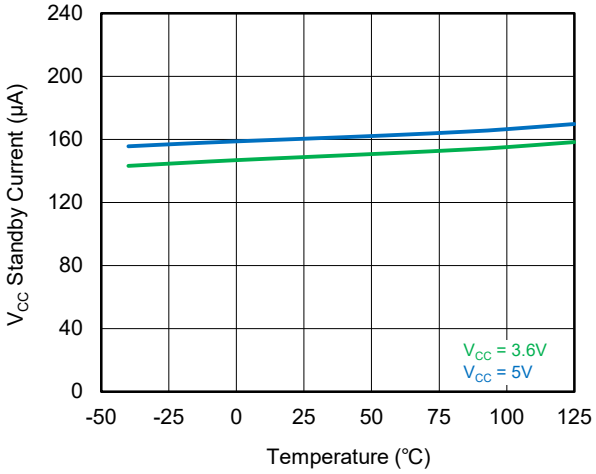
TYPICAL PERFORMANCE CHARACTERISTICS

T_J = +25℃, unless otherwise noted.

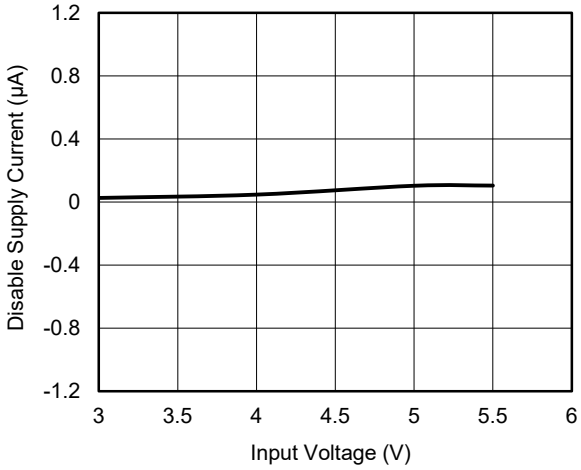
V_{CC} Standby Current vs. Supply Voltage



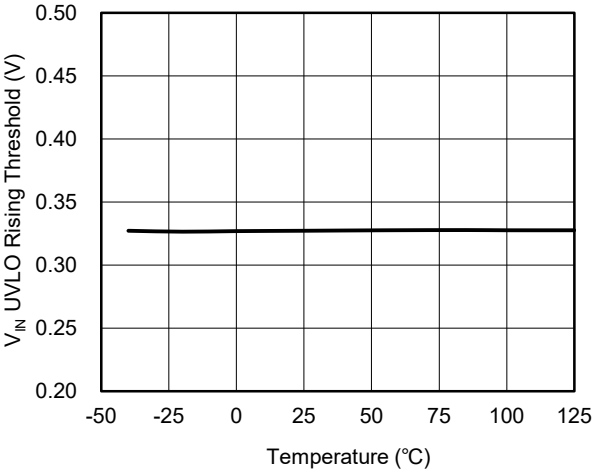
V_{CC} Standby Current vs. Temperature



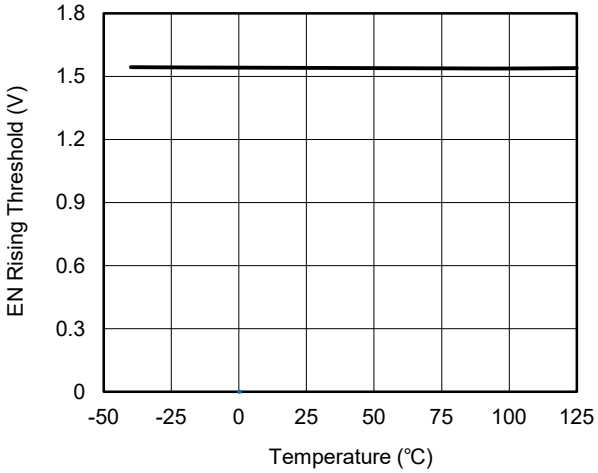
Disable Supply Current vs. Input Voltage



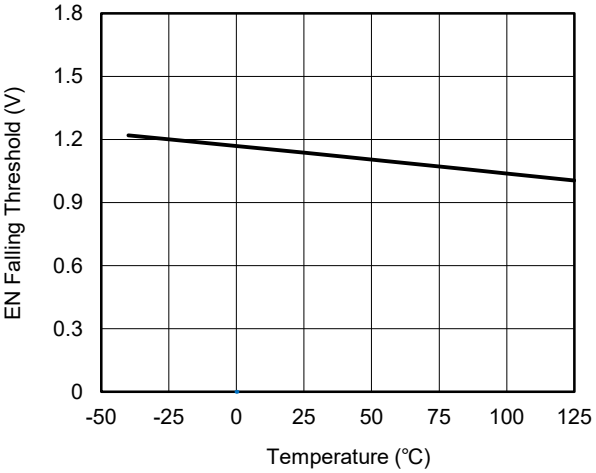
V_{IN} UVLO Rising Threshold vs. Temperature



EN Rising Threshold vs. Temperature



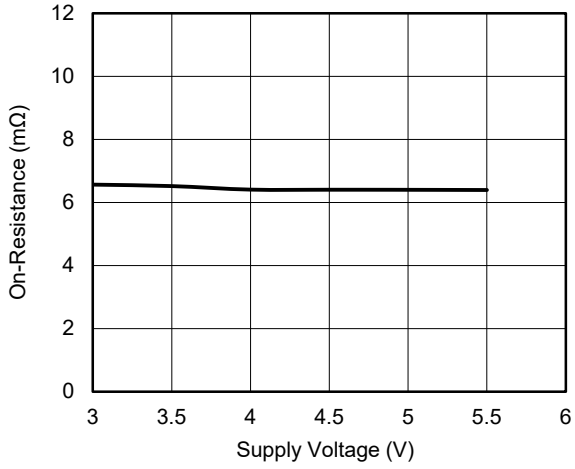
EN Falling Threshold vs. Temperature



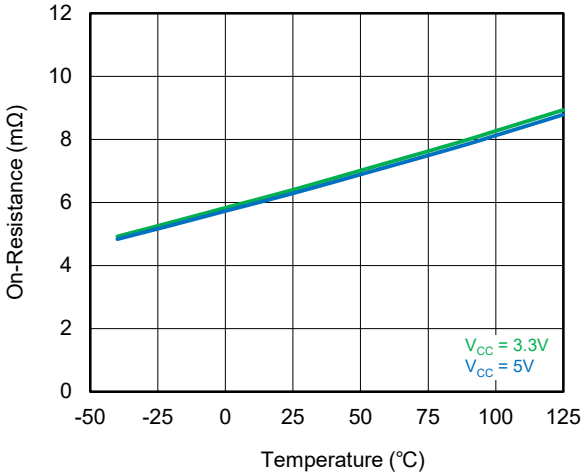
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, unless otherwise noted.

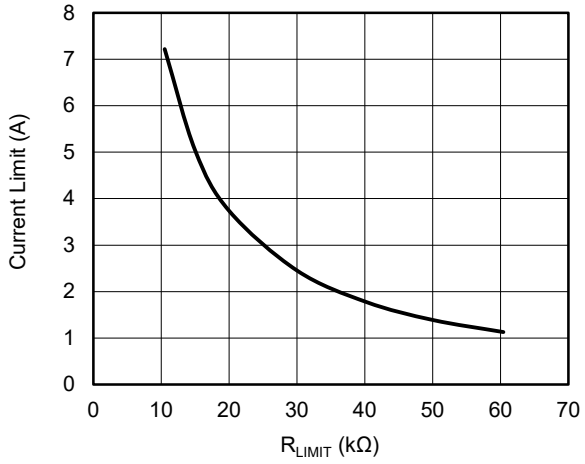
On-Resistance vs. Supply Voltage



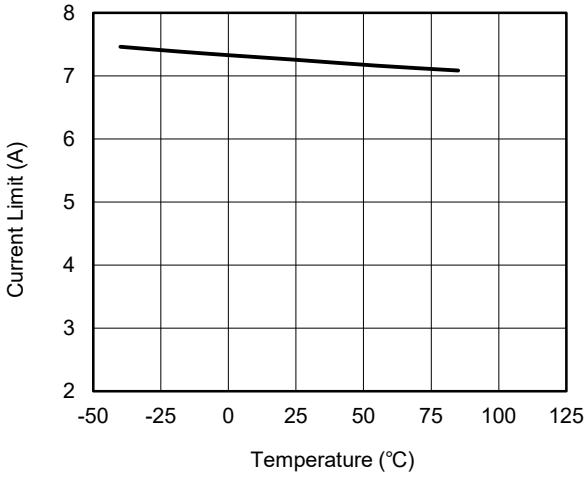
On-Resistance vs. Temperature



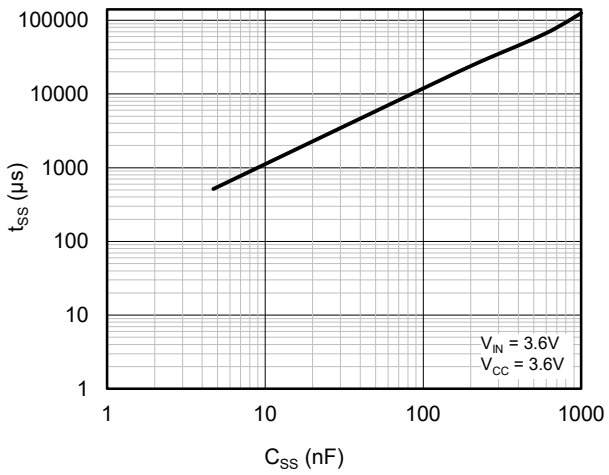
Current Limit vs. R_{LIMIT}



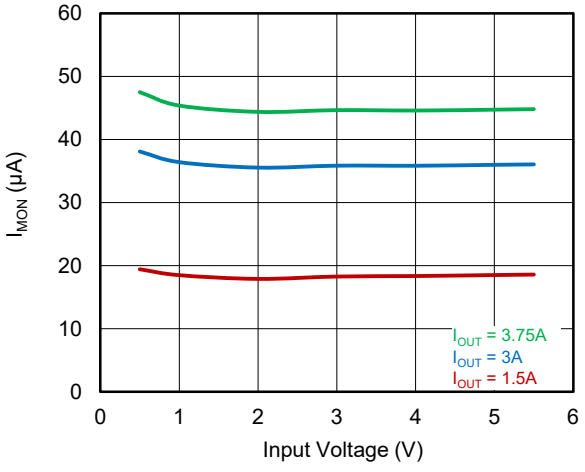
Current Limit vs. Temperature



Soft-Start Time vs. C_{SS}



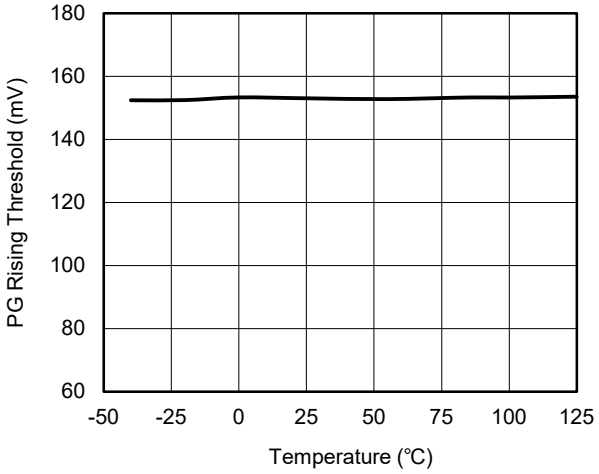
I_{MON} vs. Input Voltage



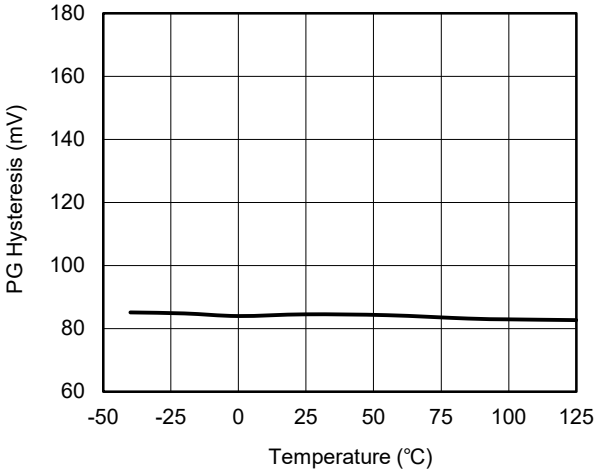
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, unless otherwise noted.

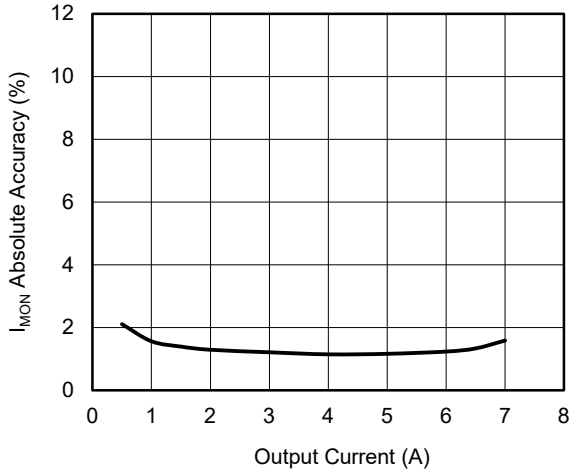
PG Rising Threshold vs. Temperature



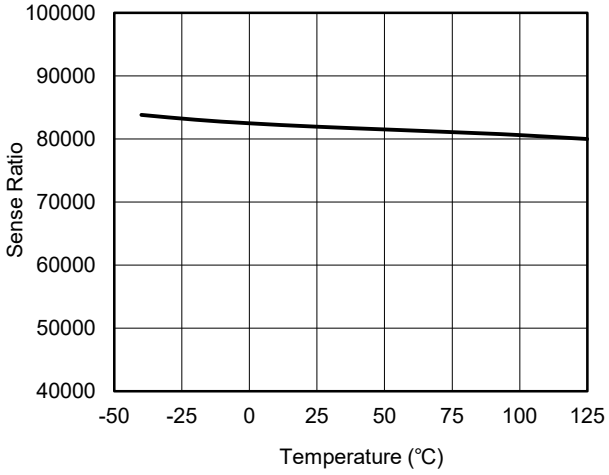
PG Hysteresis vs. Temperature



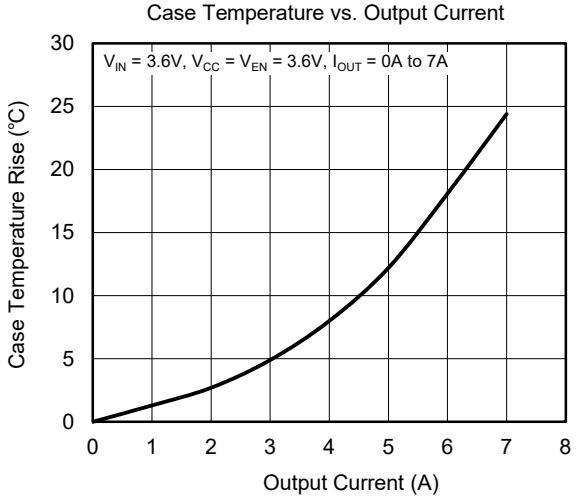
I_{MON} Absolute Accuracy vs. Output Current



Sense Ratio vs. Temperature



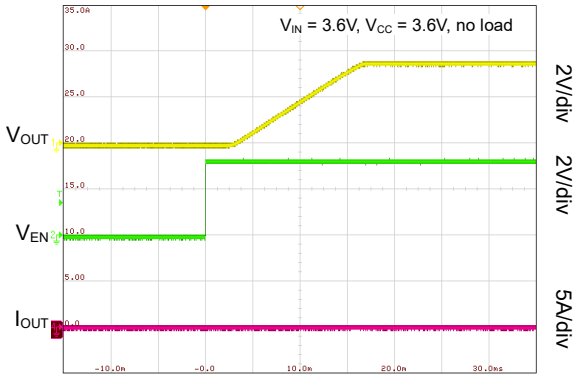
Case Temperature vs. Output Current



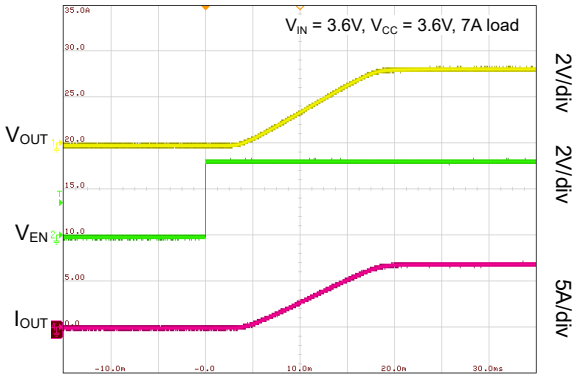
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, unless otherwise noted.

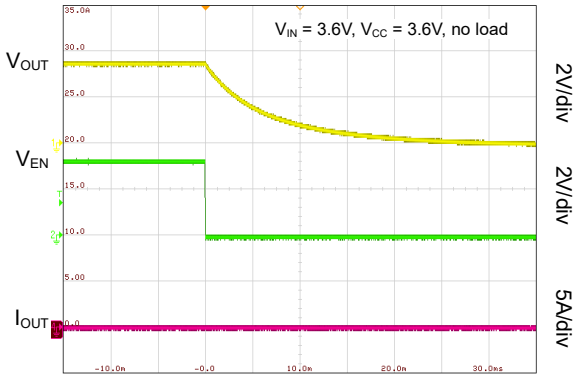
EN Startup



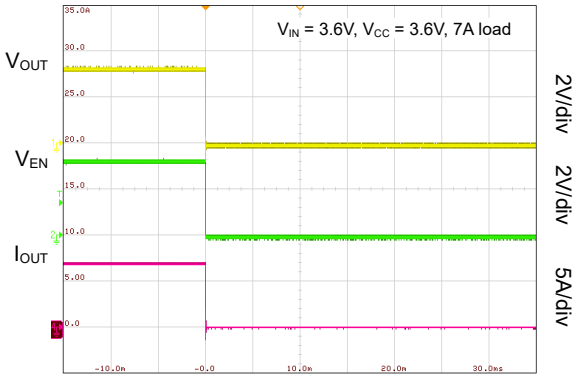
EN Startup



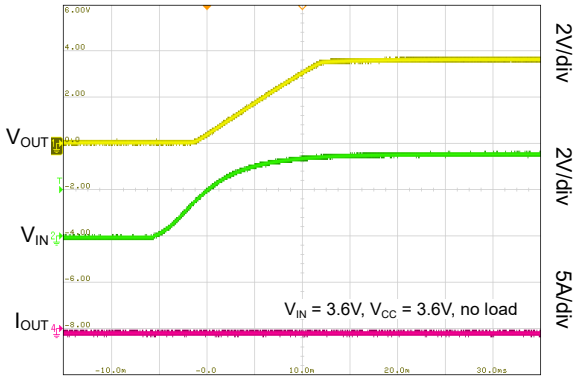
EN Shutdown



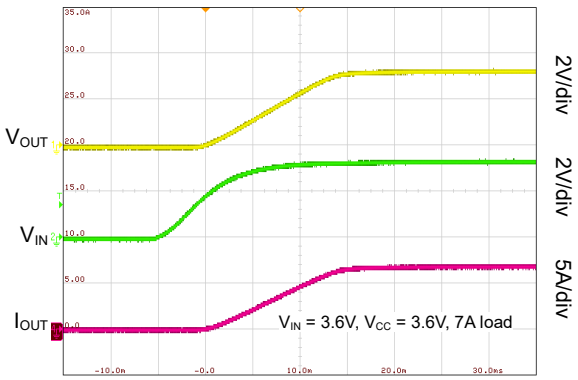
EN Shutdown



Power-Up



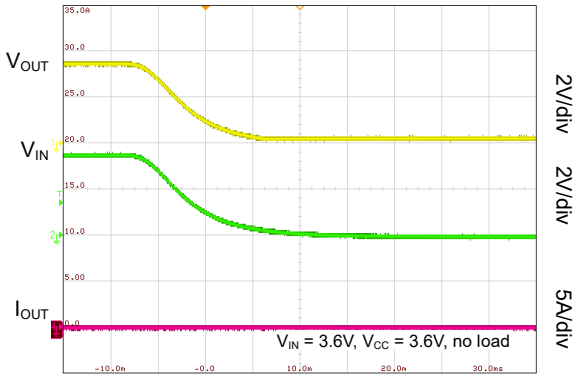
Power-Up



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

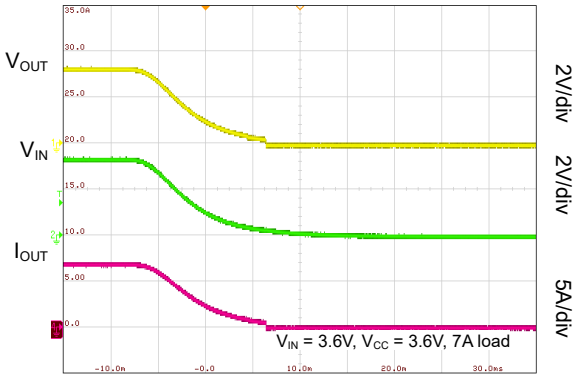
T_J = +25℃, unless otherwise noted.

Power-Down



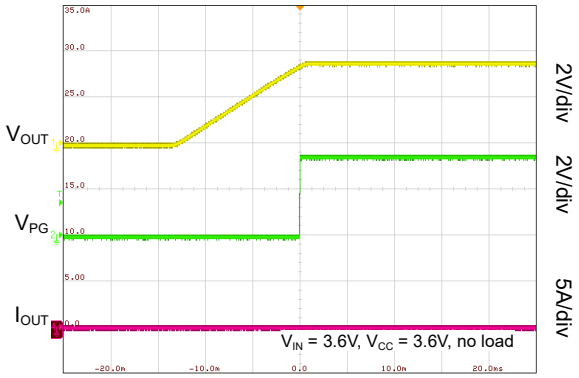
Time (5ms/div)

Power-Down



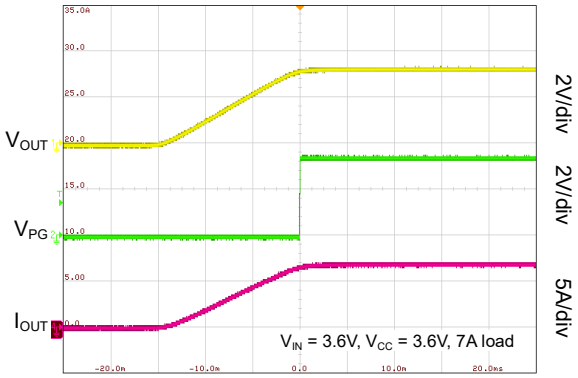
Time (5ms/div)

Power Good (EN Startup)



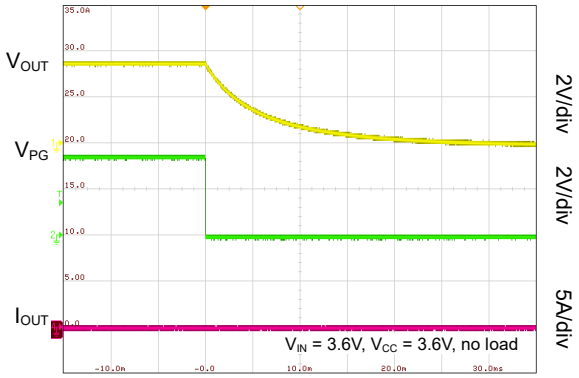
Time (5ms/div)

Power Good (EN Startup)



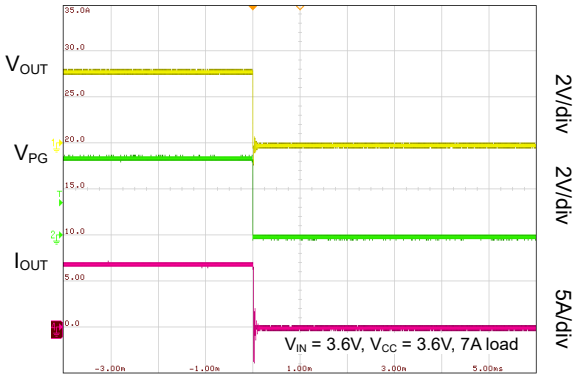
Time (5ms/div)

Power Good (EN Shutdown)



Time (5ms/div)

Power Good (EN Shutdown)

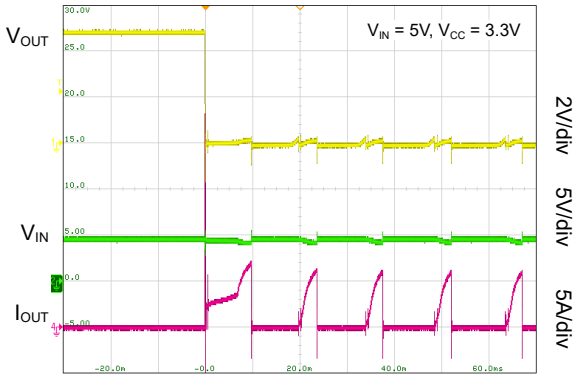


Time (5ms/div)

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

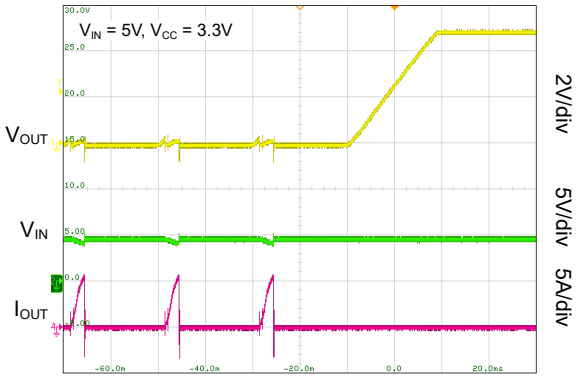
T_J = +25℃, unless otherwise noted.

SCP Enter



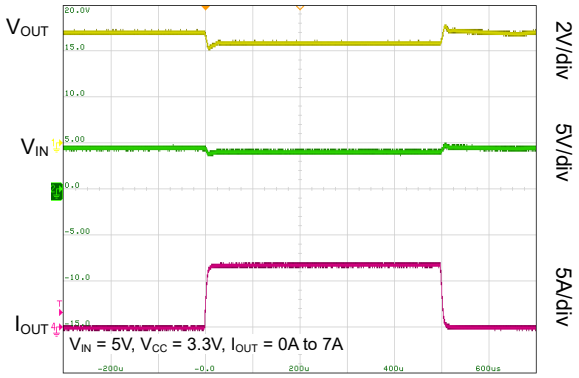
Time (10ms/div)

SCP Recover



Time (10ms/div)

Load Transient Response



Time (100μs/div)

FUNCTIONAL BLOCK DIAGRAM

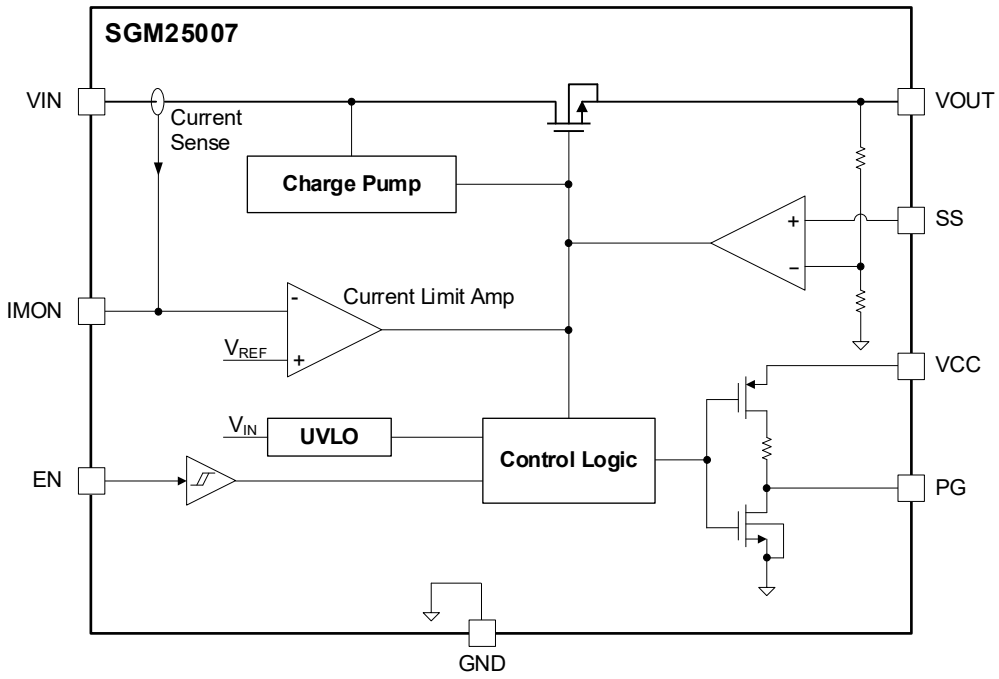


Figure 2. Block Diagram

DETAILED DESCRIPTION

The SGM25007 is used to solve the inrush current issue to the load when the circuit card is inserted into a live backplane power supply, which can limit the backplane's voltage drop and the slew rate of the load voltage. It can monitor the input voltage, output voltage and output current which can eliminate the external power device and current sense device.

Enable

If VIN voltage and VCC voltage meet the starting condition, SGM25007 can be enabled when EN pin is high. When EN pin is low, SGM25007 is disabled.

Current Limit

The SGM25007 is internally integrated with a constant current limit function that can be configured via external resistors. When the load current reaches the current limit threshold, the SGM25007 will limit the current below the current limit threshold by regulating the gate voltage of power device. The current limit will not be triggered in the response time of 20μs. A small overshoot of the load current during this period is allowed.

Set the current limit threshold using Equation 1.

$$I_{LIMIT}(mA) = \frac{88809V}{R_{IMON}^{1.061}\ k\Omega} \quad (1)$$

If the load current limit is triggered, the power loss of power device will increase and the IC temperature will rise accordingly. The device will be shut off when the junction temperature (T_J) is higher than +150℃ and will not recover until T_J is lower than +130℃.

Power Good Function

The PG pin provides a push-pull output of MOSFET as the indication pin of power good. PG pin can be pulled up to V_{CC}. When input voltage is applied to VIN pin, the MOSFET turns on and the PG pin is pulled to GND. PG is asserted as high when the value of (V_{IN} - V_{OUT}) is less than 150mV, after a delay time of 84μs. PG is asserted as low if the value of (V_{IN} - V_{OUT}) is larger than 240mV. The PG pin has built-in pull-up resistance of 240kΩ (TYP) and pull-down resistance of 100Ω (TYP).

Short-Circuit Protection

If the output is shorted to GND, the load current will increase rapidly in a short time. Before the current limit function responds, the power device current may be much higher than the current limit threshold which may cause serious damage. To solve this problem, SGM25007 integrates a fast turn-off circuit. When load current exceeds the secondary current limit level (about 9.6A), power device will be turned off, which can avoid input voltage drop. The total response time of short-circuit protection is about 200ns. If fast turn-off circuit works, the power device will be turned off for 260μs, then power device will be turned on again. If output short-circuit condition still exists, SGM25007 will reduce the current below the pre-set current limit threshold, and keep it until thermal shutdown happens.

Output Discharge

SGM25007 integrates output discharge function which is achieved through an internal pull-down resistor. It helps to discharge the V_{OUT} when IC is disabled with very light load.

Soft-Start

An external capacitor (C_{SS}) between SS and GND pins will set the soft-start time according to the application requirements.

During the soft-start phase, an internal 9μA constant current source begins to charge SS capacitor. The SS pin voltage starts to ramp up accordingly. The slew rate of output voltage is about 3 times that of SS voltage.

The soft-start time is calculated by:

$$t_{SS}(ms) = \frac{1}{3} \times \frac{V_{OUT}(V) \times C_{SS}(nF)}{I_{SS}(\mu A)} \quad (2)$$

where:

I_{SS} = 9μA (TYP).

It is recommended that the SS capacitor be larger than 4.7nF. If the SS pin is floated or C_{SS} is too small, the charge time of power device will limit V_{OUT} rising time.

APPLICATION INFORMATION

IMON Resistor Selection

The SGM25007 changes the current limit threshold through an external IMON resistor. The formula of current limit threshold is approximated in Equation 1. It is recommended to set the current limit threshold to 110% ~ 120% of the maximum load current. For example, if the full load of system is 7A, the current limit threshold is set to 7.7A.

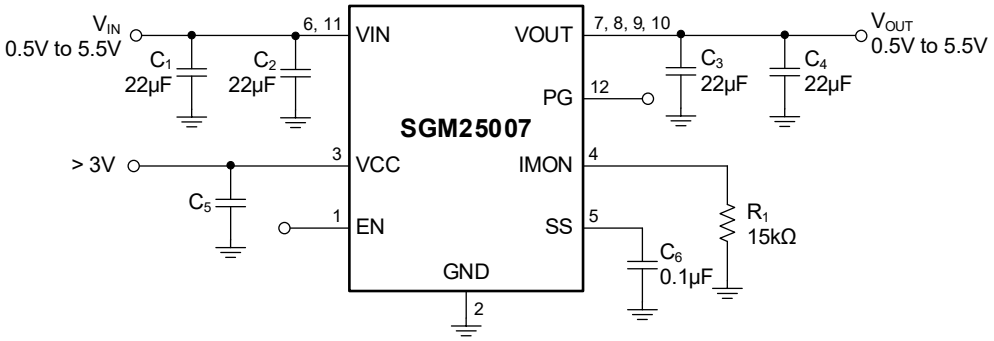
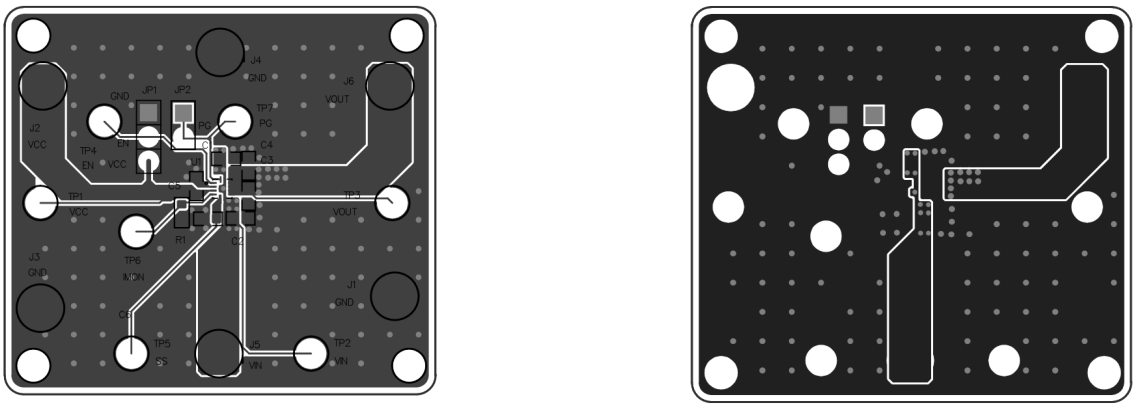


Figure 3. Typical Application

Layout Guide

A good PCB layout can achieve stable operation of the system. Please refer to the below layout guidelines and Figure 4.

- It is recommended to place R_{IMON} as close to the IMON pin as possible.
- It is recommended to place VCC capacitor as close to VCC pin as possible.
- It is recommended to place enough vias around IC to help dissipate the heat.



PCB Top Layer **PCB Bottom Layer**

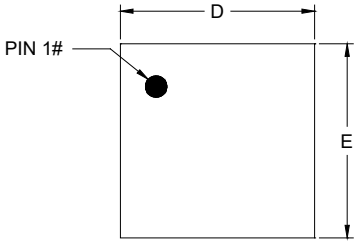
Figure 4. Recommended Layout

Changes from Original (DECEMBER 2024) to REV.A **Page**

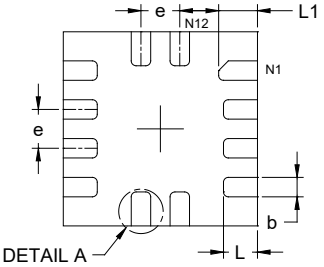
Changed from product preview to production data ..... All

PACKAGE OUTLINE DIMENSIONS

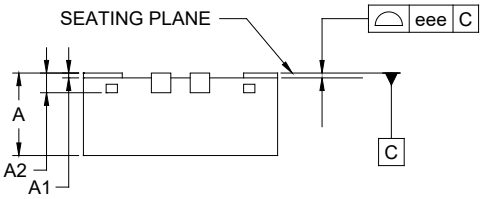
TQFN-2×2-12CL



TOP VIEW

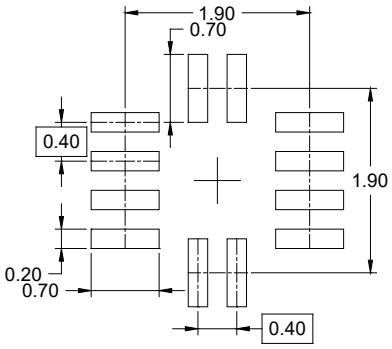


BOTTOM VIEW



SIDE VIEW

DETAIL A
ALTERNATE TERMINAL CONSTRUCTION



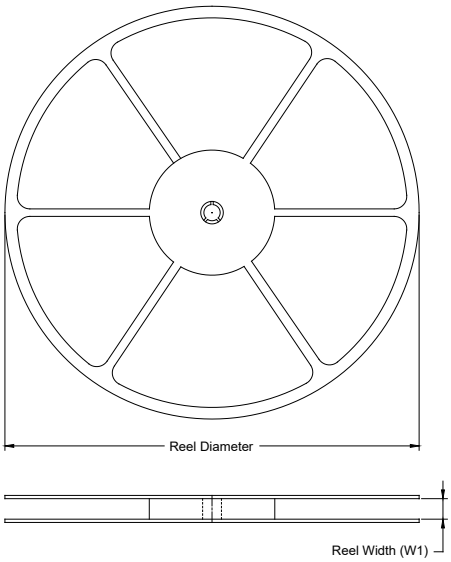
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.800	-	0.900
A1	0.000	-	0.050
A2		0.203 REF	
b	0.150	-	0.250
D	1.900	-	2.100
E	1.900	-	2.100
e		0.400 BSC	
L	0.250	-	0.450
L1	0.300	-	0.500
eee		0.080	

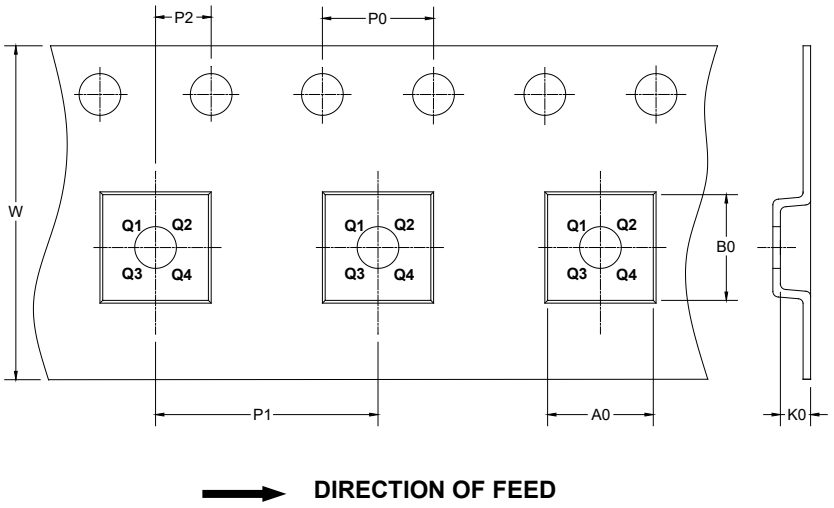
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



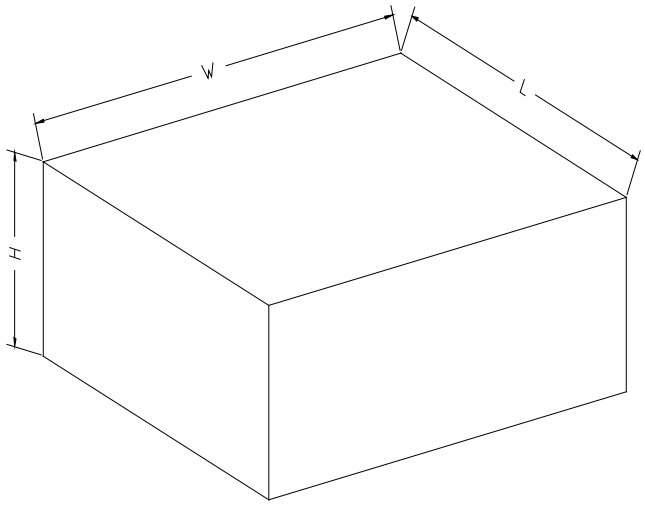
NOTE: The picture is only for reference. Please make the object as the standard.

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
TQFN-2×2-12CL	7"	8.6	2.30	2.30	1.00	4.0	4.0	2.0	8.0	Q1

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

DD0002