

### GENERAL DESCRIPTION

The SGM41106A is a monolithic primary protector device for small Li-Ion or Li-Ion polymer battery cells. The product integrates all the protections required for safe operation of polymer rechargeable cells. The device is packaged in a tiny and thin package. Its small solution size leaves more space for fitting the battery cell into a given cavity for small size wearable devices.

A bi-direction blocking switch is integrated with all essential protection functions for safe operation of the battery cell, including two for voltage abnormalities and three for currents. As a battery switch, external input is provided to set off-state. It can be used for long term stocking and power recycling.

Charging a heavily depleted cell with too low or even zero voltage is allowed by SGM41106A.

The SGM41106A is available in a Green XTDFN-1×1-4L package. It can operate in the -40°C to +85°C ambient temperature range.

### FEATURES

- Ultra-Compact Protection Solution
- Pass Resistance: 100mΩ (TYP)
- Operation Current: 0.7μA (TYP)
- Factory Programmable Over-Voltage Threshold Options 4.225V to 4.6V with 0.025V per Step
- Over-Charge/Discharge Current Protection 3 Threshold Combination Options
- Shipping Mode Function: SM Pin Logic Active-High
- Power-On Self-Locking
- Battery Under-Voltage Protection 2.8V/3.0V Options
- 0V Battery Charge Permitted
- 2nA (TYP) Deep Discharge Shutdown
- Load Short-Circuit Safe
- Battery Pack Paralleling Safe
- Charge Input Voltage Clamp
- Battery Reverse Polarity Safe
- Charge Input Reverse Polarity Safe
- Available in a Green XTDFN-1×1-4L Package

### APPLICATIONS

Earphone, Stylus, Bracelet, Watch

### TYPICAL APPLICATION

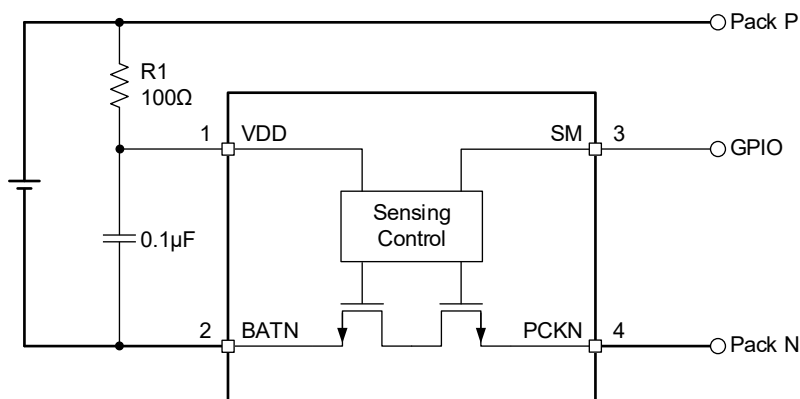


Figure 1. Typical Battery Pack Circuit

# SGM41106A Primary Protector and Switch with Shipping Mode for Tiny Li+/Poly Battery

## PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM41106A-422P31	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-422P31YXDH4G/TR	3O	Tape and Reel, 10000
SGM41106A-427O21	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-427O21YXDH4G/TR	38	Tape and Reel, 10000
SGM41106A-450O62	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-450O62YXDH4G/TR	3J	Tape and Reel, 10000
SGM41106A-452O21	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-452O21YXDH4G/TR	36	Tape and Reel, 10000
SGM41106A-452O31	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-452O31YXDH4G/TR	37	Tape and Reel, 10000
SGM41106A-455O31	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-455O31YXDH4G/TR	4Q	Tape and Reel, 10000
SGM41106A-455O62	XTDFN-1×1-4L	-40°C to +85°C	SGM41106A-455O62YXDH4G/TR	59	Tape and Reel, 10000

NOTE: For more parts, please refer to Table 1 and contact with SGMICRO.

## MARKING INFORMATION

YY

Serial Number

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.

## DEVICE DESCRIPTION

Table 1. Key Parameters and Options/Part Numbering

For All Versions								
Nominal On-State Operation Current				0.7μA				
Nominal Switch-Off Leakage Current				2nA				
Battery Off Delay				84ms				
Nominal Switch On-Resistance				100mΩ				
Model: SGM41106A-AAABCD								
Over-Voltage Threshold Options								
Option Code "AAA"	422	425	427	430	432	435	437	440
Over-Voltage Threshold (V)	4.225	4.250	4.275	4.300	4.325	4.350	4.375	4.400
Option Code "AAA"	442	445	447	450	452	455	457	460
Over-Voltage Threshold (V)	4.425	4.450	4.475	4.500	4.525	4.550	4.575	4.600
Under-Voltage Threshold Options								
Option Code "B"			O			P		
Under-Voltage Threshold (V)			2.8			3.0		
Charge/Discharge Over-Current Threshold Options								
Option Code "C"			2		3		6	
Charge/Discharge Over-Current Threshold (mA)			200/230		310/360		625/650	
Suspicious Discharge Short Current Threshold Options								
Option Code "D"			1			2		
Uncertain Discharge Short Current (A)			1.2			2.5		

NOTE: Samples are only available for some part numbers. Contact SGMICRO for sample availability.

**ABSOLUTE MAXIMUM RATINGS**

VDD to PCKN, 13V <sup>(1)</sup> , 10mA Surge Clamping <sup>(2)</sup>	5s
VDD to PCKN	-5V or +9V <sup>(3)</sup> , Continuous
SM to BATN	-0.3V to 5.5V
PCKN to BATN	-4.5V <sup>(3)</sup> or +5.5V
Pack P to Pack N Short-Circuit <sup>(4)</sup>	Continuous
Power Attachment/Detachment Peak Voltage <sup>(5)</sup>	+9V/-4.5V
Battery Attachment/Detachment Peak Voltage <sup>(6)</sup>	±4.5V
Package Thermal Resistance	
XTDFN-1×1-4L, $\theta_{JA}$	153.7°C/W
XTDFN-1×1-4L, $\theta_{JB}$	91.6°C/W
XTDFN-1×1-4L, $\theta_{JC}$ (TOP)	115.7°C/W
XTDFN-1×1-4L, $\theta_{JC}$ (BOT)	88°C/W
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10s)	+260°C
ESD Susceptibility <sup>(7) (8)</sup>	
HBM	±8000V
CDM	±1000V

**NOTES:**

1. Evaluated with  $V_{BAT} = 4.5V$ .
2. The two conditions may apply at the same time.
3. Tested with a regulated voltage source with 2A current limit and less than 1V/ms slew rate. Source is applied from 0V and then the voltage is increased to the specified level.
4. Tested with the circuit in Figure 1 and by applying a 4.5V, 5A power source to the Pack P and BATN for battery emulation. Short the Pack P and Pack N with a short wire (< 10mΩ).
5. Tested with Figure 3 circuit.
6. Tested with Figure 4 circuit.
7. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.
8. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

**RECOMMENDED OPERATING CONDITIONS**

Supply Voltage Range	0V to 6V
Battery Voltage Range	0V to 4.6V
Operating Ambient Temperature Range	-40°C to +85°C

**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.

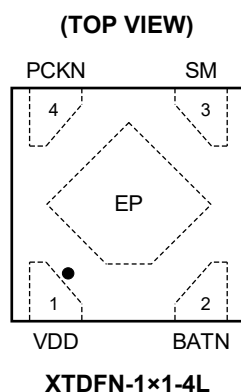
**ESD SENSITIVITY CAUTION**

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



## PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	VDD	AI	Device Bias Supply/Battery Voltage Sensing Input.
2	BATN	P	Switch Terminal: Connects to the Negative Pole of the Battery.
3	SM	AI	Shipping Mode Control Pin. Pull and hold (for a minimum time) high, to set the battery switch-off state (shipping mode).
4	PCKN	P	Switch Terminal: Connects to the Negative Terminal of the System Load.
Exposed Pad	EP	—	Package Exposed Pad with No Internal Connection. External connection to the BATN is recommended.

NOTE: AI = analog input, P = power.

## ELECTRICAL CHARACTERISTICS

(Battery voltage  $V_{BAT} = 3.7V$ ,  $T_J = -40^{\circ}C$  to  $+85^{\circ}C$ , typical values are measured at  $T_J = +25^{\circ}C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operation Voltage Range <sup>(1)</sup>	$V_{CHG\_OP}$	Normal charging source voltage range	-0.5		6	V
Normal On Voltage Range <sup>(1)</sup>	$V_{NORM\_ON}$	The maximum voltage range possibly keeps continuous on in charging	2.8		4.6	V
Switch On-Resistance	$R_{ON}$	$T_J = +25^{\circ}C$	80	100	120	mΩ
		$T_J = -40^{\circ}C$ to $+85^{\circ}C$	60	100	140	
Operating Current (VDD Current) <sup>(1)</sup>	$I_{OP}$	$T_J = +25^{\circ}C$		0.7	0.95	μA
		$T_J = -40^{\circ}C$ to $+85^{\circ}C$		0.7	1.2	
Shutdown Current	$I_{SD}$	Shutdown occurred due to battery low or due to SM input control	$T_J = +25^{\circ}C$	2	50	nA
			$T_J = -40^{\circ}C$ to $+85^{\circ}C$	2	60	
Over-Voltage Detection Delay <sup>(1)(2)</sup>	$t_{OVD}$	$T_J = +25^{\circ}C$	0.6	0.8	1	s
Under-Voltage Detection Delay <sup>(1)(2)</sup>	$t_{UVD}$	$T_J = +25^{\circ}C$	0.6	0.8	1	s
Discharge Over-Current Detection Delay <sup>(1)(2)</sup>	$t_{ODD}$	$T_J = +25^{\circ}C$	38	72	116	ms
Discharge Over-Current Retry Delay Time <sup>(1)(2)</sup>	$t_{RETRY}$	$T_J = +25^{\circ}C$	2.4	3	3.75	s
Charge Over-Current Detection Delay <sup>(1)(2)</sup>	$t_{OCD}$	$T_J = +25^{\circ}C$	38	72	116	ms
Discharge Short-Circuit Cut-Off Delay for 1 <sup>st</sup> Triggered <sup>(1)(3)(4)</sup>	$t_{DSC\_1}$	$T_J = +25^{\circ}C$	0.17	0.3	0.54	ms
Discharge Short-Circuit Cut-Off Delay during SCP Retry <sup>(1)(3)(4)</sup>	$t_{DSC\_RTY}$	$T_J = +25^{\circ}C$	0.3	0.6	1	ms
<b>Charge Battery Over-Voltage</b>						
Over-Voltage Threshold Error	$V_{OVERR}$	Voltage error to the nominal threshold voltage $V_{OV}$ (V)	$T_J = +25^{\circ}C$	-25	25	mV
			$T_J = -40^{\circ}C$ to $+85^{\circ}C$	-50	50	
Over-Voltage Threshold	$V_{OV}$	SGM41106A-422_ _ _		4.225		V
		SGM41106A-425_ _ _		4.250		
		SGM41106A-427_ _ _		4.275		
		SGM41106A-430_ _ _		4.300		
		SGM41106A-432_ _ _		4.325		
		SGM41106A-435_ _ _		4.350		
		SGM41106A-437_ _ _		4.375		
		SGM41106A-440_ _ _		4.400		
		SGM41106A-442_ _ _		4.425		
		SGM41106A-445_ _ _		4.450		
		SGM41106A-447_ _ _		4.475		
		SGM41106A-450_ _ _		4.500		
		SGM41106A-452_ _ _		4.525		
		SGM41106A-455_ _ _		4.550		
		SGM41106A-457_ _ _		4.575		
		SGM41106A-460_ _ _		4.600		
Over-Voltage Release Hysteresis <sup>(1)(2)</sup>	$V_{OVHYS}$			200		mV

## NOTES:

1. The best estimate from product characterization, guaranteed by design, functionality will be verified by other test items in production.
2. The best estimate from product characterization, guaranteed by correlated test in production.
3. The best estimate from product characterization, bench test regularly: one for each production lot.
4. Short with 100mΩ resistor.

# SGM41106A Primary Protector and Switch with Shipping Mode for Tiny Li+/Poly Battery

## ELECTRICAL CHARACTERISTICS (continued)

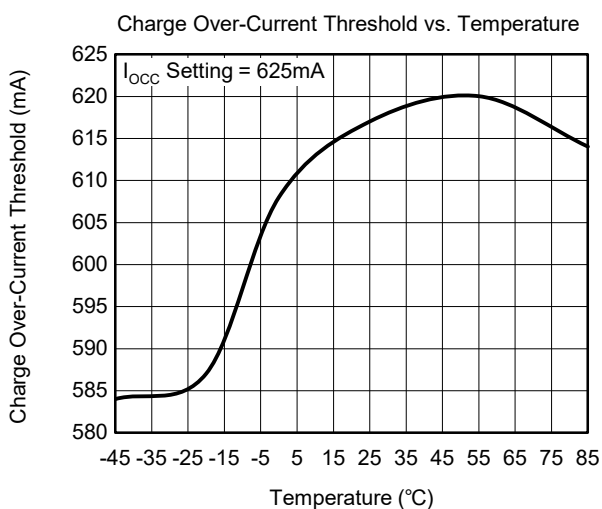
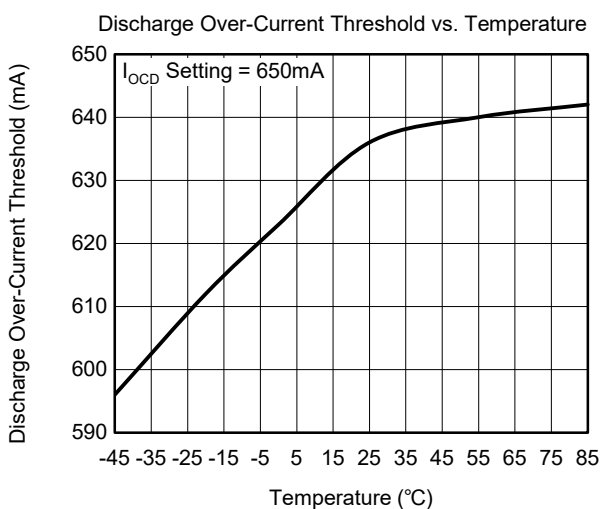
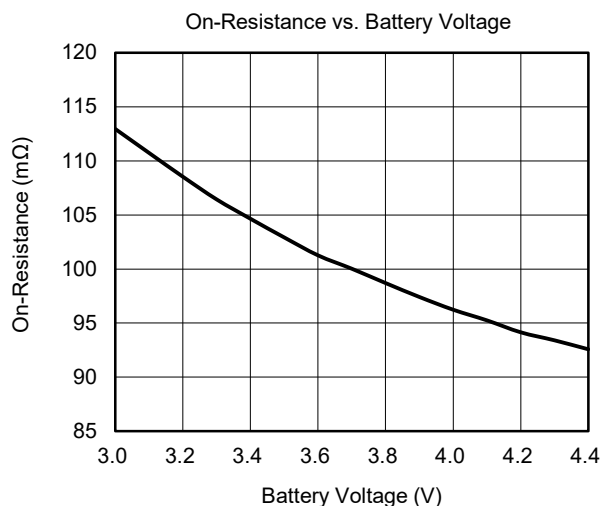
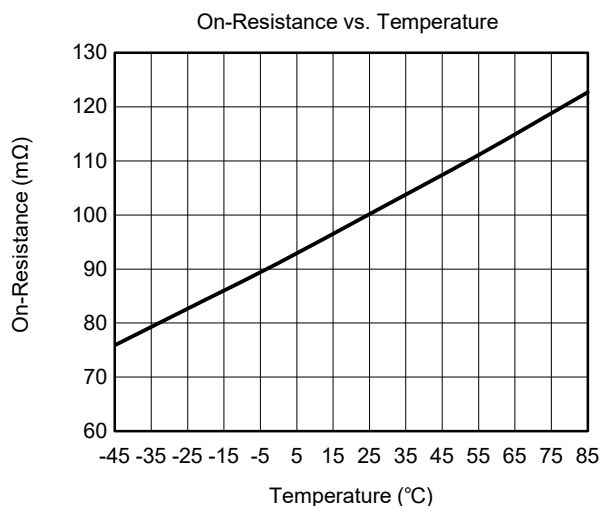
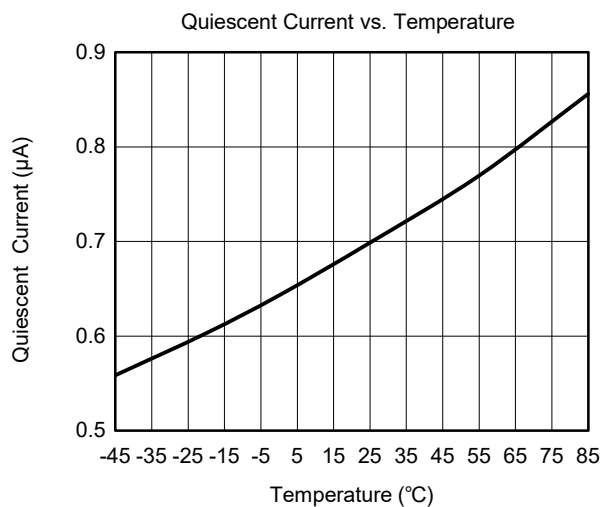
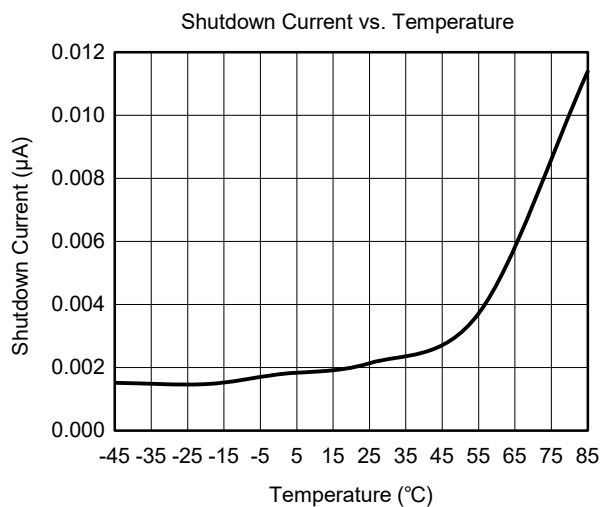
(Battery voltage  $V_{BAT} = 3.7V$ ,  $T_J = -40^{\circ}C$  to  $+85^{\circ}C$ , typical values are measured at  $T_J = +25^{\circ}C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Discharge Battery Under-Voltage							
Battery Under-Voltage Threshold	V <sub>UV</sub>	SGM41106A-___ O __	T <sub>J</sub> = +25°C	2.74	2.8	2.86	V
			T <sub>J</sub> = -40°C to +85°C	2.72	2.8	2.88	
		SGM41106A-___ P __	T <sub>J</sub> = +25°C	2.94	3.0	3.06	
			T <sub>J</sub> = -40°C to +85°C	2.92	3.0	3.08	
Under-Voltage Release Hysteresis <sup>(1) (2)</sup>	V <sub>UVHYS</sub>				200		mV
Over-Current and Short-Circuit							
Charge Over-Current Threshold	I <sub>OCC</sub>	SGM41106A-___2 __, T <sub>J</sub> = +25°C		115	200	280	mA
		SGM41106A-___3 __, T <sub>J</sub> = +25°C		210	310	400	
		SGM41106A-___6 __, T <sub>J</sub> = +25°C		500	625	770	
Discharge Over-Current Threshold	I <sub>OCD</sub>	SGM41106A-___2 __, T <sub>J</sub> = +25°C		140	230	340	mA
		SGM41106A-___3 __, T <sub>J</sub> = +25°C		260	360	460	
		SGM41106A-___6 __, T <sub>J</sub> = +25°C		500	650	790	
Discharge Short-Circuit Threshold <sup>(1) (3) (4)</sup>	I <sub>DSC</sub>	SGM41106A-_____1			1.2	1.7	A
		SGM41106A-_____2			2.5	3.3	
SM Input							
Shipping Mode Effective Voltage <sup>(1)</sup>	V <sub>PD</sub>	Voltage difference to V <sub>PCKN</sub>		1.55			V
SM Pin to Switch-Off Delay <sup>(1) (2)</sup>	t <sub>SM</sub>	Hold in the effective pulling level, T <sub>J</sub> = +25°C		57	84	116	ms

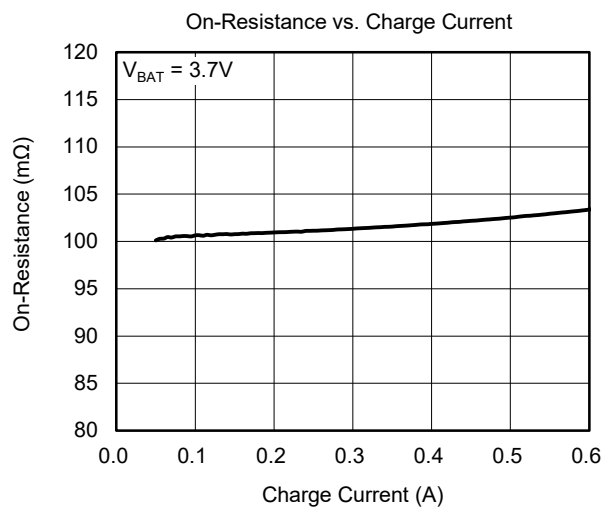
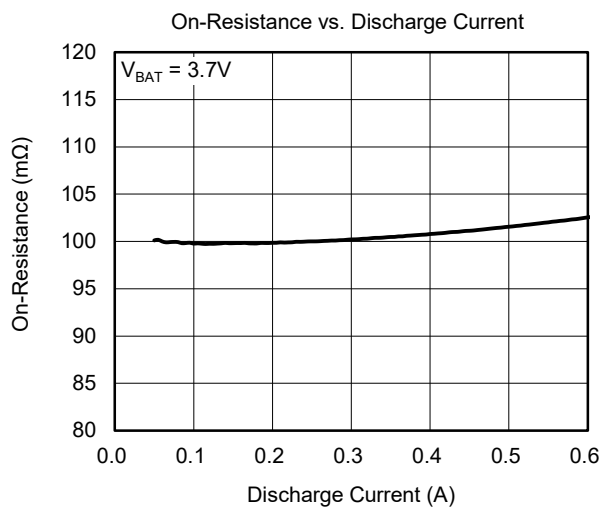
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## TYPICAL PERFORMANCE CHARACTERISTICS



## TYPICAL PERFORMANCE CHARACTERISTICS (continued)





# SGM41106A Primary Protector and Switch with Shipping Mode for Tiny Li+/Poly Battery

## FUNCTIONAL BLOCK DIAGRAM

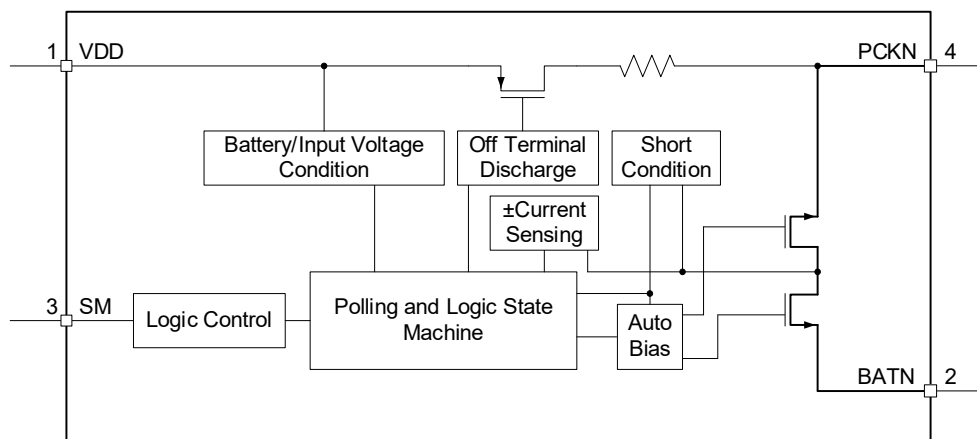


Figure 2. Block Diagram

## TEST SETUP DIAGRAMS

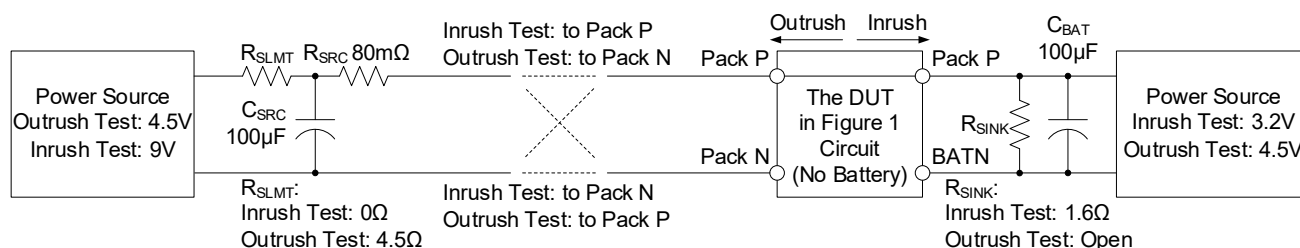


Figure 3. Power Attachment/Detachment Test Setup

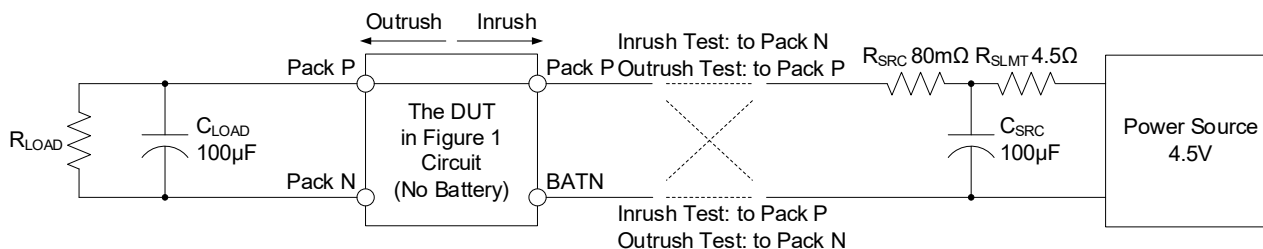


Figure 4. Battery Attachment/Detachment Test Setup

## DETAILED DESCRIPTION

The SGM41106A is a Li-Ion/Li-Ion polymer battery protector with integrated battery switch. It provides a full set of protection functions on voltage and current, and can disconnect the battery using the integrated switch. To reduce the power consumption, the battery voltage and current are measured periodically (polling), but the short-circuit condition is continuously monitored when the switch is turned on so that the device can instantly respond and turn off the switch if a suspicious short is detected in the load.

### Voltage Related Protections

The battery voltage, sensed between the VDD and BATN pins, is monitored periodically (with deglitch time) while the charge input and battery connection are detected instantly.

During charging, in every detection cycle, the battery is checked for over-voltage. When a high battery voltage is detected ( $V_{BAT} > V_{OV}$ ), the battery switch is turned into charge block mode to prohibit any further charging and allows current only in the discharge direction. The charge is unblocked when the battery voltage drops to a safe level due to discharge. The battery over-voltage threshold ( $V_{OV}$ ) depends on the selected "AAA" code of the device.

If the battery voltage is not in the over-voltage range, it is checked every detection cycle for low voltage. When a low battery voltage is detected ( $V_{BAT} < V_{UV}$ ), the battery switch blocks battery discharge direction and the device goes to the lossless off-state. The battery switch allows current only in the charge direction, and the charge over-current detection does not function in the under-voltage protection status. The battery low voltage threshold ( $V_{UV}$ ) depends on the selected "B" code of the device.

### Current Related Protections

The battery current ( $I_{BAT}$ ) is monitored periodically while the battery switch is turned on. Both charge and discharge are protected against over-current, each with its own threshold and delay timer ( $t_{OCD} = 72ms$  for charging,  $t_{ODD} = 72ms$  for discharging). Charge or discharge is blocked if the corresponding over-current is detected. Charge or discharge over-current threshold ( $I_{OCC}$  or  $I_{ODD}$ ) depends on the selected "C" code of the device.

Charge block is released when charge status is invalidated by detecting a switch forward voltage.

Discharge recovery is by hiccup mode and the block time is  $t_{RETRY} = 3s$  after it is detected. If a discharge over-current is detected again, it is blocked for another  $t_{RETRY}$  time.

### Load Short Protection

If the discharge current exceeds  $I_{DSC}$  (1.2A or 2.5A depends on "D" code), the battery switch is turned into discharge block mode and the battery attaching timer starts for retrying (hiccup).

### Battery Reverse Polarity Attachment

In case of reverse battery attachment, the current into the load is not blocked by the device. The reverse current cannot damage the device and it is safe unless the current is too high and results in overheating damage.

### Charging Input Reverse Polarity Attachment

Reverse attachment of a charging input with less than 5V is safe and does not cause damage to the device (no current flows out of the battery). The reverse attaching of charger causes a discharge over-current event and the switch is turned into the discharge block mode.

### Shipping Mode Control

SM pin active-high: when the SM pin voltage is equal to or higher than  $V_{PD}$  and lasts for  $t_{SM}$  or longer, the SGM41106A turns off the discharge MOSFETs and the discharging is stopped.

Note that SM pin is edge sensitive and must change state. The input state is latched to the last applied state even if the input floats a short time after transition. The shipping mode state is released only if the charger is activated.

### Power-On Self-Locking Function

The SGM41106A is self-locked and the battery cannot discharge at first welding. The status is released when the charger is detected.

### Parallel Battery Packs

When two battery packs are connected in parallel utilizing SGM41106As, a momentary current surge may cause charge over-current protection in the pack with the lower voltage. The higher voltage pack could enter a discharge over-current protection. The charge over-current or discharge over-current protection resets only after the higher voltage battery pack discharges to a voltage slightly higher than the lower voltage pack. After this discharge, both packs can conduct.

## APPLICATION INFORMATION

For the device and battery cell, the short-circuit and ESD tests are critical on the assembled battery and protector packs (with and without a battery cell). ESD or short surges may degrade the overall reliability and cause early aging on both parts.

If such tests are conducted on the assembled pack, use a low voltage source with low inductance for the short-circuit protection test.

## ESD Test

If the battery is the largest conducting object in the assembly and shields other parts of the equipment, a careful ESD discharging path design is needed to direct the ESD current to the free wires or free PCB copper stripes for uninterrupted operation.

To improve the system ESD level and reduce the sensitivity of the device to ESD, it is recommended to add one capacitor ( $0.1\mu\text{F}$ ) between BATN and PCKN as illustrated in Figure 5.

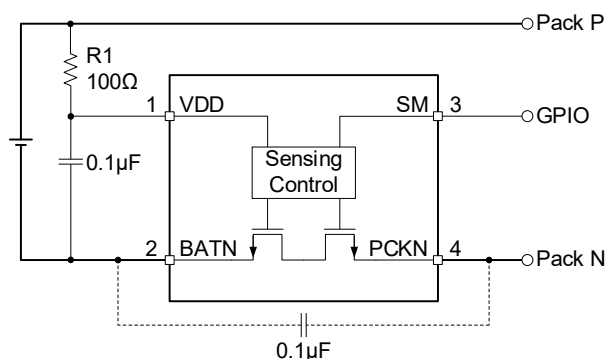


Figure 5. Recommended Capacitor Placement for ESD Protection

## Input Clamp and Discharge

If a charging input with over-voltage is applied to the pack, the VDD-PCKN is protected by the serial resistor R1 and the VDD-PCKN break-down. The voltage difference between the input and battery appears on the switch (BATN to PCKN). This switch has a break-down (clamp) with above 10mA discharge capability without damage. The battery pack terminal voltage (Pack P to Pack N) initiates clamping, and it is about 13V when the battery voltage is 4.5V.

## EVISION HISTORY

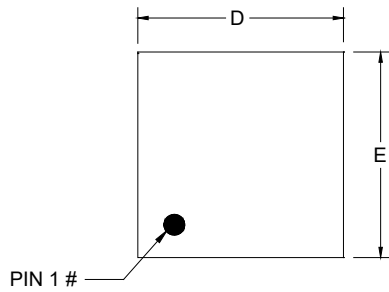
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

## Changes from Original (APRIL 2025) to REV.A

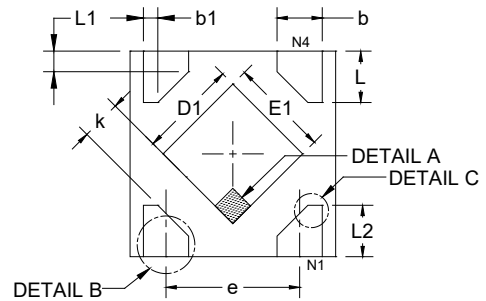
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## PACKAGE OUTLINE DIMENSIONS

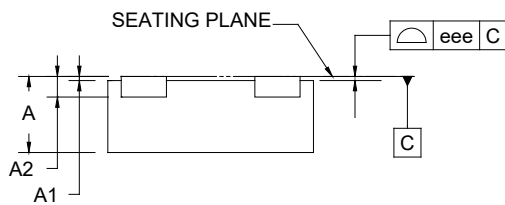
### XTDFN-1×1-4L



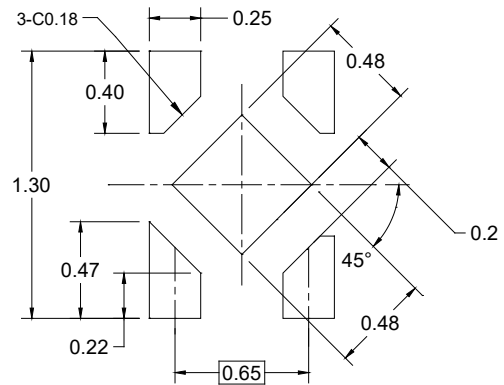
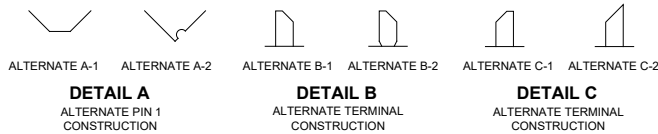
TOP VIEW



BOTTOM VIEW



SIDE VIEW



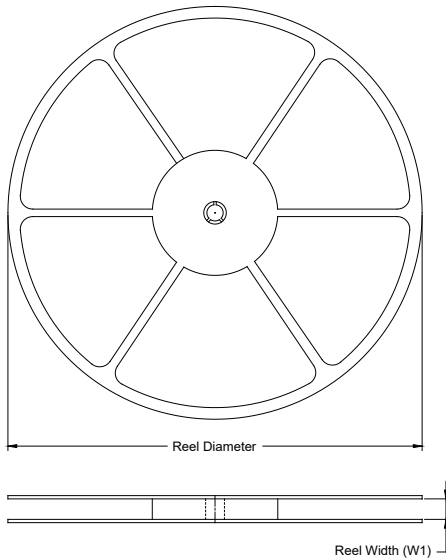
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.340	0.370	0.400
A1	0.000	0.020	0.050
A2	0.100 REF		
b	0.170	-	0.300
b1	0.068 REF		
D	0.950	1.000	1.050
E	0.950	1.000	1.050
D1	0.430	0.480	0.530
E1	0.430	0.480	0.530
L	0.200	0.250	0.300
L1	0.093 REF		
L2	0.200	-	0.370
e	0.650 BSC		
k	0.150	-	-
eee	-	0.050	-

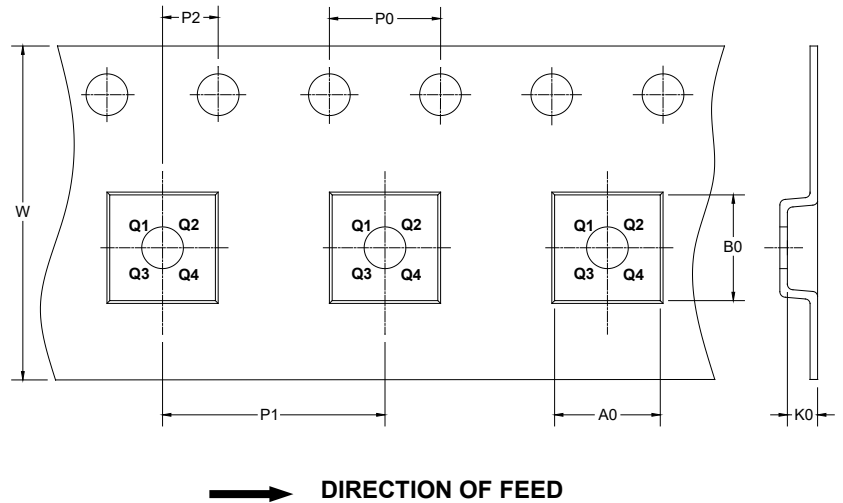
NOTE: This drawing is subject to change without notice.

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSIONS



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

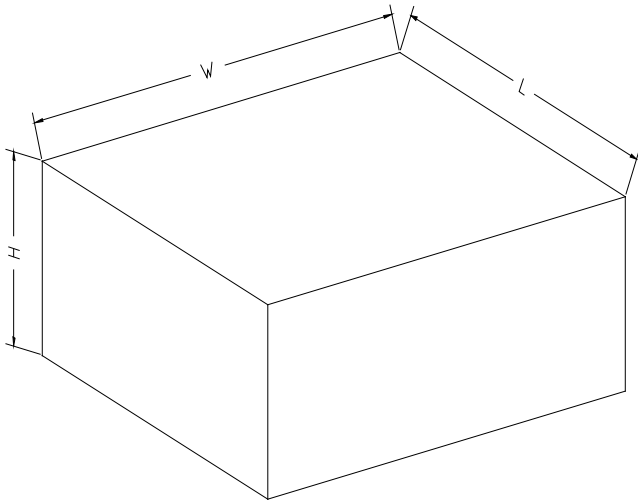
### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
XTDFN-1×1-4L	7"	9.5	1.16	1.16	0.50	4.0	2.0	2.0	8.0	Q1

DD00001

## PACKAGE INFORMATION

### 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