SGM2564/SGM2565
5.5V, 4A, 14mΩ R_{ON}, Load Switches with Reverse Current Protection and Controlled Turn On

GENERAL DESCRIPTION

The SGM2564 and SGM2565 product family is a small, ultra-low on-resistance load switch with controlled turn on. The load switch contains an N-MOSFET that can operate over an input voltage range of 1V to 5.5V and support a maximum continuous current of 4A. An integrated charge pump biases the NMOS switch in order to achieve a low switch R_{ON}. The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage GPIO control signals. The rise time of the device is internally controlled in order to avoid inrush current.

The SGM2564 and SGM2565 provide reverse current protection. When the power switch is disabled, the device will not allow the flow of current towards the input side of the switch. The reverse current protection feature is active only when the device is disabled so as to allow for intentional reverse current (when the switch is enabled) for some applications.

The SGM2564 and SGM2565 are available in Green WLCSP-1.45×0.95-6B package. They operate over an ambient temperature range of -40℃ to +85℃.

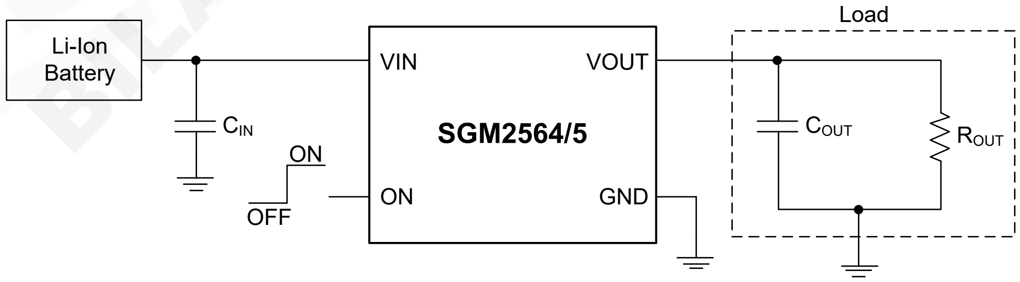
FEATURES

- **Integrated N-MOSFET Load Switch**
- **Input Voltage Range: 1V to 5.5V**
- **Ultra-Low On-Resistance**
  - **R_{ON} = 13.8mΩ at V_{IN} = 5V**
  - **R_{ON} = 14mΩ at V_{IN} = 3.3V**
  - **R_{ON} = 15mΩ at V_{IN} = 1.8V**
- **Reverse Current Protection (When Disabled)**
- **Low Shutdown Current: 144nA (TYP)**
- **Low Threshold 1.3V GPIO Control Input**
- **Controlled Slew Rate to Avoid Inrush Current**
- **Quick Output Discharge (SGM2564 Only)**
- **Bi-directional Power Supplier for Power Zone Application**
- **Available in Green WLCSP-1.45×0.95-6B Package**

APPLICATIONS

Smartphone
Notebook Computer and Ultrabook
Tablet PC Computer
Solid State Drive (SSD)
DTV/IP Set Top Box
POS Terminal and Media Gateway

TYPICAL APPLICATION CIRCUIT



PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2564	WLCSP-1.45×0.95-6B	-40℃ to +85℃	SGM2564YG/TR	XXX MZF	Tape and Reel, 3000
SGM2565	WLCSP-1.45×0.95-6B	-40℃ to +85℃			

MARKING INFORMATION

NOTE: XXX = Date Code and Trace Code.

X X X

Trace Code

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

Input Voltage Range, V_{IN} .... -0.3V to 6V
Output Voltage Range, V_{OUT} ....-0.3V to 6V
ON Pin Voltage Range, V_{ON}.................................-0.3V to 6V
Maximum Continuous Switch Current, I_{MAX}............ 4A (MAX)
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range, V_{IN} ....1V to 5.5V
Output Voltage Range, V_{OUT} ....0V to 5.5V
High-Level ON Pin Voltage, V_{IH_ON} ....1.2V to 5.5V
Low-Level ON Pin Voltage, V_{IL_ON} ....0V to 0.4V
Input Capacitance, C_{IN} 1μF (1)
Ambient Temperature Range.........................-40℃ to +85℃
Junction Temperature Range ....-40℃ to +125℃

NOTE: See the Input Capacitor section.

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

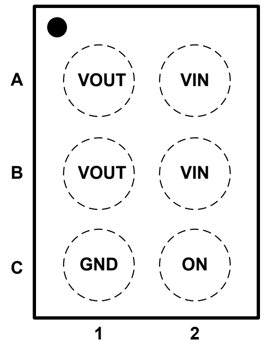
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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, or specifications without prior notice.

PIN CONFIGURATION

(TOP VIEW)



WLCSP-1.45×0.95-6B

PIN DESCRIPTION

PIN	NAME	FUNCTION
A1, B1	VOUT	Switch Output.
A2, B2	VIN	Switch Input. Use a bypass capacitor (ceramic) to ground.
C1	GND	Ground.
C2	ON	Switch Control Input. Do not float this pin. Logic high turns on power switch.

ELECTRICAL CHARACTERISTICS

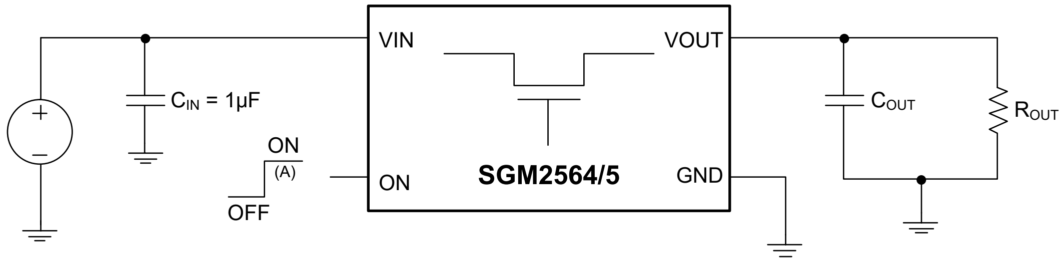
(Typical values are at T_A = +25℃, V_{IN} = 1V to 5.5V. unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}		1		5.5	V
Quiescent Current	I_{Q_VIN}	I_{OUT} = 0, V_{ON} = V_{IN} = 5V		511		nA
		I_{OUT} = 0, V_{ON} = V_{IN} = 4.5V		482		
		I_{OUT} = 0, V_{ON} = V_{IN} = 3.3V		419		
		I_{OUT} = 0, V_{ON} = V_{IN} = 2.5V		394		
		I_{OUT} = 0, V_{ON} = V_{IN} = 1.8V		351		
		I_{OUT} = 0, V_{ON} = V_{IN} = 1.2V		291		
		I_{OUT} = 0, V_{ON} = V_{IN} = 1.1V		267		
		I_{OUT} = 0, V_{ON} = V_{IN} = 1V		242		
Shutdown Current	I_{SD_VIN}	V_{ON} = 0V, V_{IN} = 5V, V_{OUT} = 0V		144		nA
		V_{ON} = 0V, V_{IN} = 1V, V_{OUT} = 0V		24		
On-Resistance	R_{ON}	V_{IN} = 5V, I_{OUT} = -200mA		13.8		mΩ
		V_{IN} = 3.3V, I_{OUT} = -200mA		14		mΩ
		V_{IN} = 1.8V, I_{OUT} = -200mA		15		mΩ
		V_{IN} = 1V, I_{OUT} = -200mA		22		mΩ
ON Pin Hysteresis	V_{HYS_ON}	V_{IN} = 5V		56		mV
		V_{IN} = 3.3V		47		
		V_{IN} = 1.8V		37		
		V_{IN} = 1V		35		
ON Pin Leakage Current	I_{ON}	V_{ON} = 1.1V to 5.5V		344		nA
Reverse Current When Disabled	I_{RC_VIN}	V_{IN} = V_{ON} = 0V, V_{OUT} = 5V		9		nA
Output Pull-Down Resistance (SGM2564 Only)	R_{PD}	V_{ON} = 0V, I_{OUT} = 2mA		275		Ω

SWITCHING CHARACTERISTICS

PARAMETER		CONDITIONS	TYP	UNITS
V_{IN} = 5.0V, T_A = +25℃, unless otherwise noted.				
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	1250	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	6.5	
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	912	
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	2.1	
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	937	
V_{IN} = 4.5V, T_A = +25℃, unless otherwise noted.				
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	1187	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	6.5	
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	890	
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	2.1	
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	937.5	
V_{IN} = 3.3V, T_A = +25℃, unless otherwise noted.				
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	1062	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	6.25	
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	818	
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	2	
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	875	
V_{IN} = 1.8V, T_A = +25℃, unless otherwise noted.				
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	812	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	6.25	
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	571	
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	2.3	
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	687.5	
V_{IN} = 1.2V, T_A = +25℃, unless otherwise noted.				
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	812	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	13.75	
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	470	
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	2.18	
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF	687	

PARAMETER MEASURMENT INFORMATION



Test Circuit

A: Rise and fall times of the control signal are 100ns.

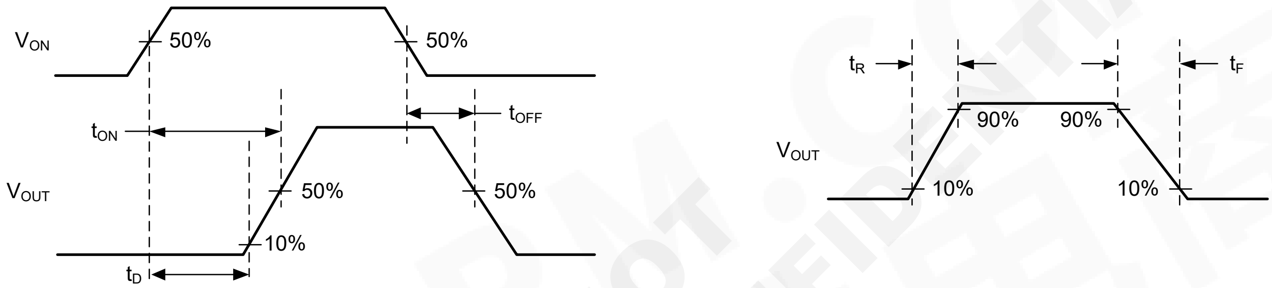
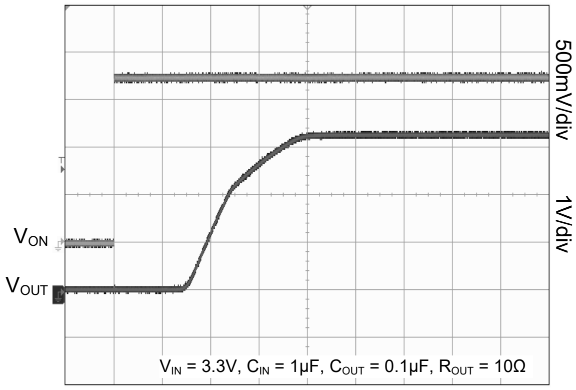


Figure 1. Timing Waveforms

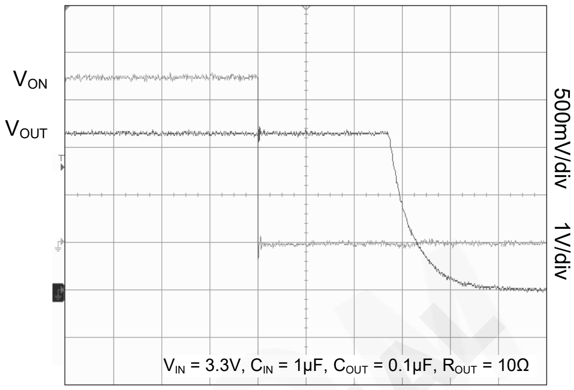
TYPICAL PERFORMANCE CHARACTERISTICS

Turn-On Response Time



Time (500μs/div)

Turn-Off Response Time



Time (2μs/div)

FUNCTIONAL BLOCK DIAGRAM

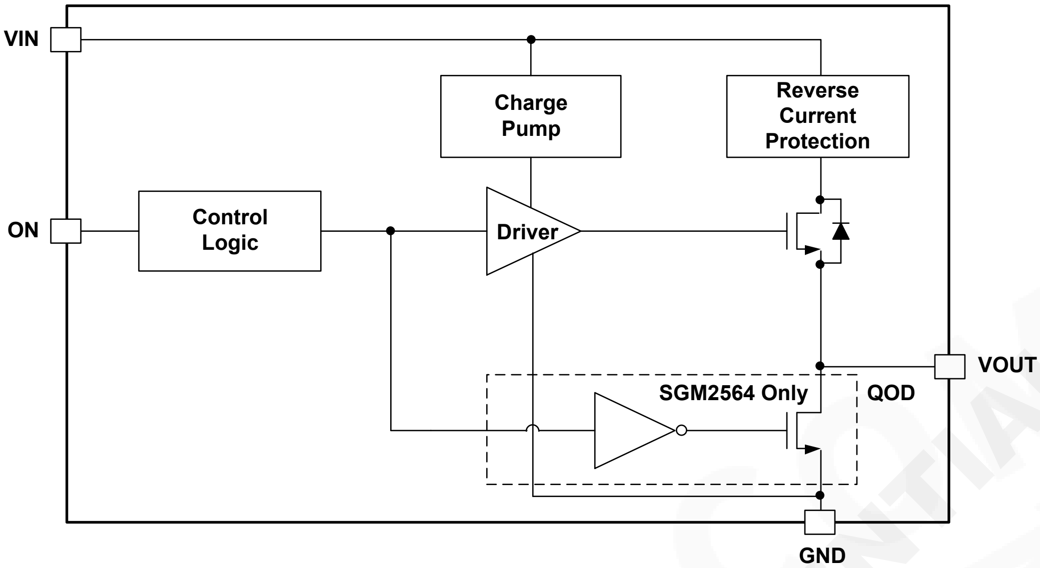


Figure 2. Block Diagram

FUNCTIONAL TABLE

ON	VIN TO VOUT	OUTPUT DISCHARGE [1] (SGM2564 Only)
L	Off	Active
H	On	Disabled

NOTE: 1. This feature discharges the output of the switch to ground through a 275Ω resistor, preventing the output from floating.

DETAILED DESCRIPTION

The SGM2564/5 are single channel, 4A load switches in a small, space saving WLCSP package. These devices implement an N-MOSFET to provide an ultra-low on-resistance for a low voltage drop across the device. A controlled rise time is used in applications to limit the inrush current.

ON/OFF Control

The ON pin controls the state of the switch. It is an active "high" pin and has a low threshold making it capable of interfacing with low voltage GPIO control signals. It can be used with any microcontroller with 1.2V, 1.8V, 2.5V, 3.3V or 5.5V GPIOs. Applying V_{IH_ON} on the ON pin will put the switch in the on-state and V_{IL_ON} will put the switch in the off-state.

Quick Output Discharge

The SGM2564 includes the quick output discharge (QOD) feature. When the switch is disabled, a discharge resistance with a typical value of 275Ω is connected between the output and ground. This resistance pulls down the output and prevents it from floating when the device is disabled.

TYPICAL APPLICATION

SGM2564/5 are ultra-low on-resistance, 4A integrated load switches that are capable of interfacing directly with 1S battery in portable consumer devices such as smartphones, tablets etc. Its wide input voltage range (1V to 5.5V) makes it suitable to be used for lower voltage rails as well inside different end equipment to accomplish power sequencing, inrush current control and reducing leakage current in sub-systems that are in standby mode. Figure 3 shows the typical application circuit of SGM2564/5.

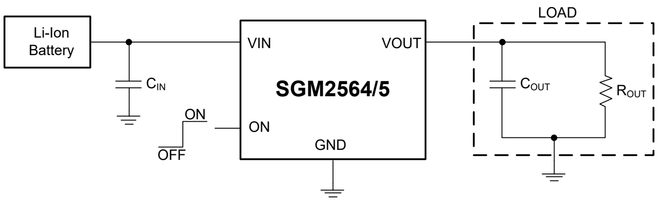


Figure 3. Typical Application Circuit

Design Requirements

DESIGN PARAMETER	EXAMPLE VALUE
V_{IN}	3.3V
C_L	4.7μF
Maximum Acceptable Inrush Current	30mA

Managing Inrush Current

When the switch is enabled, the output capacitors must be charged up from 0V to the set value (3.3V in this example). This charge arrives in the form of inrush current. Inrush current can be calculated using the following equation:

$$I_{INRUSH} = C_{OUT} \times \frac{dV_{OUT}}{dt}$$

where:

• C_{OUT} is output capacitance.
• dV_{OUT} is output voltage.
• dt is rise time.

The SGM2564/5 offer controlled rise time for minimizing inrush current. These devices can be selected based upon the minimum acceptable rise time which can be calculated using the design requirements and the inrush current equation. An output capacitance of 4.7μF will be used since the amound of inrush current increases with output capacitance:

$$30mA = 4.7\mu F \times 3.3V/dt \quad (2)$$

$$dt = 517\mu s \quad (3)$$

To ensure an inrush current of less than 30mA, a device with a rise time greater than 517μs must be used. The SGM2564/5 has a typical rise time of 818μs at 3.3V which meets the above design requirements.

APPLICATION INFORMATION

Input Capacitor

It is recommended to place a C_{IN} between VIN and GND pins. This capacitor helps to limit the voltage drop on the input voltage supply when the switch turns on into a discharged load capacitor. A 1μF ceramic capacitor that is placed close to the IC pins is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop in high current applications.

Output Capacitor

It is recommended to place a C_{OUT} between VOUT and GND pins. This capacitor acts as a low pass filter along with the switch on-resistance to remove any voltage glitches coming from the input voltage source. It is generally recommended to have C_{IN} greater than C_{OUT} so that once the switch is turned on, C_{OUT} can charge up to V_{IN} without V_{IN} dropping significantly. A 0.1μF ceramic capacitor that is placed close to the IC pins is usually sufficient.

Standby Power Reduction

Any end equipment that is being powered from the battery has a need to reduce current consumption in order to keep the battery charged for a longer time. SGM2564/5 help to accomplish this by turning off the supply to the modules that are in standby state and hence significantly reduces the leakage current overhead of the standby modules.

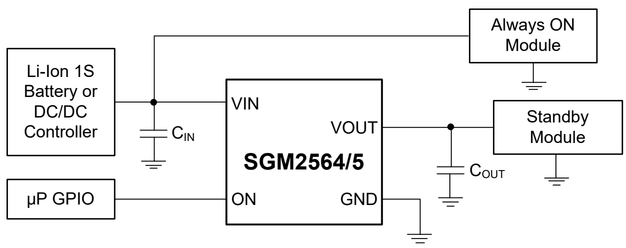


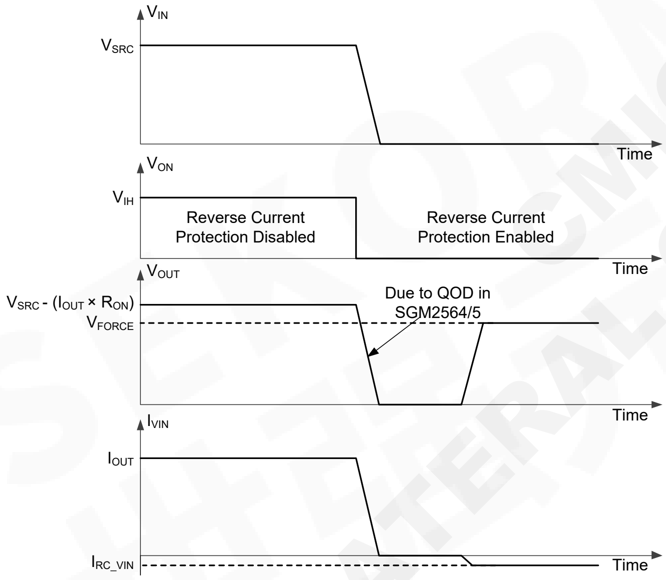
Figure 4. Standby Power Reduction

APPLICATION INFORMATION (continued)

Reverse Current Protection

The reverse current protection feature prevents the current to flow from VOUT to VIN when SGM2564/5 are disabled. This feature is particularly useful when the outputs of SGM2564/5 need to be driven by another voltage source after SGM2564/5 are disabled (for example in a power multiplexer application). In order for this feature to work, SGM2564/5 have to be disabled and either of the following conditions shall be met: V_{IN} > 1V or V_{OUT} > 1V.

Figure 5 demonstrates the ideal behavior of reverse current protection circuit in SGM2564/5. After the device is disabled via the ON pin and VOUT pin is forced to an external voltage V_{FORCE}, a very small amount of current given by I_{RC_VIN}, V_{IN} will flow from VOUT to VIN. This will prevent any extra current loading on the voltage source supplying the V_{FORCE} voltage.



I_{VIN} = Current through VIN pin.

V_{SRC} = Input voltage applied to the device.

V_{FORCE} = external voltage source forced at VOUT pin of the device.

I_{OUT} = output load current.

Figure 5. Reverse Current Protection

Power Supply Sequencing without a GPIO Input

In many end equipment, there is a need to power up various modules in a pre-determined manner. SGM2564/5 can solve the problem of power sequencing without adding any complexity to the overall system. Figure 6 shows the configuration required for powering up two modules in a fixed sequence. The output of the first load switch is tied to the enable of the second load switch, so when module 1 is powered the second load switch is enabled and module 2 is powered.

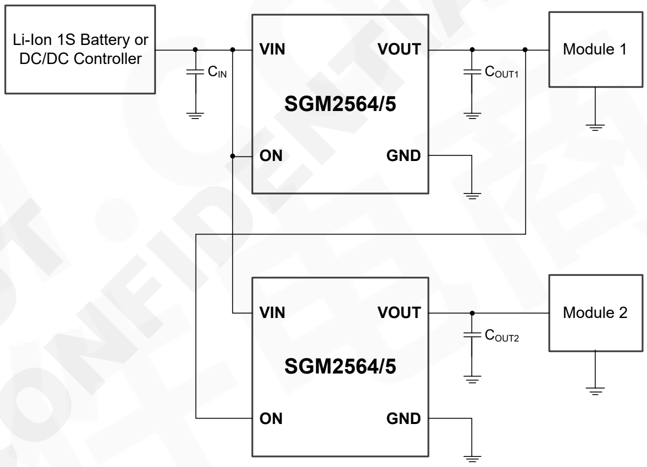


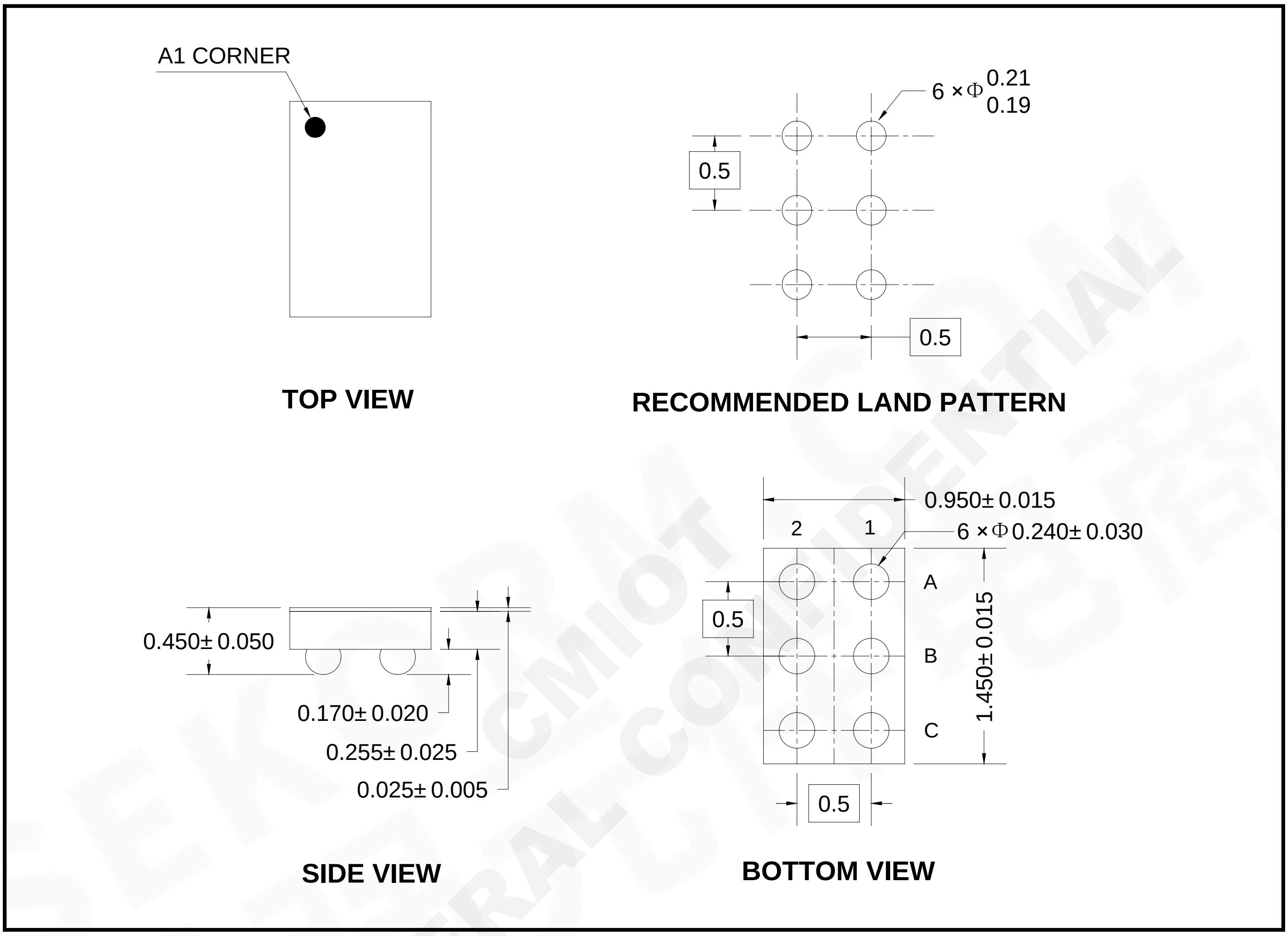
Figure 6. Power Supply Sequencing without a GPIO Input

Power Supply Recommendations

The device is designed to operate from a V_{IN} range of 1V to 5.5V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1μF bypass capacitor. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10μF may be sufficient.

PACKAGE OUTLINE DIMENSIONS

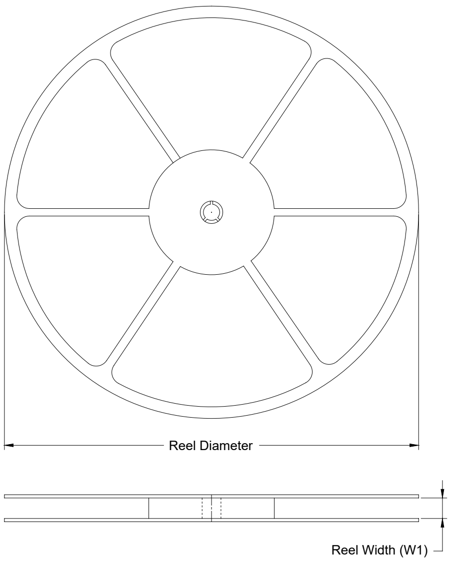
WLCSP-1.45×0.95-6B



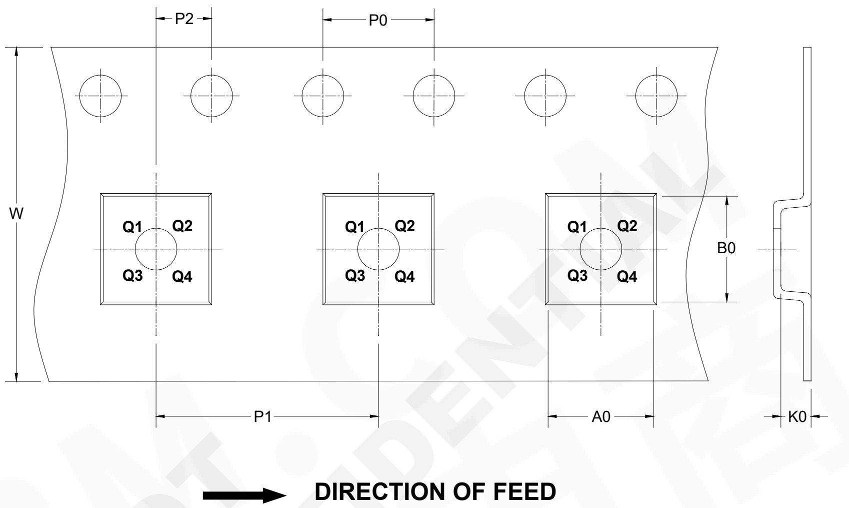
NOTE: All linear dimensions are in millimeters.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



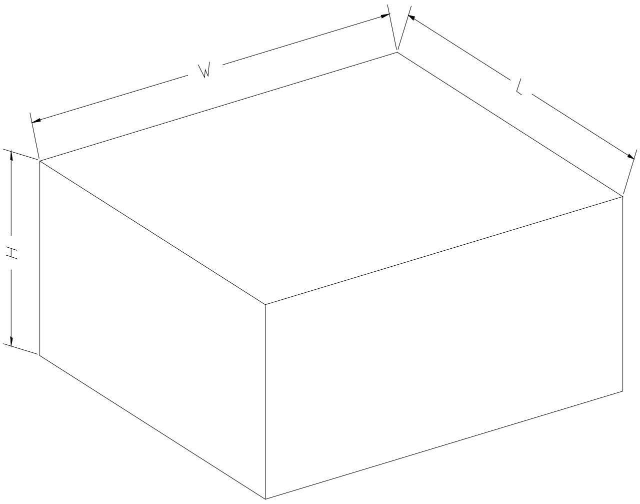
NOTE: The picture is only for reference. Please make the object as the standard.

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
WLCSP-1.45×0.95-6B	7"	9.0	1.12	1.57	0.62	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