SGM66052
Efficient Synchronous Step-Up Converter with a 2.7A Switch in UTDFN Package

GENERAL DESCRIPTION

The SGM66052 is an internally compensated, 1.1MHz switching frequency, current mode, synchronous step-up switching regulator, which is capable of generating 5V output at 1A load current from a 3.3V rail.

This device turns into power-saving mode to maintain high efficiency by lowering switching frequency. With its anti-ringing circuitry damping the charge in parasitic capacitor, it reduces EMI interference significantly. Its output is disconnected by the rectifier circuit during shutdown, with no input to output leakage.

The SGM66052-5.1 is preset for outputting 5.1V, while the SGM66052-ADJ is output voltage programmable with an external resistor divider.

The device is available in the Green UTDFN-2×1.5-6L package and operates over an ambient temperature range of -40℃ to +85℃.

FEATURES

- **90% Efficient Synchronous Boost Converter**
- **Device Quiescent Current: 20μA (TYP)**
- **Less than 1μA Shutdown Current**
- **Operating Input Voltage Range: 2.2V to 4.5V**
- **Fixed Output Voltage: 5.1V**
- **Output Voltage Clamping: 6V**
- **Adjustable Output Voltage Up to 5.2V**
- **Power-Save Mode for Improved Efficiency at Low Output Power**
- **Load Disconnect During Shutdown**
- **Low Reverse Leakage Current when V_{OUT} > V_{IN}**
- **Over-Temperature Protection**
- **Available in Green UTDFN-2×1.5-6L Package**
- **-40℃ to +85℃ Operating Temperature Range**

APPLICATIONS

Single-Cell Li-Ion Powered Products
Portable Audio Players
Cellular Phones
Personal Medical Products

TYPICAL APPLICATION

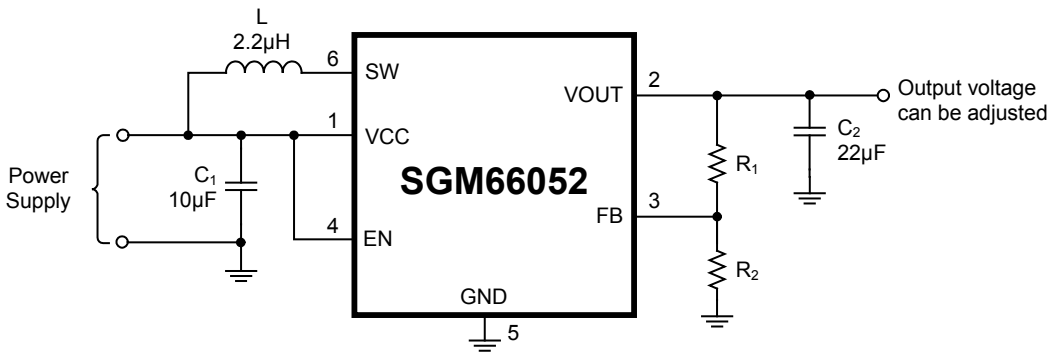


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	V_{OUT} (V)	PACKAGE DESCRIPTION	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM66052	5.1	UTDFN-2×1.5-6L	SGM66052-5.1YUDR6G/TR	G46 XXXX	Tape and Reel, 3000
	Adjustable	UTDFN-2×1.5-6L	SGM66052-ADJYUDR6G/TR	G48 XXXX	Tape and Reel, 3000

NOTE: XXXX = Date 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

Input Voltage Range on SW, VOUT, VCC, FB, EN ..... -0.3V to 6V
Package Thermal Resistance
UTDFN-2×1.5-6L, θ_{JA} ..... 75℃/W
Junction Temperature ..... +150℃
Storage Temperature Range..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM..... 4000V
MM..... 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Reliable Operating Input Voltage Range..... 2.2V to 4.5V
Operating 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.

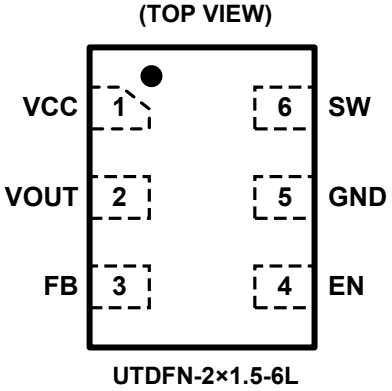
ESD SENSITIVITY CAUTION

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 CONFIGURATION



PIN DESCRIPTION

PIN	NAME	FUNCTION
1	VCC	Supply Input.
2	VOUT	Boost Converter Output. Place a storage capacitor close to this pin.
3	FB	Output Voltage Feedback Input or Internally Connected Pin. Connect to tap of external resister divider for SGM66052-ADJ; leave it floating for SGM66052-5.1.
4	EN	Enable Input. Input logic high to enable this circuit and logic low to shut down. Do not leave this pin unconnected.
5	GND	Ground.
6	SW	Boost and Rectifying Switch Input.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.6V. Full = -40℃ to +85℃, typical values are at T_A = +25℃, unless otherwise noted.)

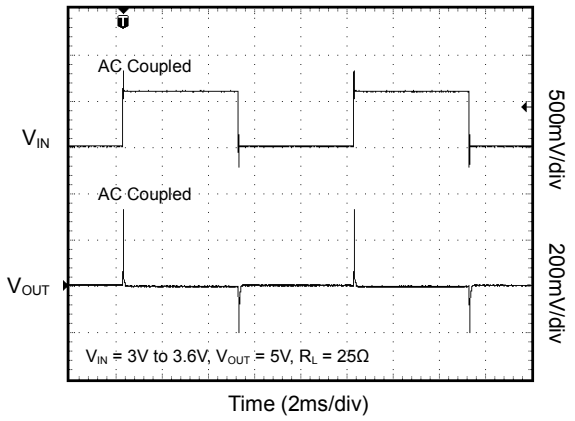
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
DC/DC STAGE							
Output Voltage Range	V_{OUT}	V_{IN} < 0.9V_{OUT}	Full	3.0		5.2	V
Input Voltage Range	V_{IN}		+25℃	2.2		5.2	V
Feedback Voltage	V_{FB}	SGM66052-ADJ	Full	478	495	510	mV
Switching Frequency	f		Full	850	1100	1300	kHz
Switch Current Limit	I_L		+25℃	2.15	2.7	3.25	A
Start-Up Current Limit			+25℃		500		mA
Boost Switch On-Resistance		V_{OUT} = 5.1V	+25℃		100		mΩ
Rectifying Switch On-Resistance		V_{OUT} = 5.1V	+25℃		110		mΩ
Output Voltage		SGM66052-5.1	Full	4.86	5.05	5.18	V
Line Regulation		V_{CC} = 2.7V to V_{OUT} - 0.5V	+25℃		0.5		%
Load Regulation			+25℃		0.5		%
Quiescent Current	I_Q	V_{EN} = V_{CC} = 3.6V, not switching	+25℃		20	35	μA
Shutdown Current		V_{EN} = 0V, V_{CC} = 3.6V	+25℃			1	μA
CONTROL STAGE							
EN Input Low Voltage	V_{IL}		Full			0.4	V
EN Input High Voltage	V_{IH}		Full	1.6			V
EN Input Current		Clamped on GND or VCC	Full			1	μA
Over-Temperature Protection					150		℃
Over-Temperature Hysteresis					20		℃

RECOMMENDED COMPONENTS OF TEST CIRCUITS

	COMPONENT		COMPONENT
INDUCTOR	2.2μH/CDRH5D28RHPNP-2R2NC	CAPACITOR	10μF/08055C106KAT2A
			22μF/08055C226KAT2A

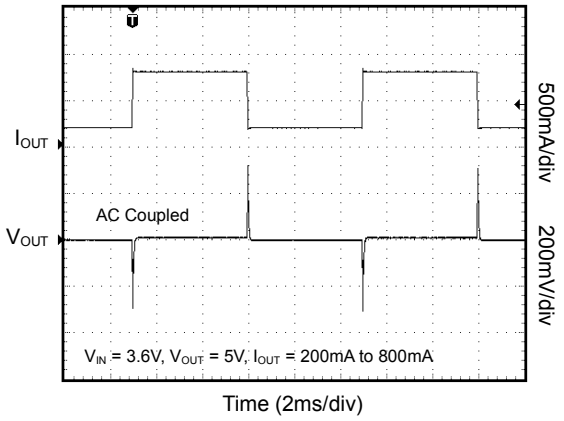
TYPICAL PERFORMANCE CHARACTERISTICS

Line Transient Response



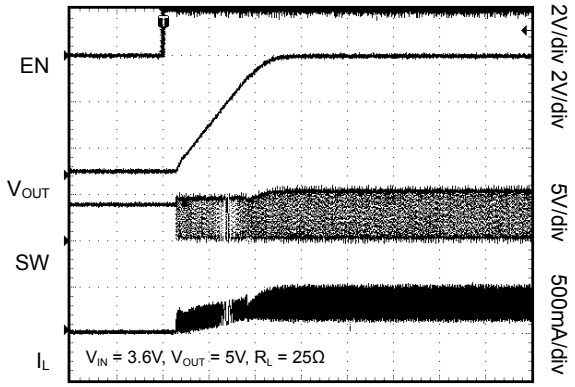
Time (2ms/div)

Load Transient Response



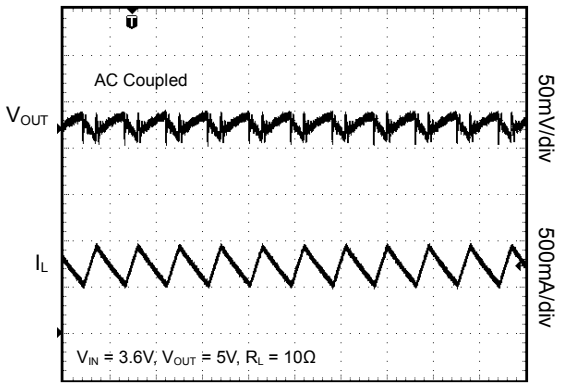
Time (2ms/div)

Start-Up after Enable



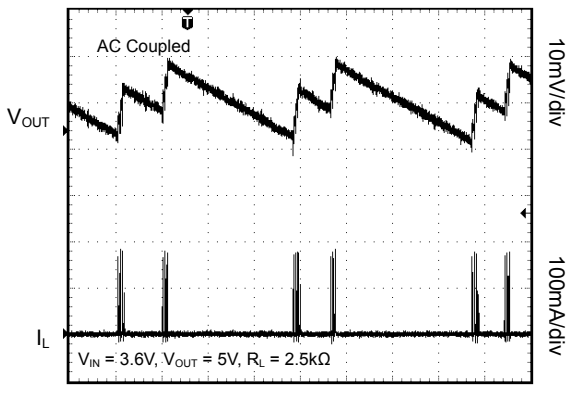
Time (1ms/div)

Output Voltage in Continuous Mode



Time (1μs/div)

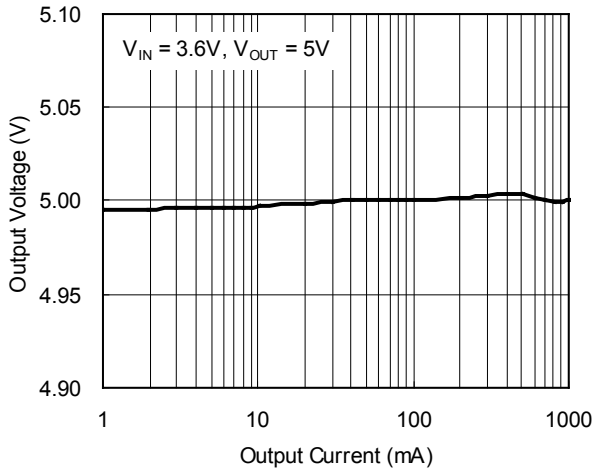
Output Voltage in Power-Save Mode



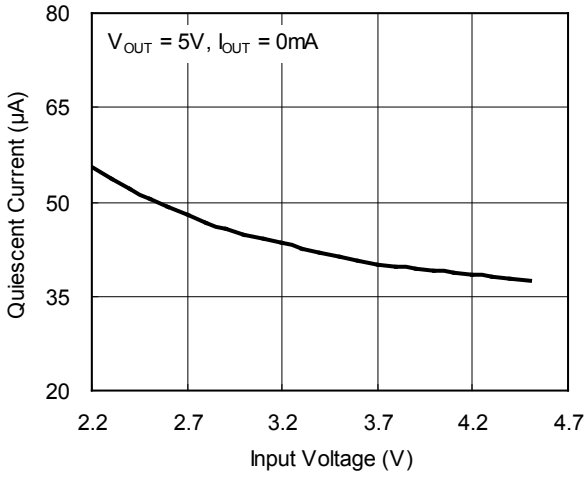
Time (20μs/div)

TYPICAL PERFORMANCE CHARACTERISTICS

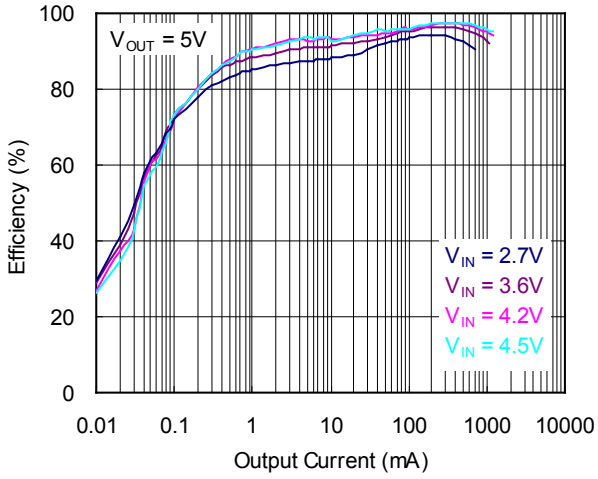
Output Voltage vs. Output Current



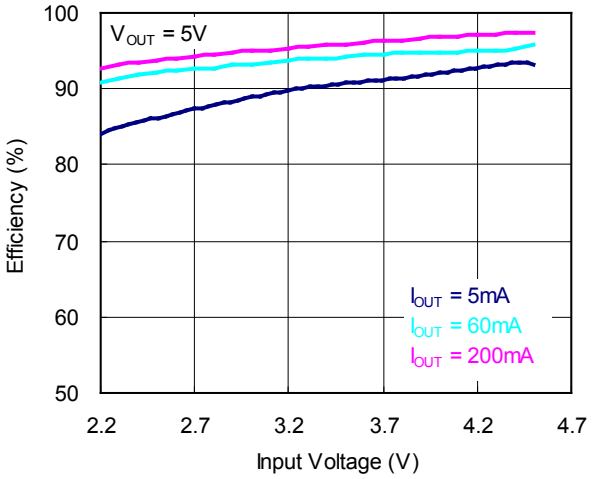
Quiescent Current vs. Input Voltage



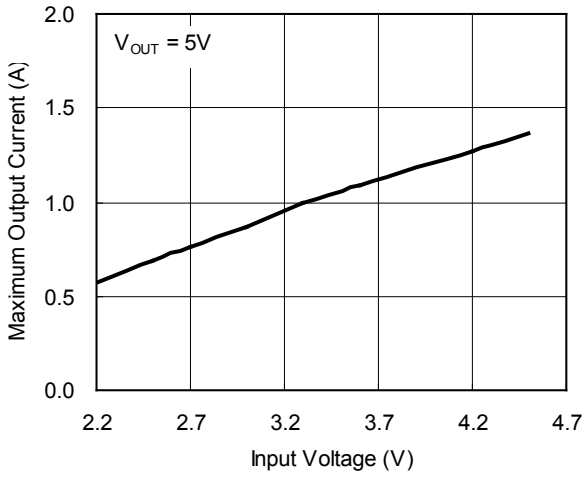
Efficiency vs. Output Current



Efficiency vs. Input Voltage



Maximum Output Current vs. Input Voltage



TYPICAL APPLICATION CIRCUITS

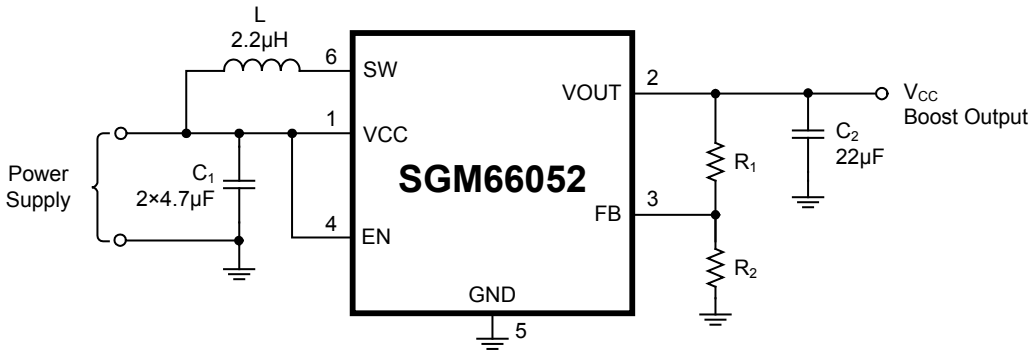


Figure 2. Typical Single-Cell Li-Ion Input or Dual Dry Cell Input Boost

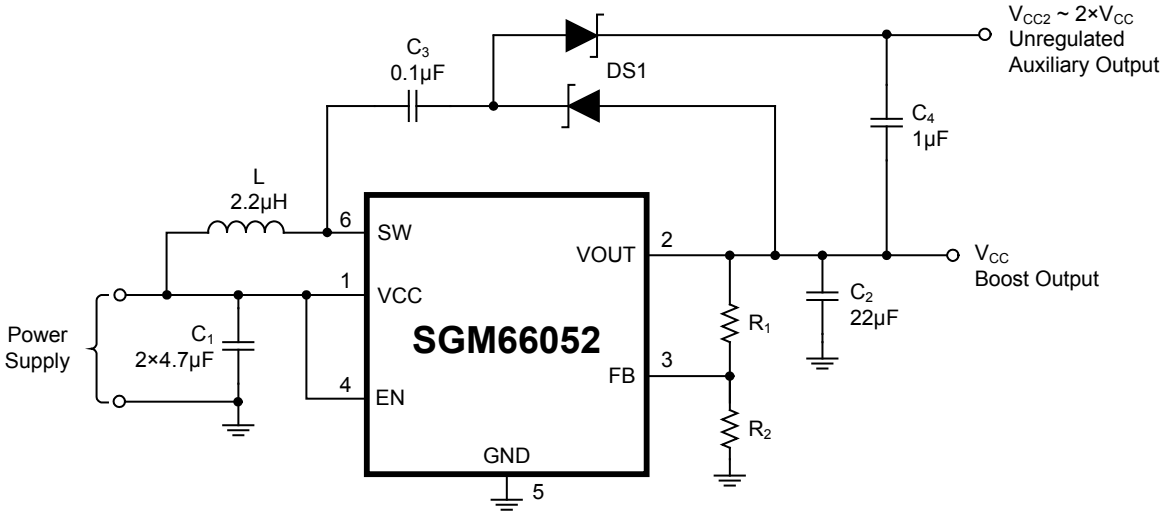


Figure 3. Supply with an Auxiliary Positive Output

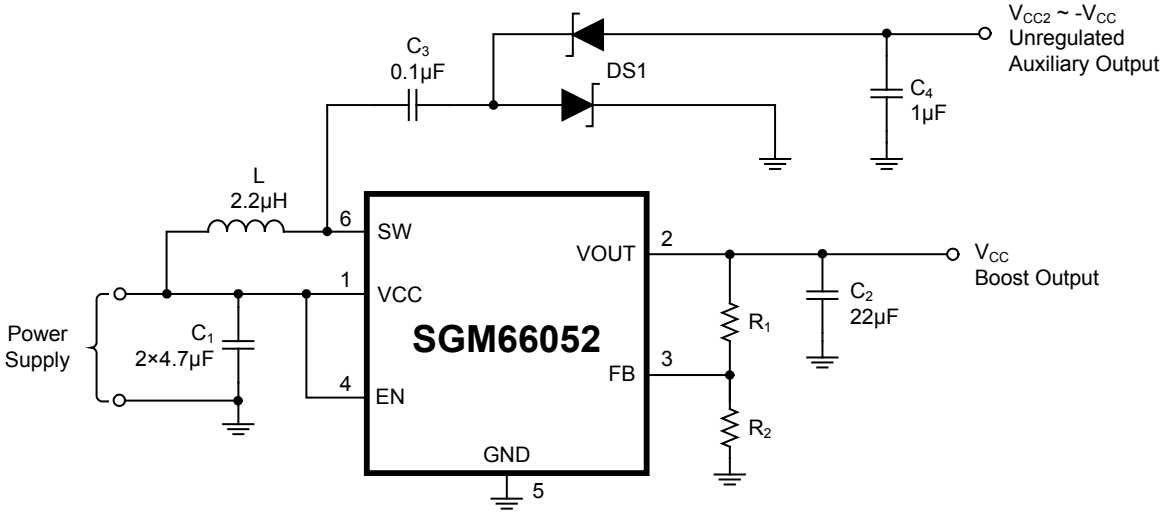


Figure 4. Supply with an Auxiliary Negative Output

TYPICAL APPLICATION CIRCUITS

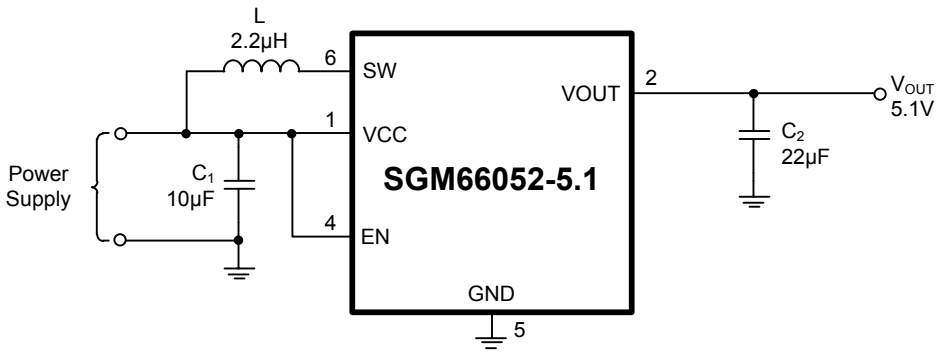


Figure 5. Typical Circuit for the Preset Output Voltage SGM66052-5.1

APPLICATION INFORMATION

The SGM66052 is a boost DC/DC converter operating in 2.7V to 5.2V supply range, for generating a regulated output voltage which can be set to as low as 10% above the supply voltage. An inductor, an output storage capacitor and an input decoupling capacitor should be selected to ensure proper performance desired in a specific application circuit.

Programming Output Voltage

In Figure 2, the output voltage of the SGM66052 DC/DC converter is set with an external resistor divider. The voltage at the FB pin is kept at 500mV when the output is regulated, and the maximum available output voltage is 5.2V. R_1 is calculated using Equation 1:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{V_{FB}} - 1 \right) = R_2 \times \left(\frac{V_{OUT}}{500mV} - 1 \right) \quad (1)$$

R_2 could be given as 100kΩ normally. For example, if an output voltage of 5.2V is needed, a 940kΩ resistor should be chosen for R_1.

Inductor Selection

The device has been optimized to operate with inductance values between 1μH and 4.7μH. Nevertheless, operation with higher inductance values may be possible. Both average current and peak current should be evaluated in inductor selection. The maximum average inductor current is estimated using Equation 2:

$$I_L = I_{OUT} \times \frac{V_{OUT}}{V_{CC} \times 0.8} \quad (2)$$

For example, for an output current of 300mA at 5V, at least an average current of 700mA flows through the inductor at a minimum input voltage of 2.7V.

Choosing a proper inductance for a given current ripple value is readily done in design practice. A smaller ripple reduces the magnetic hysteresis losses in the inductor, as well as output voltage ripple and EMI. Though regulation settle time may rise when load changes. The minimum inductance value for the inductor at given condition is estimated by using Equation 3:

$$L = \frac{V_{CC} \times (V_{OUT} - V_{CC})}{\Delta I_L \times f \times V_{OUT}} \quad (3)$$

Where f is the switching frequency and ΔI_L is the ripple current in the inductor, which normally is 20% of the average inductor current or is a design specified value. In typical applications, a 2.2μH inductance is recommended. After choosing an inductor, peak current at maximum loading and lowest input voltage is suggested to be evaluated, which should be lower than the switch current limit of this device as well as the inductor saturation current.

Input Capacitor

At least a 10μF input capacitor is recommended to improve transient behavior of the regulator and EMI behavior. A ceramic capacitor or a tantalum capacitor with a 100nF ceramic capacitor in parallel, placed close to the IC, is recommended.

APPLICATION INFORMATION

Output Capacitor

The capacitance and the ESR define the output voltage ripple. Supposing that the ESR is zero, the minimum capacitance could be estimated by using Equation 4:

$$C_{MIN} = \frac{I_{OUT} \times (V_{OUT} - V_{CC})}{f \times \Delta V \times V_{OUT}} \quad (4)$$

Where f is the switching frequency and ΔV is the maximum allowed voltage ripple.

The ESR and the additional ripple related to ESR may be negligible if a low ESR ceramic capacitor is used. This part of ESR component is calculated using Equation 5:

$$\Delta V_{ESR} = I_{OUT} \times R_{ESR} \quad (5)$$

The total ripple is the sum of the ripple caused by the capacitance and the ripple caused by the ESR of the capacitor. Additional voltage change may be caused by load transients; the output capacitor has to completely supply the load during the charging phase of the inductor.

The value of the output capacitance depends on the speed of the load transients and the load current during the load change. With the calculated minimum value of 10μF and load transient considerations, the recommended output capacitance value is in the range of 10μF to 47μF.

The capacitance loss due to the DC biasing and the high frequency performance has to be counted for de-rating. For example, larger form factor capacitors (in 1206 size) have their self-resonant frequencies in the same frequency range as the SGM66052 operating frequency. The effective capacitance of the capacitor may be significantly lower than its rating.

Layout Considerations

Careful layout is always important to ensure good performance and stable operation to any kind of switching regulators. Place the capacitors close to the device, use the GND pin of the device as the center of star-connection to other grounds, and minimize the trace area of SW node. These measures reduce transient current loops and lower the possible parasitic ringing.

If a resistor divider is employed, the center tap to FB trace should have sufficient clearance from noisy PCB traces, as the FB node is sensitive and easily picks up noise.

Thermal Information

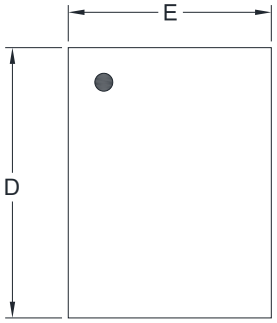
Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires attention to power dissipation. Many system-dependent issues such as thermal coupling, airflow, added heat sinks and convection surfaces, and the presence of other heat-generating components affect the power dissipation limits of a given component.

Common approaches for enhancing thermal performance are listed below for convenient reference:

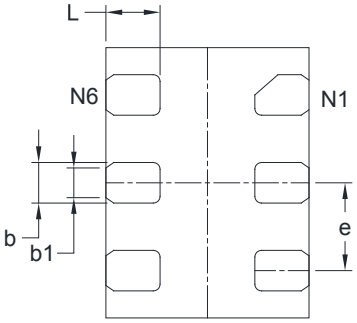
1. Improving the power dissipation capability of the PCB design.
2. Improving the thermal coupling of the component to the PCB.
3. Introducing airflow in the system.

PACKAGE OUTLINE DIMENSIONS

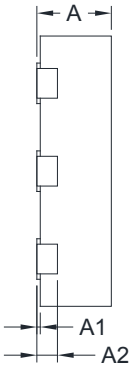
UTDFN-2×1.5-6L



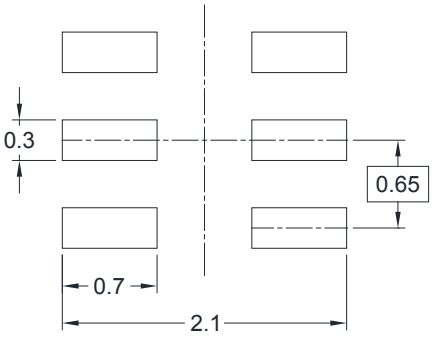
TOP VIEW



BOTTOM VIEW



SIDE VIEW

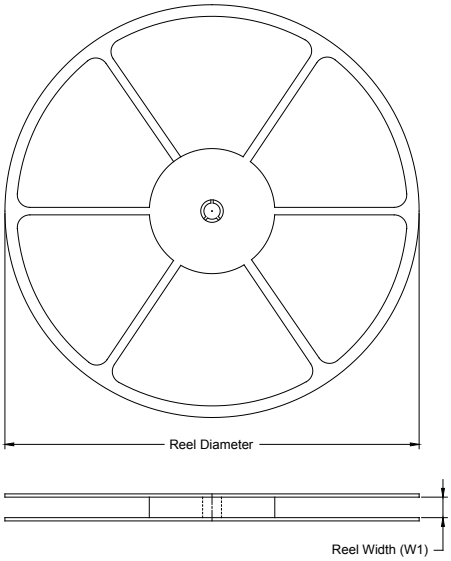


RECOMMENDED LAND PATTERN (Unit: mm)

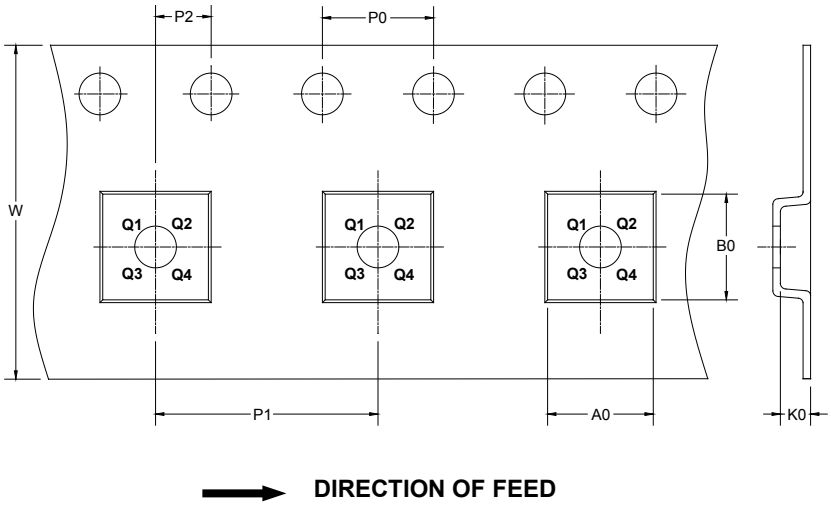
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.500	0.600	0.020	0.024
A1	0.000	0.050	0.000	0.002
A2	0.152 REF		0.006 REF	
D	1.900	2.100	0.075	0.083
E	1.400	1.600	0.055	0.063
b	0.250	0.350	0.010	0.014
b1	0.220 REF		0.009 REF	
e	0.650 BSC		0.026 BSC	
L	0.324	0.476	0.013	0.019

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



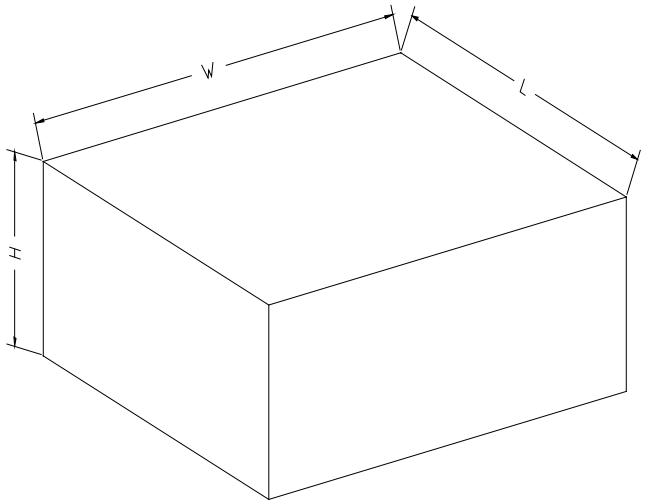
NOTE: The picture is only for reference. Please make the object as the standard.

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
UTDFN-2×1.5-6L	7″	9.5	1.75	2.25	0.65	4.00	4.00	2.00	8.00	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