SGM25641
Single 4A, Ultra-Low Loss Load Switch

GENERAL DESCRIPTION

The SGM25641 is an ultra-low on-resistance, integrated N-MOSFET, single-channel load switch. The device operates over an input voltage range of 0.6V to 1V, and is controlled by the ON pin which is capable of interfacing directly with low-voltage control signals. The typical time of turn-on delay and output rise time is only 28μs. The small package and ultra-low power loss make the device very suitable for space limited applications.

The SGM25641 is available in a Green UTDFN-1.5×1.5-6BL package.

FEATURES

- **Input Voltage Range: 0.6V to 1V**
- **V_{BIAS} Voltage Range: 2.3V to 5.5V**
- **Low R_{DSON}: 25mΩ (TYP)**
- **Maximum Output Current: 4A**
- **VBIAS Quiescent Current: 37μA (TYP)**
- **Automatic Discharge Resistance: 77Ω**
- **Available in a Green UTDFN-1.5×1.5-6BL Package**

APPLICATIONS

Notebook
Ultrabook
Server
Set-Top Box
E-Book
LCD-TV
Portable Device

TYPICAL APPLICATION

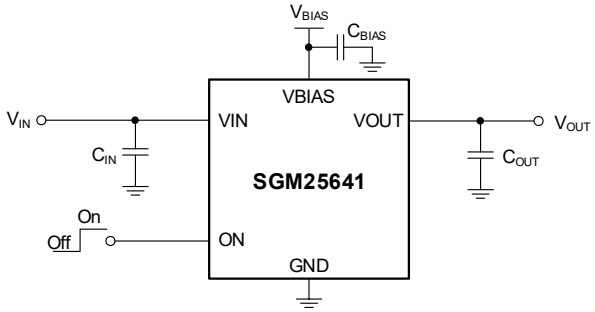


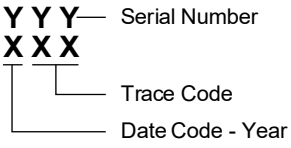
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM25641	UTDFN-1.5×1.5-6BL	-40℃ to +125℃	SGM25641XUHT6G/TR	10W XXX	Tape and Reel, 4000

MARKING INFORMATION

NOTE: XXXXX = Date Code and Trace 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}, V_{OUT} 4.2V
V_{BIAS}, V_{ON} 6V
Package Thermal Resistance
UTDFN-1.5×1.5-6BL, θ_{JA} ..... 135℃/W
UTDFN-1.5×1.5-6BL, θ_{JB} ..... 30.3℃/W
UTDFN-1.5×1.5-6BL, θ_{JC} ..... 82.2℃/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}, V_{OUT} ..... 0.6V to 1V
V_{BIAS} ..... 2.3V to 5.5V
V_{BIAS} - V_{IN} ..... ≥ 2V
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

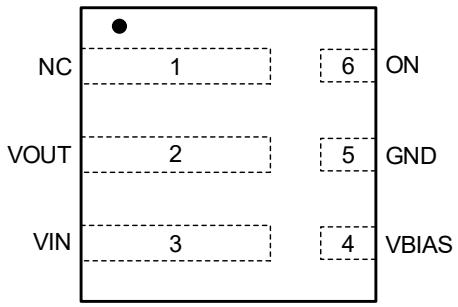
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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



UTDFN-1.5×1.5-6BL

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	NC	No Connection.
2	VOUT	Switch Output Pin.
3	VIN	Switch Input Pin.
4	VBIAS	Power Supply Pin for Internal Circuitry. V_{BIAS} voltage range is from 2.3V to 5.5V.
5	GND	Ground.
6	ON	Switch Enable Input Pin.

ELECTRICAL CHARACTERISTICS

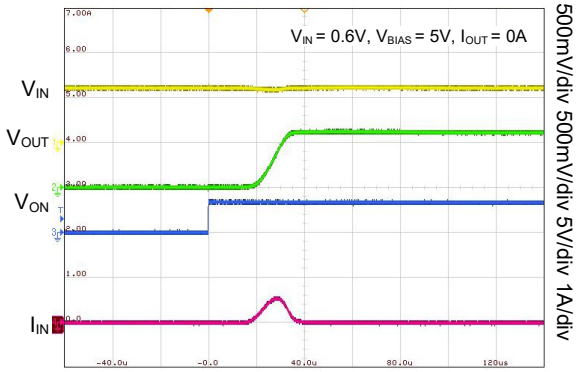
(T_J = -40℃ to +125℃, typical values are at T_J = +25℃, unless otherwise specified.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}			0.6		1	V
Bias Voltage Range	V_{BIAS}			2.3		5.5	V
VBIAS Shutdown Current	I_{SD_BIAS}	V_{ON} = 0V				1	μA
VBIAS Quiescent Current	I_{Q_BIAS}	V_{ON} = 3.3V, I_{OUT} = 0A			37	50	μA
On-Resistance	R_{DSON}	V_{IN} = 0.7V or 0.8V, V_{BIAS} = 3.3V, I_{LOAD} = 1A	T_J = +25℃		25	32	mΩ
			T_J = -40℃ to +125℃			45	
ON Turn-On Threshold, Rising	V_{IH}	T_J = +25℃		1.2	1.25	1.3	V
		T_J = -40℃ to +125℃		1.1	1.25	1.4	
ON Turn-On Threshold, Falling	V_{IL}	T_J = +25℃		1.1	1.15	1.2	V
		T_J = -40℃ to +125℃		1	1.15	1.3	
ON Hysteresis	V_{ON_HYS}				0.1		V
Rise Time	t_{RISE}	V_{IN} = 0.7V or 0.8V, V_{BIAS} = 3.3V	T_J = +25℃		10	18	μs
			T_J = -40℃ to +125℃			20	
Delay Time	t_{DELAY}	V_{IN} = 0.7V or 0.8V, V_{BIAS} = 3.3V	T_J = +25℃		18	25	μs
			T_J = -40℃ to +125℃			30	
Discharge Resistance	R_{DIS}	V_{ON} = 0V			77		Ω
Thermal Shutdown Temperature	T_{SD}				150		℃
Thermal Shutdown Hysteresis	T_{HYS}				20		℃

TYPICAL PERFORMANCE CHARACTERISTICS

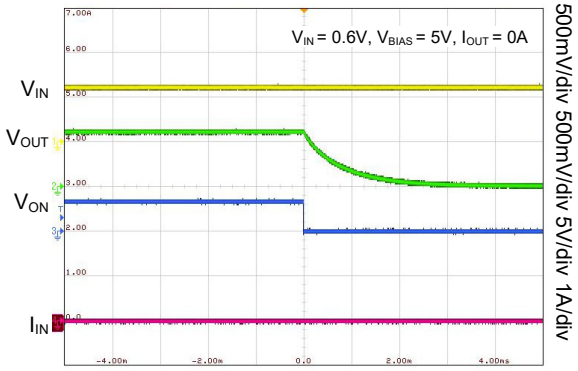
T_A = +25℃, unless otherwise noted.

Turn-On Response



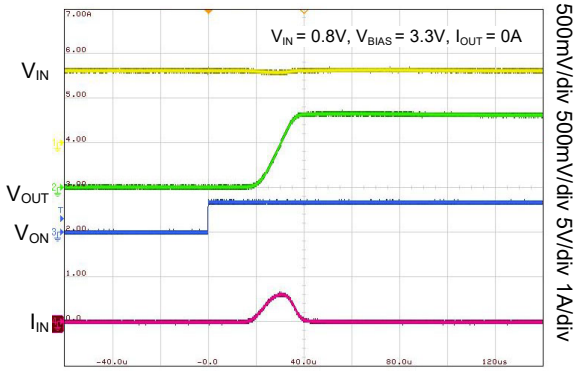
Time (20μs/div)

Turn-Off Response



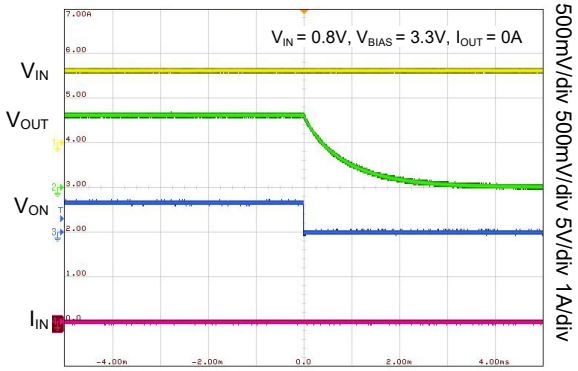
Time (1ms/div)

Turn-On Response



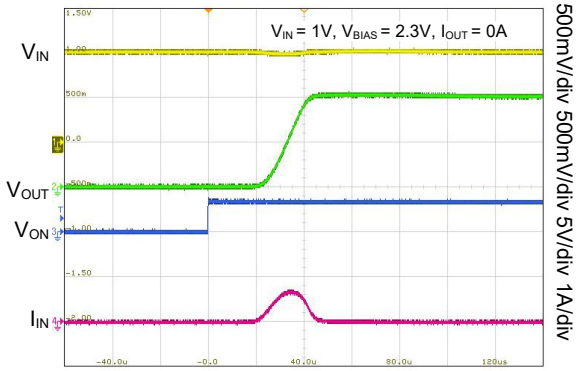
Time (20μs/div)

Turn-Off Response



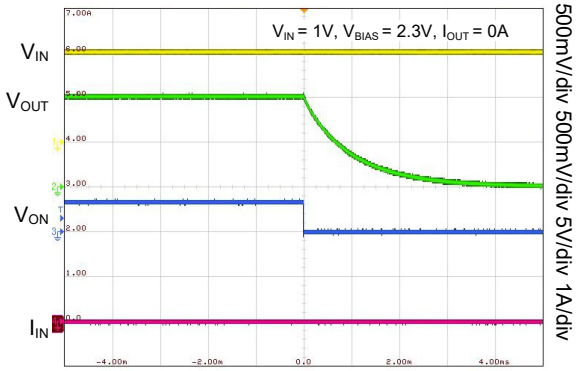
Time (1ms/div)

Turn-On Response



Time (20μs/div)

Turn-Off Response

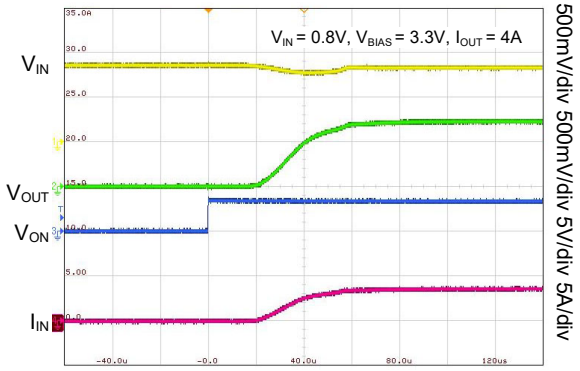


Time (1ms/div)

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

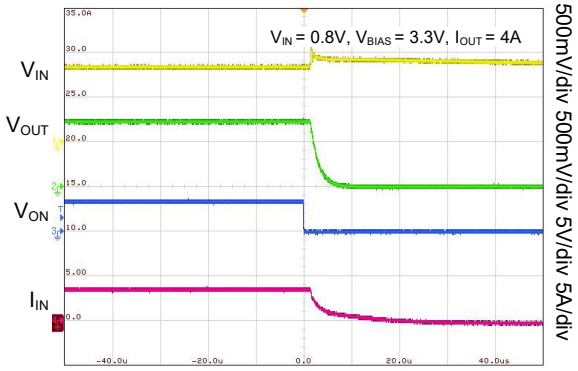
T_A = +25℃, V_{IN} = 0.7V, unless otherwise noted.

Turn-On Response



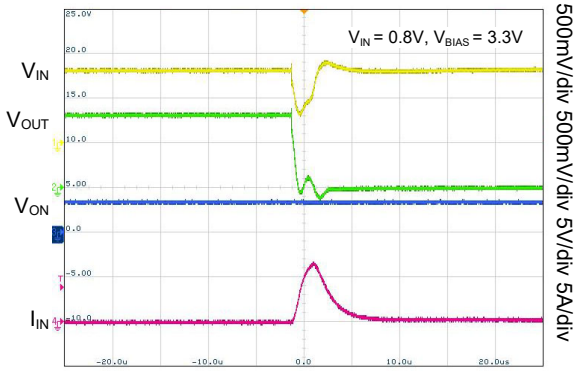
Time (20μs/div)

Turn-Off Response



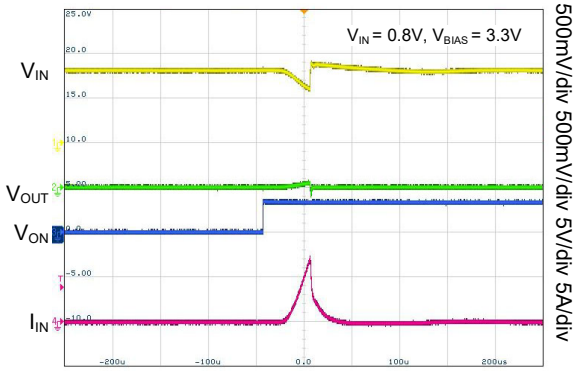
Time (10μs/div)

Short-Circuit after Power-Up



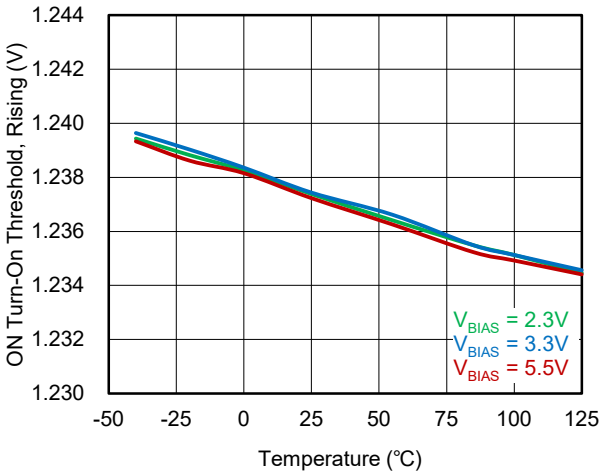
Time (5μs/div)

Power-Up with Output Shorted to GND

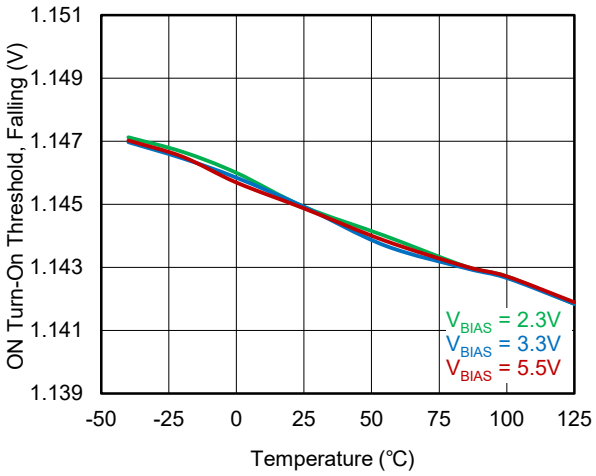


Time (50μs/div)

ON Turn-On Threshold, Rising vs. Temperature



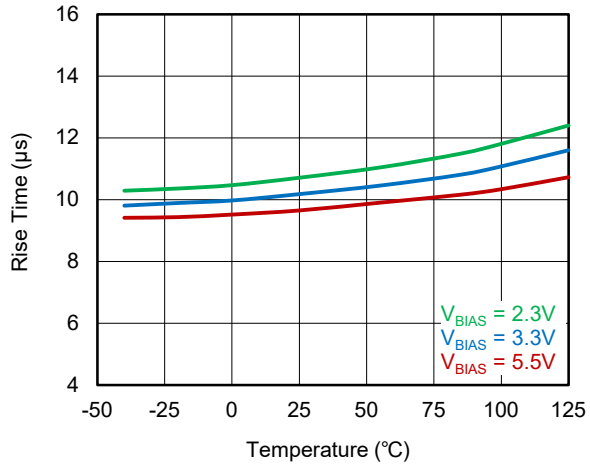
ON Turn-On Threshold, Falling vs. Temperature



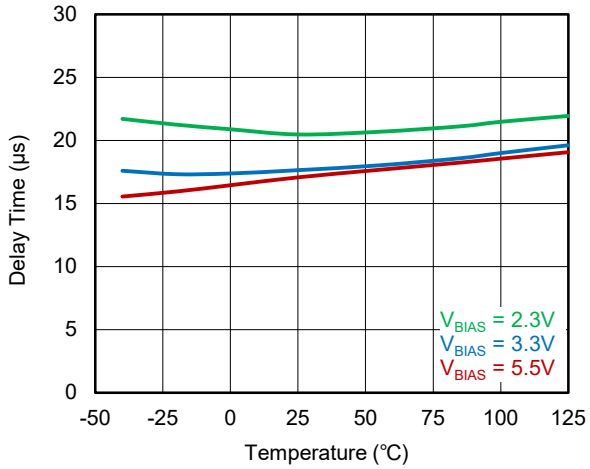
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_{IN} = 0.7V, unless otherwise noted.

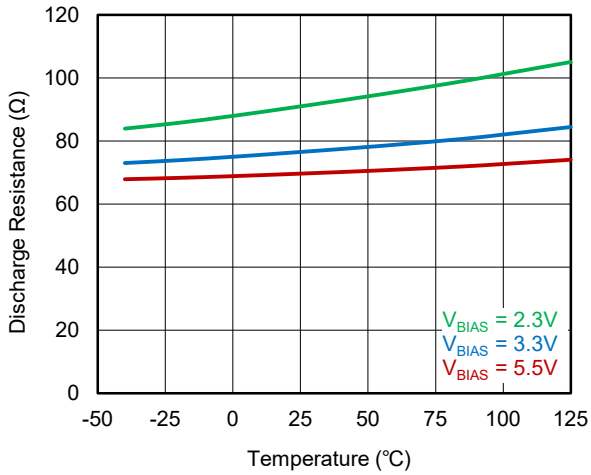
Rise Time vs. Temperature



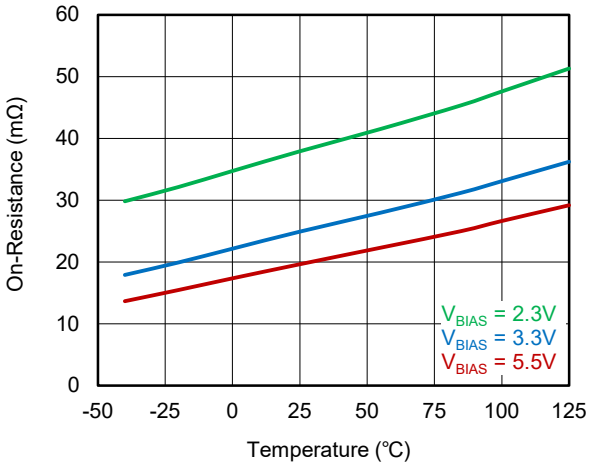
Delay Time vs. Temperature



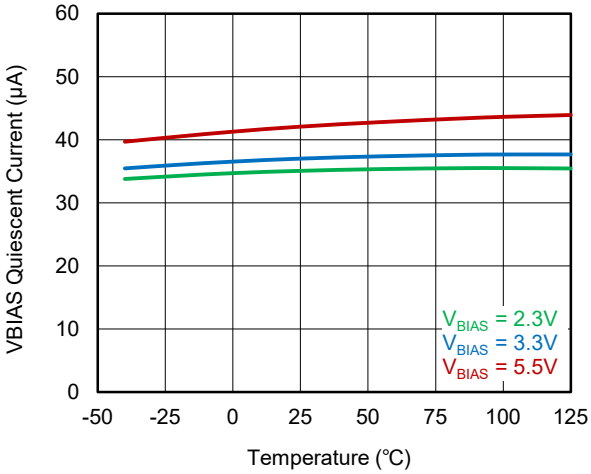
Discharge Resistance vs. Temperature



On-Resistance vs. Temperature



VBIAS Quiescent Current vs. Temperature



FUNCTIONAL BLOCK DIAGRAM

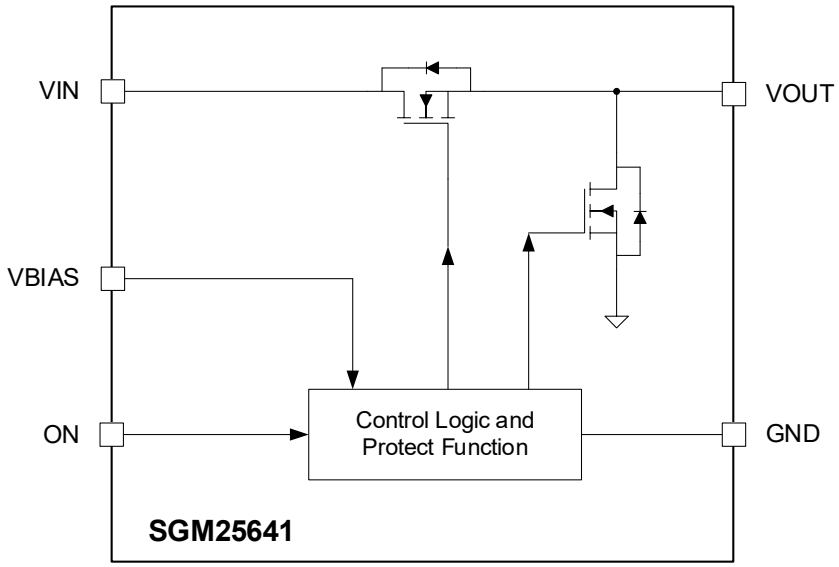


Figure 2. Block Diagram

TIMING DIAGRAM

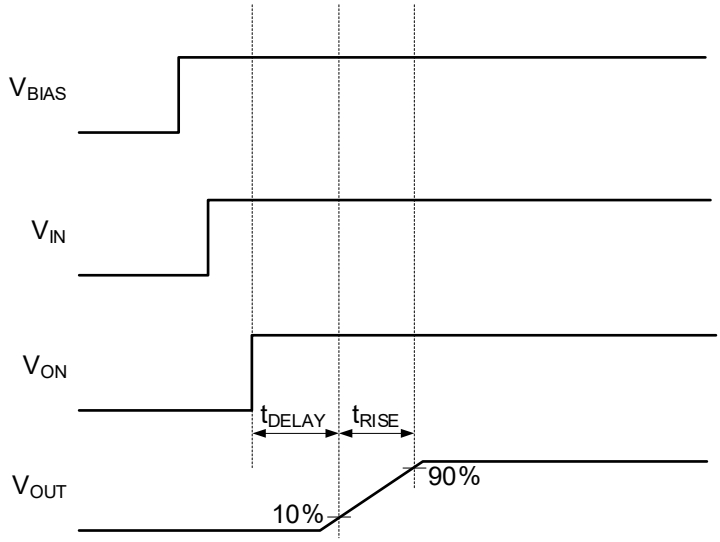


Figure 3. Timing Diagram

DETAILED DESCRIPTION

Overview

The SGM25641 is a 5.5V, 25mΩ (TYP) on-resistance, integrated N-MOSFET, single-channel load switch. It can support a 4A maximum continuous load current and be enabled by the ON pin. The device provides thermal shutdown function. The device also has internal integrated quick output discharge (QOD) to remove the remaining charge from the output when the switch is disabled.

The SGM25641 is highly integrated. Using the device can reduce the PCB area and the BOM count greatly, even the cost.

V_{BIAS} Power Supply

V_{BIAS} is the power supply to the inner circuit including control logic, quick output discharge and charge pump. The support voltage range is from 2.3V to 5.5V. For most applications, a 0.1μF capacitor is sufficient. It is recommended to use X5R or X7R dielectrics ceramic capacitor.

Control Pin

There is a control pin ON to turn on or turn off the corresponding N-MOSFET. When the ON pin is driven high, the switch will be turned on, and when the ON pin is driven low, the switch will be turned off. The ON pin is compatible with standard GPIO logic level threshold, such as 1.8V, 2.5V or 3.3V.

The recommended start-up sequence is to power on V_{BIAS} first, then V_{IN}, and finally the ON pin. Or V_{IN} and V_{BIAS} are powered on simultaneously, then the ON is enabled.

The ON pin cannot be left floating and must be connected to either high or low level as requirement.

Quick Output Discharge (QOD)

The QOD feature is available for SGM25641. The device has a resistor which is not activated to discharge by default. When the ON pin is pulled low or over-temperature happens, the resistor will be connected between the VOUT and GND to discharge the output quickly. This resistor pulls down the output and prevents it from floating when the switch is turned off.

Short-Circuit Protection

The device is incorporated with short-circuit protection. When the current flowing through the device exceeds the internal threshold, the device will be turned off and remain latched until the ON is reset.

Thermal Shutdown

Thermal shutdown protects the device from excessive temperature and can recovery automatically. When die temperature exceeds +150℃ (TYP), the MOSFET will be shut down and remained off until die temperature drops below +130℃ (TYP).

Device Functional Modes

The connection of the VOUT pin is shown in Table 1.

Table 1. SGM25641 Functions Table

ON	VIN to VOUT	VOUT
L	N-MOSFET Off	Off
H	N-MOSFET On	On

APPLICATION INFORMATION

Input Capacitor

Turn on the N-MOSFET to charge load capacitor will generate inrush current, which may cause the V_{IN} drop. In order to prevent the drop, a capacitor must be placed between the VIN and GND pins. Usually, a 1μF input capacitor (C_{IN}) placed close to the pins is sufficient. However, higher capacitance values can further reduce the voltage drop. So, larger C_{IN} can be used to reduce the voltage drop in high current applications.

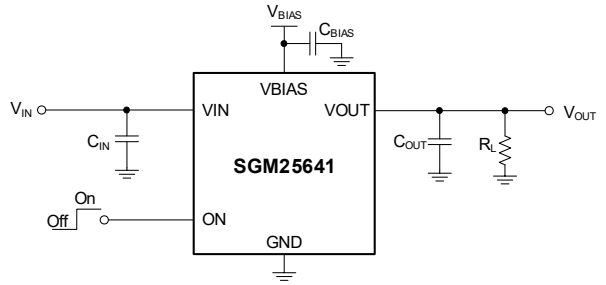
Output Capacitor

An output capacitor (C_{OUT}) of at least 1μF should be placed between the VOUT and GND pins. This capacitor can prevent parasitic board inductance from forcing V_{OUT} below GND when the switch is turned on.

VBIAS Capacitor

A bypass capacitor should be placed from VBIAS pin to GND to suppress noise. For most applications, a 0.1μF capacitor is sufficient. It is recommended to use X5R or X7R ceramic capacitor.

Typical Application



The following input parameters will be used in these design examples.

Table 2. Design Parameters

Design Parameter	Example Value
V_{BIAS}	3.3V
V_{IN}	0.8V
C_{OUT}	10μF
Load Current	4A
Ambient Temperature	+25℃
Maximum Inrush Current	800mA

Detailed Design Procedure

Managing Inrush Current

When the switch is enabled, the output capacitors must be charged up from 0V to the set value (0.8V in this example). This charge arrives in the form of inrush current. Inrush current can be calculated using Equation 1:

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

For SGM25641, the device offers relatively fixed rise time. From the specification, the typical rise time (10% to 90%) at 0.8V is 10μs. Based on Equation 1, the inrush current is calculated:

$$I_{INRUSH}=10\mu F\times 80\%\times 0.8V/10\mu s=640mA$$

The inrush current is less than 800mA and therefore meets the design requirement. Besides, for systems that require lower inrush current, the practical way is to reduce the output capacitance value.

VIN to VOUT Voltage Drop

The voltage drop from VIN to VOUT is determined by the on-resistance of the device and the load current. R_{DSON} can be found in electrical specification. When the value of R_{DSON} is found, the following equation can be used to calculate the voltage drop across the device:

$$\triangle V = I_{LOAD}\times R_{DSON} \quad (2)$$

where $\triangle V$ is the voltage drop from input to output. I_{LOAD} is the load current. R_{DSON} is the on-resistance of device determined by V_{IN} and V_{BIAS}.

At V_{IN} = 0.8V and V_{BIAS} = 3.3V, the SGM25641 has an R_{DSON} value of 25mΩ. Using this value and the defined load current, the above equation can be evaluated:

$$\Delta V = 4A\times 25m\Omega = 100mV$$

Therefore, the voltage drop across the device will be 100mV.

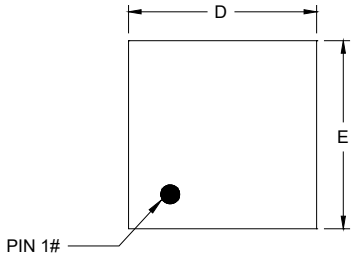
REVISION HISTORY

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

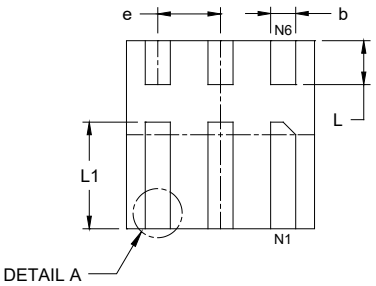
Changes from Original (OCTOBER 2024) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

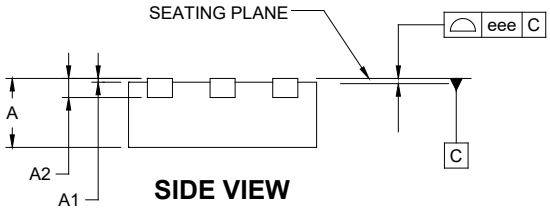
UTDFN-1.5×1.5-6BL



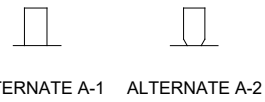
TOP VIEW



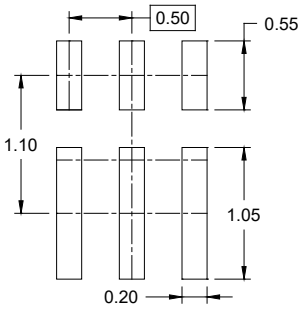
BOTTOM VIEW



SIDE VIEW



DETAIL A
ALTERNATE TERMINAL CONSTRUCTION



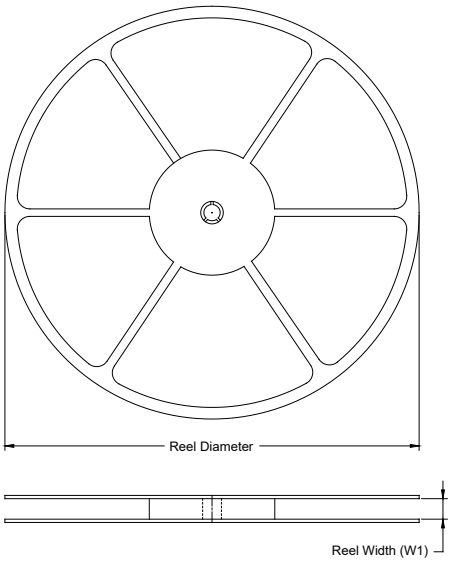
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.500	-	0.600
A1	0.000	-	0.050
A2		0.152 REF	
b	0.150	-	0.250
D	1.400	-	1.600
E	1.400	-	1.600
e		0.500 BSC	
L	0.250	-	0.450
L1	0.750	-	0.950
eee		0.080	

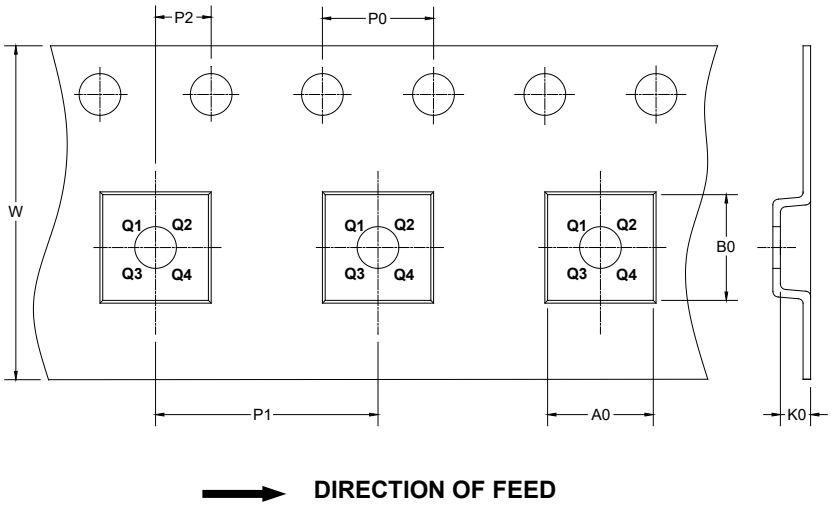
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



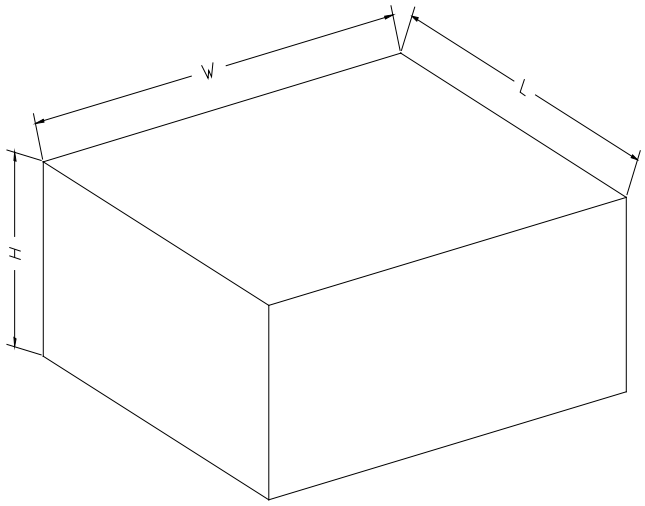
NOTE: The picture is only for reference. Please make the object as the standard.

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
UTDFN-1.5×1.5-6BL	7"	9.0	1.70	1.70	0.75	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