SGM42531
3.6A Brushed DC Motor Driver

GENERAL DESCRIPTION

The SGM42531 device is a brushed DC motor driver. This device integrates four N-MOSFETs, which can supply up to 3.6A peak current at 28V voltage.

The SGM42531 supports IN1/IN2 PWM interface. PWM signal can be implemented on the input interface to adjust motor speed. Customer can adjust PWM current limit or torque in real-time by VREF pin with a controller's DAC output or PWM signal after RC filter.

The SGM42531 integrates current sensing function which allows for the device to regulate the current during motor startup or stall event, saving PCB layout area and system cost. Current limit level can be adjusted by the external voltage reference on VREF pin. Additionally, the device provides a current proportional to the output load current, a resistor connecting from IPROPI pin to ground converts the proportional current to voltage for microcontroller ADC current sensing.

A number of protection features are provided in the device including over-current, short-circuit, under-voltage lockout and thermal shutdown. When the fault condition is removed, the device automatically resumes normal operation.

The SGM42531 is available in a Green SOIC-8 (Exposed Pad) package.

FEATURES

- **H-Bridge Motor Driver**
- **Operating Voltage Range: 4.5V to 28V**
- **Low On-Resistance: 0.55Ω (HS + LS) at +25℃**
- **3.6A Peak Output Current**
- **Interface: IN1/IN2**
- **Adjustable PWM Current Limit in Real-Time**
- **Low Power Standby Mode**
- **Integrated Current Sensing**
- **Integrated Protection Features**
  - **Over-Current Protection (OCP)**
  - **Under-Voltage Lockout (UVLO)**
  - **Thermal Shutdown (TSD)**
  - **Auto-Retry**

APPLICATIONS

Printers
Vacuum Cleaners Robotics
Industrial Pumps and Valves

SIMPLIFIED SCHEMATIC

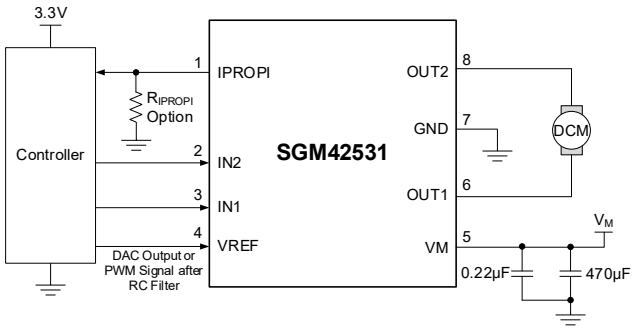


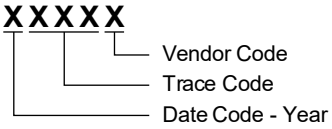
Figure 1. Simplified Schematic

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM42531	SOIC-8 (Exposed Pad)	-40℃ to +125℃	SGM42531XPS8G/TR	SGM 42531XPS8 XXXXX	Tape and Reel, 4000

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

Power Supply Voltage, V_M 35V
Logic Input Voltage, V_{INx} 6V
Reference Voltage, V_{REF} 6V
Current Sense Input Pin Voltage, IPROPI 5.75V
Output Pin Voltage, OUTx ..... -0.7V to V_M + 0.7V
Package Thermal Resistance
SOIC-8 (Exposed Pad), θ_{JA} ..... 35.1℃/W
SOIC-8 (Exposed Pad), θ_{JB} ..... 11.7℃/W
SOIC-8 (Exposed Pad), $\theta_{JC\ (TOP)}$ ..... 47.7℃/W
SOIC-8 (Exposed Pad), $\theta_{JC\ (BOT)}$ ..... 2.8℃/W
TDFN-2×2.3-8L, θ_{JA} ..... 52.5℃/W
TDFN-2×2.3-8L, θ_{JB} ..... 17.7℃/W
TDFN-2×2.3-8L, $\theta_{JC\ (TOP)}$ ..... 63.8℃/W
TDFN-2×2.3-8L, $\theta_{JC\ (BOT)}$ ..... 2.2℃/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

Power Supply Voltage, V_M ..... 4.5V to 28V
Logic Input Voltage, V_{INx} ..... 0V to 5.5V
Reference Voltage, V_{REF} ..... 0V to 3.6V
Logic Input PWM Frequency (IN1, IN2), f_{PWM} .....
..... 0kHz to 200kHz
Peak Output Current ..... 0A to 3.6A
Peak Output Current, I_{IPROPI} ..... 0mA to 3mA
Operating Ambient 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

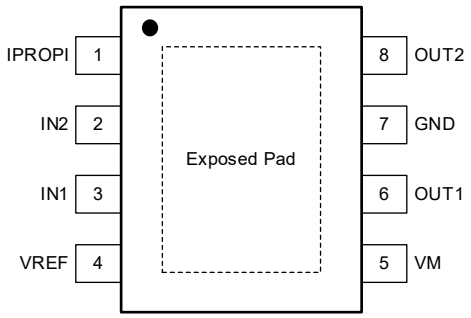
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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



SOIC-8 (Exposed Pad)

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	IPROPI	PWR	Current Proportional to the Output Current.
2	IN2	I	Logic Input 2.
3	IN1	I	Logic Input 1.
4	VREF	I	Analog Input. Analog input to set current limit.
5	VM	PWR	Supply Voltage.
6	OUT1	O	H-Bridge Output 1. Output of H-bridge driving stage.
7	GND	PWR	Power Ground. Connect directly to system ground.
8	OUT2	O	H-Bridge Output 2. Output of H-bridge driving stage.
Exposed Pad	GND	-	Exposed Pad. Connect to board ground. For enhanced thermal dissipation.

NOTE: I: input, O: output, PWR: power for the circuit.

TRUTH TABLE

Table 1. Control Truth Table

IN1	IN2	OUT1	OUT2	FUNCTION
0	1	L	H	Reverse
1	0	H	L	Forward
1	1	L	L	Brake (Slow Decay)
0	0	Hi-Z	Hi-Z	Coast, enter in the low power standby mode after standby timer.

NOTE: Hi-Z = high-impedance.

ELECTRICAL CHARACTERISTICS

(V_M = 4.5V to 28V, T_J = -40℃ to +125℃, typical values are measured at T_J = +25℃, V_M = 24V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply (VM)						
Power Supply Voltage	V_M		4.5		28	V
Power Supply Current	I_{VM}	V_M = 24V, IN1 = IN2 = high		3	5	mA
Standby Mode Supply Current	I_{VMQ}	V_M = 24V, IN1 = IN2 = low, T_J = +25℃			1	μA
Logic Level Inputs						
Input Logic Low Voltage	V_{IL}				0.4	V
Input Logic High Voltage	V_{IH}		1.7			V
Input Logic Hysteresis	V_{HYS}			300		mV
Input Logic Low Current	I_{IL}	V_{IN} = 0V	-1		1	μA
Input Logic High Current	I_{IH}	V_{IN} = 3.3V		26	100	μA
Pull-Down Resistance	R_{PD}	To GND		128		kΩ
Propagation Delay Time	t_{PD}	INx to OUTx change		0.7	1.2	μs
Motor Driver Outputs (OUT1 and OUT2)						
High-side FET On-Resistance	R_{DSON}	V_M = 24V, I_{OUT} = 0.5A		263		mΩ
Low-side FET On-Resistance		V_M = 24V, I_{OUT} = 0.5A		280		mΩ
Body Diode Forward Voltage	V_D	I_{OUT} = 1A		0.9		V
Output Rise Time	t_{RISE}	V_M = 24V, OUTx rising from 10% to 90%		220		ns
Output Fall Time	t_{FALL}	V_M = 24V, OUTx falling from 90% to 10%		160		ns
Integrated Current Sensing and Regulation (IPROPI, VREF)						
Current Mirror Scaling Factor	A_{IPROPI}			1500		μA/A
Current Mirror Total Error	A_{ERR}	0.5A ≤ I_{OUT} ≤ 1A, T_J = -40℃ to +85℃	-6		6	%
Current Regulation Off-Time	t_{OFF}			25		μs
Current Regulation Blanking Time	t_{BLANK}			1.1		μs
Current Sense Delay Time	t_{DELAY}			0.41		μs
Current Regulation Deglitch Time	t_{DEG}			0.7		μs
Timing						
Turn-On Time (1)	t_{ON}	V_M > V_{UVLO} with IN1 or IN2 high			250	μs
Crossover Delay	t_{COD}			300		ns
Standby Timer	t_{ST}	IN1 = IN2 = low	0.8		1.5	ms
Protection Circuits						
VM Under-Voltage Lockout	V_{UVLO}	V_M falls until UVLO triggers	3.9	4.2	4.45	V
		V_M rises until operation recovers	4	4.3	4.55	
VM Under-Voltage Hysteresis	V_{HYS}	Rising to falling threshold		100		mV
Under-Voltage Deglitch Time	t_{UVLO}	Supply under-voltage deglitch time		18		μs
Over-Current Protection Trip Level	I_{OCP}	T_J = +25℃	3.6			A
Over-Current Deglitch Time	t_{OCP}			1.5		μs
Over-Current Retry Time	t_{RETRY}			2.8		ms
Thermal Shutdown Temperature	T_{SD}			155		℃
Thermal Shutdown Temperature Hysteresis	T_{HYS}			20		℃

NOTE: 1. t_{ON} applies when the device initially powers up, and when it exits standby mode.

FUNCTIONAL BLOCK DIAGRAM

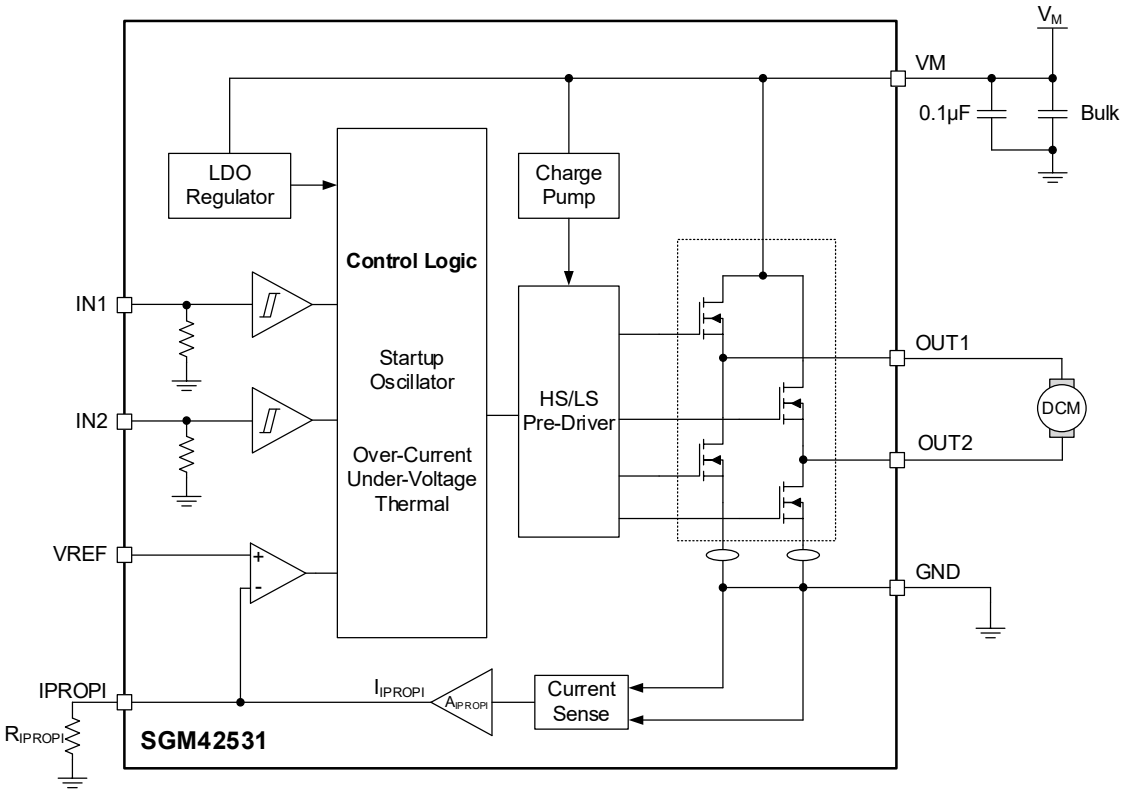
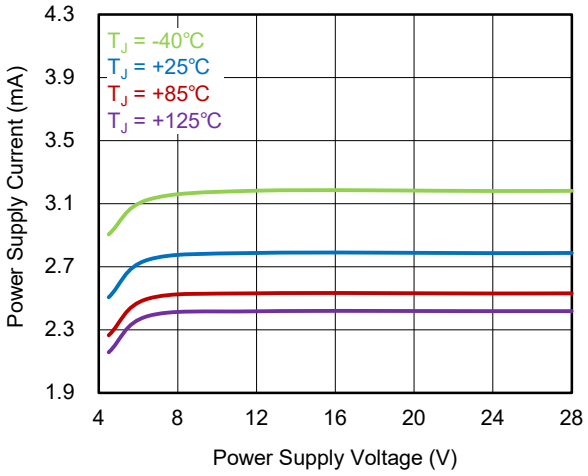


Figure 2. SGM42531 Functional Block Diagram

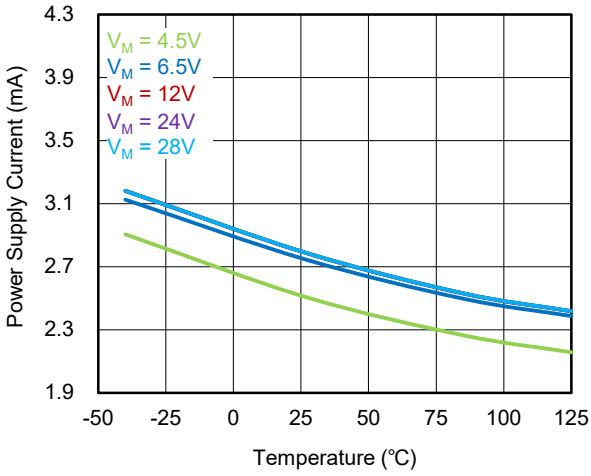
TYPICAL PERFORMANCE CHARACTERISTICS

T_J = +25℃, unless otherwise noted.

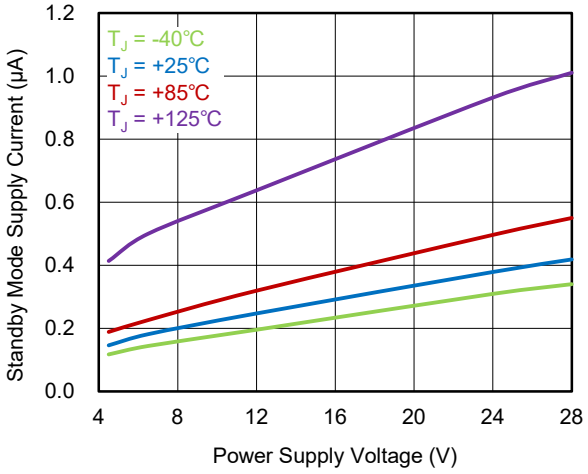
Power Supply Current vs. Power Supply Voltage



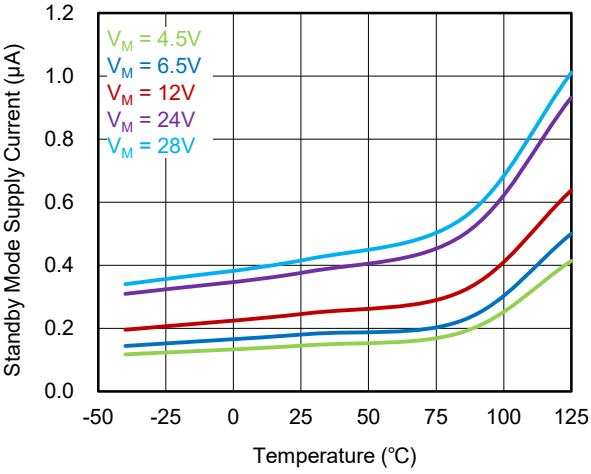
Power Supply Current vs. Temperature



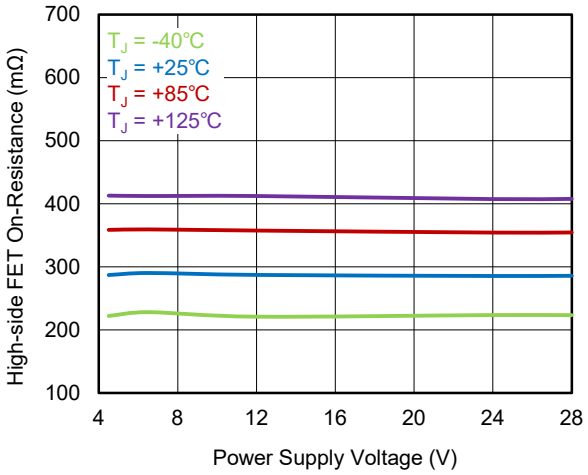
Standby Mode Supply Current vs. Power Supply Voltage



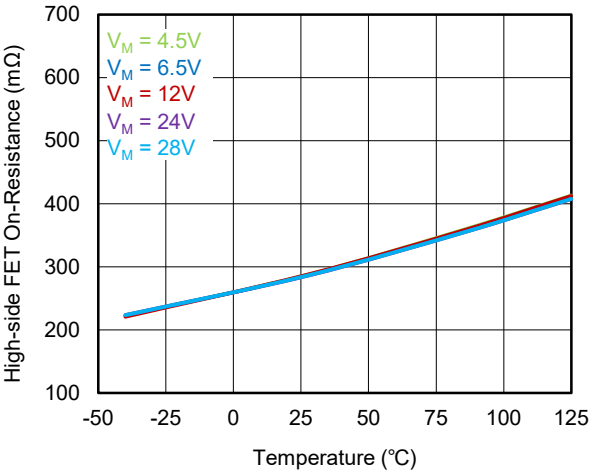
Standby Mode Supply Current vs. Temperature



High-side FET On-Resistance vs. Power Supply Voltage



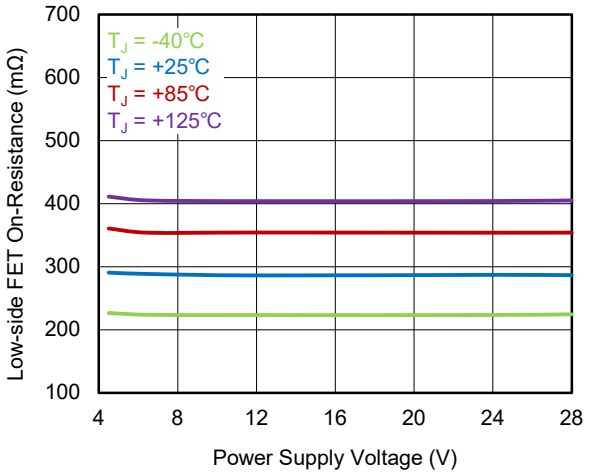
High-side FET On-Resistance vs. Temperature



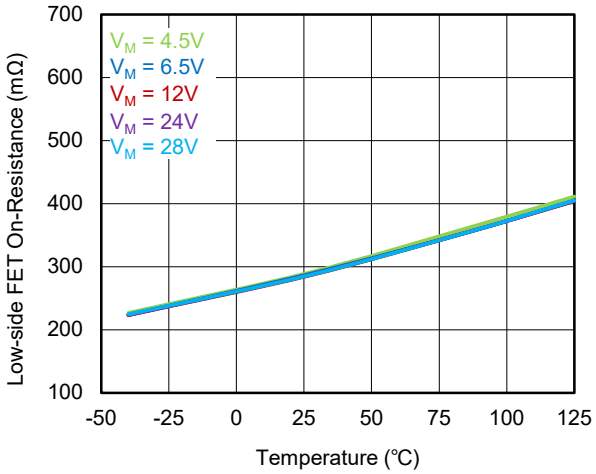
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_J = +25℃, unless otherwise noted.

Low-side FET On-Resistance vs. Power Supply Voltage



Low-side FET On-Resistance vs. Temperature



DETAILED DESCRIPTION

Device Operation

The SGM42531 is typically used to drive a DC motor. An internal charge pump generates the necessary gate-drive voltage. The SGM42531 operates from 4.5V to 28V motor power supply, which can supply a 3.6A peak current. Full protection features include over-current protection, under-voltage lockout and over-temperature protection.

Standby Mode

If both input pins (IN1/IN2) are low for longer than standby timer, the device will go to standby mode. If entering the standby mode, the output MOSFET, charge pump, and regulator are turned off for saving power.

Internal PWM Current Control

The current in the output is limited using fixed off-time control circuitry. If the motor current goes over the current limit setting, the two low-side FETs are both turned on for t_{OFF} time, slow decay mode is used to adjust the current.

Current Sensing and Regulation

Please refer to SGM42531 current sensing and regulation timing diagram blow in Figure 3. For detailed timing parameter, please refer to the electrical characteristics table.

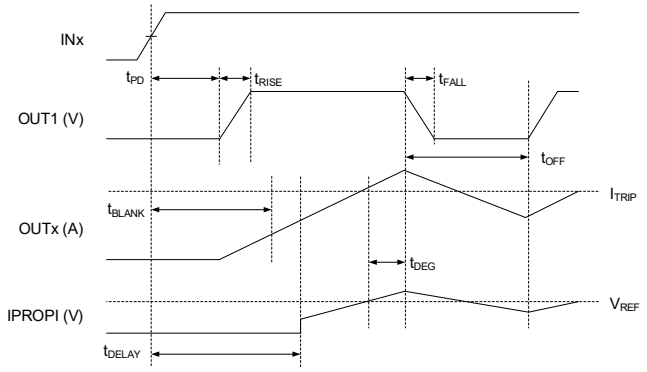


Figure 3. Detailed IPROPI Timing Diagram

Current Sensing

Please refer to the IPROPI pin output current calculation in Equation 1 below. The I_{LSx} only sense current flowing through the low-side FET in one direction (current flows from the drain to the source), while current flows from the source to the drain, the I_{LSx} for that channel is zero. For example, during slow decay/brake state, the IPROPI output current is only proportional to the low-side FET that current flows from the drain to the source.

During coast mode (refer to the logic in Table 1), the current flows from source to drain through the body diode and cannot be sensed.

$$I_{PROPI}\ (\mu A) = (I_{LS1} + I_{LS2})\ (A) \times A_{IPROPI}\ (\mu A/A) \quad (1)$$

The A_{ERR} (current mirror total error) includes offset error and gain error.

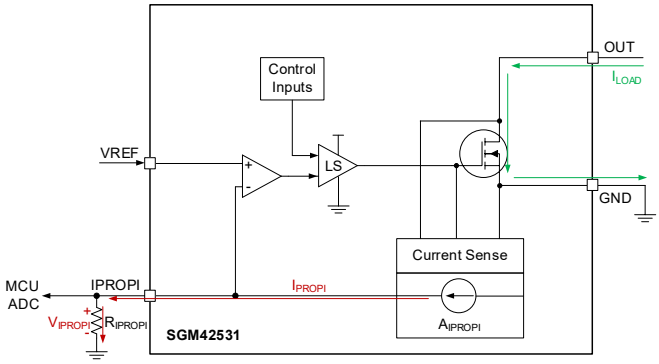


Figure 4. Integrated Current Sensing

External resistor (R_{IPROPI}) converts to proportional current to voltage for microcontroller ADC current sensing. The resistor value is decided by application current and ADC input range. Please refer to the IPROPI voltage calculation below in Equation 2.

$$V_{IPROPI}\ (V) = I_{PROPI}\ (A) \times R_{IPROPI}\ (\Omega) \quad (2)$$

The t_{DELAY} defines the delay time from INx pins command low-side FET on to IPROPI output is ready. The t_{DELAY} may limit the current sense IPROPI bandwidth during fast decay/coast mode (refer to Table 1), since the low-side FET is switching on/off. However, during the slow decay/brake mode, the low-side FET is keeping on and t_{DELAY} does not impact the IPROPI output.

DETAILED DESCRIPTION (continued)

Current Regulation

The SGM42531 device integrates a fixed off-time current regulation chopping scheme shown in Figure 5.

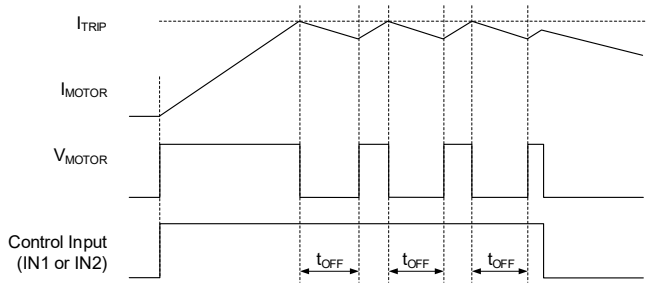


Figure 5. Off-Time Current Regulation

A combination of V_{REF} (the VREF pin voltage) and R_{IPROPI} (IPROPI output resistor) sets the I_{TRIP} current. Please refer to the calculation below:

$$I_{TRIP}\ (A) \times A_{IPROPI}\ (\mu A/A) = V_{REF}\ (V)/R_{IPROPI}\ (\Omega) \quad (3)$$

For example, if V_{REF} = 3V, R_{IPROPI} = 1000Ω, and A_{IPROPI} = 1500μA/A, then I_{TRIP} will be approximately 2A.

During output switching, there may have some voltage and current transients, to prevent the transients from affecting current regulation, the internal I_{TRIP} comparator has two parameters t_{BLANK} (blanking time) and t_{DEG} (deglitch time). For brushed DC motor application, it is common to see that a capacitor connected between motor terminals for improving EMI performance, however, the capacitor may cause big current transient over I_{TRIP} during output switching, the t_{BLANK} and t_{DEG} scheme is implemented to prevent the transient from triggering the current regulation wrongly. However, in some worse case, if the transient stand is longer than deglitch time, some external circuit may help to eliminate the prematurely trigger. Normally, a 10nF capacitor from IPROPI pin to GND closing the device is recommended during this case, the capacitor can be adjusted according to the application voltage and current transients, however, large capacitor may slow down the current regulation response time.

The current regulation or current sensing can be disabled according to the table blow. Make sure that V_{REF} should be within the range specified in absolute maximum ratings section.

Table 2. Current Feedback and Current Regulation

Condition	Current Feedback Function	Current Regulation
Connecting the IPROPI to GND and set V_{REF} > GND.	Disabled	Disabled
Connecting R_{IPROPI} resistor from IPROPI to GND and set V_{REF} > V_{IPROPI}.	Enable	Disabled

Over-Current Protection (OCP)

Each MOSFET is protected by its own preset over-current limit. In case of an over-current (any direction), the whole bridge will be disabled (shutdown), and the device will retry after t_{RETRY}. An over-current will occur due to a short between a switching node and ground, VM supply line, or the other node of the bridge (a winding short).

Thermal Shutdown (T_{SD})

The driver is shutdown if a junction over-temperature occurs in the device. Once the temperature goes back to the safe level, the device resumes its operation.

Under-Voltage Lockout (UVLO)

If the voltage on VM pin falls below its under-voltage lockout threshold, the device will be disabled. The device resumes operation when the power supply goes back above UVLO thresholds.

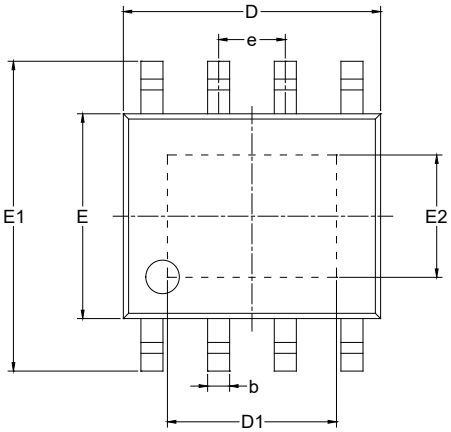
REVISION HISTORY

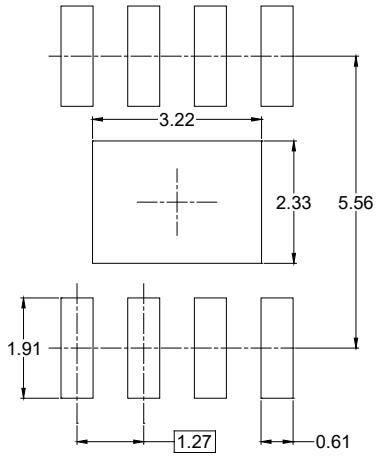
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original to REV.A (DECEMBER 2025)	Page
Changed from product preview to production data	All

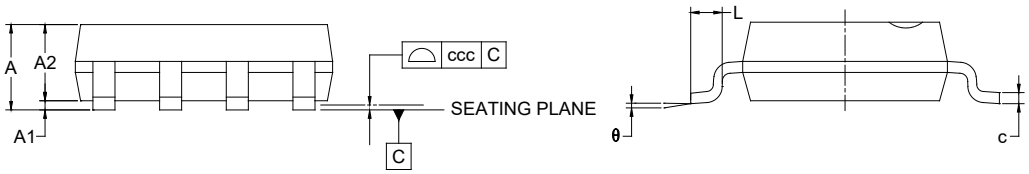
PACKAGE OUTLINE DIMENSIONS

SOIC-8 (Exposed Pad)





RECOMMENDED LAND PATTERN (Unit: mm)

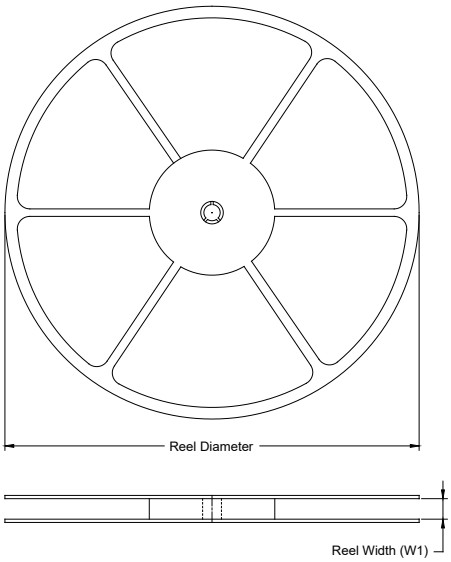


Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A			1.700
A1	0.000	-	0.150
A2	1.250	-	1.650
b	0.330	-	0.510
c	0.170	-	0.250
D	4.700	-	5.100
D1	3.020	-	3.420
E	3.800	-	4.000
E1	5.800	-	6.200
E2	2.130	-	2.530
e	1.27 BSC		
L	0.400	-	1.270
θ	0°	-	8°
ccc	0.100		

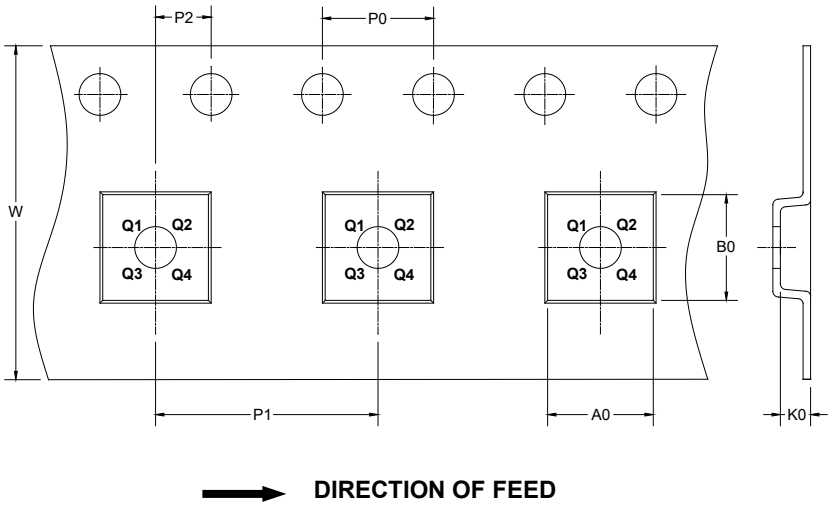
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MS-012.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



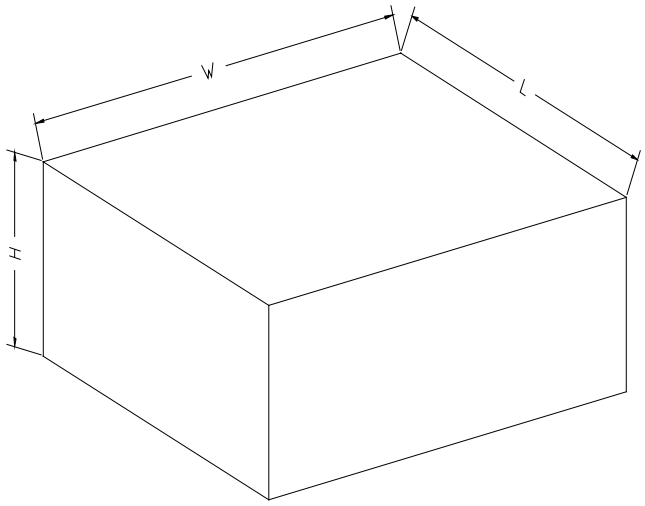
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOIC-8 (Exposed Pad)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	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
13″	386	280	370	5

DD0002