SGM42601
Dual H-Bridge Motor Driver

GENERAL DESCRIPTION

The SGM42601 is a motor driver device with two integrated H-bridges that can run a bipolar stepper motor. The device can operate over a wide input voltage range of 2.5V to 12V, and each H-bridge of the SGM42601 can deliver up to 600mA RMS (or DC) current continuously.

Internal over-current and over-temperature circuits prevent the device from being in over-stress condition, while a fault output simplifies stalling sensing, which is a useful feature for most applications. Sleep mode is provided for low power situation

The device is available in a Green TQFN-4×4-16L package.

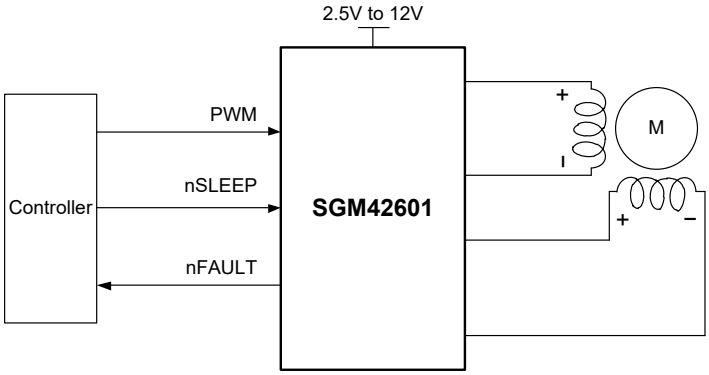
FEATURES

- **Wide Power Supply Voltage Range: 2.5V to 12V**
- **Dual H-Bridge Motor Driver**
- **Low Quiescent Current: 150μA (TYP)**
- **Sleep Mode Supply Current: 0.32μA (TYP)**
- **xINx (PWM) Interface**
- **Output Current Capability (at V_{CC} = 5V, +25℃)**
  - **0.6A RMS, 1A Peak per H-Bridge**
  - **1.2A RMS in Parallel Mode**
- **UVLO for VCC Voltage**
- **Over-Current Protection (OCP)**
- **Thermal Shutdown (TSD)**
- **Fault Indication Pin (nFAULT)**
- **Available in a Green TQFN-4×4-16L Package**

APPLICATIONS

Robotics
Point-of-Sale Printers
Battery-Powered Toys
Video Security Cameras
Office Automation Machines

SIMPLIFIED SCHEMATIC

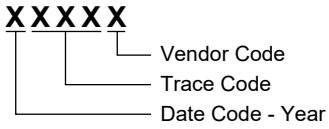


PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM42601	TQFN-4×4-16L	-40℃ to +125℃	SGM42601XTQE16G/TR	SGM42601 XTQE16 XXXXX	Tape and Reel, 3000

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 Range, V_{CC} ..... -0.3V to 13.2V
Control Pins
(AIN1, AIN2, BIN1, BIN2, nSLEEP, nFAULT) to GND.....
..... -0.3V to 6V
Package Thermal Resistance
TQFN-4×4-16L, θ_{JA} ..... 46℃/W
Operating Junction Temperature.....+150℃
Storage Temperature Range .....-65℃ to +150℃
Lead Temperature (Soldering, 10s).....+260℃
ESD Susceptibility
HBM.....6000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage Range, V_{CC} .....2.5V to 12V
Motor RMS Current, I_{RMS} .....0A to 0.6A
Applied PWM Signal to AIN1, AIN2, BIN1, or BIN2, f_{PWM} .....
..... 0 to 200kHz
Operating Ambient Temperature Range.....-40℃ to +125℃
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

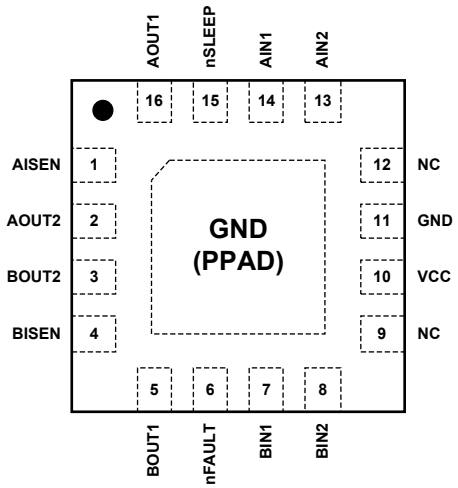
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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



TQFN-4×4-16L

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	AISEN	I/O	Bridge A Ground or I_{CHOP}.
16	AOUT1	O	Bridge A Nodes.
2	AOUT2		
5	BOUT1	O	Bridge B Nodes.
3	BOUT2		
4	BISEN	I/O	Bridge B Ground or I_{CHOP}.
6	nFAULT	OD	Fault Indication Pin. The logic is pulled low with a fault condition. Open-drain output requires an external pull-up.
7	BIN1	I	H-Bridge B PWM Inputs. Control the state of BOUT1 and BOUT2. Internal pull-down.
8	BIN2	I	
9, 12	NC	–	No Connection.
10	VCC	P	Device Power Supply. Connect to motor supply. A 10μF (MIN) ceramic bypass capacitor to GND is recommended.
11	GND	G	Ground.
14	AIN1	I	H-Bridge A PWM Inputs. Control the state of AOUT1 and AOUT2. Internal pull-down.
13	AIN2	I	
15	nSLEEP	I	Sleep Mode Input. Apply logic high to enable device, and apply logic low to enter in the low power sleep mode. Internal pull-down.
Exposed Pad	GND (PPAD)	G	Exposed Pad. Exposed pad is internally connected to GND. Connect it to a large ground plane to maximize thermal performance. It is not intended as an electrical connection point.

NOTE: I = input, O = output, I/O = input or output, OD = open-drain output, G = ground, P = power for the circuit.

ELECTRICAL CHARACTERISTICS

(V_{CC} = 5V, Full = -40℃ to +125℃. Typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Power Supplies (VCC)							
Power Supply Voltage	V_{CC}		Full	2.5		12	V
Power Supply Current	I_{VCC}	xINx low, nSLEEP high	+25℃		150	220	μA
			Full			230	
Sleep Mode Supply Current	I_{VCCQ}	nSLEEP low	+25℃		0.32	0.6	μA
			Full			5	
Time to Enter Sleep Mode	t_{SLEEP}	nSLEEP low to sleep mode	+25℃		10		μs
Wake-Up Time	t_{WAKE}	nSLEEP high to output transition	+25℃		100		μs
Turn-On Time	t_{ON}	V_{CC} > V_{UVLO} to output transition	+25℃		30		μs
Control Inputs (AIN1, AIN2, BIN1, BIN2 and nSLEEP)							
Input Logic Low Voltage	V_{IL}	xINx	Full	0		0.5	V
		nSLEEP	Full	0		0.5	
Input Logic High Voltage	V_{IH}	xINx	Full	1.5		5.5	V
		nSLEEP	Full	1.5		5.5	
Input Logic Hysteresis	V_{HYS}		+25℃		200		mV
Input Logic Low Current	I_{IL}	V_{IN} = 0V	+25℃	-0.5	0.01	0.5	μA
			Full	-1		1	
Input Logic High Current	I_{IH}	xINx, V_{IN} = 5V	+25℃		33	45	μA
			Full			52	
		nSLEEP, V_{IN} = 5V	+25℃		10	14	
			Full			17	
Pull-Down Resistance	R_{PD}	xINx	+25℃	110	150	190	kΩ
			Full	80		220	
		nSLEEP	+25℃	380	500	620	
			Full	280		730	
Input Deglitch Time	t_{DEG}		+25℃		610		ns
Propagation Delay INx to OUTx	t_{PROP}		+25℃		800		ns
Control Output (nFAULT)							
Output Logic Low Voltage	V_{OL}	I_O = 5mA	+25℃		0.22	0.3	V
			Full			0.35	
Output Logic High Leakage Current	I_{OH}	R_{PULLUP} = 1kΩ to 5V	+25℃	-1	0.01	1	μA
			Full	-2		2	

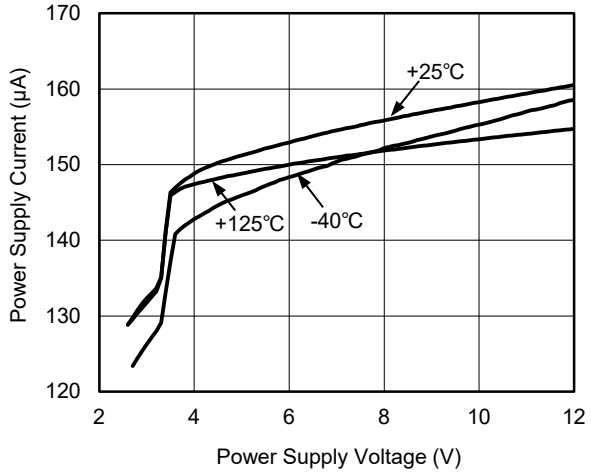
ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 5V, Full = -40℃ to +125℃. Typical values are at T_A = +25℃, unless otherwise noted.)

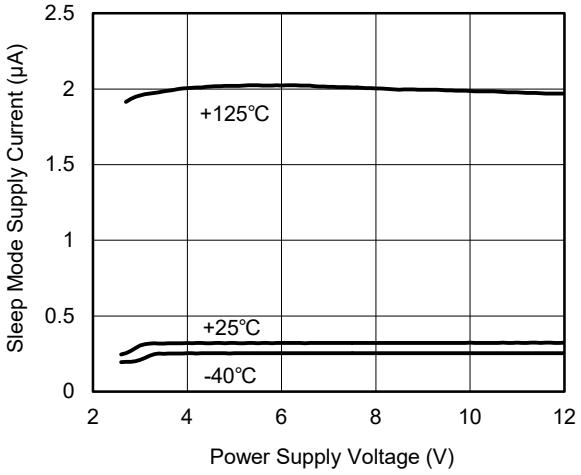
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Motor Driver Outputs (AOUT1, AOUT2, BOUT1 and BOUT2)							
High-side FET On-Resistance	R_{DSON_H}	V_{CC} = 5V, I = 0.2A	+25℃		1120	1450	mΩ
			Full			2000	
		V_{CC} = 2.5V, I = 0.2A	+25℃		1480	1850	
			Full			2460	
Low-side FET On-Resistance	R_{DSON_L}	V_{CC} = 5V, I = -0.2A	+25℃		490	610	mΩ
			Full			820	
		V_{CC} = 2.5V, I = -0.2A	+25℃		655	900	
			Full			1150	
Off-State Leakage Current	I_{OFF}		+25℃	-0.5	0.01	0.5	μA
			Full	-1.5		1.5	
Output Rise Time	t_{RISE}	R_L = 16Ω to GND	+25℃		70		ns
Output Fall Time	t_{FALL}	R_L = 16Ω to V_{CC}	+25℃		60		ns
Output Dead Time	t_{DEAD}	Internal dead time	+25℃		90		ns
PWM Current Controls (AISEN and BISEN)							
xISEN Trip Voltage	V_{TRIP}		+25℃	185	202	219	mV
			Full	180		224	
Current Control Constant Off-Time	t_{OFF}	Internal PWM constant off-time	+25℃		25		μs
Protection Circuits							
VCC Under-Voltage Lockout	V_{UVLO}	V_{CC} falling, UVLO report	+25℃	2.02	2.1		V
			Full	2			
		V_{CC} rising, UVLO recovery	+25℃		2.3	2.42	
			Full			2.45	
VCC Under-Voltage Hysteresis	V_{UVLO_HYS}	Rising to falling threshold	+25℃		200		mV
Over-Current Protection Trip Level	I_{OCP}		+25℃	1.01	1.5		A
Over-Current Deglitch Time	t_{DEG}		+25℃		2.6		μs
Over-Current Protection Period	t_{OCP}		+25℃		2.3		ms
Thermal Shutdown Temperature	T_{TSD}				160		℃
Thermal Shutdown Hysteresis	T_{HYS}				20		℃

TYPICAL PERFORMANCE CHARACTERISTICS

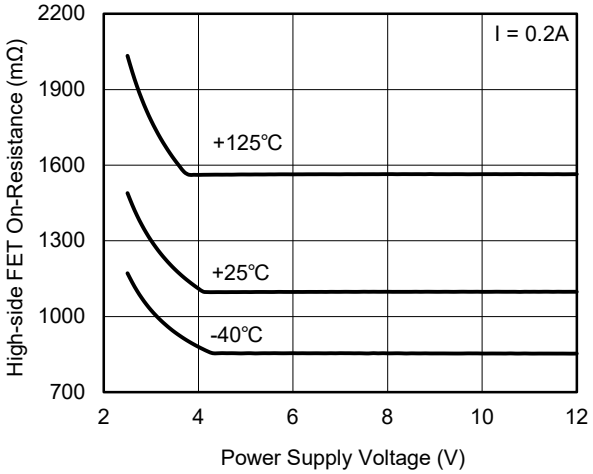
Power Supply Current vs. Power Supply Voltage



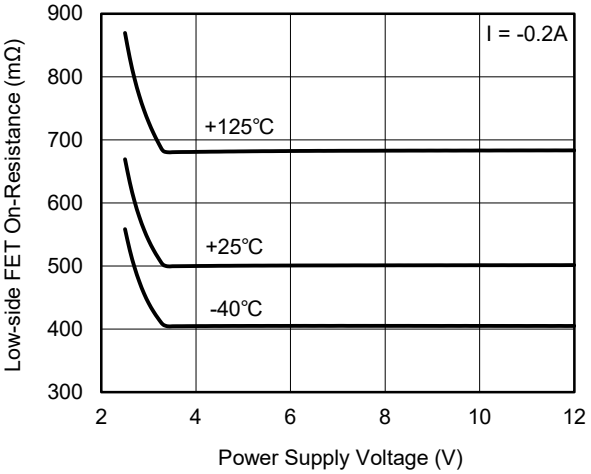
Sleep Mode Supply Current vs. Power Supply Voltage



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



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



FUNCTIONAL BLOCK DIAGRAM

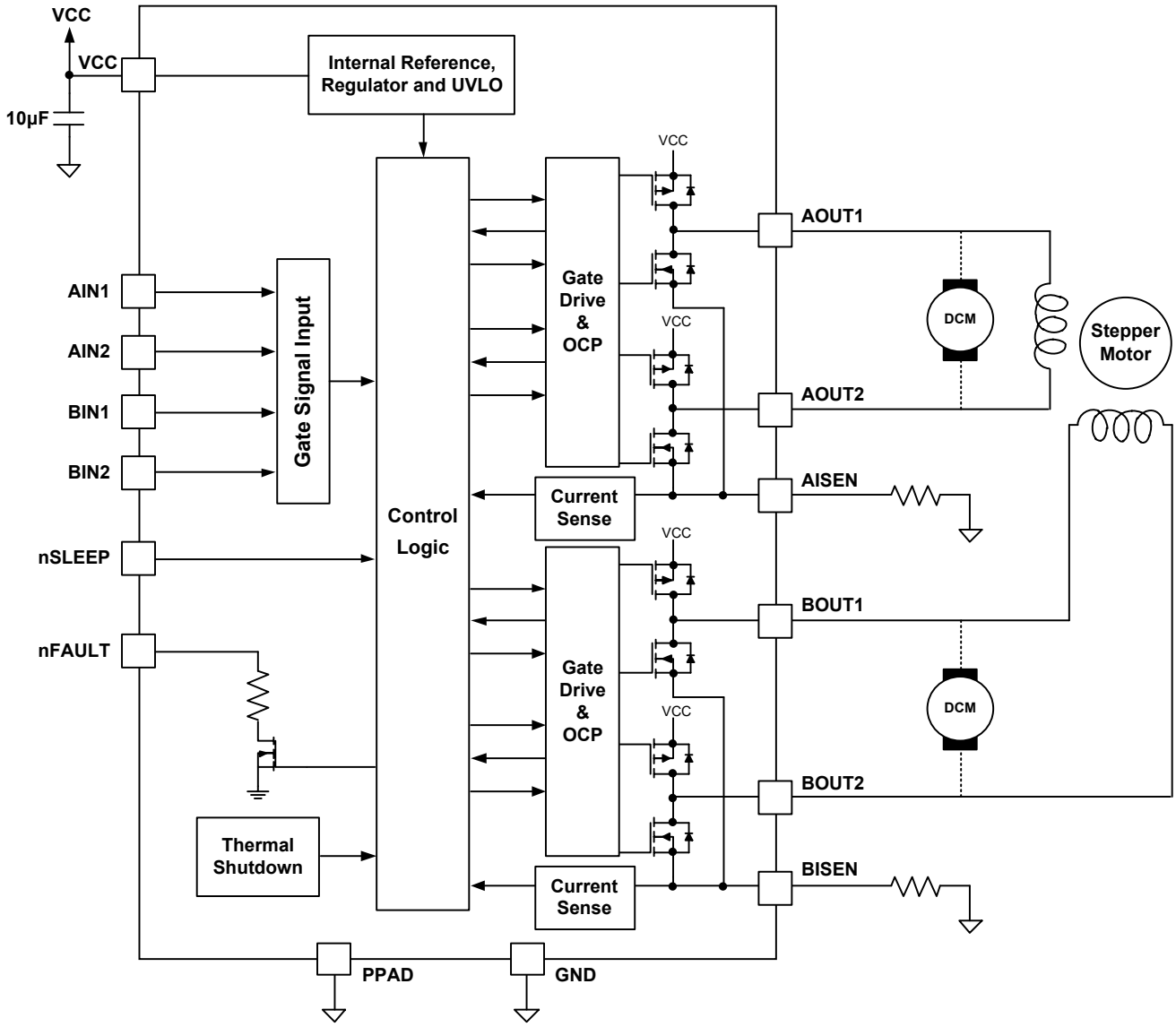


Figure 1. SGM42601 Block Diagram

DETAILED DESCRIPTION

The SGM42601 is dual H-bridge motor driver suitable for stepper motor or brushed motor. Each of the internal H-bridges consists of NMOS and PMOS, which has 600mA output current capability over an input voltage range of 2.5V to 12V.

The output current can be regulated by PWM from xIN1/xIN2 input or internal current limit.

Several protection features are included: under-voltage lockout, over-current protection, and over-temperature protection. Power dissipation can be saved by entering sleep mode.

DETAILED DESCRIPTION (continued)

PWM Motor Drivers

Block diagram of the integrated motor driver including current control PWM H-bridges is shown in Figure 2.

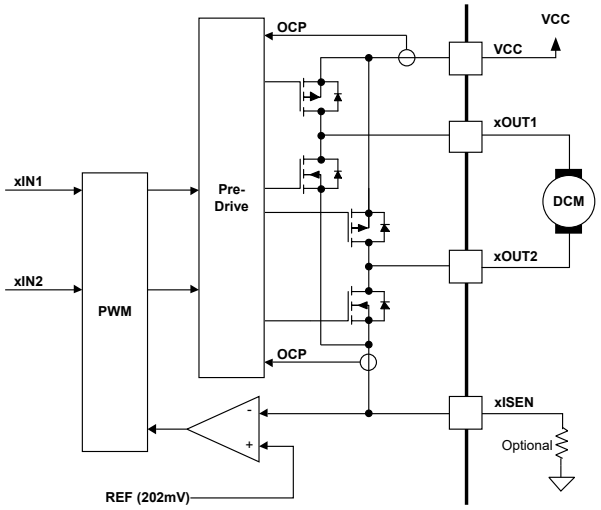


Figure 2. H-Bridge and Current Chopping Circuitry

Bridge Control and Decay Modes

The AINx and BINx input pins control the output states of the AOUTx and BOUTx respectively, as shown in Table 1.

Table 1. H-Bridge Logic

xIN1	xIN2	xOUT1	xOUT2	Function
0	0	Z	Z	Coast/Fast Decay
0	1	L	H	Reverse
1	0	H	L	Forward
1	1	L	L	Brake/Slow Decay

The SGM42601 supports PWM mode of input to control motor current. When the PWM driving on time ends, current begins to decay through a recirculation path since it must continue to flow. There are two different decay modes available for the H-bridge as shown in Figure 3. In fast mode, current flows through the body diode when the whole H-bridge is disabled. In slow decay mode, current recirculates in low-side MOSFETs when the high-side MOSFETs is disabled.

When external PWM modulate signal is applied to one xIN pin while the other is held low, the bridge is in fast decay mode; when the other xIN pin is held high, the bridge is in slow decay mode (see Table 2).

Table 2. PWM Control of Motor Speed

xIN1	xIN2	Function
PWM	0	Forward PWM, Fast Decay
1	PWM	Forward PWM, Slow Decay
0	PWM	Reverse PWM, Fast Decay
PWM	1	Reverse PWM, Slow Decay

If connecting a sense resistor from xISEN pin to GND, the internal current limit is always enabled. To disable this function, please short the xISEN pin to GND directly. Please refer to Figure 3 for the current path of the drive and the decay modes.

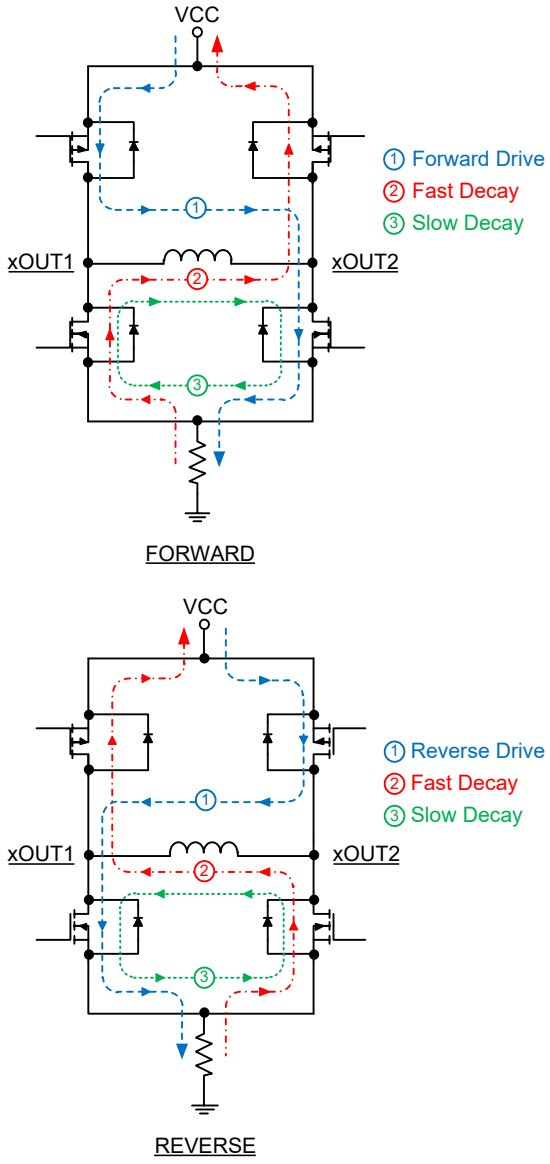


Figure 3. Drive and Decay Modes

DETAILED DESCRIPTION (continued)

Current Control

Current is regulated by a 25μs constant off-time PWM regulation when chopping conditions are met. For DC motor applications, it is possible to limit the current to prevent overshoot when motor startup or stall. For stepper motor applications, current control can provide a constant current.

When the output is enabled, the motor current rises up depending on the power supply and motor inductance, and the xISEN pin voltage is ignored for a fixed blanking time of about 3.2μs. After that, if the xISEN voltage reaches the internal reference voltage (VTRIP) of typically 202mV, the high-side MOSFETs may be turned off, and both low-side MOSFETs may be turned on for a fixed time of 25μs.The PWM chopping current is set by a comparator that compares the voltage across a current sense resistor connected to the xISEN pins with a reference voltage. The reference voltage (V_{TRIP}) is fixed at 202mV nominally.

The chopping current is calculated in Equation 1.

$$I_{CHOP} = \frac{202mV}{R_{xISEN}} \quad (1)$$

Example: If a 0.5Ω sense resistor is used, the chopping current will be 202mV/0.5Ω = 404mA.

Note that if current control is not needed, the xISEN pins need to be shorted to ground directly.

Decay Mode

After any drive phase, when phase current reaches the current limit setting point, the H-bridge turns to slow decay mode (two low-side MOSFETs on), lasting for 25μs.

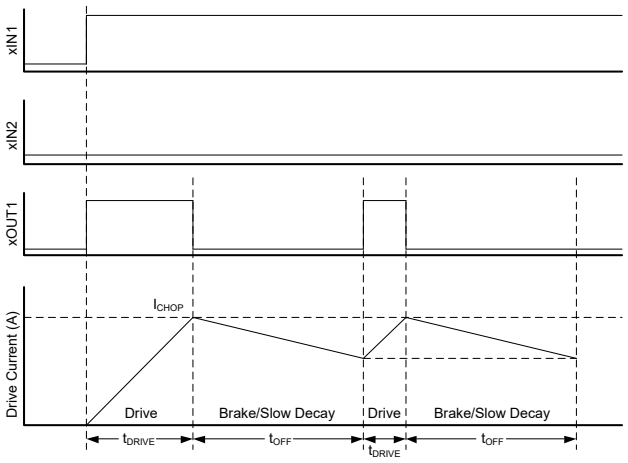


Figure 4. Current Chopping Operation

Sleep Mode

To idle the device and put it in the low power sleep mode, the nSLEEP pin can be pulled low. In the sleep mode, all H-bridges and drivers are disabled, and the device will not respond to input signals in any way until it resumes operation. When waking up from sleep mode, it takes at least t_{WAKE} to fully recover.

DETAILED DESCRIPTION (continued)

Parallel Mode

The SGM42601 can be parallel connected for doubling the current of a single H-bridge to drive a DC motor. The dead time of the SGM42601 prevents any risk of cross-conduction (shoot-through) between the two H-bridges. Figure 5 shows this configuration.

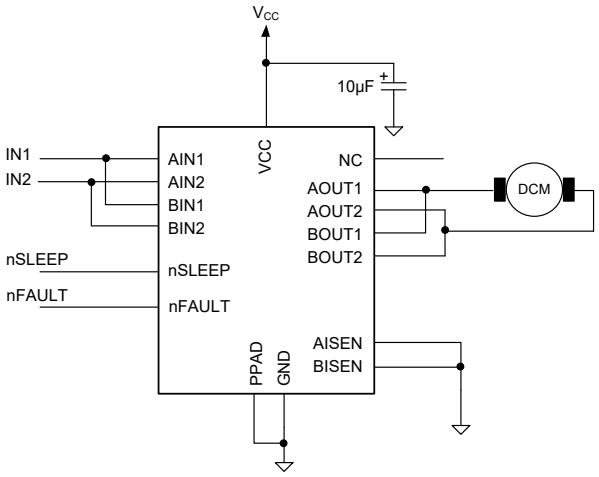


Figure 5. Parallel Mode Schematic

Protection Circuits

The SGM42601 is fully protected against over-current, over-temperature, and under-voltage events.

Over-Current Protection (OCP)

Each MOSFET has an independent over-current protection current. When the operating current exceeds the over-current point and lasts for more than the OCP deglitch time, the H-bridge will be shut down and OCP fault will be reported on nFAULT pin. The driver will be re-enabled periodically at OCP retry intervals.

The OCP protection circuit works even if the xISEN pin is shorted to GND.

Thermal Shutdown (TSD)

All bridges and drivers are shutdown if a junction over-temperature occurs in the device and the nFAULT pin will be driven low. Once the temperature goes back to the safe level, the device resumes its operation.

Under-Voltage Lockout (UVLO)

If the voltages on VCC pin fall below their under-voltage lockout thresholds, the device will be disabled and internal logic will be reset. Device resumes operation when all of them go back above their UVLO thresholds. The UVLO event is not reported on the nFAULT pin.

Table 3. Device Protection

Fault	Condition	Error Report	H-Bridge	Internal Circuits	Recovery
V_{CC} Under-Voltage Lockout (UVLO)	V_{CC} < 2.1V	None	Disabled	Disabled	V_{CC} > 2.3V
Over-Current Protection (OCP)	I_{OUT} > I_{OCP}	nFAULT	Disabled	Operating	OCP
Thermal Shutdown (TSD)	T_J > T_{TSD}	nFAULT	Disabled	Operating	T_J < T_{TSD} - T_{HYS}

Table 4. Modes of Operation

Fault	Condition	H-Bridge	Internal Circuits
Operating	nSLEEP pin high	Operating	Operating
Sleep Mode	nSLEEP pin low	Disabled	Disabled
Fault Encountered	Any fault condition met	Disabled	See Table 3

APPLICATION INFORMATION

Power Supply Recommendations

The SGM42601 operates from a supply voltage range of 2.5V to 12V. It is recommended to connect at least one ceramic capacitor between VCC and GND, as close as possible to the VCC pin of the device.

Bypass Capacitance for Motor Drive Systems

The selection of bypass capacitors is crucial for motor drive system. The following conditions should be considered during design, including:

- Maximum power supply voltage
- Parasitic inductance in the power supply wiring
- Type of motor (brushed DC, brushless DC, stepper)
- Motor speed
- Motor braking method

Motor datasheets generally specify the capacitance value, however, it is recommended to do a system level test to size the bypass capacitors properly.

Layout Guidelines

Use a low ESR ceramic bypass capacitor connected between VCC pin and GND pin. The capacitor should be placed near the VCC pin and connected to the GND pin and PPAD of the device using thick wires or ground plane.

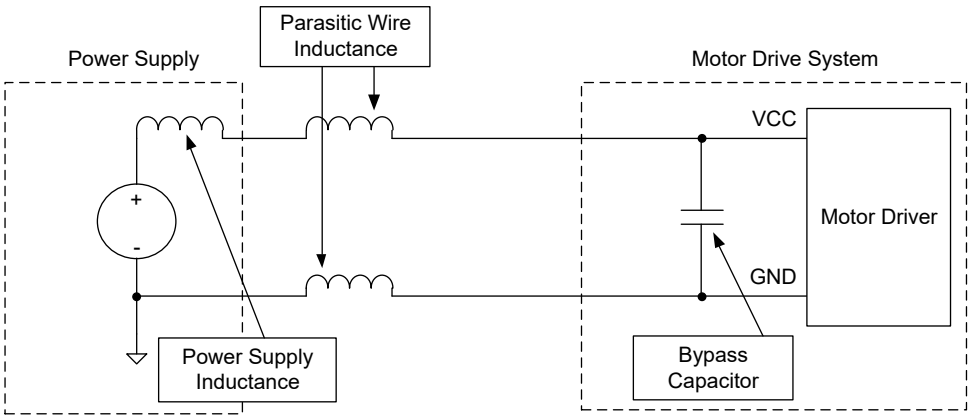


Figure 6. Setup of Motor Drive System with External Power Supply

REVISION HISTORY

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

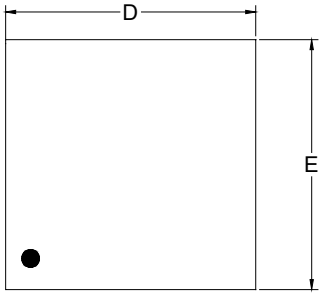
DECEMBER 2025 – REV.A.1 to REV.A.2	Page
Updated Detailed Description and Application Information	All

AUGUST 2021 – REV.A to REV.A.1	Page
Updated Electrical Characteristics section	5

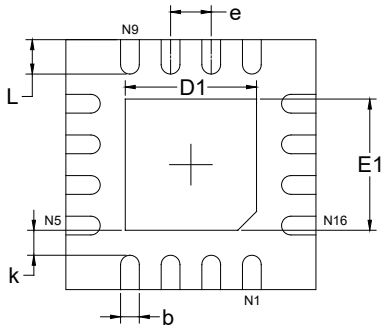
Changes from Original to REV.A (JULY 2021)	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

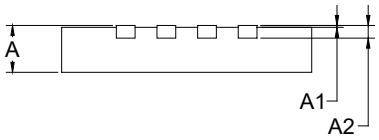
TQFN-4×4-16L



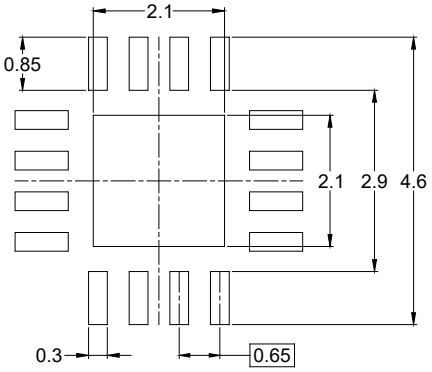
TOP VIEW



BOTTOM VIEW



SIDE VIEW



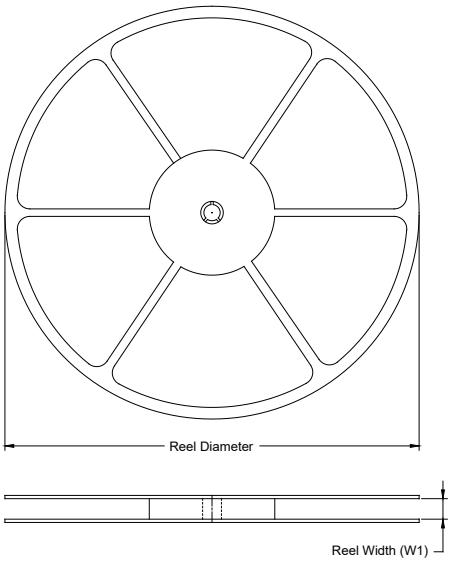
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	3.900	4.100	0.154	0.161
D1	2.000	2.200	0.079	0.087
E	3.900	4.100	0.154	0.161
E1	2.000	2.200	0.079	0.087
k	0.200 MIN		0.008 MIN	
b	0.250	0.350	0.010	0.014
e	0.650 TYP		0.026 TYP	
L	0.450	0.650	0.018	0.026

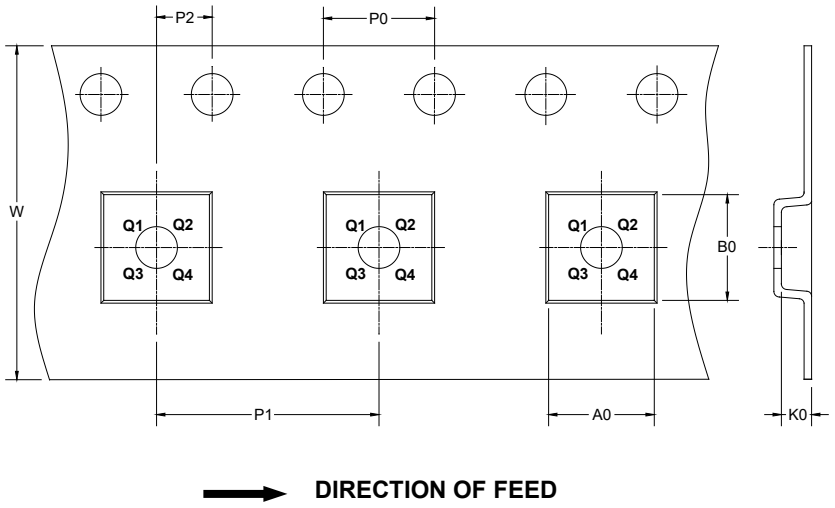
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



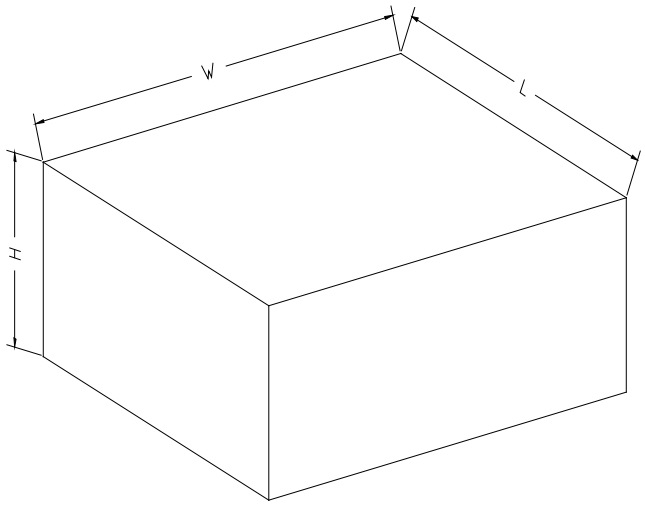
NOTE: The picture is only for reference. Please make the object as the standard.

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
TQFN-4×4-16L	13″	12.4	4.30	4.30	1.10	4.0	8.0	2.0	12.0	Q2

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