SGM42535
Dual Low-Voltage H-Bridge IC

GENERAL DESCRIPTION

The SGM42535 has two H-bridge drivers, which drive a stepping motor or two DC motors, and other devices, such as solenoids. Each H-bridge of SGM42535 can provide an output current of up to 1.5A. The motor power supply voltage ranges from 0V to 12V, and the device power supply voltage ranges from 2V to 5.5V. Each output driver module is composed of N-channel power MOSFETs and configured as an H-bridge to drive the motor windings. The internal charge pump generates the gate driving voltage. The SGM42535 provides integrated motor driver solutions for consumer electronics, cameras, toys and other battery-powered or low-voltage motion control applications.

PHASE/ENBL and IN/IN interfaces are compatible with industry-standard devices.

A number of protection features are provided in the device including over-current protection, short-circuit protection, under-voltage lockout protection and over-temperature protection.

The SGM42535 is available in a Green TDFN-3×2-12L package.

FEATURES

- **Dual-H-Bridge Motor Driver**
  - **Able to Drive One Stepper Motor or Two DC Motors**
  - **Low R_{DSON}: 300mΩ for HS + LS**
- **Separate Logic Supply and Motor Power Supply:**
  - **Device Power Supply Voltage: 2V to 5.5V**
  - **Motor Power Supply Voltage: 0V to 12V**
- **Drive Current per H-Bridge: 1.5A (MAX)**
- **Configure Bridges Parallel for 3A Drive Current**
- **Flexible PWM or PHASE/ENBL Interface**
- **Available in a Green TDFN-3×2-12L Package**

APPLICATIONS

Consumer Products
Toys
Cameras
DSLR Lenses
Medical Devices
Robotics

SIMPLIFIED SCHEMATIC

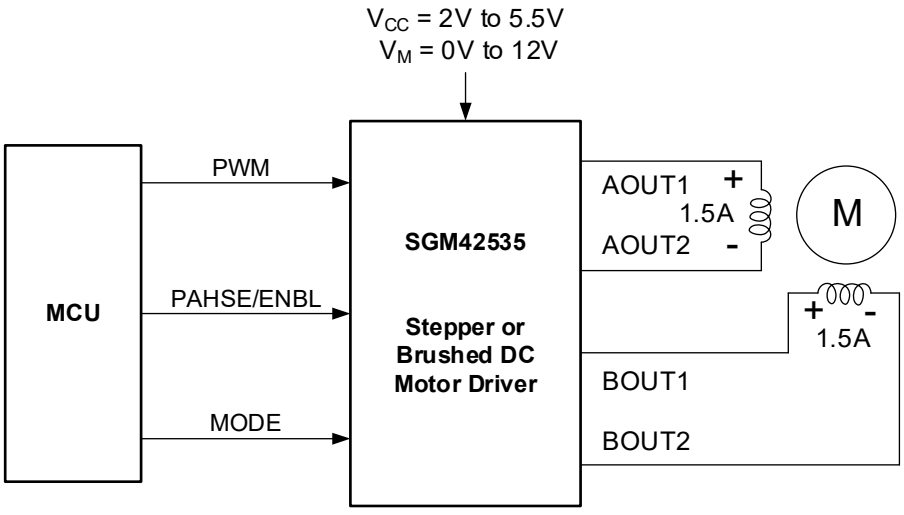


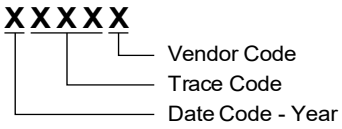
Figure 1. Simplified Schematic

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM42535	TDFN-3×2-12L	-40℃ to +125℃	SGM42535XTHX12G/TR	1MZTHX 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

Motor Power Supply Voltage, V_M ..... -0.3V to 13.2V
Device Power Supply Voltage, V_{CC} ..... -0.3V to 6V
Digital Input Pin Voltage ..... -0.5V to V_{CC} + 0.5V
Continuous Motor Drive Output Current per H-Bridge (1) .....
..... -1.5A to 1.5A
Package Thermal Resistance
TDFN-3×2-12L, θ_{JA} ..... 50.1℃/W
TDFN-3×2-12L, θ_{JB} ..... 18.1℃/W
TDFN-3×2-12L, $\theta_{JC\ (TOP)}$ ..... 56.5℃/W
TDFN-3×2-12L, $\theta_{JC\ (BOT)}$ ..... 3.3℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility (1) (2)
HBM ..... ±4000V
CDM ..... ±2000V

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

Motor Power Supply Voltage, V_M ..... 0V to 12V
Device Power Supply Voltage, V_{CC} ..... 2V to 5.5V
Logic Level Input Voltage, V_{IN} ..... 0V to V_{CC}
H-Bridge Output Current (1) ..... 0A to 1.5A
Externally Applied PWM Frequency ..... 0kHz to 250kHz
Operating Junction Temperature Range ..... -40℃ to +150℃

NOTE: 1. Power dissipation and thermal limits must be observed.

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

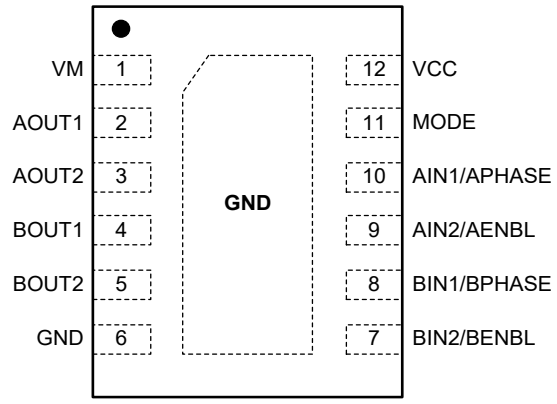
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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



TDFN-3×2-12L

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
1	VM	P	Power Supply for the Motor. Bypass to GND with a 0.1μF (MIN) ceramic capacitor.
2	AOUT1	O	Bridge A Output 1. Connect it to motor winding A.
3	AOUT2	O	Bridge A Output 2. Connect it to motor winding A.
4	BOUT1	O	Bridge B Output 1. Connect it to motor winding B.
5	BOUT2	O	Bridge B Output 2. Connect it to motor winding B.
6	GND	G	Device Ground Pin.
7	BIN2/BENBL	I	Bridge B Input 2/Enable Input. IN/IN mode: BOUT2 high set by logic high. PHASE/ENBL mode: logic high enables H-bridge B. Internal pull-down resistor.
8	BIN1/BPHASE	I	Bridge B Input 1/Phase Input. IN/IN mode: BOUT1 high set by logic high. PHASE/ENBL mode: logic high to set BOUT2 high and BOUT1 low. Internal pull-down resistor.
9	AIN2/AENBL	I	Bridge A Input 2/Enable Input. IN/IN mode: AOUT2 high set by logic high. PHASE/ENBL mode: logic high enables H-bridge A. Internal pull-down resistor.
10	AIN1/APHASE	I	Bridge A Input 1/Phase Input. IN/IN mode: AOUT1 high set by logic high. PHASE/ENBL mode: logic high to set AOUT2 high and AOUT1 low. Internal pull-down resistor.
11	MODE	I	Input Mode Selection Pin. The device enters IN/IN mode at logic low. The device enters PHASE/ENBL mode at logic high. Internal pull-down resistor.
12	VCC	P	Device Supply Pin. Bypass to GND with a 0.1μF (MIN) ceramic capacitor.
Exposed Pad	GND	G	Device Ground.

NOTE: I = input, O = output, P = power, G = ground.

ELECTRICAL CHARACTERISTICS

(V_M = 5V, V_{CC} = 3V, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Power Supply							
VM Operating Supply Current	I_{VM}	No PWM, no load			100	130	μA
		50kHz PWM, no load			175	210	
VM Sleep Mode Supply Current	I_{VMQ}	V_{CC} = 0V, all inputs 0V	V_M = 2V		10	70	nA
			V_M = 5V		20	70	
VCC Operating Supply Current	I_{VCC}				700	1050	μA
VCC Under-Voltage Lockout Voltage	V_{UVLO}	V_{CC} rising threshold		1.65	1.8	2	V
		V_{CC} falling threshold		1.55	1.7	1.85	
Logic-Level Inputs							
Input Low Voltage	V_{IL}					0.3 × V_{CC}	V
Input High Voltage	V_{IH}			0.5 × V_{CC}			V
Input Low Current	I_{IL}	V_{IN} = 0V		-200		200	nA
Input High Current	I_{IH}	V_{IN} = 3.3V		15	23	30	μA
Pull-Down Resistance	R_{PD}				140		kΩ
H-Bridge FETs							
HS + LS FET On-Resistance	R_{DSON}	I_O = 800mA, T_J = +25℃	V_{CC} = 3V, V_M = 3V		350	430	mΩ
			V_{CC} = 5V, V_M = 5V		300	370	
OFF-State Leakage Current	I_{OFF}			-300		300	nA
Protection Circuits							
Over-Current Protection Trip Level (1)	I_{OCP}			1.6	2.5	3.6	A
Over-Current Protection Retry Time (1)	t_{OCR}				5		ms
Over-Current De-Glitch Time	t_{DEG}				1.4		μs
Output Dead Time	t_{DEAD}				100		ns
Thermal Shutdown Temperature (2)	T_{SD}	Die temperature		150	165	180	℃

NOTES:

1. When V_M ≥ 4.5V and V_{CC} ≤ 2.9V, I_{OCP} and t_{OCR} will cut off 50%.
2. Not production tested.

TIMING REQUIREMENTS

(V_M = 5V, V_{CC} = 3V, T_A = +25℃, and R_L = 20Ω, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Delay Time	t_1	xPHASE high to xOUT1 low			300	ns
	t_2	xPHASE high to xOUT2 high			300	ns
	t_3	xPHASE low to xOUT1 high			300	ns
	t_4	xPHASE low to xOUT2 low			300	ns
	t_5	xENBL high to xOUTx high			300	ns
	t_6	xENBL high to xOUTx low			300	ns
Output Enable Time	t_7				160	ns
Output Disable Time	t_8				300	ns
Delay Time	t_9	xINx high to xOUTx high			300	ns
	t_{10}	xINx low to xOUTx low			300	ns
Output Rise Time	t_R		10		70	ns
Output Fall Time	t_F		10		110	ns

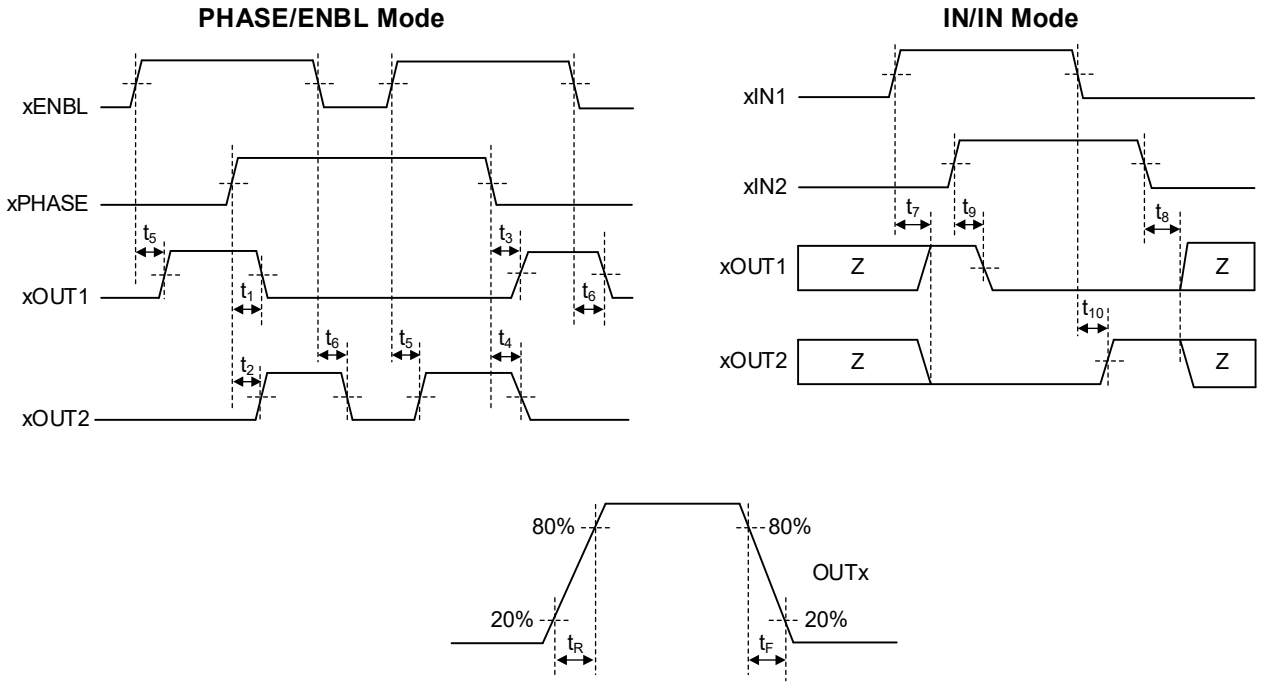
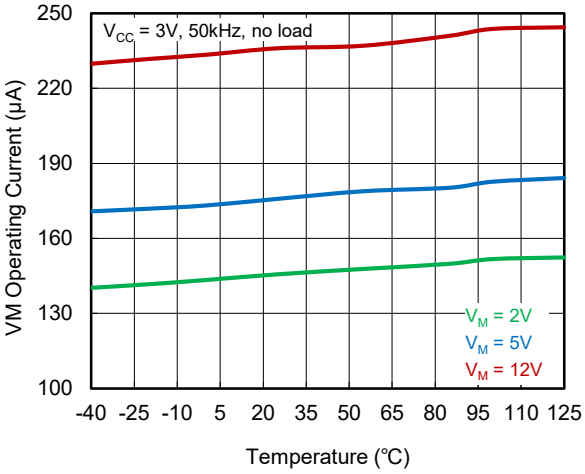


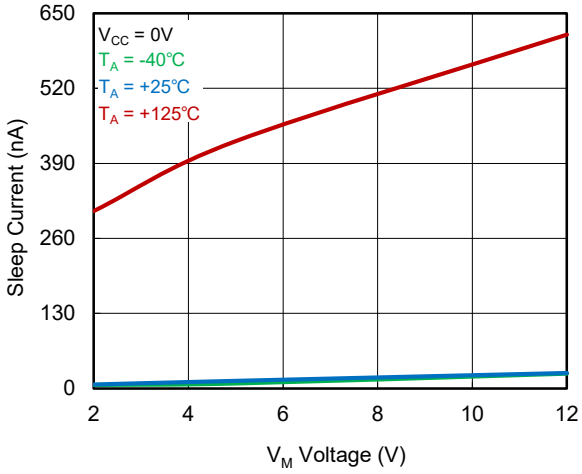
Figure 2. Timing Requirements

TYPICAL PERFORMANCE CHARACTERISTICS

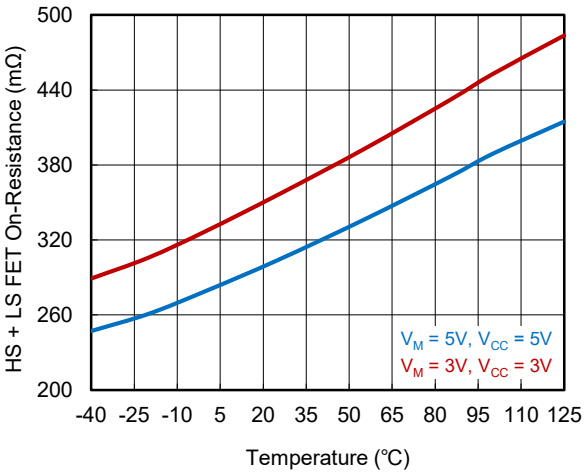
VM Operating Current vs. Temperature



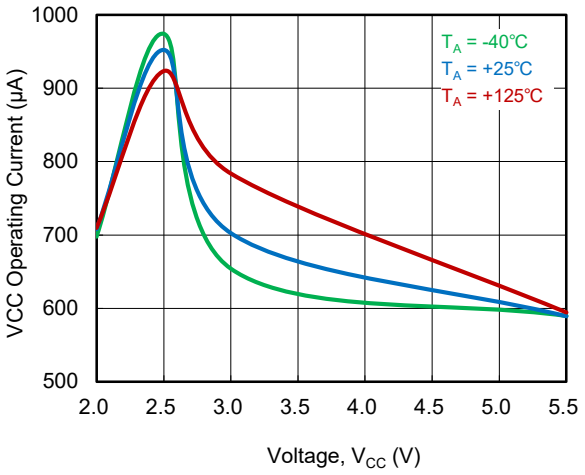
Sleep Current vs. V_M Voltage



HS + LS FET On-Resistance vs. Temperature



VCC Operating Current vs. V_{CC} Voltage



FUNCTIONAL BLOCK DIAGRAM

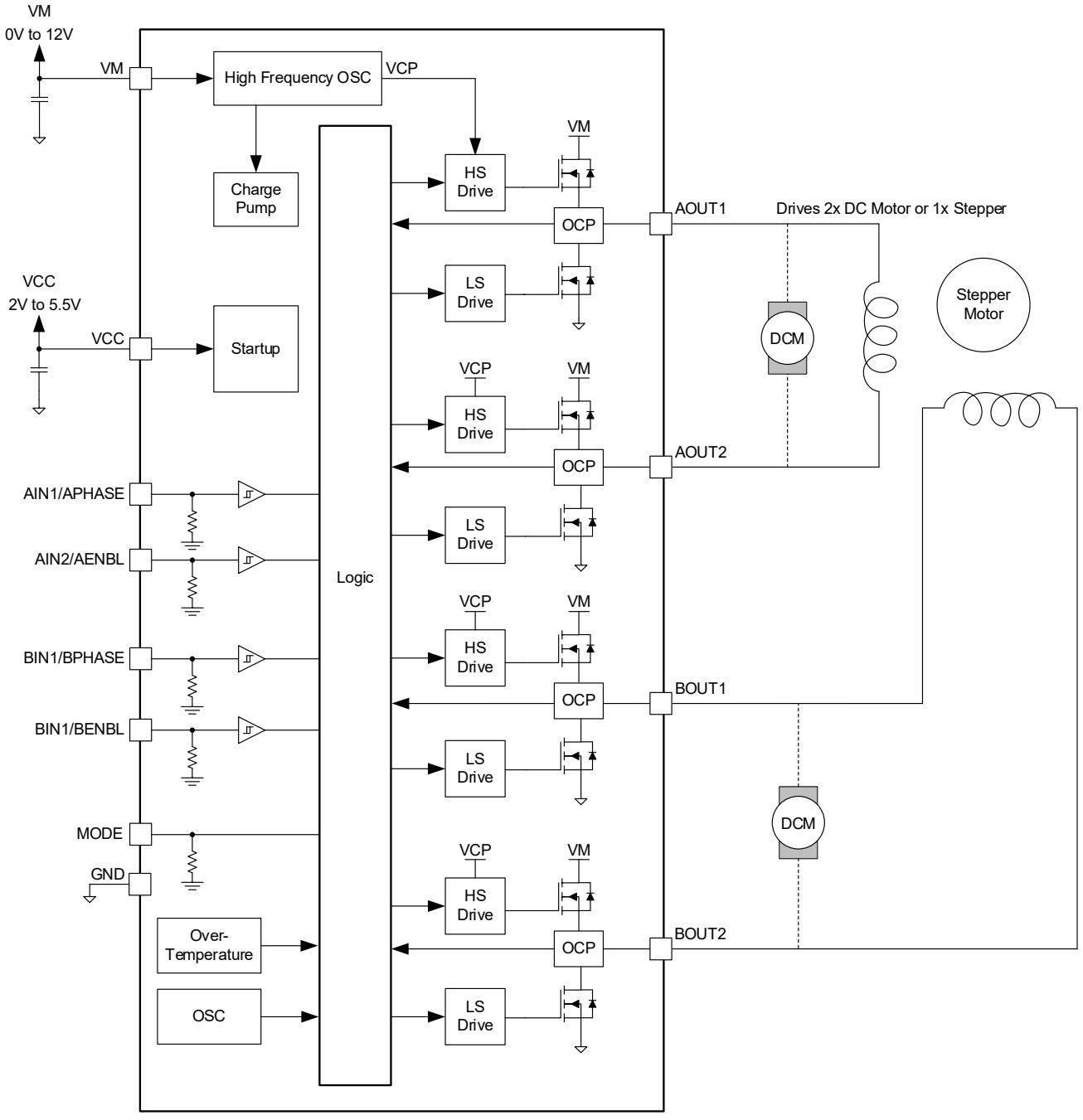


Figure 3. Block Diagram

DETAILED DESCRIPTION

The SGM42535 is a device designed for flexible control of brushed DC or stepper motors. It incorporates two full H-bridge output stages within a single chip, enabling it to manage a wide range of motor types. This architecture allows the system to drive two DC motors independently or a single two-phase stepper motor.

A key feature of its output stage is the use of N-channel power MOSFETs for both the high-side and low-side switches. To ensure the proper gate drive voltage for the high-side N-MOSFETs, the device includes an integrated charge pump.

The chip offers significant design flexibility by providing separate supply inputs for the motor power (V_M) and the logic circuitry (V_{CC}). For lower voltage applications, these supply rails can be tied together if their voltage does not exceed 5.5V.

Robust system operation is ensured by a comprehensive suite of built-in protection features, including over-current protection (OCP), short-circuit protection, under-voltage lockout (UVLO), and thermal shutdown.

For applications demanding higher current drive, the two internal H-bridges can be configured to operate in parallel.

Two control modes are available in the SGM42535: IN/IN mode, and PHASE/ENBL mode. IN/IN mode is selected if the MODE pin is driven low or left unconnected; PHASE/ENBL mode is selected if the MODE pin is driven to logic high. Table 1 and Table 2 show the logic for these modes.

Table 1. IN/IN Mode

MODE	xIN1	xIN2	xOUT1	xOUT2	Function (DC Motor)
0	0	0	Z	Z	Coast
0	0	1	L	H	Reverse
0	1	0	H	L	Forward
0	1	1	L	L	Brake

Table 2. PHASE/ENBL Mode

MODE	xENBL	xPHASE	xOUT1	xOUT2	Function (DC Motor)
1	0	X	L	L	Brake
1	1	1	L	H	Reverse
1	1	0	H	L	Forward

Feature Description

The SGM42535 incorporates a comprehensive suite of protection features, including under-voltage, over-current, and over-temperature lockouts.

Thermal Shutdown (TSD)

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

Output Over-Current Protection (OCP)

Current in each MOSFET is limited by an analog circuit that kills its gate signal when it reaches the limit (2.5A TYP). This protection is effective in hard short-circuit events besides the load over-current events. If the over-current is severe and lasts for longer than a deglitch time (t_{DEG}), all bridge MOSFETs will be disabled. The OCP is a hiccup type and device operation resumes automatically after t_{RETRY} and may repeat the cycle if the OC condition is still present. If for a period longer than the over-current deglitch time (t_{OCP}), the output current exceeds the I_{OCP} over-current threshold, all bridge MOSFETs will also be disabled and normal operation is resumed after t_{RETRY}. In each retry, the MOSFETs are enabled based on the current state of the inputs (IN1 or IN2). The hiccup cycle repeats as long as the overcurrent condition persists. The OCP is detected for OUTx shorts to VM, GND or between OUT1 and OUT2.

Under-Voltage Lockout (UVLO)

If at any time, the V_{CC} voltage drops below its UVLO falling threshold (V_{UVLO}), all bridge MOSFETs, charge pump and logic circuit are disabled. Normal operation resumes when V_{CC} exceeds the UVLO rising threshold.

Sleep Mode

If the VCC power supply is removed, the SGM42535 enters a low-power sleep mode. In this state, all unnecessary internal circuitry powers down with its H-bridge outputs in a high-impedance (High-Z) state. For minimum supply current, all inputs should be low (0V) during sleep mode.

Table 3. Device Protection

Fault	Condition	Error Report	H-Bridge	Internal Circuits	Recovery
VCC Under-Voltage (UVLO)	$V_{CC} < V_{UVLO}$	None	Disabled	Disabled	$V_{CC} > V_{UVLO}$
Over-Current Protection (OCP)	$I_{OUT} > I_{OCP}$	None	Disabled	Operating	t_{OCR}
Thermal Shutdown Protection (TSD)	$T_J > T_{TSD}$	None	Disabled	Operating	$T_J < T_{SD} – T_{HYS}$

APPLICATION INFORMATION

The SGM42535 can be deployed in single or dual motor control systems. To double the current drive for a single motor, the device can be configured in a parallel bridge topology. The following procedure outlines the design steps for a brushed motor application.

Typical Application

The two H-bridges of the SGM42535 can be paralleled to double the output current. The connection diagram is shown in Figure 4.

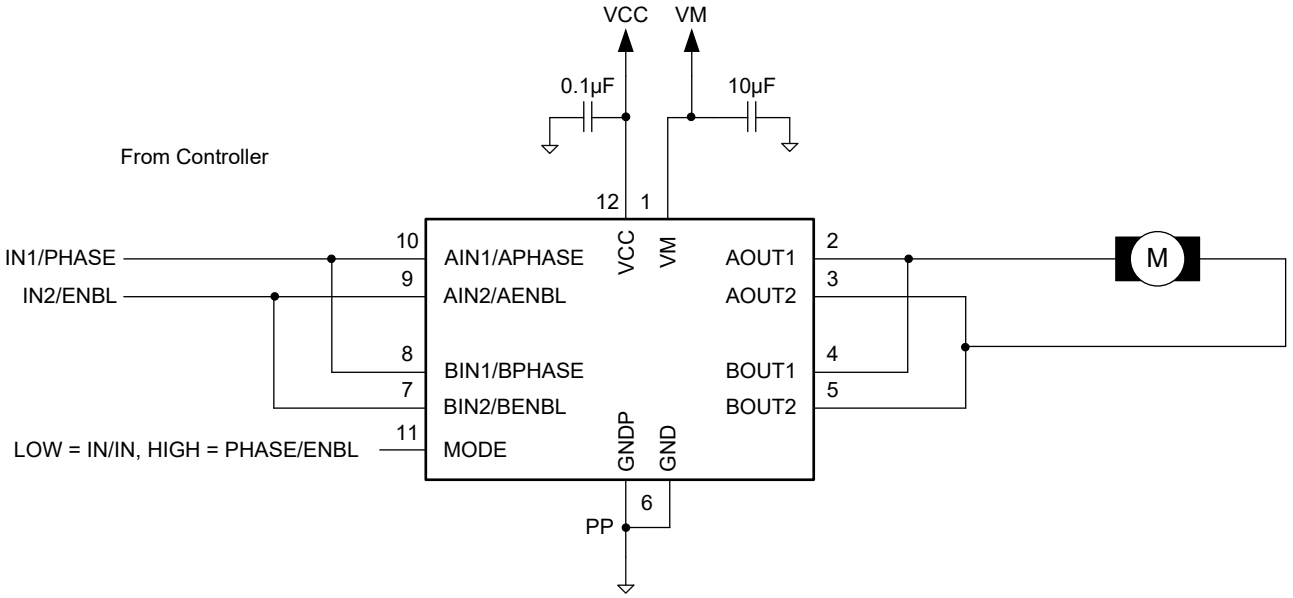


Figure 4. Parallel Mode Connections

Design Requirements

The design requirements are shown in Table 5.

Table 4. Design Requirements

Design Parameter	Reference	Value
Motor Voltage	V_{CC}	4V
Motor RMS Current	I_{RMS}	0.3A
Motor Startup Current	I_{START}	0.6A
Motor Current Trip Point	I_{LIMIT}	0.5A

Motor Voltage

The motor voltage should be selected based on the motor's ratings and the target RPM. Increasing the voltage not only raises the motor speed for a given PWM duty cycle but also accelerates the rate of current change through the inductive windings.

Lower-Power Operation

To minimize system power in sleep mode, it is recommended to set all inputs to a logic low level.

The SGM42535 is a dual H-bridge driver typically suitable for driving stepper motor, brushed DC motors or solenoid loads. The design process to configure these devices is explained in the following section.

Bulk Capacitance

It is important to have sufficient bulk capacitance on the supply lines to avoid instability. Too much bulk capacitance increases the size and cost of the design and may have adverse effects on the system stability as well. System-level testing is highly recommended to verify and determine the proper size of the bulk capacitors. The required local capacitance can be selected by considering many factors including:

- The peak current of the load or motor system.
- The power supply current sourcing capability and installed capacitance. Note that in case of regenerative motor braking, motor current is injected back to the VM line and if this kinetic energy is not properly absorbed in the capacitors, it can cause large over-voltages.
- The parasitic line inductance between the source and load location.
- The system acceptable line voltage ripple.
- The motor braking/reversal method (kinetic energy recycled to the line capacitors or dissipated in the motor/bridge).

APPLICATION INFORMATION (continued)

The supply line parasitic inductance limits the current change rate supplied from the source. If the load (like motor) has fast current changes, the deficit/excess current during transitions must be supplied/absorbed by the local line capacitors. Therefore, if the total bulk capacitance near the load is too small, the excessive currents can result in large voltage variations. So, sufficient bulk capacitance must be used to keep the VM voltage stable.

The bulk capacitor voltage rating should be selected with a sufficient margin above the peak operating voltage to safely absorb motor energy during braking. It also helps to prolong the capacitor's lifetime.

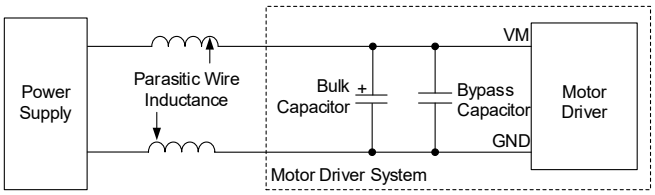


Figure 5. Example Setup of Motor Drive System with External Power Supply

Power Supply and Inputs

The VCC and VM sources may be applied and removed in any order. By removing VCC, a low-power sleep state is initiated and VM current drops to very small levels. All input pins are weakly pulled down to GND with approximately 100kΩ resistors, so to minimize supply currents in the sleep mode, the inputs should be kept at GND level.

As long as V_{CC} is above 1.8V, the device remains active. There is no UVLO limit for the VM and it can go down to 0V, however, the load may not function properly at low VM voltage levels.

PCB Layout Considerations

Use 0.1μF low ESR ceramic capacitor (rated for VCC voltage or higher) near the VCC and GND pins to decouple VCC voltage. Choose thick traces for connection of this capacitor to minimize parasitic resistance and inductance. Using ground plane connection for capacitor return to the device GND is preferred. A bulk capacitor (e.g. electrolytic) is also needed between VCC and GND near the device to stabilize supply voltage.

Thermal Considerations

The device thermal shutdown (TSD) occurs when the die temperature exceeds approximately +165℃. This fault disables the device until the temperature falls to the safe level. To avoid unwanted thermal shutdowns, proper heatsinking of the device should be considered in the layout. Use the exposed pad under the device for heatsinking and connect it to the large copper planes. Preferably use thermal vias connected to the planes on all other layers and especially the layer in the back of the PCB, to improve heat removal and device cooling. Note that this pad is internally connected to GND, but it is not an electrical connection point for GND currents.

Natural air circulation should also be considered to keep low ambient temperature around the device.

Power Losses

The active mode power loss in these devices is mainly due to the output MOSFET On-resistances (R_{DSON}). The approximate power loss in the H-bridge can be estimated from Equation 1:

$$P_{TOT} = 2 \times R_{DSON} \times (I_{OUT\_RMS})^2 \quad (1)$$

where,

P_{TOT} is the power dissipation in the device, and I_{OUT_RMS} is the RMS output current in the load or motor winding.

The maximum amount of power dissipated in the device is dependent on ambient temperature and heat sinking performance as well.

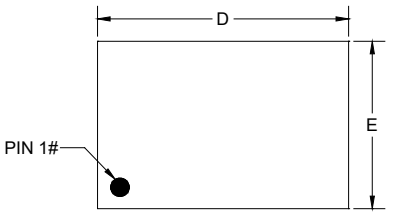
REVISION HISTORY

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

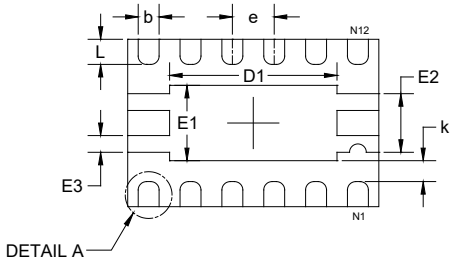
Changes from Original to REV.A (DECEMBER 2025)	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

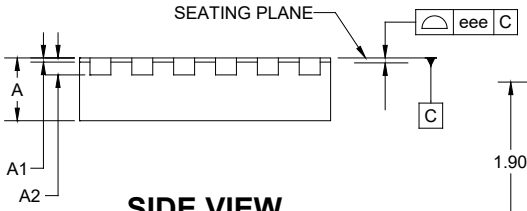
TDFN-3×2-12L



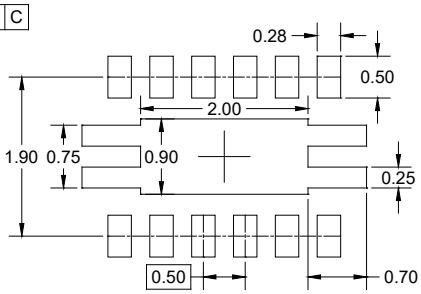
TOP VIEW

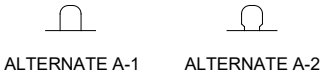


BOTTOM VIEW



SIDE VIEW





DETAIL A

ALTERNATE TERMINAL CONSTRUCTION

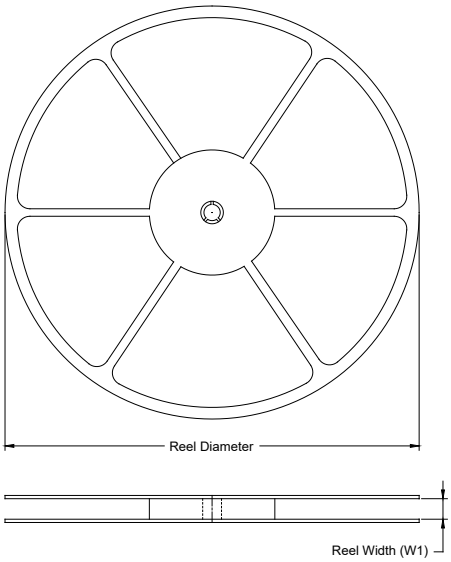
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.200	-	0.300
D	2.900	-	3.100
D1	1.900	-	2.100
E	1.900	-	2.100
E1	0.800	-	1.000
E2	0.600	-	0.800
E3	0.100	-	0.300
e	0.500 BSC		
k	0.250 REF		
L	0.200	-	0.400
eee	0.080		

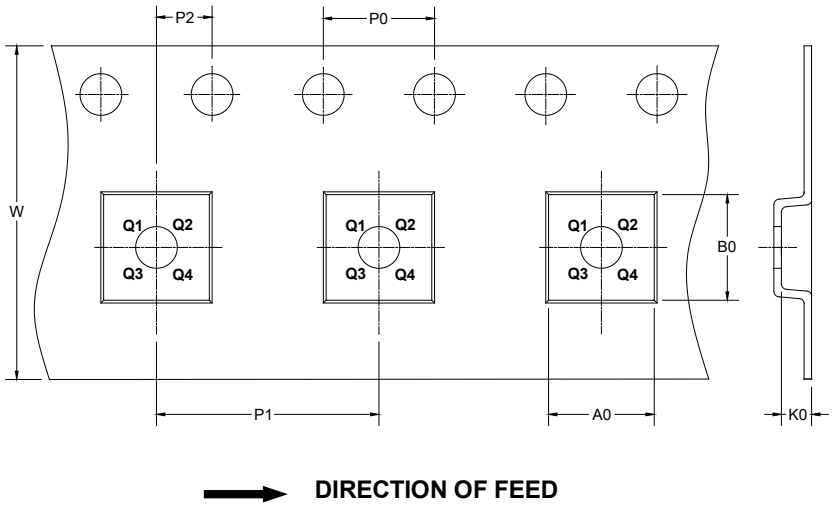
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



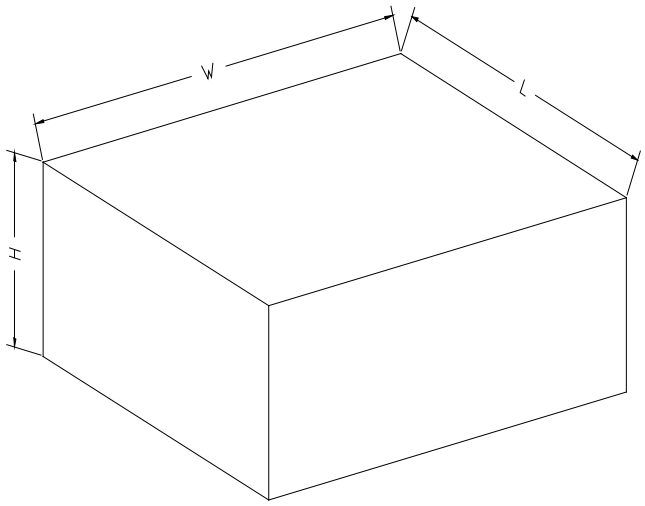
NOTE: The picture is only for reference. Please make the object as the standard.

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
TDFN-3×2-12L	7"	9.5	2.30	3.30	0.95	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