SGM42403
Quad Low-side Driver IC

GENERAL DESCRIPTION

The SGM42403 consists of four identical low-side drivers with over-current protection. It has integrated diodes to discharge the inductive load energy such as unipolar stepper motors, DC motors, relays, solenoids or other loads when output is turned off.

The SGM42403 can provide continuous output current up to 1.5A (1-channel on) or 800mA/CH (4-channel on) by the SOIC package at +25℃. And its continuous output current capability is up to 2A (1-channel on) or 1A/CH (4-channel on) by the TSSOP package at +25℃.

The device has multiple protection functions, including under-voltage lockout, over-current, short-circuit protection and thermal shutdown. Over-current and over-temperature can be reported by the nFAULT pin.

The SGM42403 is available in Green SOIC-20 and TSSOP-16 (Exposed Pad) packages.

FEATURES

- **Supply Voltage Range: 8.5V to 50V**
- **Quad Low-side Driver**
  - **Four N-Channel MOSFETs**
  - **Can be Paralleled for Higher Current Capability**
  - **Integrated Diodes for Inductive Energy Discharge**
- **Continuous Output Current**
  SOIC-20 Package:
  - **1.5A (1-Channel On)**
  - **800mA/CH (4-Channel On)**
  TSSOP-16 (Exposed Pad) Package:
  - **2A (1-Channel On)**
  - **1A/CH (4-Channel On)**
- **Full Set of Protections**
  - **Integrated Diodes for Inductive Energy Clamp**
  - **Thermal Shutdown with Auto-Retry**
  - **Overload Protection**
  - **Short-Circuit Protection**
  - **Under-Voltage Lockout**

SIMPLIFIED SCHEMATIC

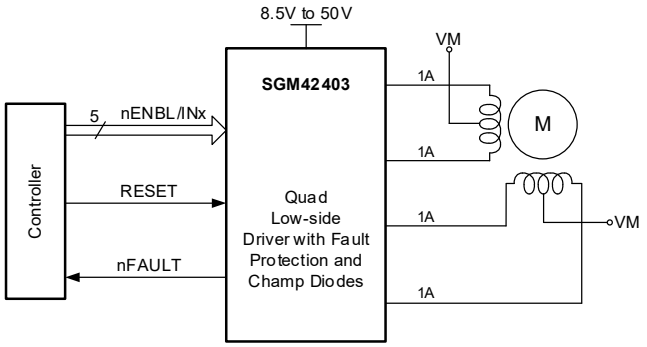


Figure 1. Simplified Schematic

APPLICATIONS

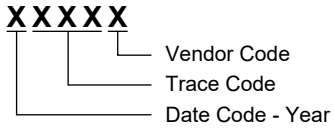
Low-side Switch Applications
Unipolar Stepper Motor Drivers
Relay Drivers and Solenoid Drivers

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM42403	TSSOP-16 (Exposed Pad)	-40℃ to +125℃	SGM42403XPTS16G/TR	SGM42403 XPTS16 XXXXX	Tape and Reel, 4000
	SOIC-20	-40℃ to +125℃	SGM42403XS20G/TR	SGM42403XS20 XXXXX	Tape and Reel, 1500

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_M ..... -0.3V to 52V
Output Voltage, V_{OUTx} ..... -0.3V to 52V
Output Clamp Voltage (1), V_{CLAMP} ..... -0.3V to 52V
Output Current, I_{nFAULT} ..... < 20mA
Peak Clamp Diode Current ..... < 2A
DC or RMS Clamp Diode Current ..... < 1A
Digital Input Pin Voltage ..... -0.3V to 6V
Digital Output Pin Voltage, V_{nFAULT} ..... -0.3V to 6V
Peak Motor Drive Output Current, t < 1μs... Internally Limited
Package Thermal Resistance
TSSOP-16 (Exposed Pad), θ_{JA} ..... 36℃/W
SOIC-20, θ_{JA} ..... 58℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 2500V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage Range, V_M ..... 8.5V to 50V
Output Clamp Voltage (1), V_{CLAMP} ..... 0V to 50V
Continuous Output Current, I_{OUTx}
SOIC-20 at T_A = +25℃
1-Channel On 1.5A
4-Channel On 0.8A
TSSOP-16 (Exposed Pad) at T_A = +25℃
1-Channel On 2A
4-Channel On 1A

NOTE: 1. V_{CLAMP} is not a power supply and is only used to supply the power to clamp diodes.

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

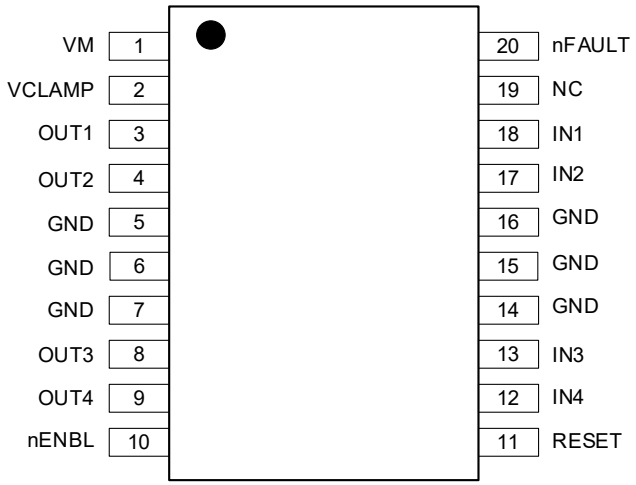
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

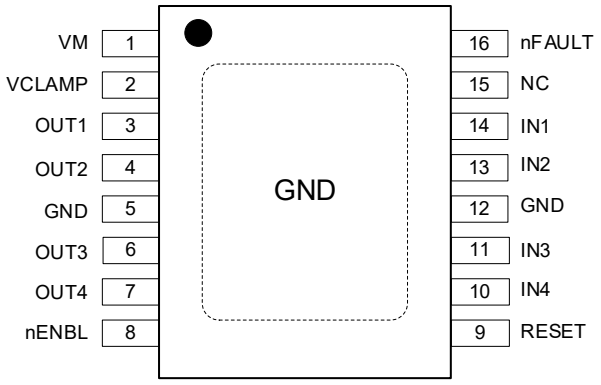
PIN CONFIGURATIONS

(TOP VIEW)



SOIC-20

(TOP VIEW)



TSSOP-16 (Exposed Pad)

PIN DESCRIPTION

PIN		NAME	TYPE	FUNCTION
SOIC-20	TSSOP-16 (Exposed Pad)			
1	1	VM	-	Power Supply.
2	2	VCLAMP	-	Output Clamp Voltage. Tie to V_M supply, or Zener diode to V_M supply.
3	3	OUT1	O	Output 1 of the Device.
4	4	OUT2	O	Output 2 of the Device.
5, 6, 7, 14, 15, 16	5, 12	GND	-	Ground.
8	6	OUT3	O	Output 3 of the Device.
9	7	OUT4	O	Output 4 of the Device.
10	8	nENBL	I	Enable Input Pin. A low DC signal on this pin will enable the device, internal pull-down.
11	9	RESET	I	Reset Input Pin. Logic high resets internal logic and over-current protection, internal pull-down.
12	10	IN4	I	Channel 4 Input. Active high drives OUT4 to low, internal pull-down.
13	11	IN3	I	Channel 3 Input. Active high drives OUT3 to low, internal pull-down.
17	13	IN2	I	Channel 2 Input. Active high drives OUT2 to low, internal pull-down.
18	14	IN1	I	Channel 1 Input. Active high drives OUT1 to low, internal pull-down.
19	15	NC	-	No Connection.
20	16	nFAULT	OD	Fault Flag Pin. Pull this pin low when the over-temperature or over-current occurs.
-	Exposed Pad	GND	-	Ground.

NOTE: I = input, O = output, OD = open-drain output.

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supplies						
Power Supply Voltage	V_M		8.5		50	V
Power Supply Current	I_{VM}			0.6	0.9	mA
Under-Voltage Lockout Voltage	V_{UVLO}	V_M rising			8.5	V
Logic Level Inputs (Schmitt Trigger Inputs with Hysteresis)						
Input Logic Low Voltage	V_{IL}				0.7	V
Input Logic High Voltage	V_{IH}		2			V
Input Logic Hysteresis	V_{HYS}			0.35		V
Input Logic Low Current	I_{IL}	V_{IN} = 0V			1	μA
Input Logic High Current	I_{IH}	V_{IN} = 3.3V			20	μA
Pull-Down Resistance	R_{PD}			300		kΩ
nFAULT Output (Open-Drain Output)						
Output Low Voltage	V_{OL}	I_O = 5mA			0.5	V
Output High Leakage Current	I_{OH}	V_O = 3.3V			1	μA
Low-side FETs						
FET On-Resistance	R_{DSON}	I_O = 700mA		0.35	0.7	Ω
		I_O = 700mA, T_J = +85℃		0.45		
Off-State Leakage Current	I_{OFF1}	V_M = 50V			10	μA
High-side Diodes						
Diode Forward Voltage	V_F	I_O = 700mA		1		V
Off-State Leakage Current	I_{OFF2}	V_M = 50V			1	μA
Outputs						
Rise Time	t_R	I_O = 700mA, resistive load			200	ns
Fall Time	t_F	I_O = 700mA, resistive load			250	ns
Protection Circuits						
Over-Current Protection Trip Level	I_{OCP}	T_J = +25℃	2		3.6	A
Over-Current Protection Deglitch Time	t_{OCP}			3.5		μs
Over-Current Protection Retry Time	t_{RETRY}			10		ms
Thermal Shutdown Temperature	T_{SD}	Die temperature		160		℃

TIMING PARAMETERS AND REQUIREMENTS

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Enable Time	t_{nENBL}	nENBL to output low			300	ns
Propagation Delay Time	t_{PD_L-H}	INx to OUTx, low to high			450	ns
	t_{PD_H-L}	INx to OUTx, high to low			250	ns
RESET Pulse Width	t_{RESET}			20		μs

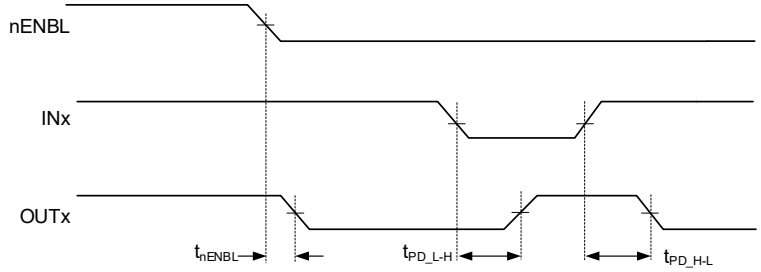


Figure 2. SGM42403 Timing Definition

FUNCTIONAL BLOCK DIAGRAM

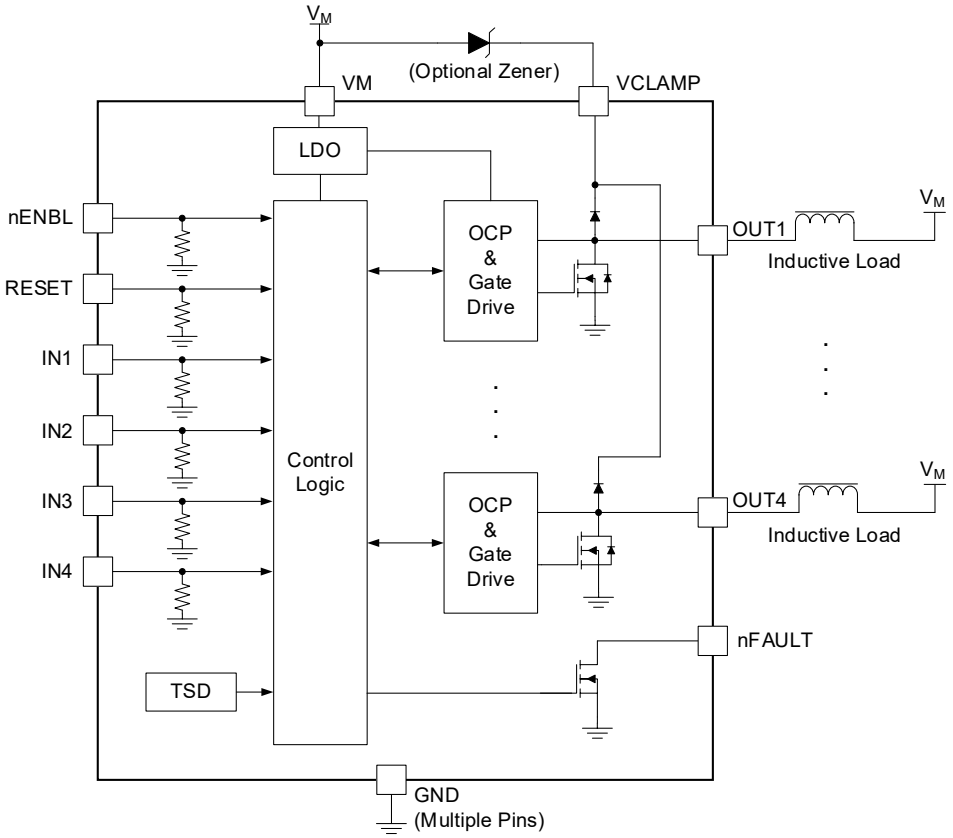
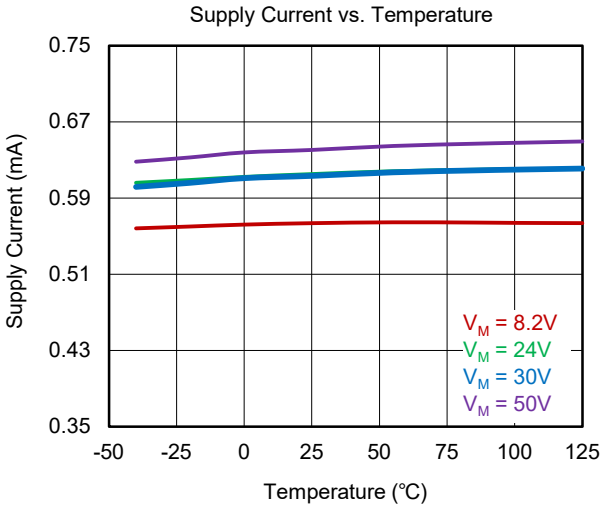
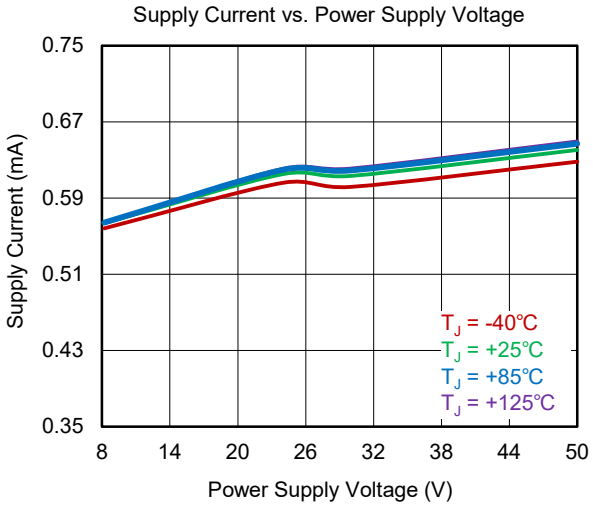
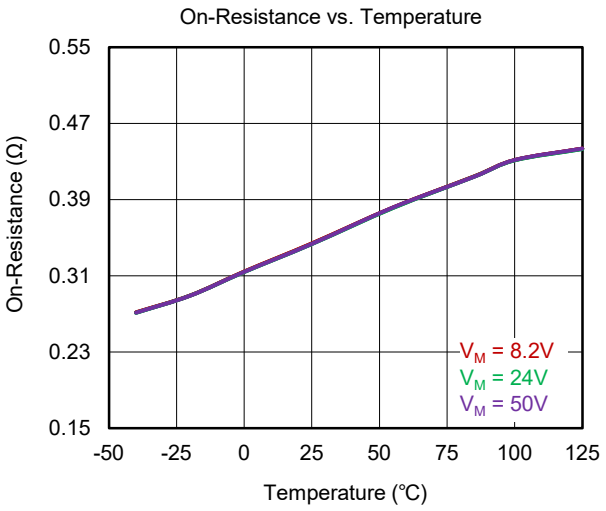


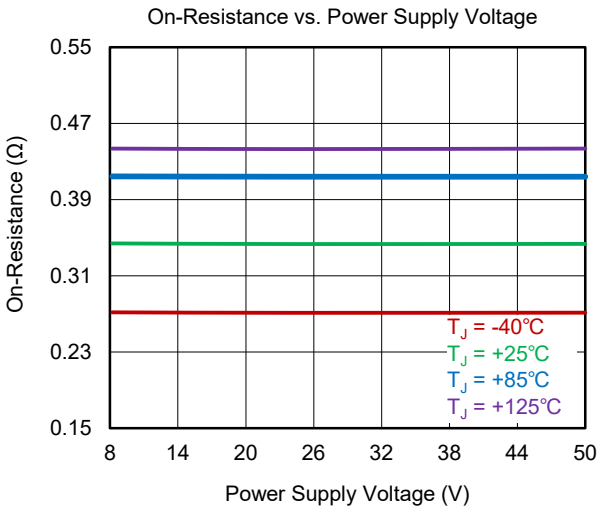
Figure 3. Block Diagram

TYPICAL PERFORMANCE CHARACTERISTICS



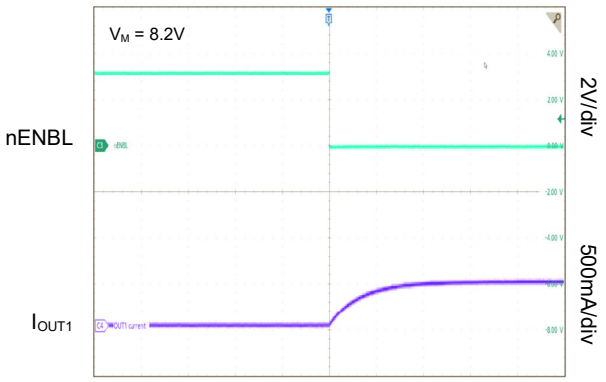






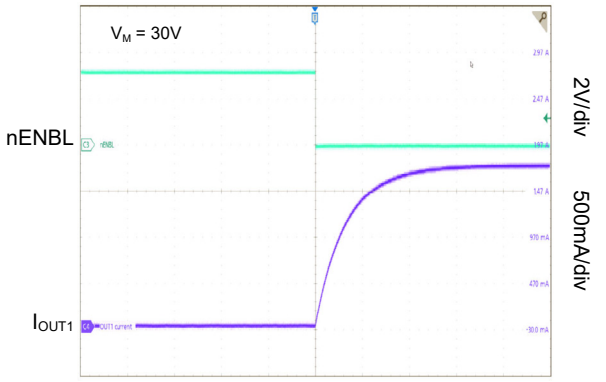
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Current Ramp with a 16Ω, 1mH RL Load



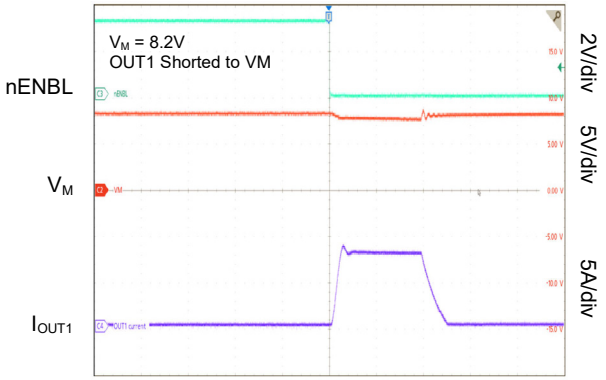
Time (100μs/div)

Current Ramp with a 16Ω, 1mH RL Load



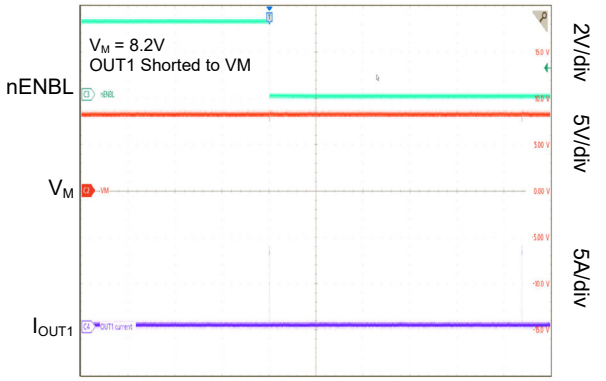
Time (100μs/div)

OCP



Time (2μs/div)

OCP Separated by t_{RETRY}



Time (2ms/div)

TYPICAL APPLICATION CIRCUIT

The SGM42403 drives one unipolar stepper motor.

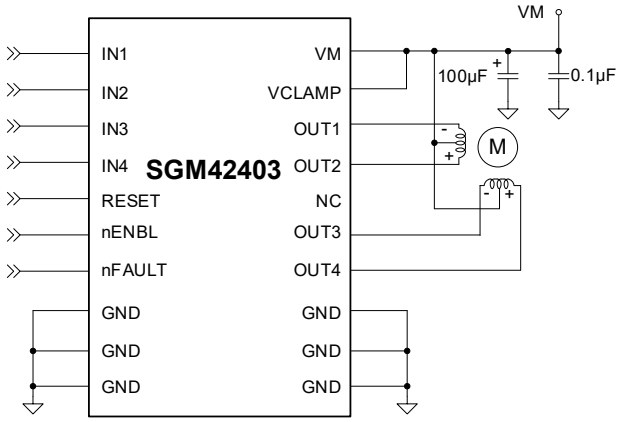


Figure 4. Typical Application Circuit

Design Requirements

Table 1 lists the design parameters for this design example.

Table 1. Design Parameters

Design Parameter	Reference	Example Value
Supply Voltage	V_M	24V
Motor Winding Resistance	R_L	7.4Ω/phase
Motor Full Step Angle	θ_{step}	1.8°/step
Motor Rated Current	I_{RATED}	0.75A
PWM Frequency	f_{PWM}	31.25kHz

Motor Voltage

The motor voltage used depends on the application requirements. Higher voltage will generate more current and torque, and using higher voltage can also make the motor run faster than low voltage.

Drive Current

There is a current path from the power supply to the motor winding and low-side MOSFET. For the power dissipation on the MOSFET, please refer to calculation below:

$$P = I^2 \times R_{DSON} \quad (1)$$

For the TSSOP package, SGM42403 can support up to 2A (1-channel on) or 1A/channel (4-channel on simultaneously) at +25℃, while the SOIC package can support to 1.5A (1-channel on) or 800mA/channel (4-channel on simultaneously). The max continuous current depends on PCB layout and ambient temperature.

DETAILED DESCRIPTION

Overview

The SGM42403 is a quad industrial low-side switch. Each output is controlled by its individual input. And the low-side MOSFET has a low R_{DSON} of typically 350mΩ. The four switches are pin controlled, allowing parallel interface and high switching rates of over 100kHz on each channel. The outputs are protected against short-circuit and thermal overload.

Output Drivers

The SGM42403 integrates four low-side MOSFETs. Each MOSFET is protected by its own over-current protection circuit. And all the four outputs are connected to VCLAMP pin through the integrated diodes. The VCLAMP can be shorted to power supply (VM pin) directly. Also, a Zener or TVS can be put between VM and VCLAMP pins, this connection is used when current fast decay is needed. However, if using this connection, it is necessary to make sure that the output voltage should not go beyond the maximum rating of output pin.

Protection Circuits

The SGM42403 device is fully protected against over-current, over-temperature and under-voltage events.

Over-Current Protection (OCP)

Each MOSFET is protected by its own over-current limit. In case of an over-current (if the current limit lasts longer than OCP deglitch time), all the four output MOSFETs will be turned off, the nFAULT pin will be driven low, and the device will retry after about 10ms.

Thermal Shutdown (TSD)

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

Under-Voltage Lockout (UVLO)

If the voltages on VM pin fall below under-voltage lockout threshold, the device will be disabled, and internal logic will be reset. Device resumes its operation when VM goes back above its UVLO threshold.

Parallel Interface Operation

Paralleling the outputs is used for higher current applications, please refer to SGM42403 control interface in Figure 5.

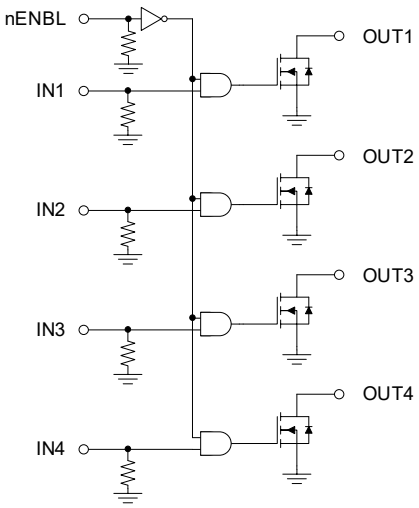


Figure 5. Parallel Interface Operation

nENBL and RESET Operation

The nENBL pin is active low and is pulled down internally.

The RESET pin is active high. If RESET pin is pulled to high, the internal logic is reset, outputs are turned off, and input control signal on INx pin is ignored. RESET pin is pulled down internally.

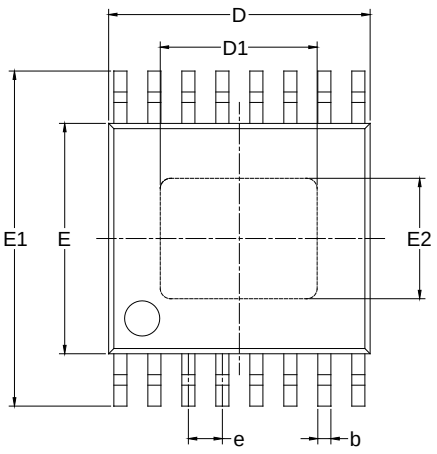
REVISION HISTORY

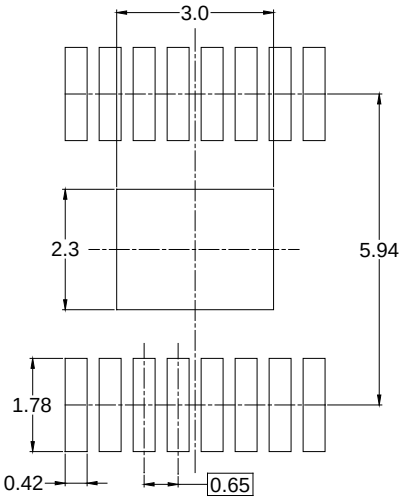
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (MAY 2023) to REV.A	Page
Changed from product preview to production data	All

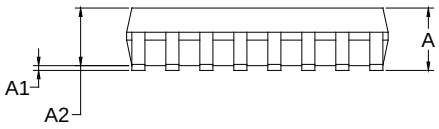
PACKAGE OUTLINE DIMENSIONS

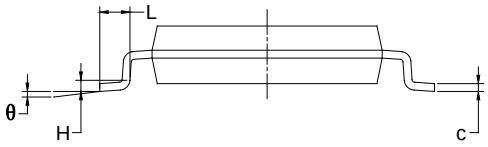
TSSOP-16 (Exposed Pad)





RECOMMENDED LAND PATTERN (Unit: mm)



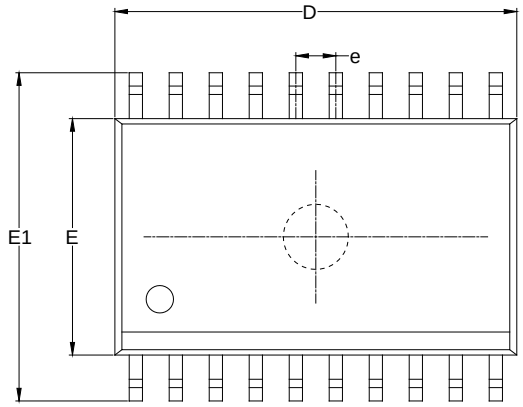


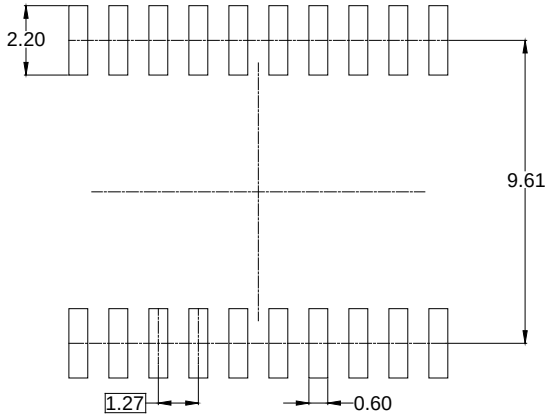
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
D1	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
E2	2.200	2.400	0.087	0.094
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

SOIC-20





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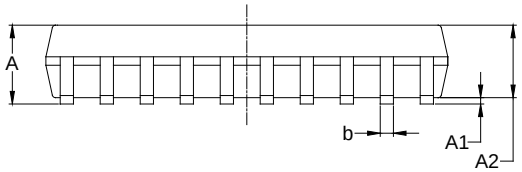
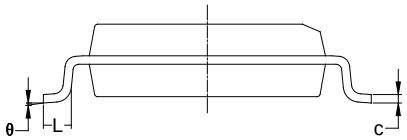


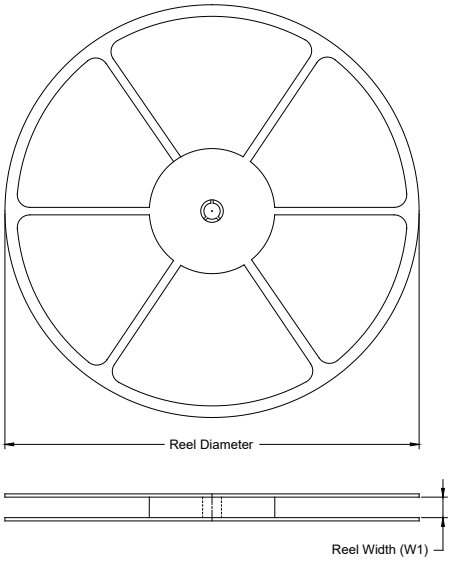


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	2.350	2.650	0.093	0.104
A1	0.100	0.300	0.004	0.012
A2	2.100	2.500	0.083	0.098
b	0.330	0.510	0.013	0.020
c	0.204	0.330	0.008	0.013
D	12.520	13.000	0.493	0.512
E	7.400	7.600	0.291	0.299
E1	10.210	10.610	0.402	0.418
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

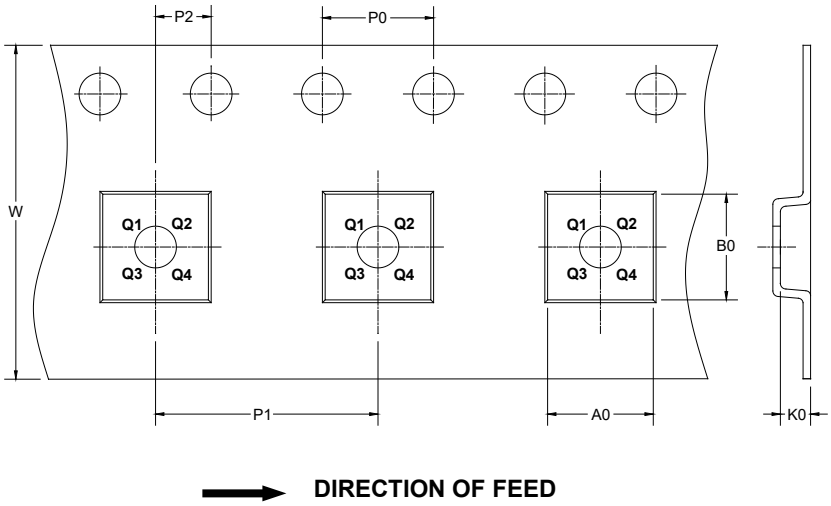
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



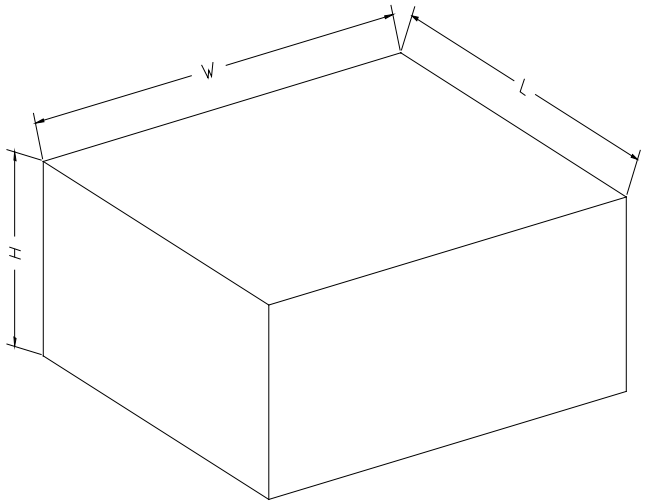
NOTE: The picture is only for reference. Please make the object as the standard.

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
TSSOP-16 (Exposed Pad)	13″	12.4	6.80	5.40	1.50	4.0	8.0	2.0	12.0	Q1
SOIC-20	13″	24.4	10.90	13.30	3.00	4.0	12.0	2.0	24.0	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