

Four-Channel, Serial Interface, Low-Side Driver

FEATURES

- Four-channel, Serial Interface, Low-side Driver
- Integrated Clamp Diode
- Serial Interface
- Under Well Heat Dissipation:
Maximum Driving Current: 2A for Each Channel
- Power Supply: 7.2V~50V
- eTSSOP16 Package

APPLICATIONS

- Relay
- Unipolar Stepper Motor
- Solenoid
- Low-side Switch

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS31804TE	eTSSOP16	MS31804TE

PRODUCT DESCRIPTION

The MS31804TE is a four-channel, low-side driver with overcurrent protection function. The MS31804TE integrates clamp diode to clamp the voltage generated by inductance load regeneration. The MS31804TE can drive unipolar stepper motor, DC motor, relay, solenoid or other loads.

The MS31804TE can provide up to 2A continuous current for each channel under well heat dissipation. When all channels are enabled, maximum 1A continuous current is available.

The MS31804TE can be controlled by simple serial interface.

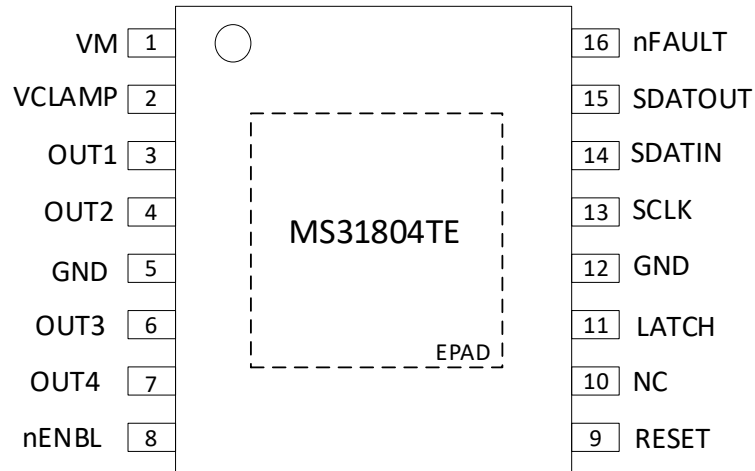
The integrated protection functions include undervoltage lockout, overcurrent protection, short-circuit protection and thermal shutdown. And the specific fault is indicated by fault output pin.

The MS31804TE is available in eTSSOP16 package.

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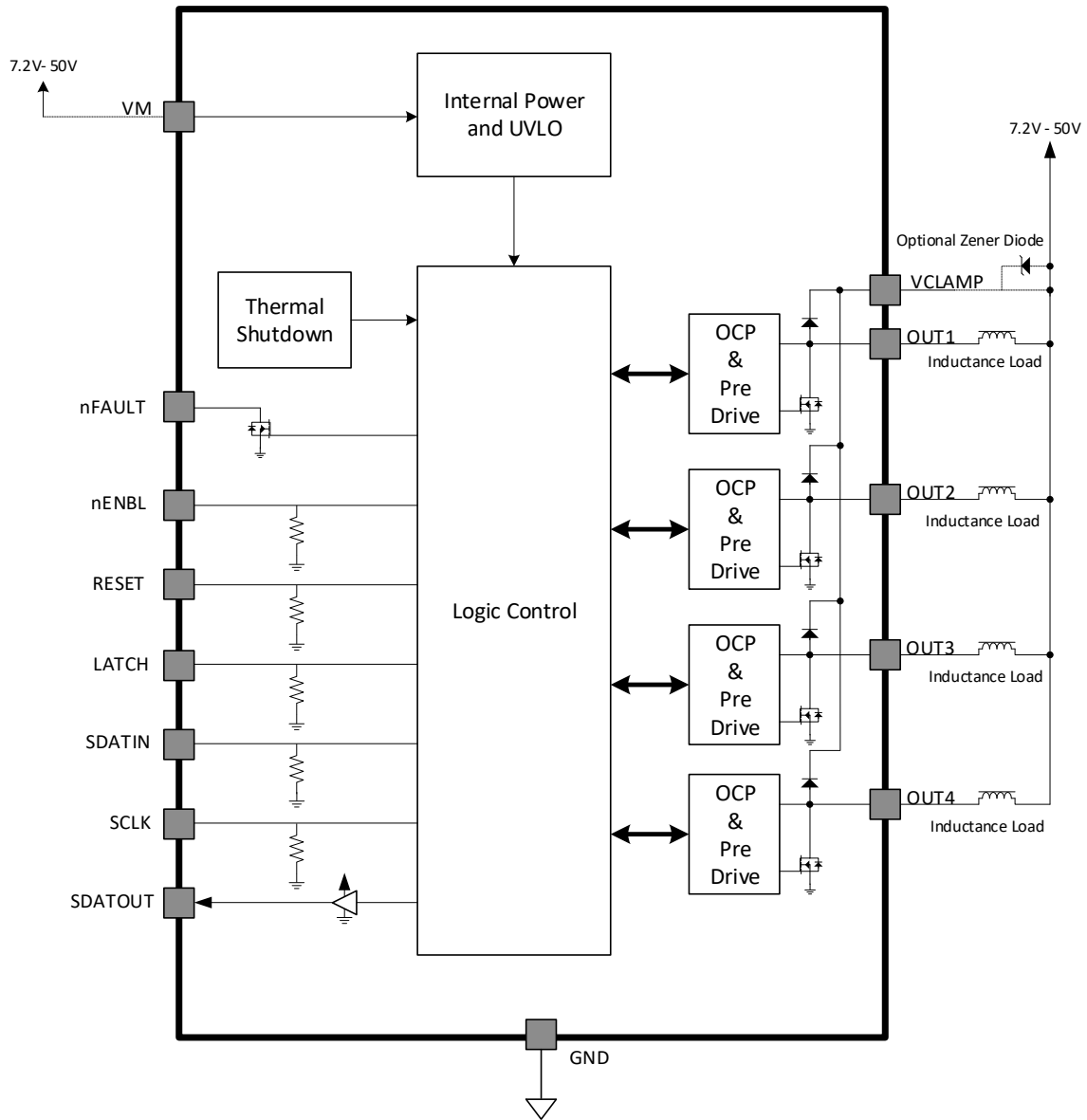
PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1	VM	-	Power Supply, connected to motor power
2	VCLAMP	-	Output Clamp Voltage, connected to VM or by Zener diode
3	OUT1	O	Output 1
4	OUT2	O	Output 2
5	GND	-	Ground
6	OUT3	O	Output 3
7	OUT4	O	Output 4
8	nENBL	I	Enable Input, Low Active. Internal 100kΩ Pull-down Resistor
9	RESET	I	Reset Input. Reset internal logic and OCP when it is high-level. Internal 100kΩ Pull-down Resistor
10	NC	-	Not Connection
11	LATCH	I	Shift register is latched to output on the rising edge. Internal 100kΩ Pull-down Resistor
12	GND	-	Ground
13	SCLK	I	Clock Input for Shift Register. Internal 100kΩ Pull-down Resistor
14	SDATIN	I	Data Input for Shift Register. Internal 100kΩ Pull-down Resistor
15	SDATOUT	O	Data Output for Shift Register
16	nFAULT	OD	Fault Indication. Low-level when fault occurs
-	EPAD	-	Thermal Pad, recommended to ground

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Symbol	Ratings	Unit
Power Supply	V_M	-0.3 ~ 55	V
	V_{CLAMP}	-0.3 ~ 55	V
V_{OUTx}	V_{OUTx}	-0.3 ~ 55	V
Digital Input Voltage	$V_{INRANGE}$	-0.3 ~ 5.5	V
Digital Output Voltage	$V_{OUTRANGE}$	-0.3 ~ 5.5	V
Peak Clamp Diode Current	I_{PD}	2	A
RMS Clamp Diode Current	I_{RMSPD}	1	A
Open-drain Output Current	I_{OD}	0 ~ 20	mA
Open-drain Output Voltage	V_{OD}	-0.3 ~ 5.5	V
Junction Temperature	T_J	-40 ~ 150	°C
Storage Temperature	T_{STG}	-65 ~ +150	°C
ESD(HBM)	V_{ESD}	±8k	V

RECOMMENDED OPERATING CONDITIONS

Parameter		Symbol	Range			Unit
			Min	Typ	Max	
Power Supply		V_M	7.2		50	V
		V_{CLAMP}	0		50	V
Output Current	(Single Channel On)	I_{OUT}			2	A
	(Four Channels On)				1	A

ELECTRICAL CHARACTERISTICS

Within power supply and operating temperature ranges. The operating conditions are $V_M=24V$ and $T_A=25^\circ C$ for all typical values.

Power Supply

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Current	I_{VM}			1.6	2.1	mA
Undervoltage Lockout	V_{UVLO}	V_M rising			7	V

Logic Input

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Low-level Voltage	V_{IL}	No load			0.7	V
Input High-level Voltage	V_{IH}	No load	2			V
Input Hysteresis	V_{HYS}	No load		0.3		V
Input Low-level Current	I_{IL}	$V_{IN} = 0V$, No load	-20		20	μA
Input High-level Current	I_{IH}	$V_{IN} = 3.3V$, No load			60	μA
Pull-down Resistor	R_{PD}			100		k Ω

nFAULT Open-drain Output

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output Low-level Voltage	V_{OL}	$I_O = 5mA$			0.4	V
Output Leakage Current	I_{OH}	$V_O = 3.3V$			1	μA

SDATOUT Output

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output Low-level Voltage	V_{OL}	$I_O = 5mA$			0.4	V
Output High-level Voltage	V_{OH}	$I_O = 1mA$, $V_M = 24V$	3.3	4.1	5.6	V
Output Source Current	I_{SOURCE}	$V_M = 24V$			1	mA
Output Sink Current	I_{SINK}	$V_M = 24V$			5	mA

Low-side MOS

Parameter	Symbol	Condition	Min	Typ	Max	Unit
On-Resistance	$R_{DS(on)}$	$V_M = 24V$, $I_O = 700mA$, $T_J = 25^\circ C$		420		m Ω
		$V_M = 24V$, $I_O = 700mA$, $T_J = 85^\circ C$		550		m Ω
		$V_M = 24V$, $I_O = 700mA$, $T_J = 125^\circ C$		650		m Ω
Output Leakage Current	I_{OFF}		-50		50	μA

Regeneration Diode

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Forward Voltage	V_F	$V_M = 24V, I_O = 700mA, T_J = 25^\circ C$		1		V
Reverse Leakage Current	I_R	$V_M = 24V, T_J = 25^\circ C$	-50		50	μA

Output

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Rise Time	t_R	$V_M = 24V, I_O = 700mA,$ $T_J = 25^\circ C, \text{Resistive load}$	50		300	ns
Fall Time	t_F	$V_M = 24V, I_O = 700mA,$ $T_J = 25^\circ C, \text{Resistive load}$	50		300	ns

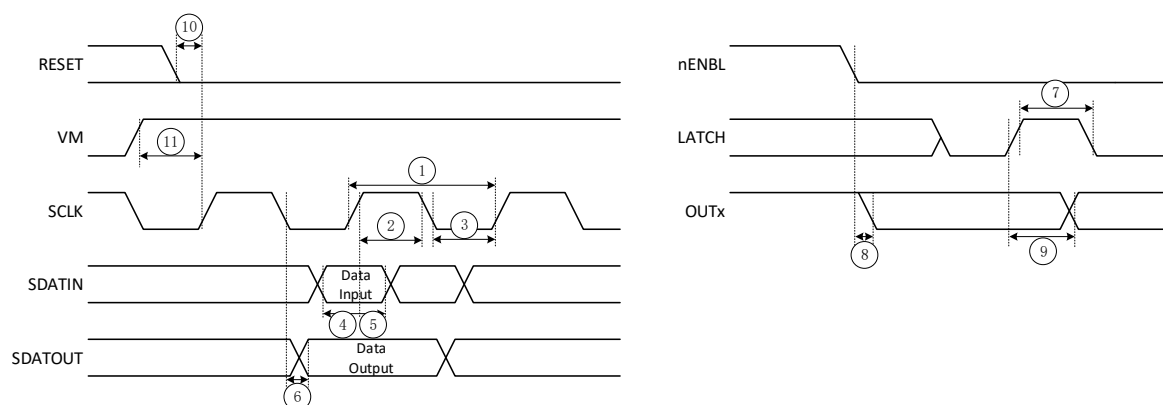
Protection Circuit

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Overcurrent Protection Point	I_{OCP}		2.2	2.7	4	A
Overcurrent Protection Detection Time	t_{OCP}			3.6		μs
Overcurrent Protection Retry Time	t_{RETRY}			1.2		ms
Thermal Shutdown Point	T_{TSD}	Temperature rising	145	160	175	$^\circ C$

Timing

Number	Parameter	Symbol	Min	Typ	Max	Unit
1	Clock Cycle	t_{CYC}	62			ns
2	Clock High Time	t_{CLKH}	25			ns
3	Clock Low Time	t_{CLKL}	25			ns
4	Setup Time, SDATIN to SCLK	$t_{SU(SDATIN)}$	5			ns
5	Hold Time, SDATIN to SCLK	$t_{H(SDATIN)}$	1			ns
6	Delay Time, SCLK to SDATOUT, Without External Pull-up Resistor, $C_{OUT}=100pF$	$t_{D(SDATOUT)}$		50	100	ns
7	LATCH Pulse Width	$t_{W(LATCH)}$	200			ns
8	Enable Time, nENABLE to Output Low	$t_{OE(ENABLE)}$		60		ns
9	Delay Time, LATCH to Output Change	$t_{D(LATCH)}$		200		ns
10	Delay Time, Reset to Clock Input	$t_{D(RESET)}$	20			ns

Number	Parameter	Symbol	Min	Typ	Max	Unit
11	Delay Time, VM Start to Clock Input	t_{STARTUP}	55			ns
-	Reset Pulse Width	t_{RESET}	20			ns



TYPICAL CHARACTERISTICS CURVES

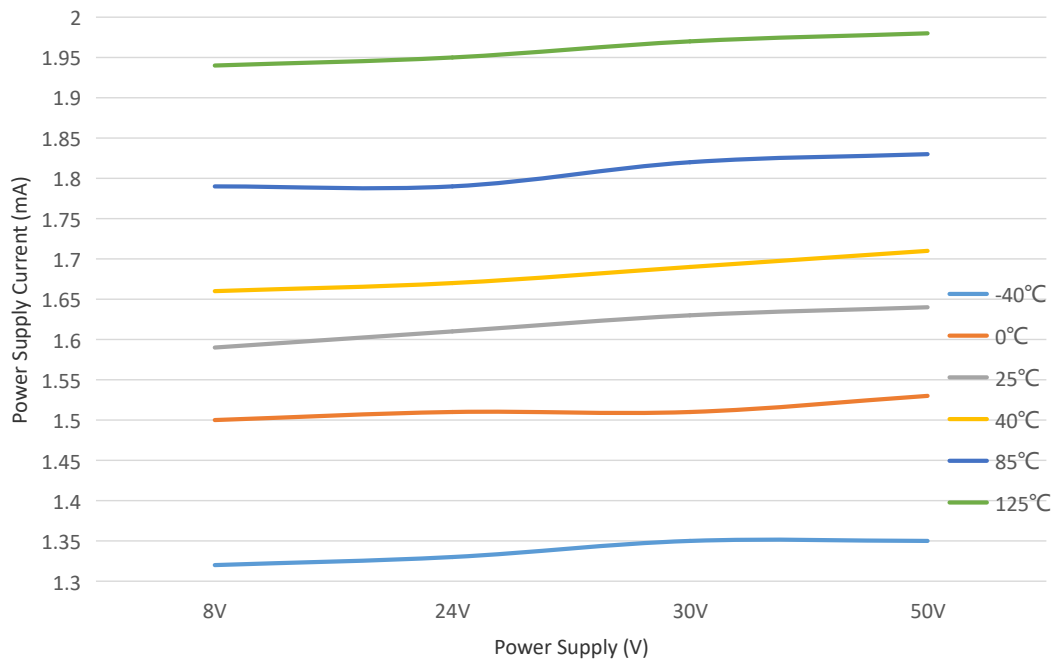


Figure 1. Power Supply Current VS. Power Supply

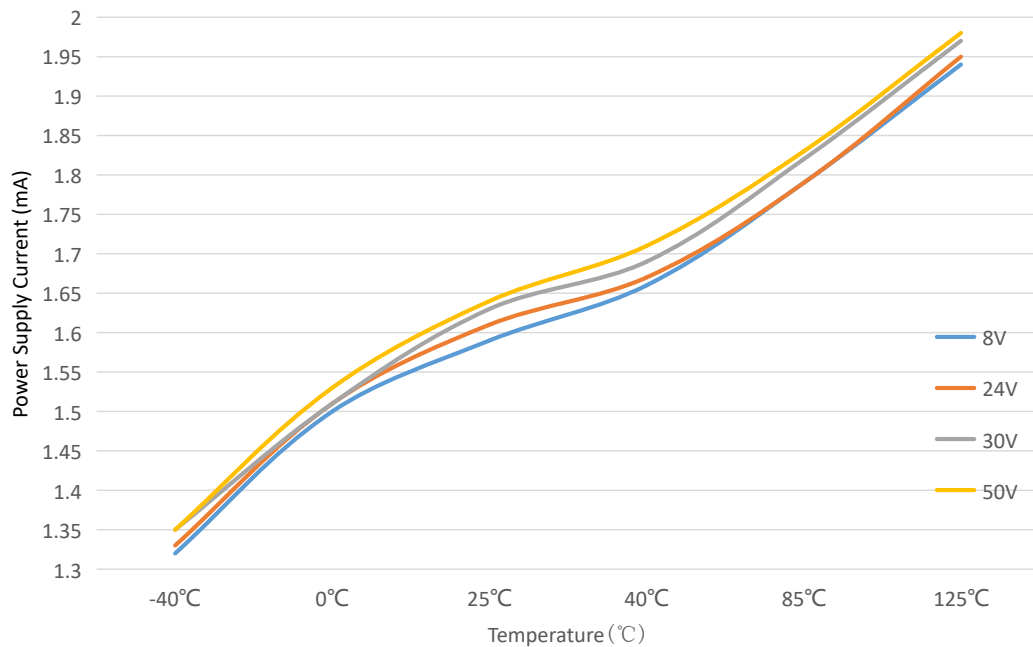


Figure 2. Power Supply Current VS. Temperature

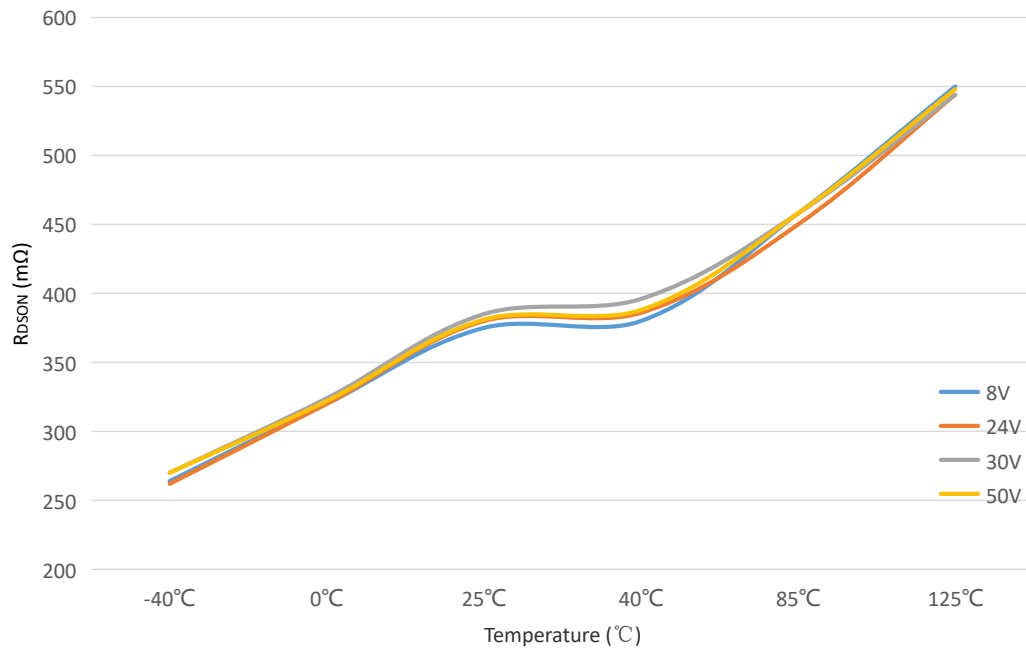


Figure 3. $R_{DS(on)}$ VS. Temperature

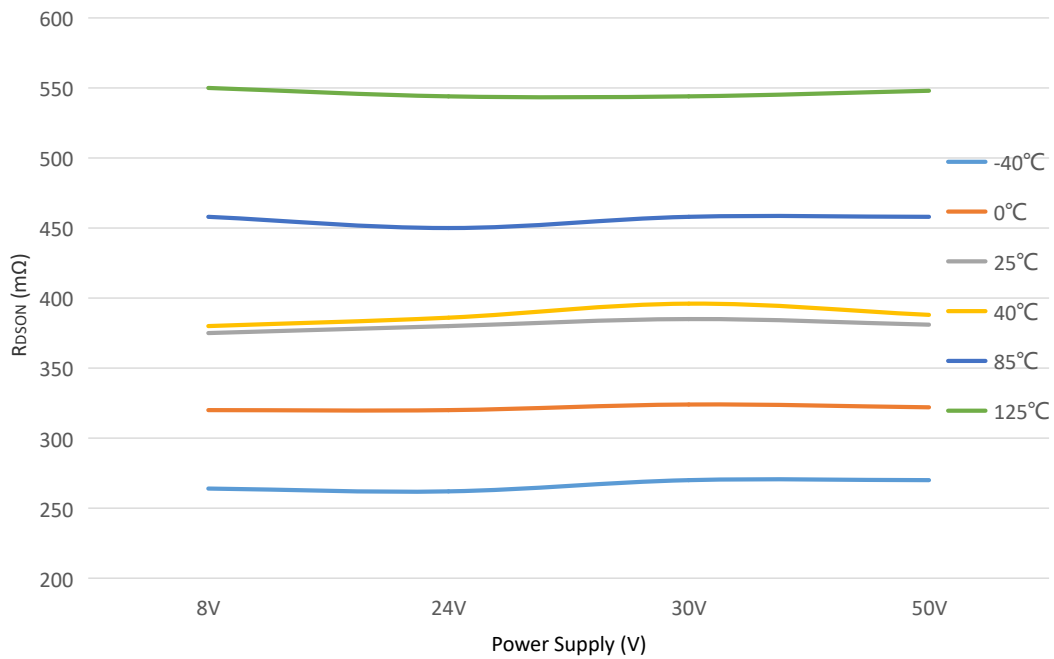


Figure 4. $R_{DS(on)}$ VS. Power Supply

FUNCTION DESCRIPTION

1. Overview

The MS31804TE is a four-channel, low-side driver. And it can be controlled by simple serial interface and allows several chips in series. The MS31804TE integrates clamp diode to clamp the voltage generated by inductance load regeneration. The MS31804TE can drive unipolar stepper motor, DC motor, relay, solenoid or other loads.

The integrated protection functions include undervoltage lockout, overcurrent protection, short-circuit protection and thermal shutdown.

2. Output Driver

The MS31804TE includes four low-side drivers with protection functions. Each output integrates a clamp diode, which is connected to common pin, VCLAMP.

VCLAMP can be connected to VM. It can also be connected to a Zener or TVS diode to VM, allowing the switch voltage to exceed VM. Thus it can be beneficial to drive loads requiring fast decay, such as unipolar stepper motor.

Output voltage cannot exceed the maximum output voltage limit.

3. Protection Circuit

The MS31804TE has protection functions: undervoltage lockout, overcurrent protection and thermal shutdown. When these functions are triggered, shutdown operation is performed to protect the chip and motor.

3.1 Undervoltage Lockout

When VM pin voltage is less than undervoltage lockout threshold, all channels of the MS31804TE are disabled and internal logic is reset. When VM rises to above ULVO, the MS31804TE will recover normal operation.

3.2 Overcurrent Protection

Overcurrent protections on all output drivers limit the driving current by disabling the gate drive. If overcurrent limit time exceeds t_{OCP} (approximately 3.6 μ s), the output will be disabled and the nFAULT pin will be pulled low. The driver will remain disabled within t_{RETRY} (approximately 1.2ms).

Current recoveries and the fault will be automatically removed after t_{RETRY} . If RESET pin is activated or VM is reset, the fault will be removed immediately.

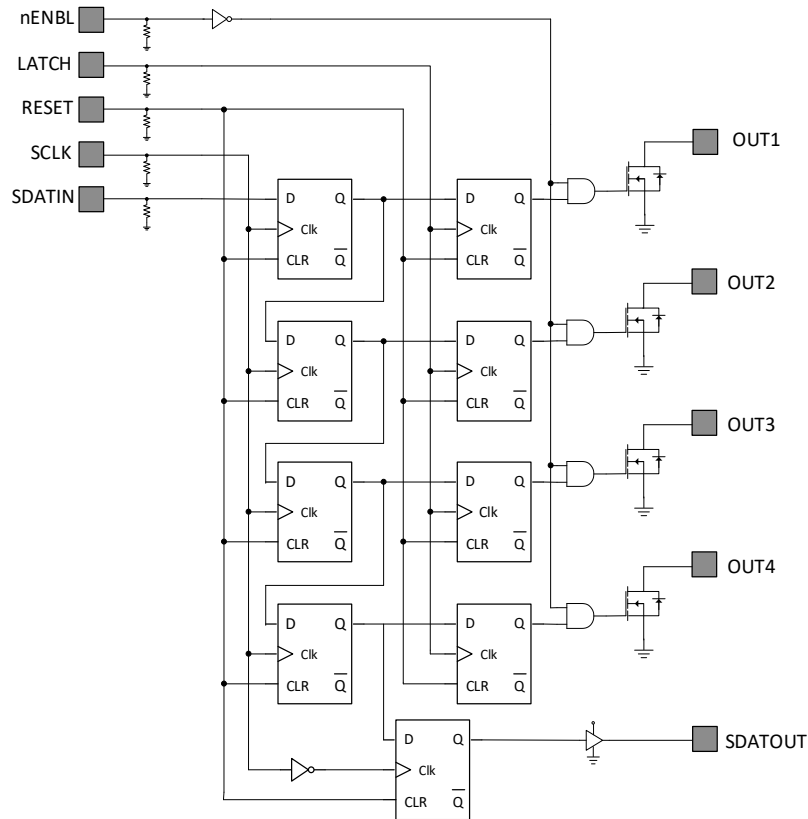
3.3 Thermal Shutdown

When chip temperature exceeds temperature limit, thermal shutdown is triggered, output is off and fault indication pin is pulled down. If chip temperature is normal, the fault is automatically removed and operation is recovered.

4. Function Description

4.1 Serial Interface

The MS31804TE is controlled by a simple serial interface. Several chips are used in series by SDATOUT interface. Logic function is shown as follows:

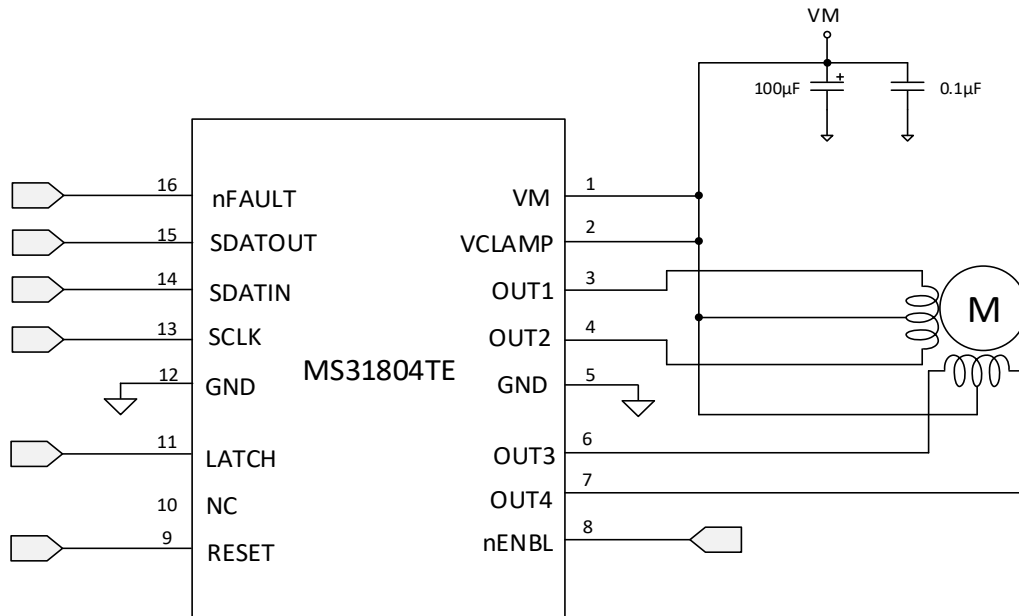


4.2 nENBL and Reset Operation

nENBL pin can enable or disable output driver. Driver can only be enabled when nENBL must be low. nENBL pin contains a pull-down resistor. When nENBL is high-level, internal logic is reset and all inputs are ignored. The MS31804TE provides automatic power-up reset function internally. No operation is performed on RESET pin when power-up.

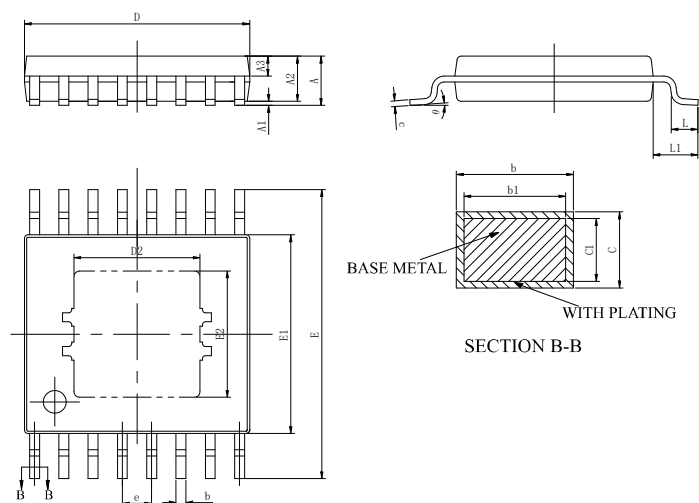
TYPICAL APPLICATION DIAGRAM

The typical application is for driving unipolar stepper motor as follows.



PACKAGE OUTLINE DIMENSIONS

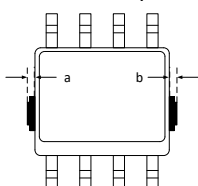
eTSSOP16



Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	-	-	1.20
A1	0.00	-	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	-	0.28
b1	0.19	0.22	0.25
c	0.13	-	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
D2	2.80 REF		
L	0.45	-	0.75
L1	1.00 BSC		
θ	0	-	8°
E2	2.10 REF		

Note: In addition to the package size, a and b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

The diagram is as follows: taking SOP8 package as an example.



MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description



Product Name : MS31804TE

Product Code : XXXXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece /Box	Box/Carton	Piece/Carton
MS31804TE	eTSSOP16	3000	1	3000	8	24000

STATEMENT

- All Revision Rights of Datasheets Reserved for Ruimeng. Don't release additional notice.
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- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.

**MOS CIRCUIT OPERATION PRECAUTIONS**

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.
2. The equipment shell must be grounded.
3. The tools used in the assembly process must be grounded.
4. Must use conductor packaging or anti-static materials packaging or transportation.



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