



XTM5833

Dual H-Bridge Motor Driver

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Product Overview

The XTM5833 is a dual-channel motor driver solution designed for electromagnetically applications such as cameras, printers, toys, and more. This device integrates two H-bridge drivers, capable of driving two DC brushed motors, one bipolar stepper motor, or solenoids and other inductive loads.

The XTM5833 supports a maximum operating voltage of 18V, with a continuous current of 1.2A and a peak current of 2.5A. Each H-bridge power output stage consists of NLD MOS transistors, including rectification and current-limiting circuits. The chip integrates thermal shutdown protection, undervoltage lockout (UVLO), short-circuit protection, overcurrent protection, and a fault detection output pin.

The XTM5833 features a PWM input interface (AIN1/AIN2/BIN1/BIN2) compatible with industry-standard devices.

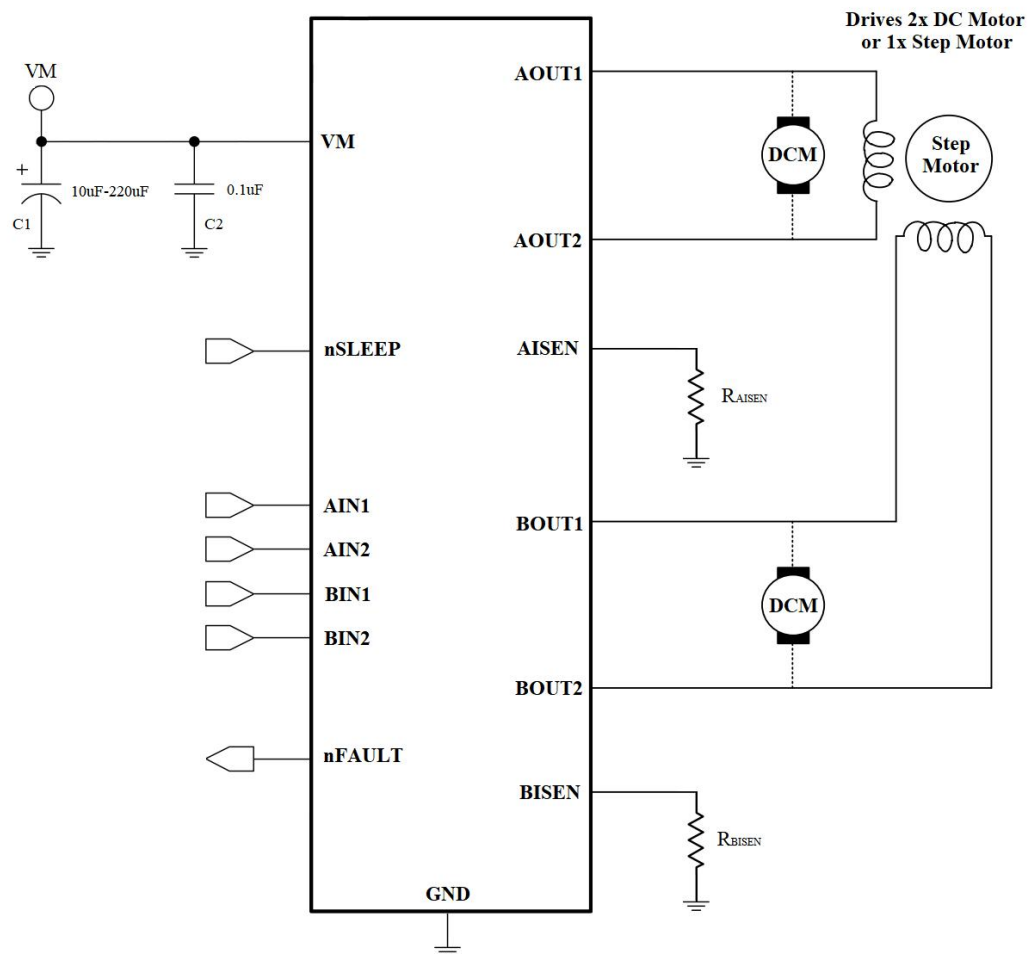
Features

- Operating Voltage Range: 1.65V to 18V
- Continuous Current: 1.2A, Peak Current: 2.5A
- $R_{DS(ON)}$ (per bridge): 0.59Ω
- Drives two DC brushed motors or one bipolar stepper motor
- Low-power sleep mode
- Integrated UVLO, thermal shutdown, overcurrent, and short-circuit protection
- Package Options: ETSSOP16, QFN16-3×3, QFN16-4×4

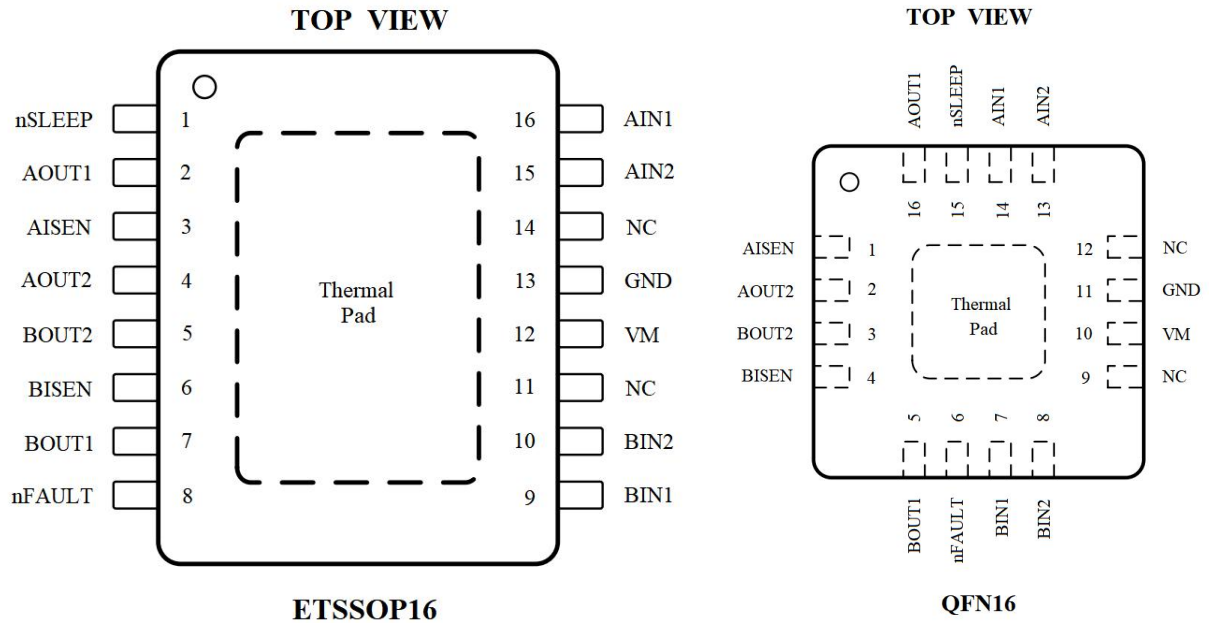
Applications

- Cameras
- Printers and office automation equipment
- Toys, robots

Typical Applications



Pin Definitions



NAME	NO.		TYPE	DESCRIPTION
	ETSSOP16	QFN16		
nSLEEP	1	15	I	Sleep mode logic input
AOUT1	2	16	O	H-bridge A, full-bridge output 1
AISEN	3	1	I/O	Channel A current sense resistor
AOUT2	4	2	O	H-bridge A, full-bridge output 2
BOUT2	5	3	O	H-bridge B, full-bridge output 2
BISEN	6	4	I/O	Channel B current sense resistor
BOUT1	7	5	O	H-bridge B, full-bridge output 1
nFAULT	8	6	O	Fault output (open-drain)
BIN1	9	7	I	H-bridge B logic input 1
BIN2	10	8	I	H-bridge B logic input 2
NC	11, 14	9, 12	-	No connect
VM	12	10	Power	Power supply
GND	13	11	GND	Ground
AIN2	15	13	I	H-bridge A logic input 2
AIN1	16	14	I	H-bridge A logic input 1
Thermal Pad	-	-	GND	Exposed pad (connect to ground)

Ordering Information

Part Number	Package	Quantity	Operating Temperature Range
XTM5833AT2CT	ETSSOP16	3000/Reel	-40°C~85°C
XTM5833AQ3CT	QFN16-3*3	3000/Reel	-40°C~85°C
XTM5833AQ6CT	QFN16-4*4	3000/Reel	-40°C~85°C

Absolute Maximum Ratings

Parameter		Min	Max	Unit
Power Supply	V_M	-0.3	25	V
Peak Output Current	I_{PEAK}	0	2.5	A
Logic Input Voltage	$V_{AIN1/AIN2/BIN1/BIN2/nSleep}$	-0.3	5.5	V
ESD Protection (HBM)	ESD	2000	-	V
Operating Temperature	T_{OPR}	-40	85	°C
Storage Temperature	T_{stg}	-65	150	°C
Junction Temperature	T_j	-	150	°C
Soldering Temperature (10s)		-	260	°C

Recommended Operating Conditions (Unless otherwise noted, $T_A=25^{\circ}\text{C}$)

Parameter		Min	Max	Unit
Power Supply	V_M	1.65	18	V
Input Logic Voltage	$V_{AIN1/AIN2/BIN1/BIN2/nSleep}$	0	5	V
Output Current (continuously)	I_{OUT}	0	1.2	A

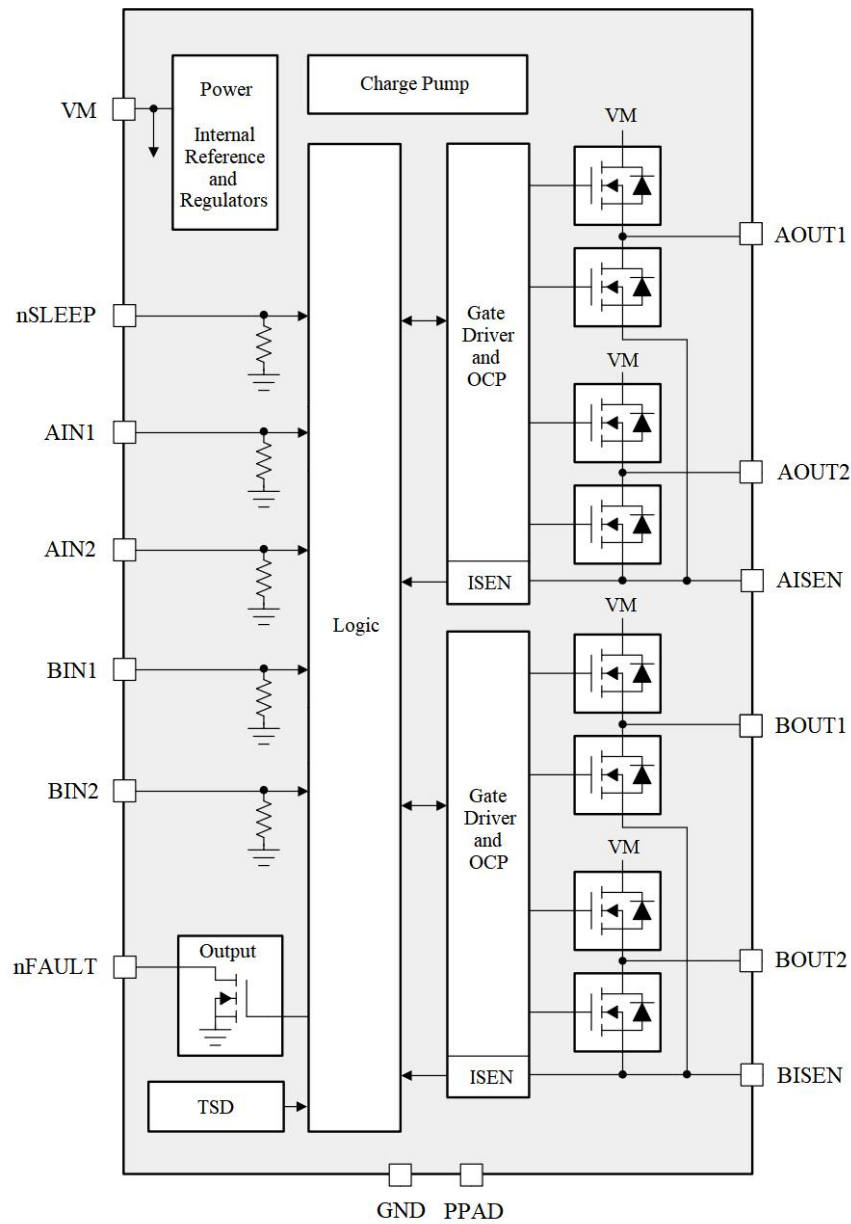
Electrical Characteristics (Unless otherwise noted, $V_M=12V$, $T_A=25^{\circ}C$)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
POWER SUPPLY (VM)						
V_M	Operating Supply Voltage		1.65	-	18	V
I_{VM}	Operating Supply Current	nSLEEP = 1; xIN1=xIN2 = 0	-	2	3	mA
I_{VMQ}	Sleep Mode Supply Current	nSLEEP = 0	-	-	1	uA
t_{SLEEP}	Sleep time	nSLEEP = 0 to sleep mode	-	5	-	us
t_{WAKE}	Wake-up Time	nSLEEP = 1 to output transition	-	0.8	1.5	ms
LOGIC-LEVEL INPUTS (AIN1、AIN2、BIN1、BIN2、nSLEEP)						
V_{IL}	Input logic low voltage		-	-	0.6	V
V_{IH}	Input logic high voltage		1.5	-	5.5	V
V_{HYS}	Input logic hysteresis		-	100	-	mV
I_{IL}	Input logic low current	$V_{xIN1/xIN2} = 0V$	-1	-	1	uA
I_{IH}	Input logic high current	$V_{xIN1/xIN2} = 5V$	-	-	25	uA
R_{PD}	Input pulldown resistance		-	100	-	K Ω
$t_{DEGLITCH}$	Input deglitch time		-	50	-	ns
OPEN-DRAIN OUTPUTS (nFAULT)						
V_{OL}	Output logic low voltage	$I_{OD} = 5mA$	-	-	0.5	V
I_{OH}	Output logic high current	$V_{OD} = 3.3 V$	-1	-	1	uA
PWM CURRENT CONTROL						
V_{TRIP}	xISEN trip voltage		180	200	220	mV
t_{BLANK}	Current sense blanking time		-	3	-	us
t_{OFF}	Current control constant off time		-	20	-	us

Electrical Characteristics (Unless otherwise noted, $V_M=12V$, $T_A=25^{\circ}C$)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
DRIVER OUTPUTS						
$R_{HS_DS(ON)}$	High-side MOSFET on resistance	$I_{XOUT} = 0.2A$	-	310	-	$m\Omega$
$R_{LS_DS(ON)}$	Low-side MOSFET on resistance	$I_{XOUT} = 0.2A$	-	280	-	$m\Omega$
V_{SD}	Body diode forward voltage	$I_{XOUT} = 0.5A$	-	1.1	-	V
t_{RISE}	Output rise time	$V_M = 12V$, $I_{OUT} = 0.5A$	-	150	-	ns
t_{FALL}	Output fall time	$V_M = 12V$, $I_{OUT} = 0.5A$	-	150	-	ns
t_{PD}	Propagation Delay INx to OUTx		-	400	-	ns
t_{DEAD}	Output dead time	Internal dead time	-	300	-	ns
PROTECTION CIRCUITS						
V_{UVLO}	Supply undervoltage lockout	Supply rising	-	-	1.5	V
		Supply falling	1.4	-	-	V
V_{UVLO_HYS}	Supply undervoltage hysteresis	Rising to falling threshold	-	100	-	mV
I_{OCP}	Overcurrent protection trip point		2.5	-	-	A
t_{OCP}	Overcurrent protection deglitch time		-	2	-	μs
t_{RETRY}	Overcurrent protection retry time		-	1.4	-	ms
T_{TSD}	Thermal shutdown temperature		-	165	-	$^{\circ}C$
T_{HYS}	Thermal shutdown hysteresis		-	40	-	$^{\circ}C$

Functional Block Diagram



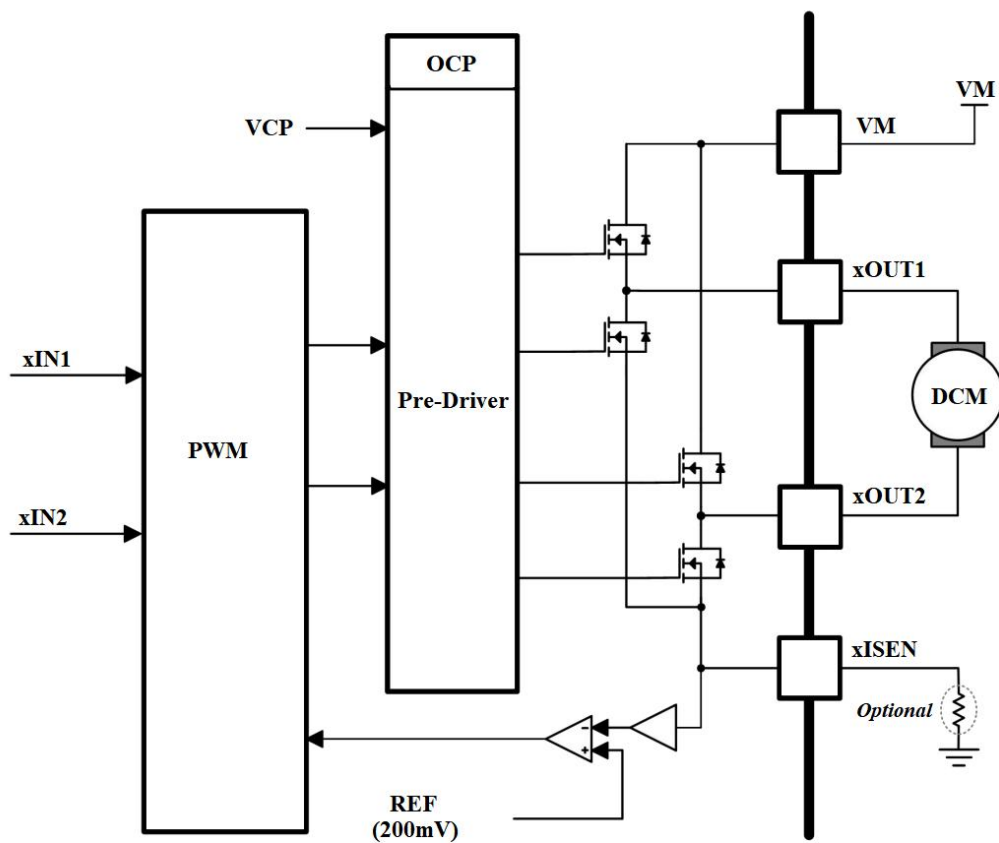
Detailed Description

Overview

The XTM5833 drives two DC brushed motors or one bipolar stepper motor using dual NMOS H-bridges with low $R_{DS(ON)}$. It integrates thermal shutdown, UVLO, overcurrent, and short-circuit protection. The device operates from 1.65V to 18V, delivering 1.2A continuous current. A low-power sleep mode minimizes energy consumption when idle.

PWM Current Control

XTM5833 contains two identical H-bridge motor drivers with current-control PWM circuitry. As shown in the following figure shows a block diagram of the circuitry.



Bridge Control and Decay Modes

The AIN1 and AIN2 input pins control the state of the AOUT1 and AOUT2 outputs; similarly, the BIN1 and BIN2 input pins control the state of the BOUT1 and BOUT2 outputs. As shown in the following table shows the logic.

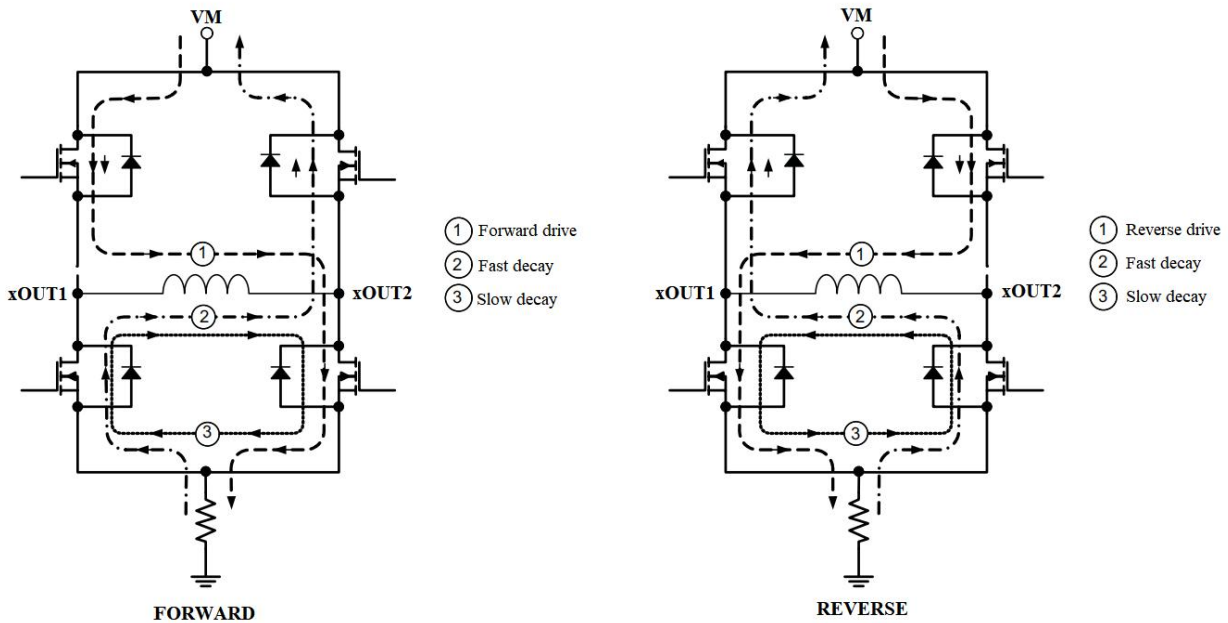
xIN1	xIN2	xOUT1	xOUT2	FUNCTION
L	L	High-Z	High-Z	Coast
L	H	L	H	Reverse
H	L	H	L	Forward
H	H	L	L	Brake

The inputs can also be used for PWM control of the motor speed. When controlling a winding with PWM, when the drive current is interrupted, the inductive nature of the motor requires that the current must continue to flow. This is called re-circulation current. To handle this re-circulation current, the H-bridge can operate in two different states: fast decay or slow decay. In fast decay mode, the H-bridge is disabled and re-circulation current flows through the body diodes; in slow decay, the motor winding is shorted.

To PWM using fast decay, the PWM signal is applied to one xIN pin while the other is held low; to use slow decay, one xIN pin is held high.

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

As shown in the following figure shows the current paths in different drive and decay modes.



Current Control

The current through the motor windings may be limited, or controlled, by a fixed-frequency PWM current regulation, or current chopping. For DC motors, current control is used to limit the start-up and stall current of the motor. For stepper motors, current control is often used at all times.

When an H-bridge is enabled, current rises through the winding at a rate dependent on the DC voltage and inductance of the winding. If the current reaches the current chopping threshold, the bridge disables the current until the beginning of the next PWM cycle. Immediately after the current is enabled, the voltage on the xISEN pin is ignored for a fixed period of time before enabling the current sense circuitry. This blanking time is fixed at 3μs. This blanking time also sets the minimum on time of the PWM when operating in current chopping mode.

The PWM chopping current is set by a comparator which compares the voltage across a current sense resistor connected to the xISEN pins with a reference voltage. The reference voltage is fixed at 200 mV.

The chopping current is calculated as shown in the following equation.

$$I_{CHOP} = 200\text{mV}/R_{xISEN}$$

Example: If a 1-Ω sense resistor is used, the chopping current will be 200 mV/1 Ω = 200 mA. Once the chopping current threshold is reached, the H-bridge switches to slow decay mode. Winding current is recirculated by enabling both of the low-side FETs in the bridge. This state is held until the beginning of the next fixed-frequency PWM cycle. If current control is not needed, the xISEN pins should be connected directly to ground.

nSLEEP Operation

Driving nSLEEP low will put the device into a low power sleep state. In this state, the H-bridges are disabled, the gate drive charge pump is stopped, all internal logic is reset, and all internal clocks are stopped. All inputs are ignored until nSLEEP returns inactive high. When returning from sleep mode, some time (up to 0.8ms) needs to pass before the motor driver becomes fully operational.

Blanking Time

There is usually a current spike during the switching transition due to the body diode's reverse-recovery current or the distributed inductance or capacitance. This current spike requires filtering to prevent it from erroneously shutting down the high-side MOSFET. An internal blanking time T_{BLANK} blanks the output of the current sense comparator when the outputs are switched, which is also the minimum on time for high-side MOSFET.

Overcurrent Protection (OCP)

The over-current protection circuit limits the current through the FET by disable the gate driver. If the over-current limit threshold is reached and lasts for longer than the overcurrent deglitch time, all MOSFETs in the H-bridge will be disabled and the nFAULT pin will be driven low. The driver will remain disabled and is reset to enable state after 1.4ms(typ). Please note that only the H-bridge in which the OCP is detected will be disabled while the other bridge will operate normally.

Over-current conditions on both high and low side devices; i.e., a short to ground, supply, or across the motor winding will all result in an over current shutdown. Note that over-current protection does not use the current sense circuitry used for PWM current control, and is independent of the sense resistor value or VREF voltage

Thermal Shutdown (TSD)

If the die temperature exceeds safe limits, all FETs in the H-bridge will be disabled and the nFAULT pin will be driven low. Once the die temperature has fallen to a safe level, operation will automatically resume.

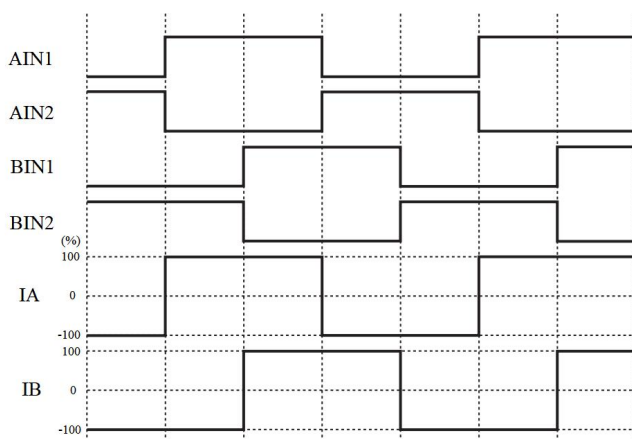
Under-Voltage Lockout (UVLO)

If at any time the voltage on the VM pin falls below the under-voltage lockout threshold voltage, all circuitry in the device will be disabled, and all internal logic will be reset. Operation will resume when VM rises above the UVLO threshold. nFAULT is driven low in the event of an under-voltage condition.

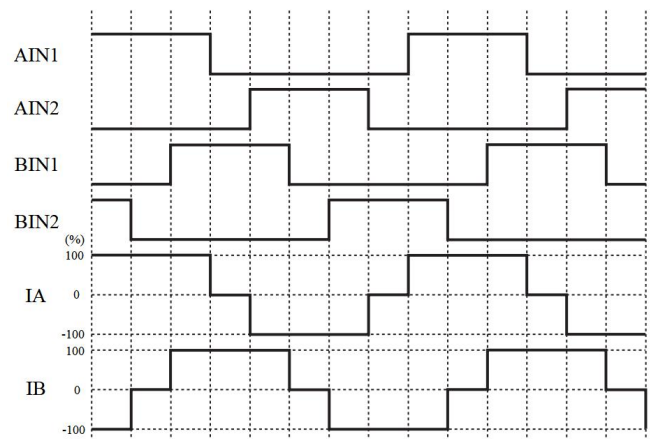
Stepper Motor Truth Table

AIN1	AIN2	BIN1	BIN2	AOUT1	AOUT2	BOUT1	BOUT2	FUNCTION	
0	0	0	0	Z	Z	Z	Z	Sleep	Sleep
1	0	1	0	H	L	H	L	Step1	Step1
0	0	1	0	Z	Z	H	L	-	Step2
0	1	1	0	L	H	H	L	Step2	Step3
0	1	0	0	L	H	Z	Z	-	Step4
0	1	0	1	L	H	L	H	Step3	Step5
0	0	0	1	Z	Z	L	H	-	Step6
1	0	0	1	H	L	L	H	Step4	Step7
1	0	0	0	H	L	Z	Z	-	Step8

Stepper Motor Output Current Wave



Full-step mode



Half-step mode

Application Note

For a smoother drive motor, the software timing recommendations:

In Full-step mode, or need PWM speed regulation, or PWM control current, slow decay can be more conducive to motor energy release.

For example:

(xIN2, xIN1) from 10 to 01, xIN1 change statement first and xIN2 change statement later, so that the timing is 10→11→01, which is not recommended 10→00→01.

Similarly, when the DC motor needs speed regulation, slow decay is recommended, with the following example:

If the output is currently turning in a certain direction, assuming the xOUT2 is high and xOUT1 is low, the corresponding input should be xIN2 high and xIN1 low. If speed control is needed, (xIN2, xIN1) input can be controlled as 10→11→10→11, the duty cycle of part 10 is the corresponding speed regulation ratio.

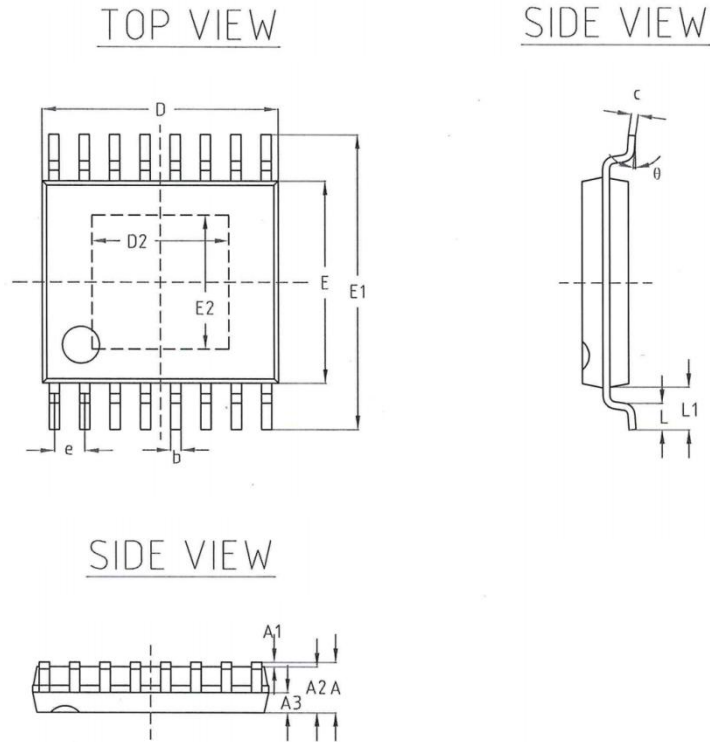
NTOE: Due to the brake state, the motor energy can be released quickly, and the motor speed can be accurately controlled by the duty cycle of the PWM signal. However, it must be noted that if the PWM signal frequency is too low, the motor will not be able to rotate continuously and smoothly due to entering the brake mode. To reduce the motor noise, it is recommended that the PWM signal frequency be greater than 10KHz and less than 50KHz.

Application Circuit Note

1. The operating condition over the absolute parameters of the chip is not allowed
2. Don't short the two outputs or the power supply and ground. If the peak current is too high, the IC will be burned
3. If the motor exceeds the peak current designed by the IC when locked, the IC will also be damaged
4. The bypass capacitor of VM should be as close to the VM pin of the chip as possible
5. The ground wire connecting the motor needs to be isolated in the layout

Package Information

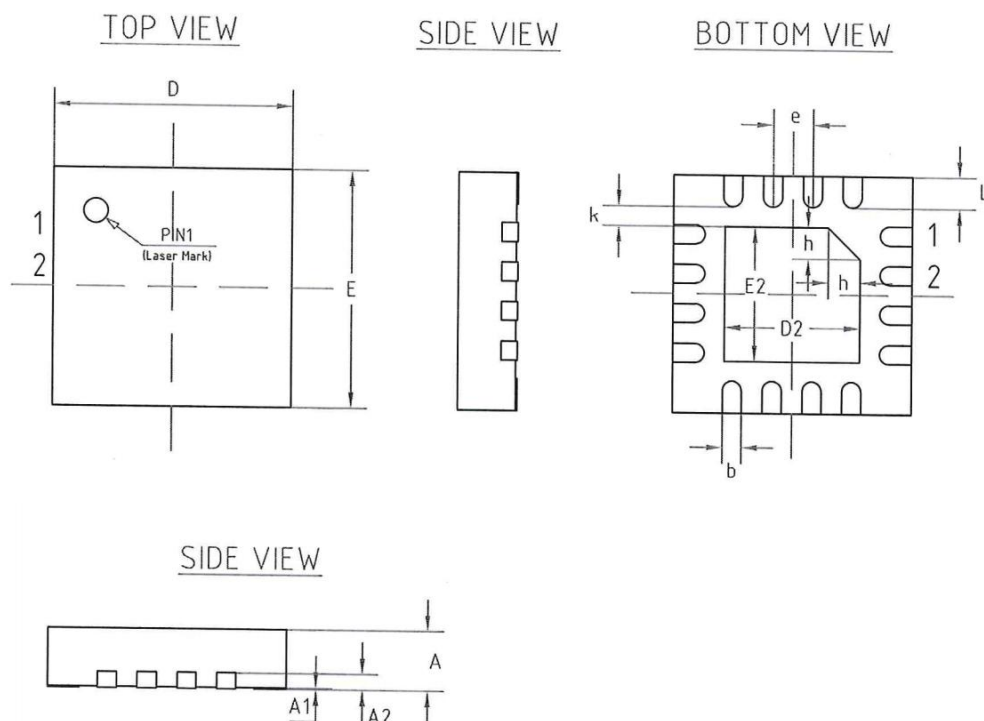
ETSSOP16



Symbol	Dimensions In Millimeters		
	Min	Nom	Max
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	-	0.28
c	0.13	-	0.17
D	4.90	5.00	5.10
D2	2.80REF		
E	4.30	4.40	4.50
E1	6.20	6.40	6.60
E2	2.10REF		
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00REF		
θ	0°	-	8°

Package Information

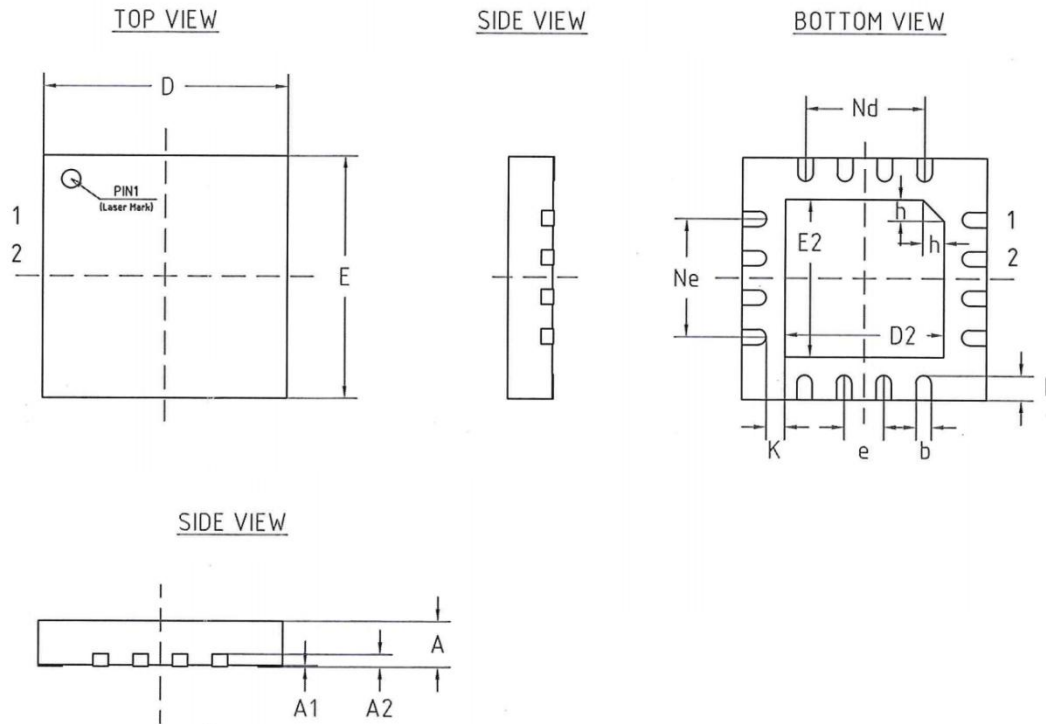
QFN16-3*3



Symbol	Dimensions In Millimeters		
	Min	Nom	Max
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2	0.203REF		
b	0.18	0.24	0.30
D	2.90	3.00	3.10
D2	1.60	1.70	1.80
E	2.90	3.00	3.10
E2	1.60	1.70	1.80
e	0.50BSC		
L	0.30	0.40	0.50
K	0.20	0.25	0.30
h	0.35	0.40	0.45

Package Information

QFN16-4*4



Symbol	Dimensions In Millimeters		
	Min	Nom	Max
A	0.70	0.75	0.80
A1	-	0.02	0.05
A2	0.203REF		
b	0.20	0.25	0.30
D	3.90	4.00	4.10
D2	2.50	2.60	2.70
E	3.90	4.00	4.10
E2	2.50	2.60	2.70
e	0.65BSC		
L	0.30	0.40	0.50
K	0.20	0.30	0.40
h	0.30	0.35	0.40
Ne	1.95BSC		
Nd	1.95BSC		

Revision History

Number	Description
Rev 1.0	XTM5833 datasheet release
Rev 1.3	Update the Electrical Characteristics