description

AT8833 provides an integrated dual-channel motor drive solution for toys, printers, and other motorized applications. AT8833 features two H-bridge drivers that can drive either two brushed DC motors, a bipolar stepper motor, or solenoids and other inductive loads.

The power output stage of each H-bridge consists of N channel power MOSFET, called H-bridge driver. Each bridge contains a rectifier circuit and a current limiting circuit.

The internal shutdown function includes overcurrent protection, short circuit protection, undervoltage lo-ckout protection, and overtemperature protection, and provides a fault detection output pin.

AT8833 Provide three packages, one is the ETSSOP16 package with exposed pads, and the other two are QFN16 packages with exposed pads, size 4*4 and 3*3, which can effectively improve the heat dissipation perform-ance. Both are lead-free products and meet environme-ntal standards.

apply

- Lithium battery powered toys
- POS, printer
- Security cameras
- business automation equipment
- recreational machines
- robot

Model selection

Order number	Package	Packaging inform-ation
AT8833CT	ETSSOP16	Strips, 3000 beads per disc
AT8833CQ	QFN4*4-16	Strips, 5000 beads per disc
AT8833CR	QFN3*3-16	Strips, 5000 beads per disc

characteristic

Dual channel H bridge motor driver

Drive two DC brushed motors or one stepper motor

Low RDS (ON) resistance, 800mΩ (HS+ LS)

1.2A drive output

Wide voltage supply, 2.7V-15V

PWM control interface

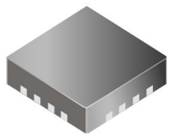
Overtemperature shutdown circuit

short-circuit protection

Under-voltage lockout protection

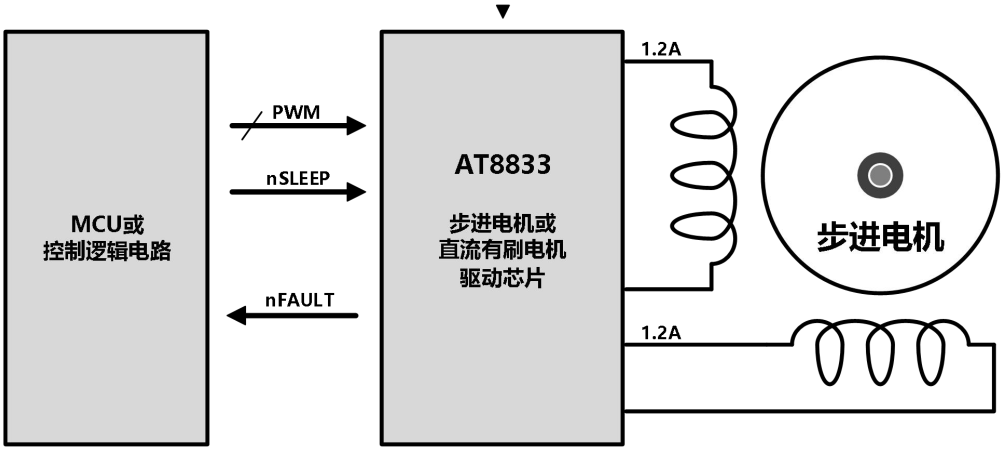
Packaging form

ETSSOP16



QFN16

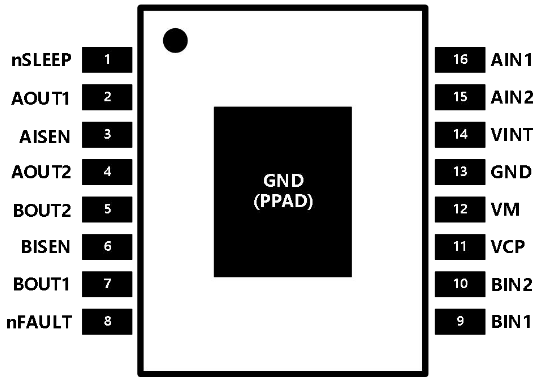
Typical application schematic



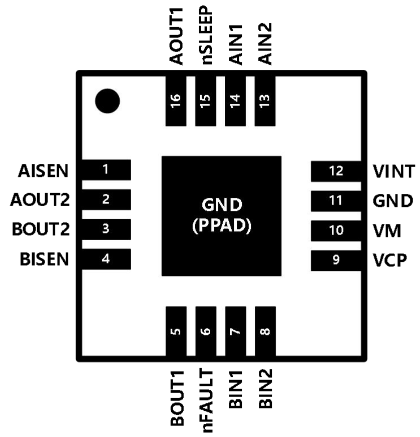
Version update log

Date	Edition	Content
2017.08	V0.1	Draft prepared
2017.12	V1.0	Official edition
2018.02	V1.1	Correct errors in printing
2020.03	V1.2	Add packaging information
2020.07	V1.3	Add VINT to the VCP voltage value
2021.05	V1.4	Parameter correction

Pin definition



ETSSOP16

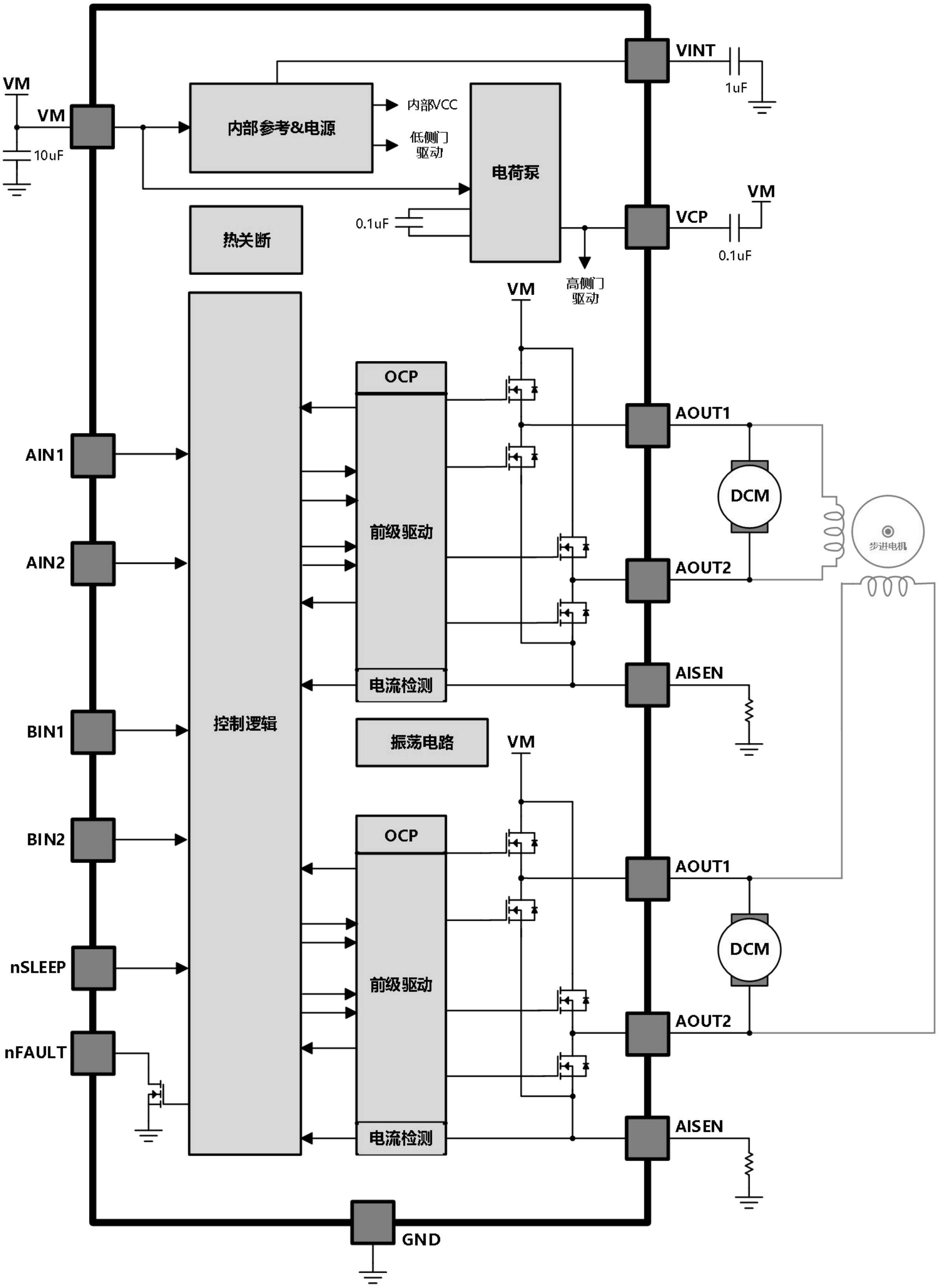


QFN16

Pin list

Name	Pin number		Pin description	External components or connections
	ETSSOP	QFN		
Power supply and ground				
GND	13	11	Device location	All ground pins and bare pads must be connected to the system ground
PPAD	-	-		
VM	12	10	Device power supply	Motor power supply, do a good job of filtering, minimum 10uF capacitor to ground
VINT	14	12	Internal rectifica-tion	Connect a 1uF capacitor to ground
VCP	11	9	High-side gate dri-ves energy storage	Connect a 0.1uF capacitor to VM
Control input				
AIN1	16	14	H bridge A input 1	Logical input, control AOUT1, internal pull-down
AIN2	15	13	H bridge A input 2	Logical input, control AOUT2, internal pull-down
BIN1	9	7	H bridge B input 1	Logical input, control BOUT1, internal pull-down
BIN2	10	8	H bridge B input 2	Logical input, control BOUT2, internal pull-down
nSLEEP	1	15	Sleep mode input	The chip works normally during high voltage; the chip enters sleep and low power mode during low voltage
Status output				
nFAULT	8	6	Error output	When there is an overtemperature or overcurrent, the output is low level and open drain output. An external pull-up is required for use
Output				
AISEN	3	1	Group A was tested for flow	In group A, connect the galvanometer resistance to grou-nd; if the galvanometer is not used, directly ground
BISEN	6	4	Group B test flow	For group B, connect the galvanometer resistance to the ground; if the galvanometer is not used, connect it directly to the ground
AOUT1	2	16	H bridge A output 1	Connect the coil of motor A
AOUT2	4	2	H bridge A output 2	
BOUT1	7	5	H bridge B output 1	Connect the motor B coil
BOUT2	5	3	H bridge B output 2	

Functional module block diagram



The operating limit of the circuit atTA = 25°C

Parameter	Symbol	Test condition	Scope	Unit
Load voltage	VM		-0.3 – 18	V
Maximum output current	I_{OUT}		±1.2	A
Instantaneous peak current	I_{PEAK}	Internal restrictions	>2	A
Logic input voltage	V_{IN}		-0.7 to 7	V
Sense voltage	V_{SENSE}		-0.3 to 0.5	V
Working temperature	T_A		-40 to 85	°C
Maximum junction temperature	T_J(max)		150	°C
Storage temperature	T_{stg}		-55 to 150	°C

Thermal resistance characteristics at TA= 25°C

Heat metering	ETSSOP 16PINS	QFN 16PINS	Unit
θJA-Thermal resistance coefficient (*) from silicon core to environment	44.5	39	°C/W

(*) The thermal resistance coefficient of silicon core to the environment under natural convection is obtained by actual test on a JEDEC standard high K circuit board specified in JESD51-7, and the environmental conditions are as described in JESD51-2a.

Recommended working conditions at TA= 25°C

Parameter	Symbol	Minimum	Typical case	Maximum	Unit
Rated supply voltage range	VM	2.7	-	15	V
Logic input voltage range	V_{IN}	0	-	5.25	V
Single channel H bridge RMS output current	I_{OUT}	0	-	1.0	A

Electrical characteristics atTA = 25°C, VM= 8V

Parameter		Test condition	Minimum	Typical case	Maximum	Unit
Power supply						
I_{VM}	VM quiescent current	xIN1 = 0 V, xIN2 = 0 V	-	-	3.5	mA
I_{VMQ}	VM sleep current		-	-	10	uA
V_{UVLO}	VM under-voltage threshold	VM descend	-	-	2.5	V
V_{HYS}	VM under-voltage hysteresis		-	200	-	mV
V_{VINT}	VINT voltage		3.0	3.2	3.4	V
V_{VCP}	VCP voltage		VM+4.0	VM+5.0	VM+5.5	V
Logical input						
V_{IL}	The logical input is at a low level	nSLEEP	-	-	0.5	V
		Other pins	-	-	0.7	
V_{IH}	The logical input is high	nSLEEP	2.5	-	-	V
		Other pins	2	-	-	
V_{HYS}	Logical input hysteresis		-	0.3	-	V
R_{PD}	Enter the internal pull-down resistance	nSLEEP	-	500	-	kΩ
		Other pins	-	100	-	
I_{IL}	Input low level current	V_{IN} = 0 V	-	-	1	uA
I_{IH}	Input high level current	V_{IN} = 3.3 V, nSLEEP	-	6.6	13	uA
		VIN = 3.3 V, other pins	-	16.5	33	
t_{DEG}	Damping time		-	450	-	ns
nFAULT Output (open drain output)						
V_{OL}	Output low level	I_O = 5 mA	-	-	0.5	V
I_{OH}	Turn off leakage current	V_O = 3.3 V	-	-	1	uA
H bridge FETS						
$R_{DS(ON)}$	H Bridge high side FET on-state resistance	VM = 5 V, I_O = 500 mA	-	400	-	mΩ
		VM = 2.7 V, I_O = 500 mA	-	450	-	
	H Bridge low side FET on-state resistance	VM = 5 V, I_O = 500 mA	-	400	-	
		VM = 2.7 V, I_O = 500 mA	-	450	-	

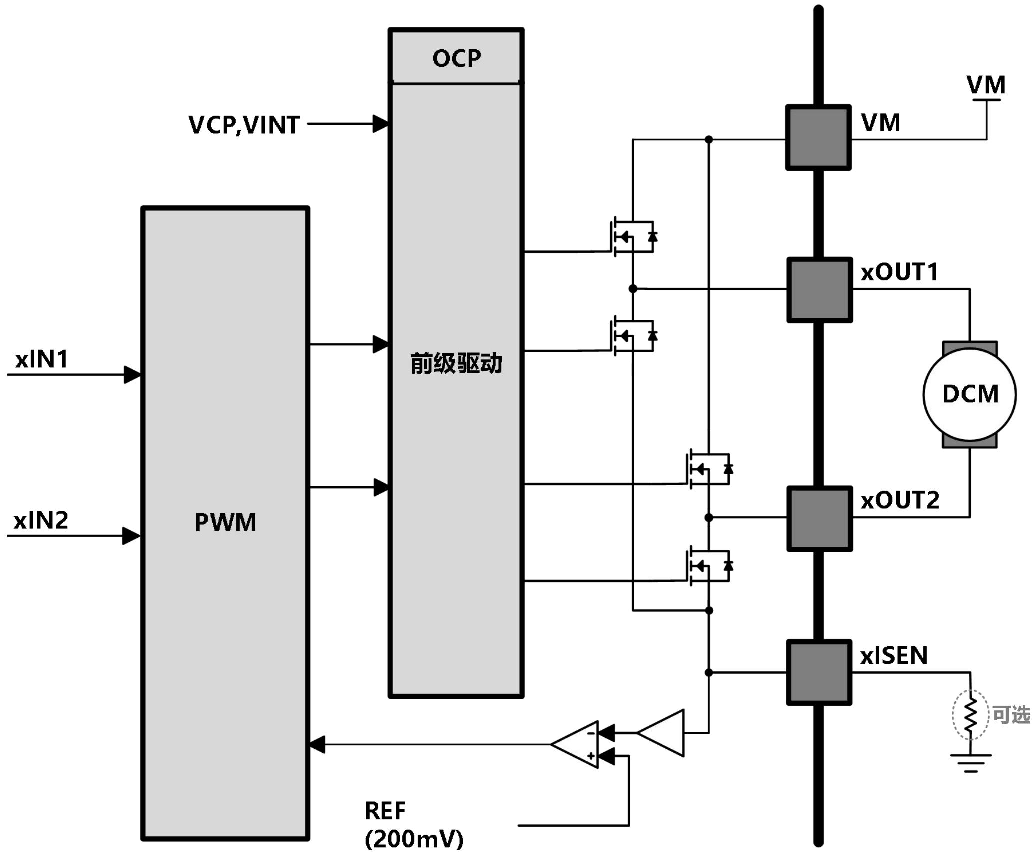
I_{OFF}	Turn off leakage current	VM = 5 V, V_{OUT} = 0 V	-1	-	1	uA
Motor drive						
f_{PWM}	The PWM frequency is controlled by the current	Internal PWM frequency	-	50	-	kHz
t_R	Increase the output rise time	16Ω to GND, 10% to 90%	-	240	-	ns
t_F	Reduce the time of output decline	16Ω to VM, 10% to 90%	-	200	-	ns
t_{PROP}	INx to OUTx Delay		-	0.5	-	us
t_{DEAD}	Dead zone time		-	200	-	ns
Guard circuit						
I_{OCP}	Overcurrent protection threshold		2.2	-	3	A
t_{DEG}	Overcurrent delay time		-	1.5	-	us
t_{OCP}	Overcurrent protection restart time		-	1.9	-	ms
t_{TSD}	Over temperature threshold	Junction temperature	150	160	180	℃
Current-controlled						
V_{TRIP}	xISEN Sampling voltage		160	200	240	mV
t_{BLANK}	blanking Time		-	2.4	-	us
Sleep mode						
t_{WAKE}	Trunon delay time	nSLEEP Rise to H bridge opening	-	0.2	1	ms

Module function description

AT8833 provides an integrated drive solution for brushed DC motors or stepper motors. The chip integrates a dual-channel H-bridge and rectifier circuit. AT8833, the supply range is from 2.7V to 15V, with a continuous output of 1.2A. It can be controlled via a simple PWM interface, and the internal rectifier circuit has a cycle time of 25us. AT8833 also includes a low-power sleep mode to save power when not driving the motor.

PWM motor driver

AT8833 It contains two H-bridge drive circuits, using PWM to regulate the current. The following figure shows the functional modules of the circuit:



H bridge and chopping circuit

H Bridge and attenuation mode control logic

Input pins AIN1 and AIN2 control the state of output pins AOUT1 and AOUT2. Similarly, input pins BIN1 and BIN2 control the state of output pins BOUT1 and BOUT2. The table below shows the logical relationships between them.

xIN1	xIN2	xOUT1	xOUT2	Function
0	0	Z	Z	Slide / Fast decay
0	1	L	H	Reversal
1	0	H	L	Corotation
1	1	L	L	Brake / slow decay

H bridge control logic

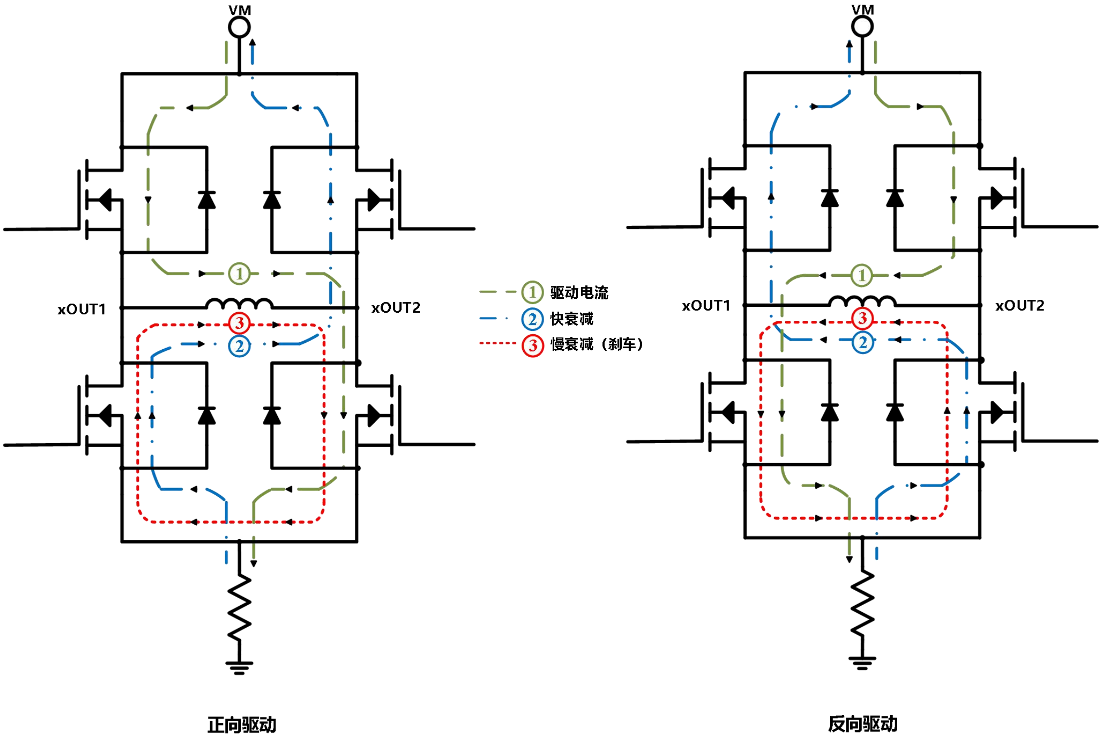
The logic input can also use PWM control to achieve speed regulation. When a PWM wave controls a coil, the drive current is interrupted, and due to the inductive characteristics of the motor, the motor coil must continue to conduct. To operate the motor coil to continue conducting, the H-bridge can operate in two different states: fast decay or slow decay. In fast decay mode, the H-bridge turns off, and the freewheeling current flows through the body diode; in slow decay mode, the ends of the motor coil are short-circuited.

When PWM control is used in fast attenuation mode, the PWM signal controls one xIN pin while the other pin remains low; when used in slow attenuation mode, one of the pins remains high.

xIN1	xIN2	Function
PWM	0	Forward PWM, fast attenuation
1	PWM	Forward PWM, slow decay
0	PWM	Reverse PWM, fast attenuation
PWM	1	Reverse PWM, slow attenuation

PWM controls motor speed

The following figure shows the current path in different drive and attenuation modes.



Drive and attenuation mode diagram

Current rectification

The current flowing through the motor coil is regulated by a fixed-frequency PWM rectifier or current chopping. When driving a DC motor, the rectifier is used to limit the starting current and stall current of the motor. When driving a stepper motor, the rectification function always exists, and the current can be adjusted for step subdivision.

When an H-bridge is enabled, the current flowing through the motor coil increases, with the rate of increase determined by the DC voltage VM and the inductance value of the motor coil. When the current reaches the chopping threshold, the output H-bridge turns off, and the current decays until the next PWM cycle begins. Note that at the moment the H-bridge enables to charge the motor coil, the voltage on the xISEN pin is ignored; after a fixed delay for the blanking time, the current sensing circuit becomes active. This blanking time is typically set to 2.4us.

The PWM chopping current is set by the comparator, which compares the voltage on the xISEN pin connected to the galvanometer resistance with a reference voltage. This reference voltage VTRIP is usually fixed at 200mV. The following formula calculates the chopping current:

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

For example, if a 1Ω resistor is used, the target current is 200mA.

Note: If the flow limiting function is not required, the xISEN pin should be directly grounded.

nSLEEP Input logic

When the nSLEEP pin is driven to a low voltage, the chip enters a low-power sleep mode. In this state, the H-bridge turns off, the charge pump stops working, all internal logic resets, and all internal clocks stop counting. All input signals are ignored until the nSLEEP pin is pulled high. After the sleep mode is released, it takes some time (usually 1ms) for the chip to resume normal operation. To simplify board-level design, the nSLEEP pin can be pulled up to VM. In this case, a pull-up resistor is recommended to limit the input current when VM is greater than 5.8V. Internally, a 500kΩ resistor pulls the nSLEEP pin down to ground, along with a 5.8V Zener clamp diode. Excessive current can damage the internal input structure. Therefore, it is recommended that the pull-up resistor value be between 20kΩ and 75kΩ.

guard circuit

AT8833 Overcurrent protection, overtemperature protection and undervoltage protection.

Overcurrent protection (OCP)

On each FET, there is a current-limiting circuit that detects the current flowing through the FET. If this current exceeds the overcurrent threshold and persists for more than the OCP protection time, all FET outputs in the H-bridge turn off, and the nFAULT pin outputs a low level. After an OCP reset time (tOCP), the driver is re-enabled, and the nFAULT pin outputs a high level. If this fault condition persists, the same phenomenon repeats. If this fault condition disappears, the chip returns to normal operation. Note that only the H-bridge that detects overcurrent will turn off; the other H-bridges continue to operate normally.

Overcurrent on the upper and lower pipes of the H bridge, such as short circuit to ground, short circuit to VM, and short circuit between output, will trigger overcurrent protection. Note that the overcurrent protection does not use the current detection circuit for PWM current control, so the overcurrent protection function is independent of the xISEN resistor.

Overtemperature protection (TSD)

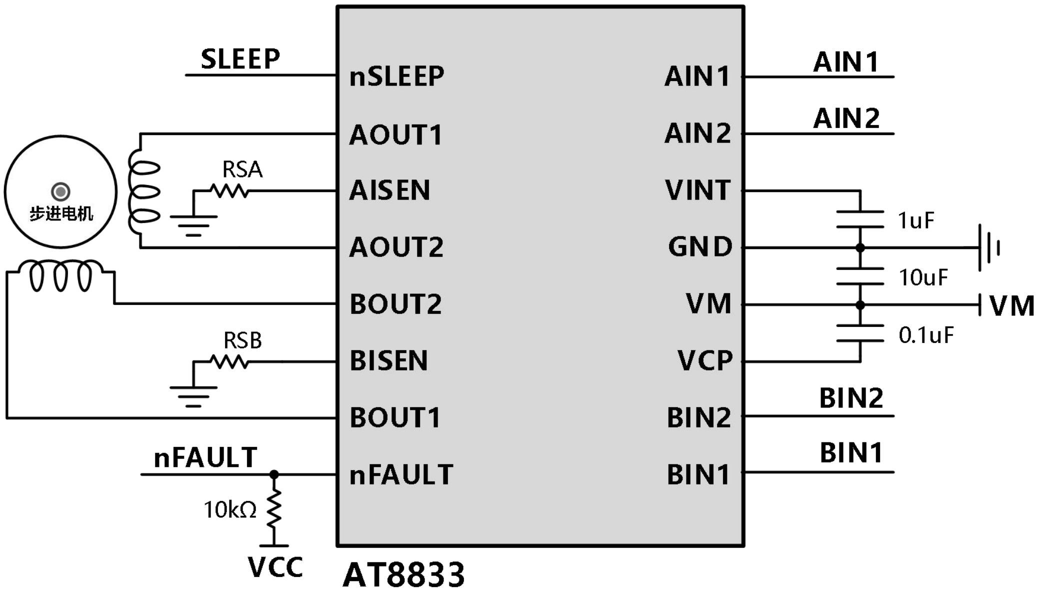
If the junction temperature exceeds the safety threshold, all FETs in the H bridge are turned off and nFAULT, pin output is low. Once the junction temperature drops to a safe level, all functions of the chip will automatically return to normal.

Under-voltage lockout protection (UVLO)

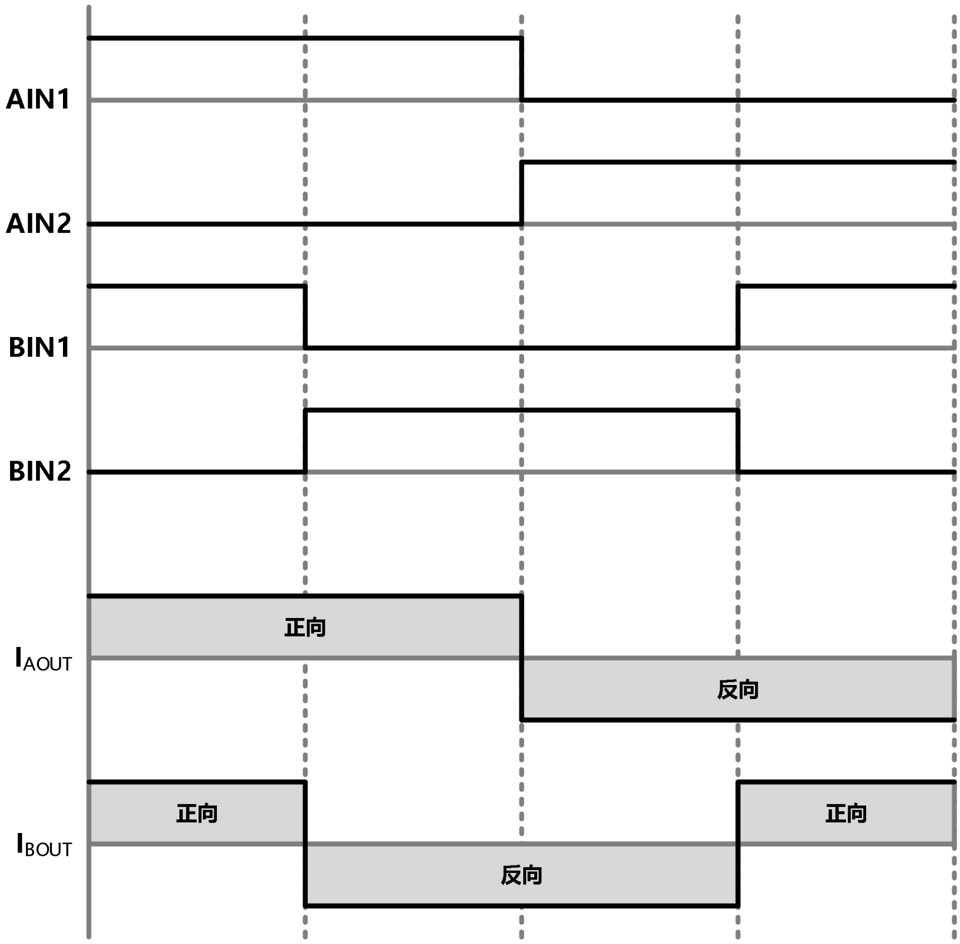
At any time, if the voltage on the VM pin drops below the under-voltage lockout threshold, all internal circuits are turned off and the internal logic is reset. When the voltage on the VM rises above UVLO, all functions return to normal.

Information on circuit applications

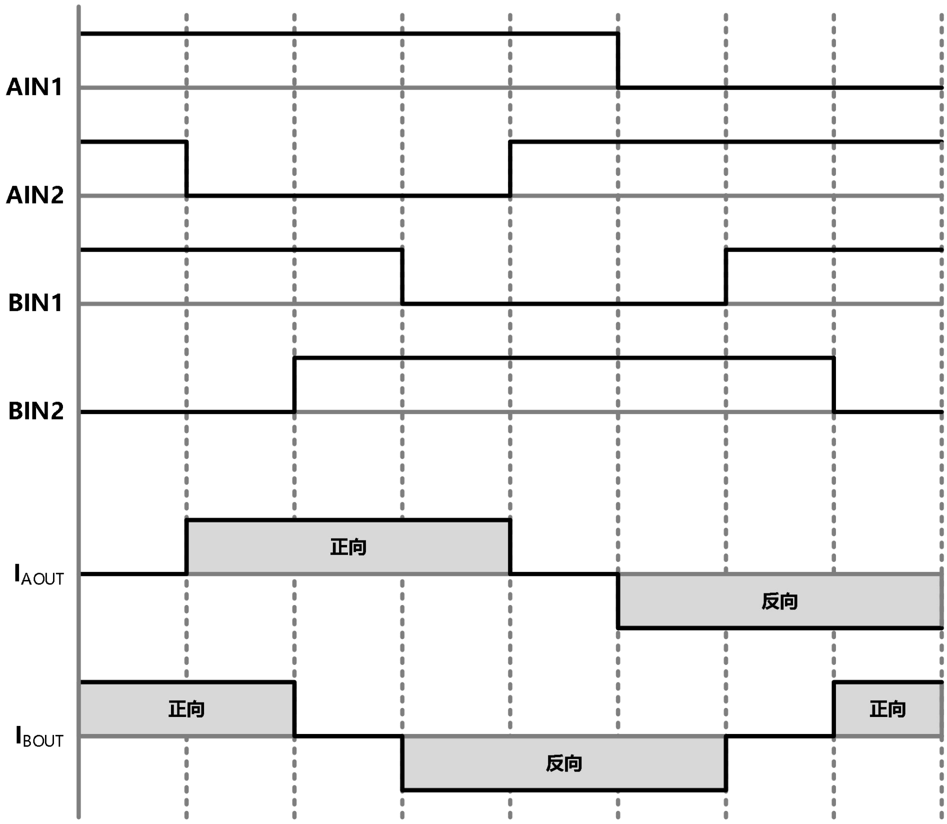
Bipolar stepper motor mode



Typical schematic diagram



Control the timing of the steps



Half a step to control the sequence

Map layout notes

A large heat sink should be placed on the PCB board, and a wide ground wire should be connected to the ground. In order to optimize the electrical characteristics and thermal performance of the circuit, the chip should be directly attached to the heat sink.

For the electrode power supply VM, an electrolytic capacitor of no less than 10uF should be coupled to the ground, and the capacitor should be placed as close to the device as possible.

In order to avoid the capacitance coupling problem caused by high speed dv/dt transformation, the wiring at the output end of the drive circuit should be far away from the wiring at the logic control input end. The lead wire at the logic control end should use low impedance routing to reduce the noise caused by thermal resistance.

Ground wire setting

All ground lines on a chip should be connected together and the connections should be as short as possible. A star-diffused ground line located under the device will be an optimized design.

Adding a copper heat sink under the laid ground will better optimize the circuit performance.

Current sampling Settings

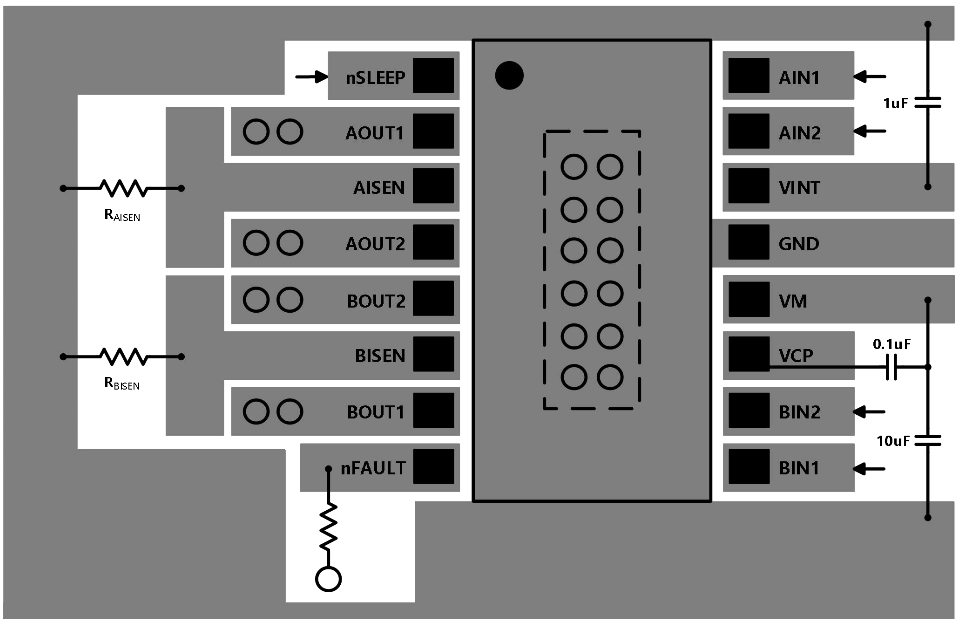
To reduce errors caused by parasitic resistance on the ground wire, the sampling resistor RS for motor current should be grounded separately to minimize errors from other factors. The separate ground wire must ultimately connect to the star-distributed ground bus, and this connection should be as short as possible. For small-value Rs, the voltage drop V = I × RS is 0.2V. The voltage drop across the PCB traces will be significant compared to 0.2V, which must be taken into account.

PCB should avoid using test transfer sockets as much as possible, the connection resistance of test sockets may change the size of Rs, causing errors to the circuit. The selection of Rs value follows the following formula:

$$R_S = 0.2 / I_{TRIP\max}$$

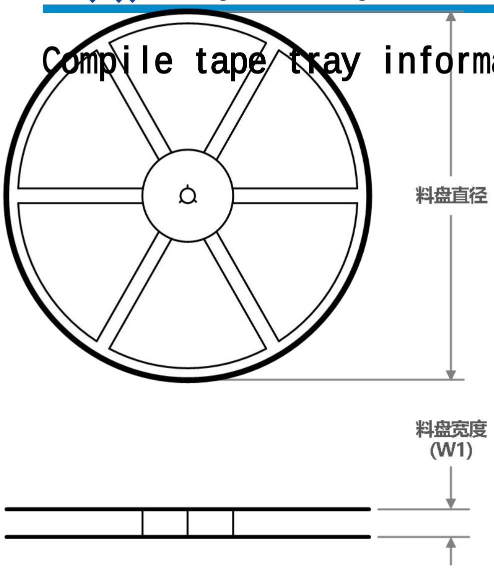
Thermal protection

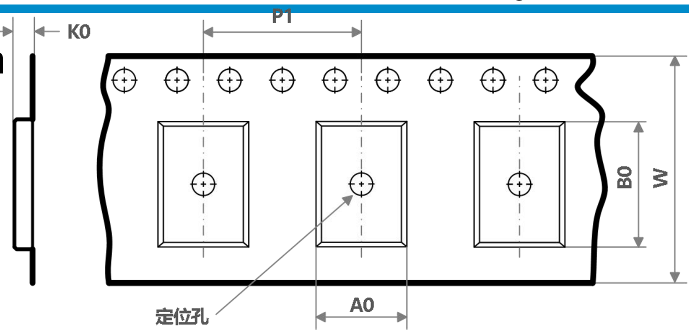
When the junction temperature of the internal circuit exceeds 160 , the overtemperature protection circuit starts to work and shuts down all the internal circuits until the temperature drops by 45 before it returns to normal operation.



Typical PCB, layout diagram

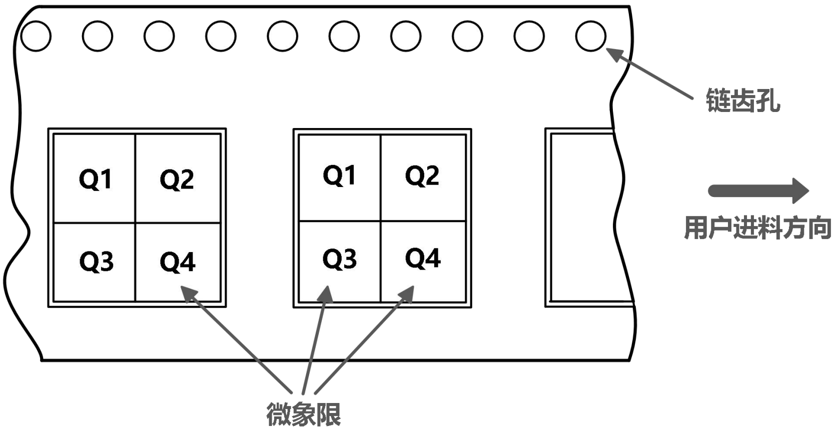
Compile tape tray information





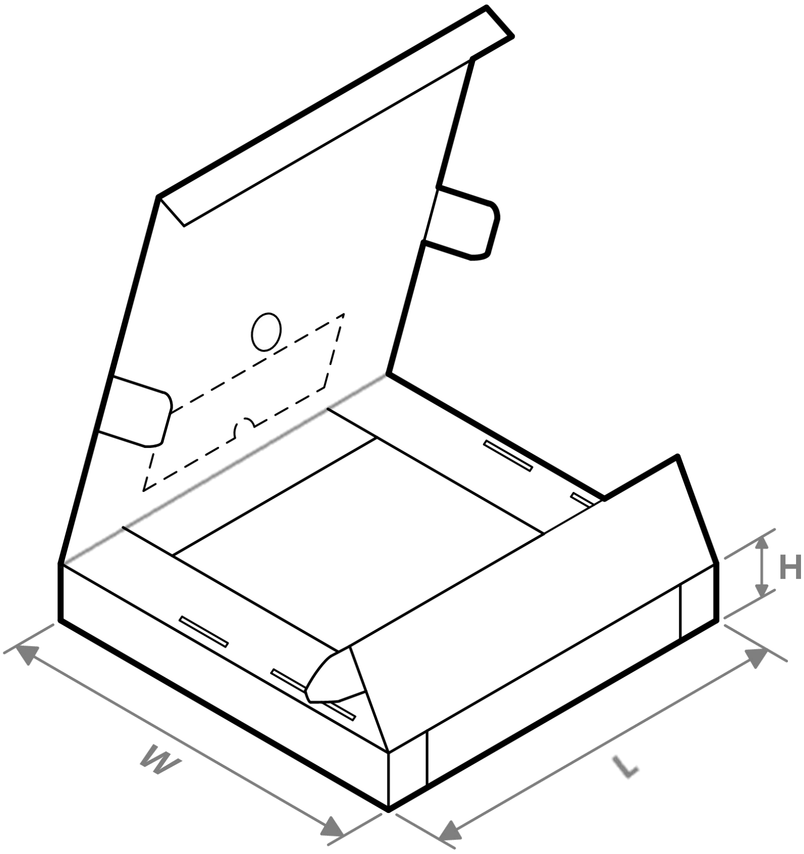
A0	Bin width
B0	Length of trough
K0	Bin thickness
W	Overall width of the carrier
P1	Center spacing of adjacent slots

Bandage PIN 1 Quadrant allocation



Device	Package Type	Package Characteristic	Number of pins	SPQ	Charging tray Diameter (mm)	Charging tray Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin 1 Quadrant
AT8833CT	ETSSOP	CT	16	3000	330	12	7.50	6.00	1.50	8	12	Q1
AT8833CQ	QFN	CQ	16	5000	330	12	4.45	4.45	1.2	8	12	Q2
AT8833CR	QFN	CR	16	5000	330	12	3.3	3.3	1.05	8	12	Q2

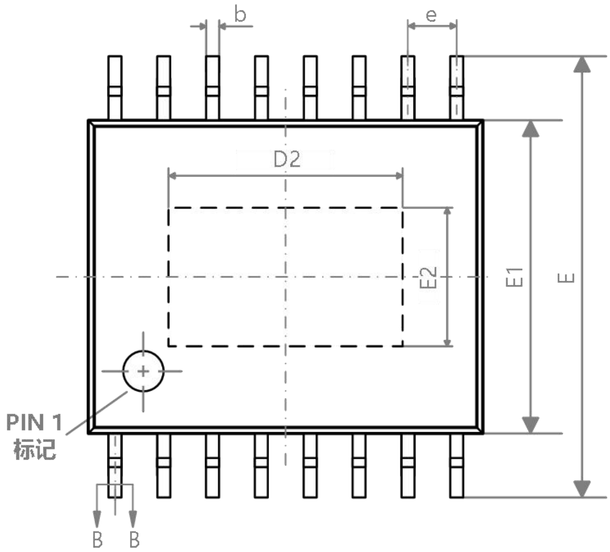
Band material tray packaging size

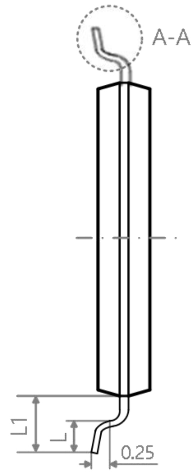


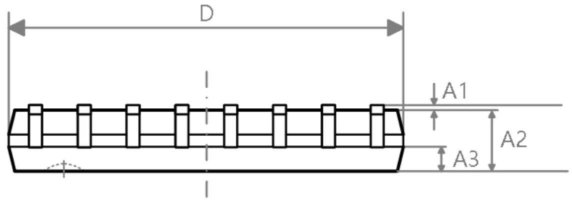
Device	Packaging type	Package identification	Number of pins	SPQ	Length (mm)	Width (mm)	Altitude (mm)
AT8833 CT	ETSSOP	CT	16	3000	360	360	65
AT8833 CQ	QFN	CQ	16	5000	365	365	70
AT8833 CR	QFN	CR	16	5000	360	360	65

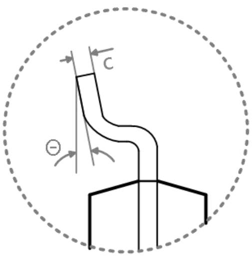
Package information

ETSSOP16

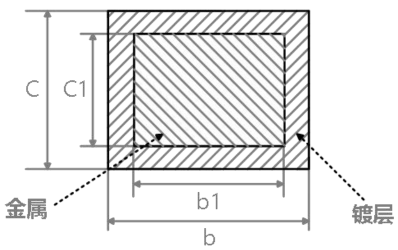








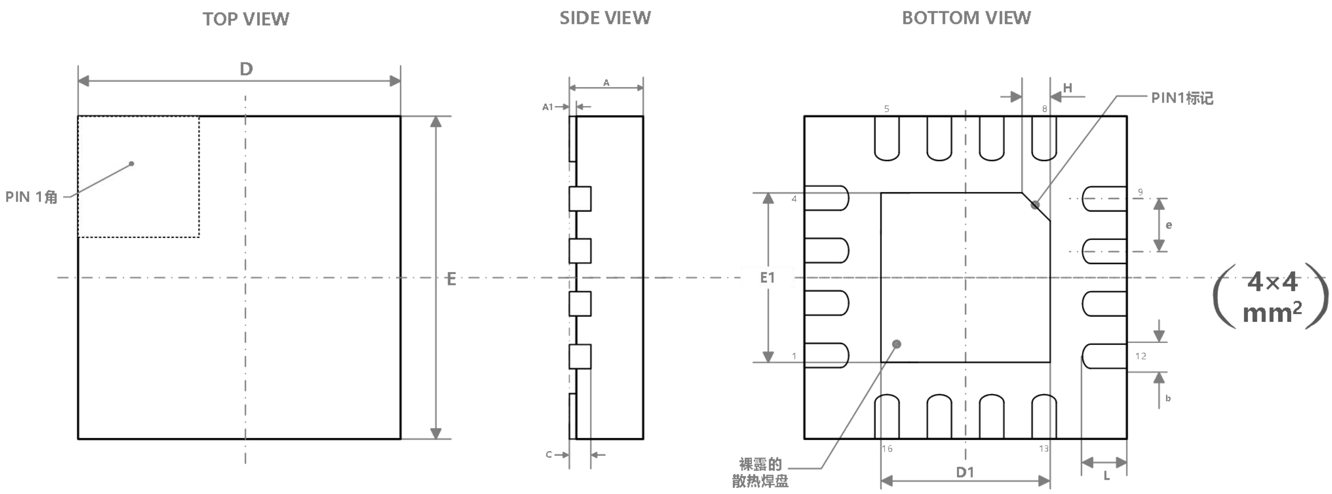
SECTION
A-A

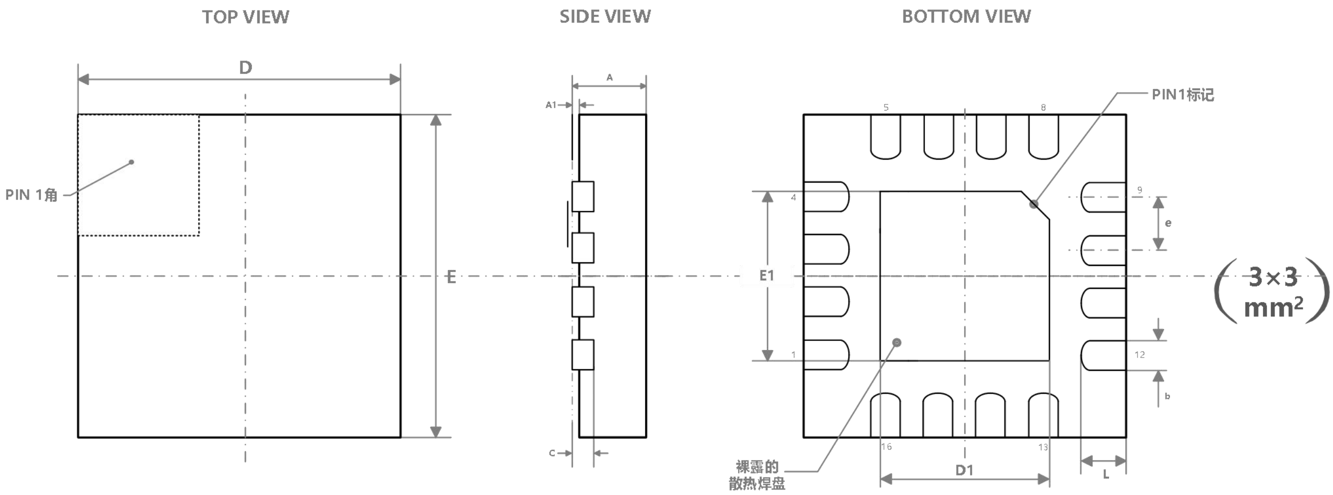


SECTION
B-B

Symbol	Millimetre (mm)		
	MIN	NOM	MAX
A	-	-	1.20
A1	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	-	0.30
b1	0.19	0.22	0.25
c	0.13	-	0.19
c1	0.12	0.13	0.14
D	4.86	4.96	5.06
D2	2.90	3.00	3.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
E2	2.20	2.30	2.40
e	0.65BSC		
L	0.45	-	0.75
L1	1.00BSC		
θ	0	-	8°

QFN16





Symbol	QFN16(4*4mm)		QFN16(3*3mm)	
	Millimetre (mm)		Millimetre (mm)	
	MIN	MAX	MIN	MAX
D	3.90	4.10	2.90	3.10
D1	2.10	2.30	1.55	1.75
E	3.90	4.10	2.90	3.10
b	0.25	0.35	0.18	0.30
c	0.18	0.25	0.18	0.25
E1	2.10	2.30	1.55	1.75
L	0.45	0.65	0.35	0.45
A	0.70	0.80	0.70	0.80
A1	-	0.05	-	0.05
e	0.650(BSC)		0.50(BSC)	
H	0.30	0.40	0.20	0.30