7V H-Bridge DC Motor Driver

Features

- Drives a DC Motor or Coil
- Rdson HS + LS: 770mΩ(Typ)
- Low-Power Sleep Mode With 100nA Maximum Sleep Current
- VM: 2V to 7V Supply Voltage Range
- 1A Maximum Drive Current
- WBDFN 2mm×2mm×0.75mm-8L package
- Over-Current Protection
- Over-Temperature Protection
- Under-Voltage Protection

Applications

- LXSF
- IR-CUT
- Toys
- Medical Devices
- Consumer Products

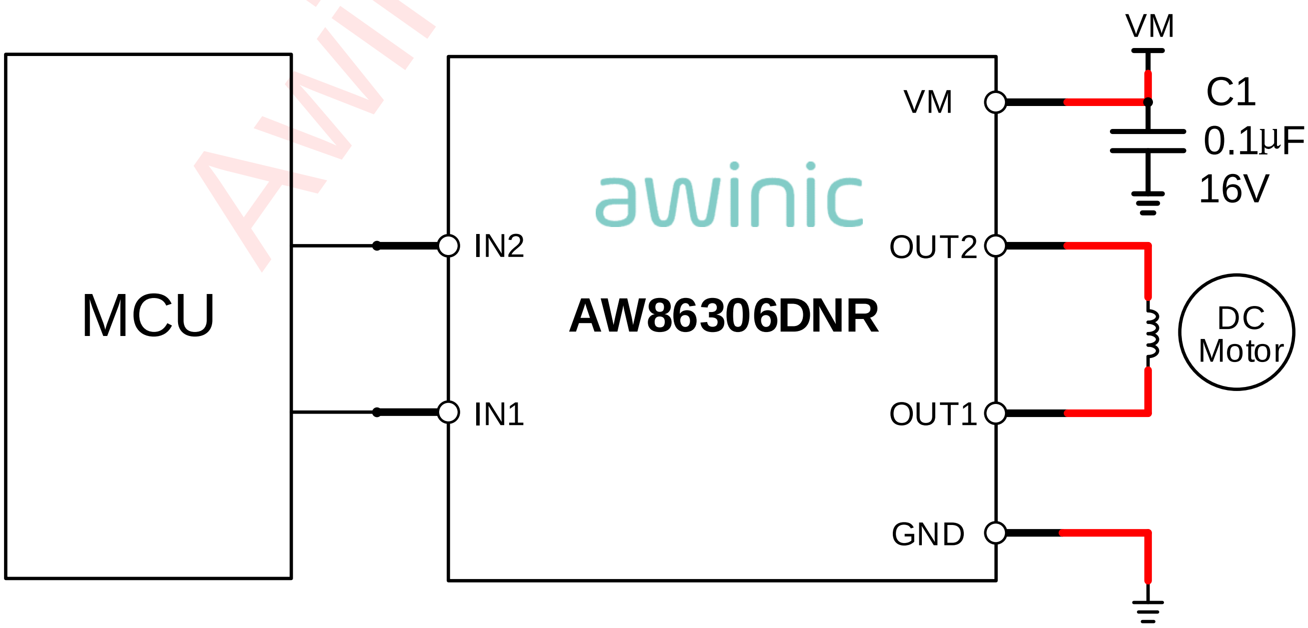
General Description

The AW86306 provides an integrated motor driver solution for LXSP, IR-CUT, consumer products, toys, and other low-voltage or battery-powered motion control applications. The device can drive one dc motor or other devices like solenoids. The output driver block consists of N-channel and P-channel power MOSFETs configured as an H-bridge to drive the motor winding.

The AW86306 has a PWM(IN1 and IN2) input interface, which is compatible with industry standard devices.

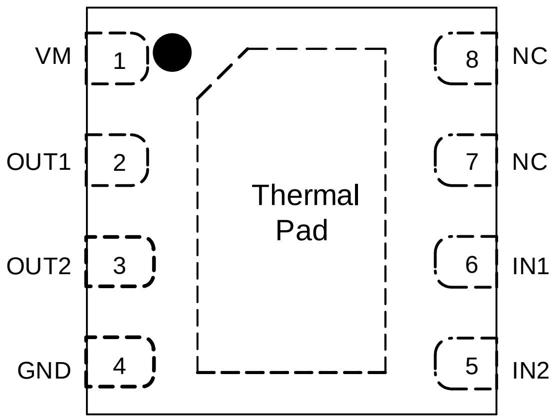
Internal shutdown functions are provided for Over-current protection, Over-temperature protection and Under-voltage Protection.

Typical Application Circuit

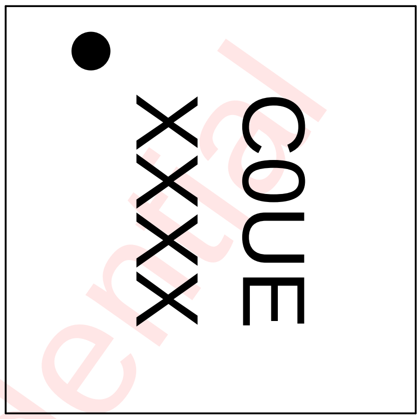


Pin Configuration And Top Mark

AW86306DNR
(Top view)



AW86306DNR Marking
(Top view)



C0UE- AW86306DNR
XXXX - Production Tracing Code

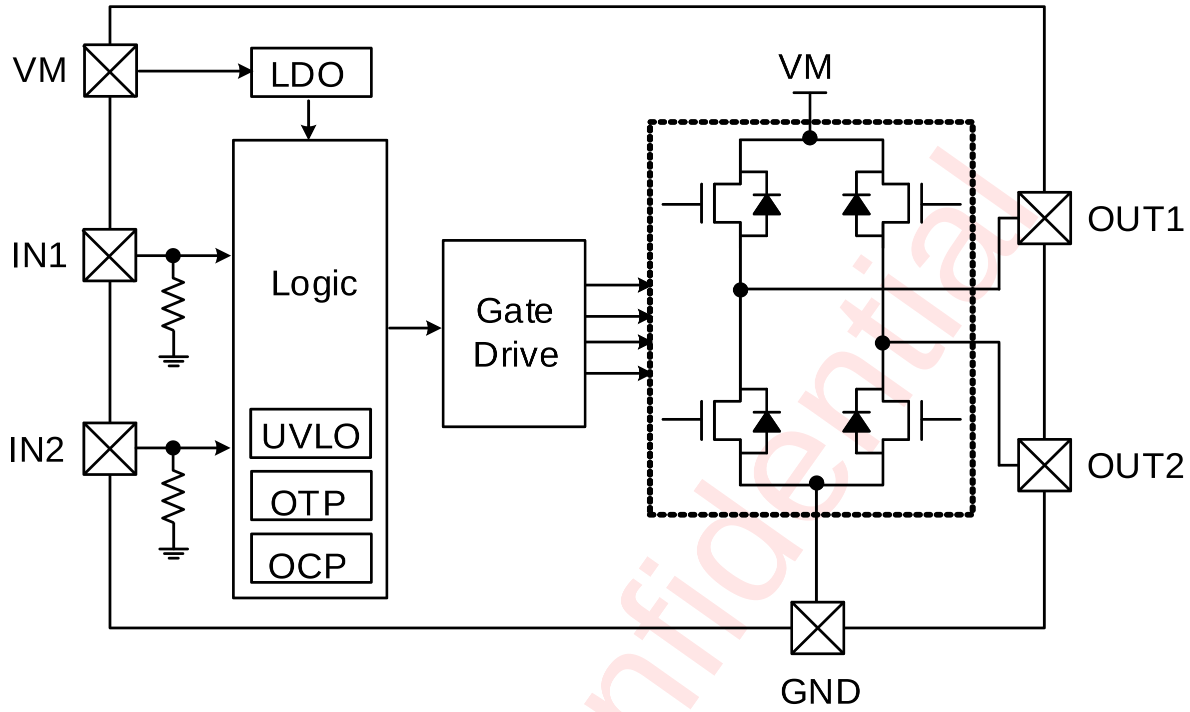
Pin Definition

No.	NAME	DESCRIPTION
1	VM	Motor power supply. Bypass this pin to the GND pin with a 0.1-μF ceramic capacitor rated for VM.
2	OUT1	H-bridge output. Connect these pins to the motor winding.
3	OUT2	H-bridge output. Connect these pins to the motor winding.
4	GND	Device ground. This pin must be connected to ground.
5	IN2	Logic inputs. Controls the H-bridge output. Has internal pulldowns.
6	IN1	Logic inputs. Controls the H-bridge output. Has internal pulldowns.
7、8	NC	-
	Thermal Pad	Beneath the IC for heat dissipation. Always solder to the PCB ground for high-current power converter.

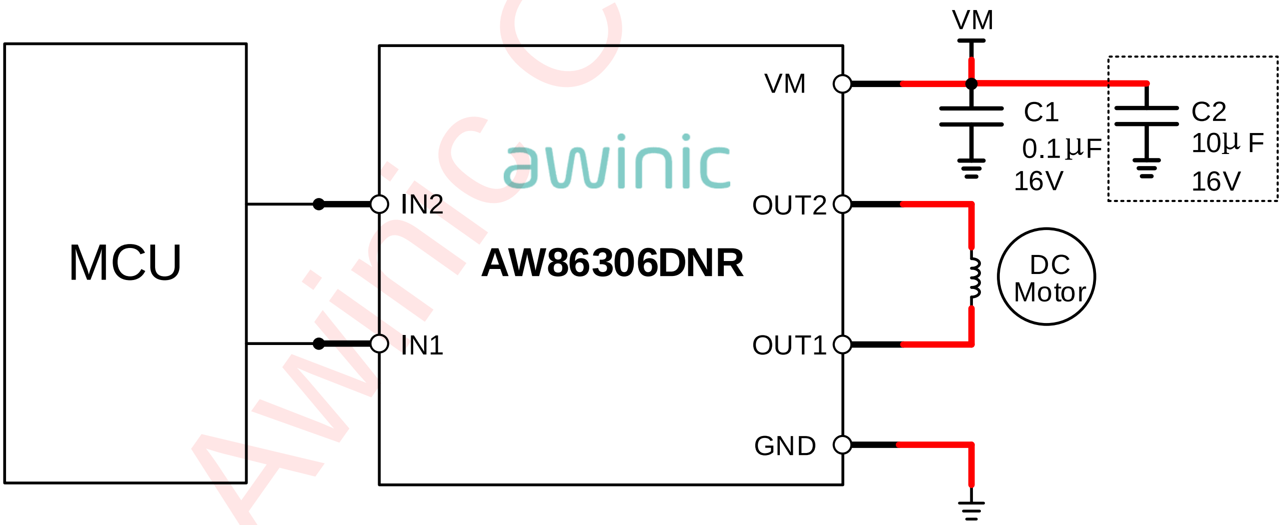
Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW86306DNR	-40°C~125°C	DFN 2mm×2mm -8L(0.75mm)	C0UE	MSL1	ROHS+HF	3000 units/ Tape and Reel

Functional Block Diagram



Typical Application Circuits



- Notice for Typical Application Circuits:

1. Please place C1,C2 as close to the chip as possible.
2. For the sake of driving capability, C2 is recommended.
3. **Table 1** lists the recommended external components for the device.

Table 1 External Components

COMPONENT	PIN 1	PIN 2	RECOMMENDED
C1	VM	GND	16V, 0.1μF ceramic capacitor rated for VM
C2	VM	GND	16V, 10μF ceramic capacitor rated for VM

Absolute Maximum Ratings(NOTE1)

PARAMETERS	RANGE
Motor power-supply voltage (VM)	-0.3V to 9V
Control pin voltage (IN1, IN2)	-0.5V to 7V
Peak drive current (OUT1, OUT2)	Internally limited
Junction-to-ambient thermal resistance θ_{JA}	94.4°C/W
Operating free-air temperature range	-40°C to 125°C
Maximum operating junction temperature T_{JMAX}	160°C
Storage temperature TSTG	-65°C to 150°C
Lead temperature (soldering 10 seconds)	260°C
ESD(Including HBM CDM)(NOTE 2)	
HBM(Human Body Model)	±4000V
CDM(Charge Device Model)	±1000V
Latch-Up	
Test Condition: JEDEC STANDARD NO.78E	+IT：200mA -IT：-200mA

NOTE1: Conditions out of those ranges listed in "absolute maximum ratings" may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in "recommended operating conditions". Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

NOTE2: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. HBM method: ESDA/IEDEC JS-001-2017. CDM method: ESDA/JEDEC JS-002-2018. MM method: IESD22-A115C.

Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

PARAMETERS		Range			Unit
VM	Power supply voltage	2	to	7	V
V_I	Logic input voltage (IN1, IN2)	1.8	to	7	V
f_{PWM}	Logic input PWM frequency (IN1, IN2)	0	to	300(1)	kHz
I_{peak}	Peak output current(2)	0	to	1	A
T_A	Operating ambient temperature	-40	to	125	°C

(1) The voltages applied to the inputs should have at least 1500ns of pulse width to ensure detection.

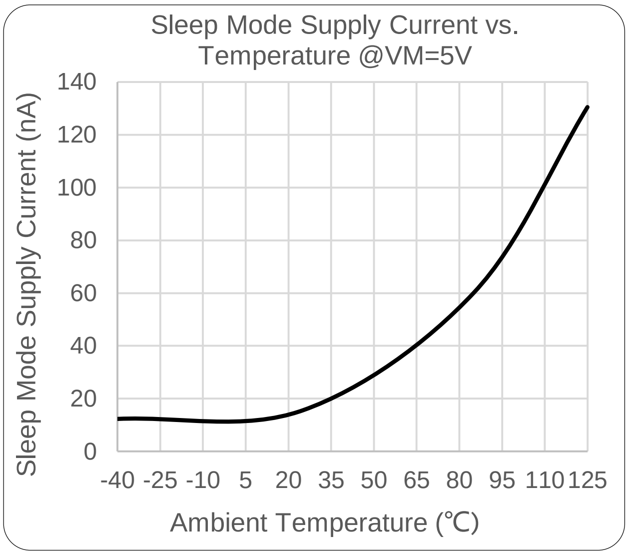
(2) Power dissipation and thermal limits must be observed.

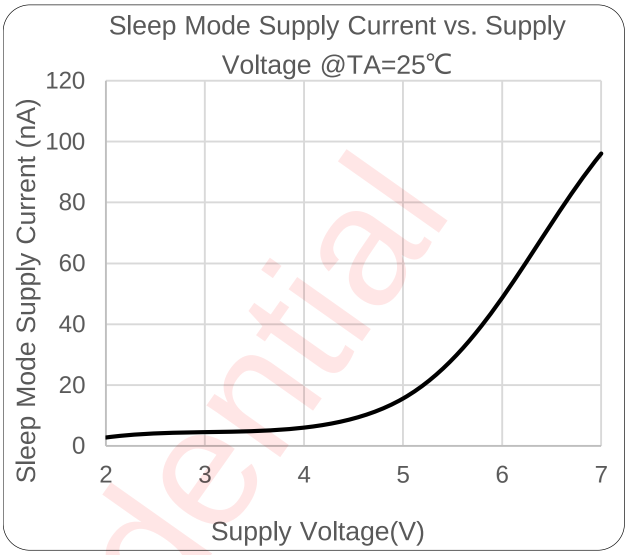
Electrical Characteristics

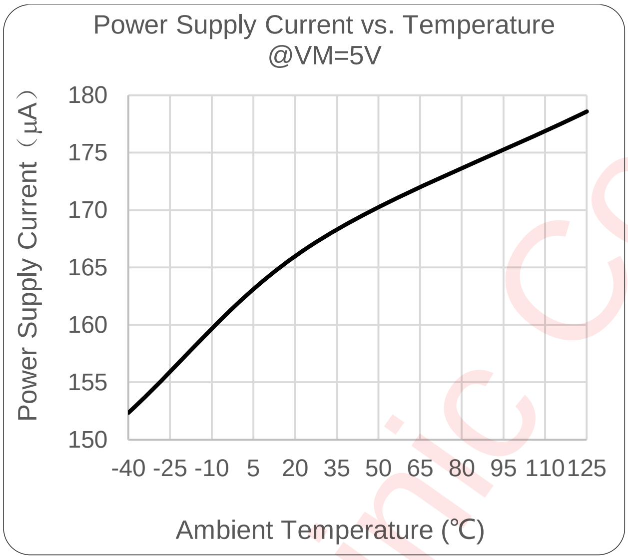
T_A=25°C,V_M=5V for typical values (unless otherwise noted)

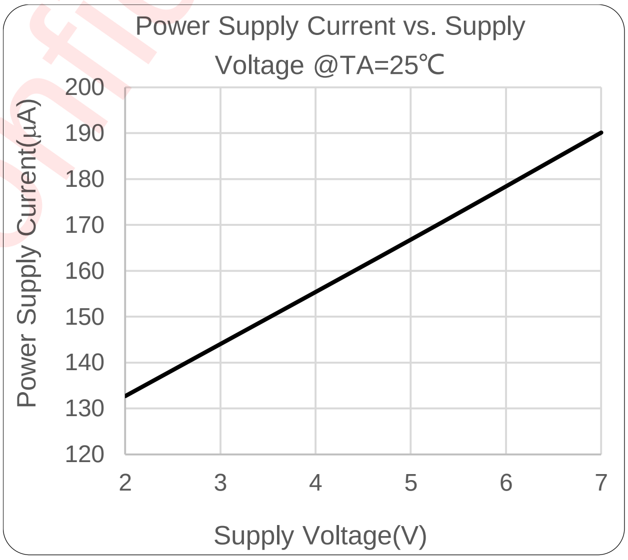
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLIES (VM)						
V_M	VM operating voltage		2		7	V
I_{VM}	VM operating supply current	IN1 = 5V; IN2 = 0V No load		165	210	μA
I_{VMQ}	VM sleep mode supply current	IN1 = IN2 = 0V		50	100	nA
LOGIC-LEVEL INPUTS (IN1, IN2)						
V_{IL}	Input logic-low voltage	V_M = 2V~7V			0.6	V
V_{IH}	Input logic-high voltage	V_M = 2V~7V	1.6			V
V_{HYS}	Input logic hysteresis			160		mV
I_{IL}	Input logic low current	V_{IN} = 0V	-1		1	μA
I_{IH}	Input logic high current	V_{IN} = 3.3V		25	70	μA
R_{PD}	Pulldown resistance			132		kΩ
t_{SLEEP}	Time to sleep	Inputs low to sleep		1.5	2	ms
MOTOR DRIVER OUTPUTS (OUT1, OUT2)						
$R_{DS(on)}$	HS + LS FET on-resistance	I_{OUT} = 200mA		770		mΩ
I_{OFF}	Off-state leakage current	V_{OUT} = 0V	-200		200	nA
t_{DEAD}	Dead Time			200		ns
PROTECTION CIRCUITS						
V_{UVLO}	VM undervoltage lockout	VM falling		1.65	1.85	V
		VM rising		1.75	1.95	V
V_{UVHYS}	VM undervoltage hysteresis	Rising to falling threshold		100		mV
I_{OCP}	Overcurrent protection trip level		1.1			A
t_{DEG}	Overcurrent deglitch time			1.5		μs
t_{RETRY}	Overcurrent retry time			2		ms
T_{SD}	Thermal shutdown temperature	Die temperature T_J	145	155	165	°C
T_{HYS}	Thermal shutdown hysteresis			30		°C

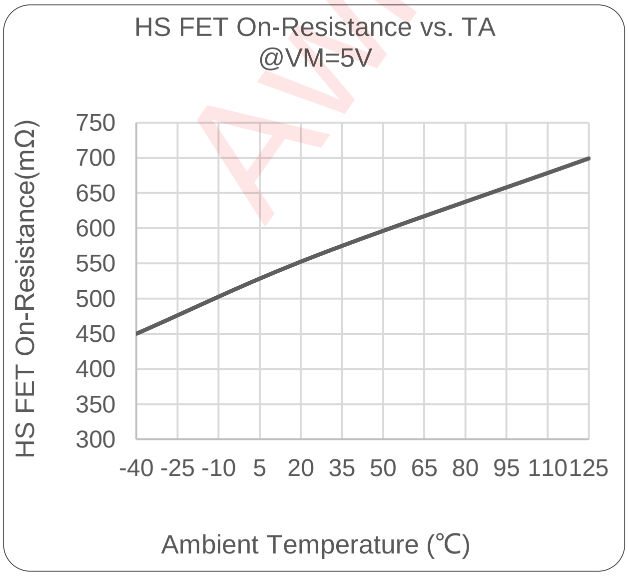
Typical Characteristics

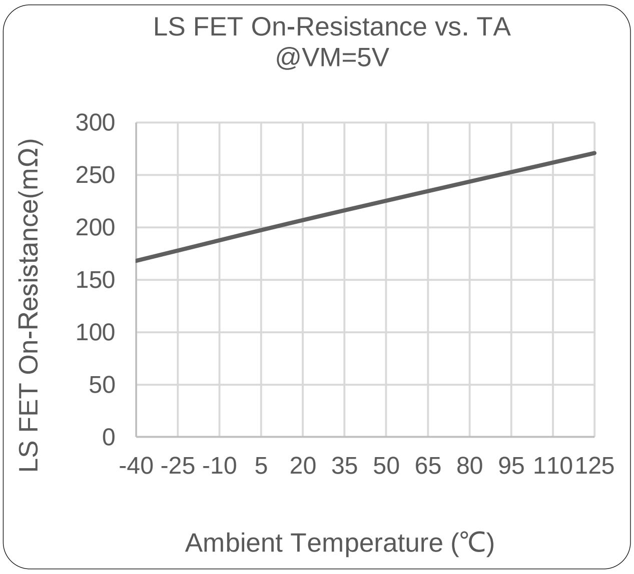












Timing Requirements

T_A=25°C,V_M=5V for typical values (unless otherwise noted)

NO.	DESCRIPTION		MIN	MAX	UNIT
1	t_1	Output enable time		900	ns
2	t_2	Output disable time		600	ns
3	t_3	Delay time, INx high to OUTx high		300	ns
4	t_4	Delay time, INx low to OUTx low		600	ns
5	t_5	Output rise time	50	200	ns
6	t_6	Output fall time	50	200	ns
7	t_{wake}	Wake time		40	µs

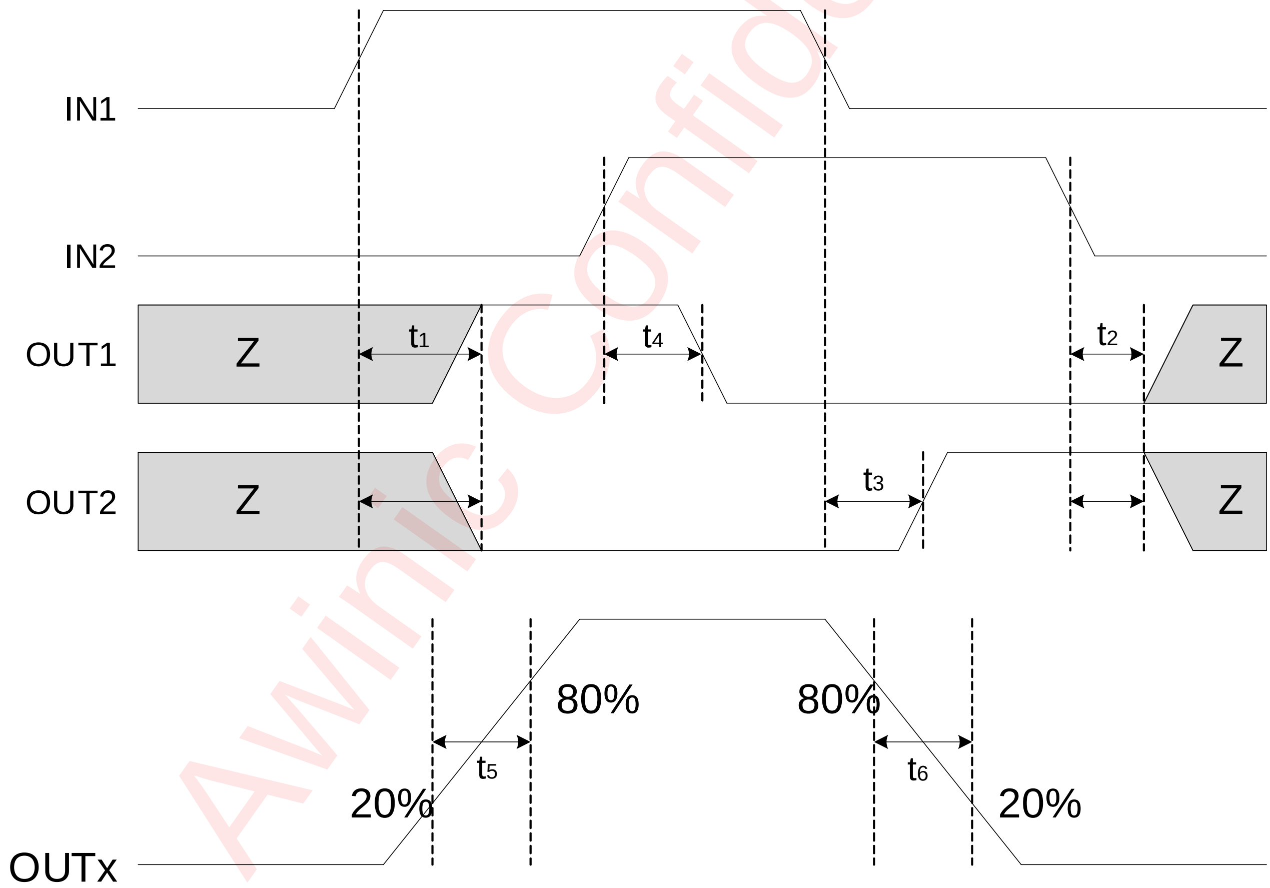


Figure 1 Input and Output Timing for AW86306DNR

Detailed Functional Description

OVERVIEW

The AW86306 is an H-bridge driver that can drive one dc motor or other devices like solenoids. The outputs are controlled by two logic inputs IN1 and IN2 interface on the AW86306 device. When the inputs are all low, the chip enters low power sleep mode after t_{SLEEP} time. The device greatly reduce the component count of motor driver systems by integrating the necessary driver FETs and FET control circuitry into a single device. In addition, the AW86306 adds protection features beyond traditional discrete implementations: under-voltage lockout, overcurrent protection, and thermal shutdown.

FEATURE DESCRIPTION

BRIDGE CONTROL

The AW86306 is controlled by two logic inputs IN1 and IN2 interface. Each output is controlled by a corresponding input pin. **Table 2** shows the logic for the AW86306 device.

Table 2 AW86306 Device Logic

IN1	IN2	OUT1	OUT2	FUNCTION (DC MOTOR)
0	0	Z	Z	Coast , H-bridge disabled to High-Z (Sleep entered after 1.5ms)
0	1	L	H	Reverse
1	0	H	L	Forward
1	1	L	L	Brake, low-side slow decay

The input pins can be powered before VM is applied. The H-bridge driver is controlled using a PWM interface (IN1 and IN2), and PWM input can adjust the motor speed by changing the duty cycle and frequency.

The H-bridge current paths can be controlled by setting IN1 and IN2. Alternatively, the coast mode (IN1 = 0, IN2 = 0) for fast current.

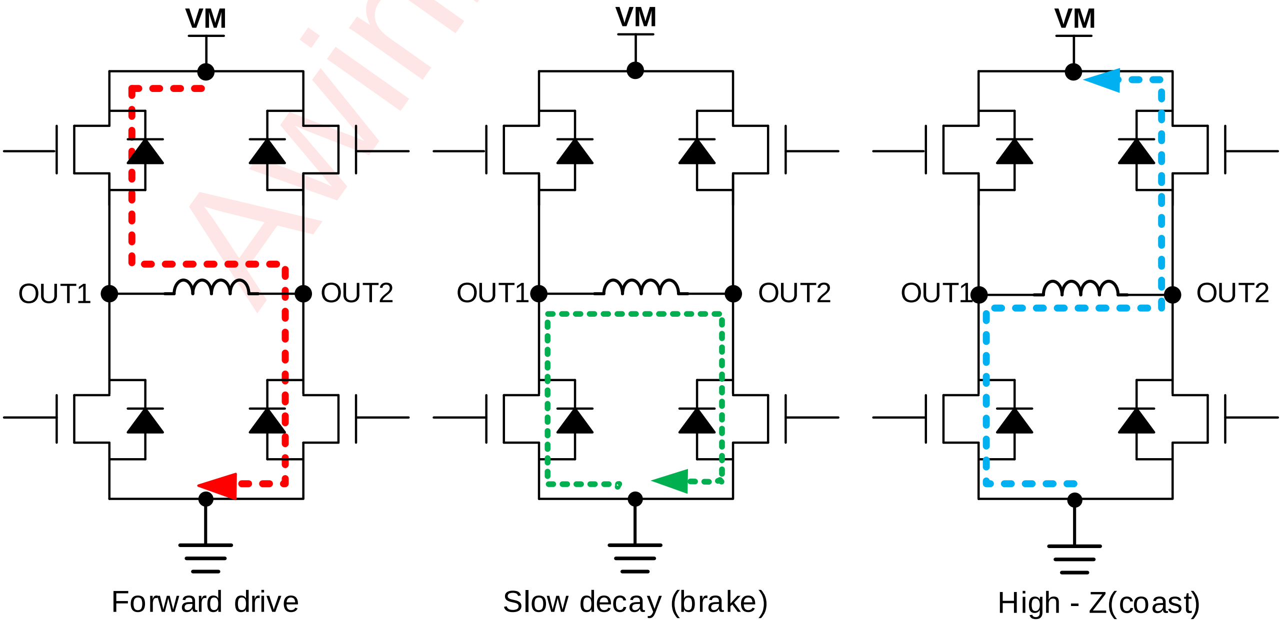


Figure 2 H-Bridge Forward drive Paths

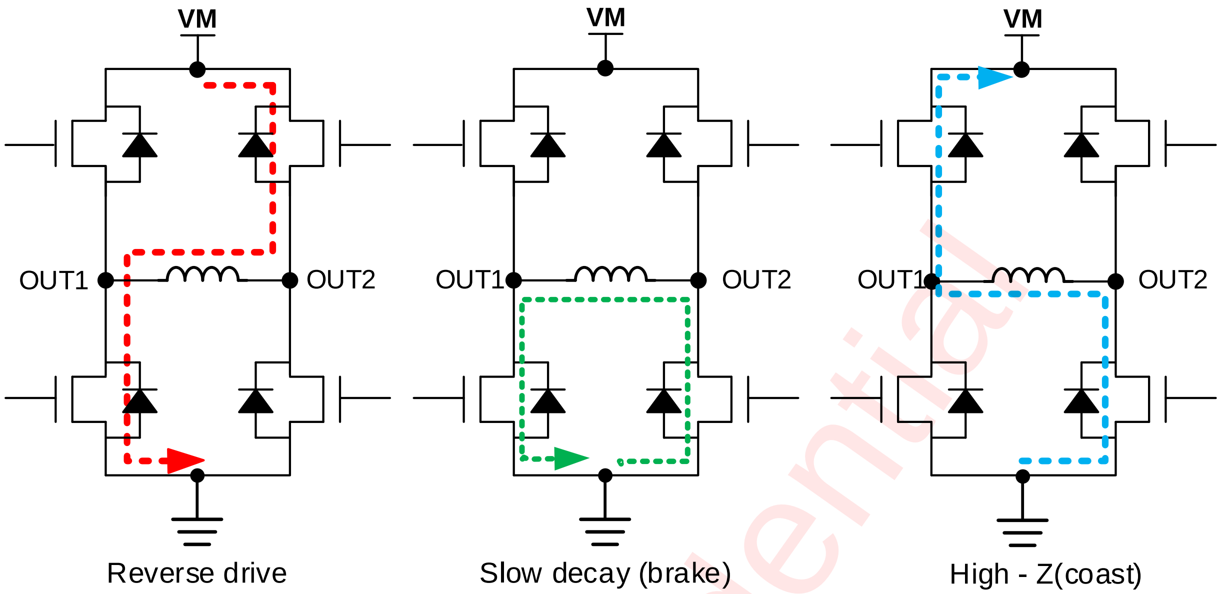


Figure 3 H-Bridge Reverse drive Paths

SLEEP MODE

When the IN1 and IN2 Pins are both low for time t_{SLEEP}(typically 1.5 ms), the AW86306 device enter a low-Power sleep mode, where the outputs remain High-Z and the device uses I_{VMQ} (μA) of current.

OVERCURRENT PROTECTION

An analog current-limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than t_{DEG}, all FETs in the H-bridge are disabled. Operation resumes automatically after t_{RETRY} has elapsed. Overcurrent conditions are detected on both the high-side and low side FETs. A short to the VM pin, GND, or from the OUT1 pin to the OUT2 pin results in an overcurrent condition.

UNDERVOLTAGE LOCKOUT

If at any time the voltage on the VM pin falls below the under-voltage lockout threshold voltage, all FETs in the H-bridge are disabled. Operation resumes when the VM pin voltage rises above the UVLO threshold.

THERMAL SHUTDOWN

If the die temperature exceeds safe limits, all FETs in the H-bridge are disabled. After the die temperature falls to a safe level, operation automatically resumes.

Table 3 Fault Behavior

FAULT	CONDITION	H-BRIDGE	RECOVERY
VM under-voltage (UVLO)	$VM < V_{UVLO}$	Disabled	$VM > V_{UVLO} + V_{HYS}$
Overcurrent (OCP)	$I_{OUT} > I_{OCP}$	Disabled	t_{RETRY} elapses
Thermal Shutdown (TSD)	$T_J > T_{SD}$	Disabled	$T_J < T_{SD} - T_{HYS}$

POWER SUPPLY RECOMMENDATIONS

BULK CAPACITANCE

Having appropriate local bulk capacitance is an important factor in motor-drive system design. It is generally beneficial to have more bulk capacitance, while the disadvantages are increased cost and physical size.

The amount of local capacitance needed depends on a variety of factors, including:

- The highest current required by the motor system
- The power-supply capacitance and ability to source current
- The amount of parasitic inductance between the power supply and motor system
- The acceptable voltage ripple
- The type of motor used (brushed dc, brushless dc, stepper)
- The motor braking method

The inductance between the power supply and motor drive system limits the rate at which current can change from the power supply. If the local bulk capacitance is too small, the system responds to excessive current demands or dumps from the motor with a change in voltage. When adequate bulk capacitance is used, the motor voltage remains stable and high current can be quickly supplied.

The datasheet generally provides a recommended value, but system-level testing is required to determine the appropriate size of bulk capacitor.

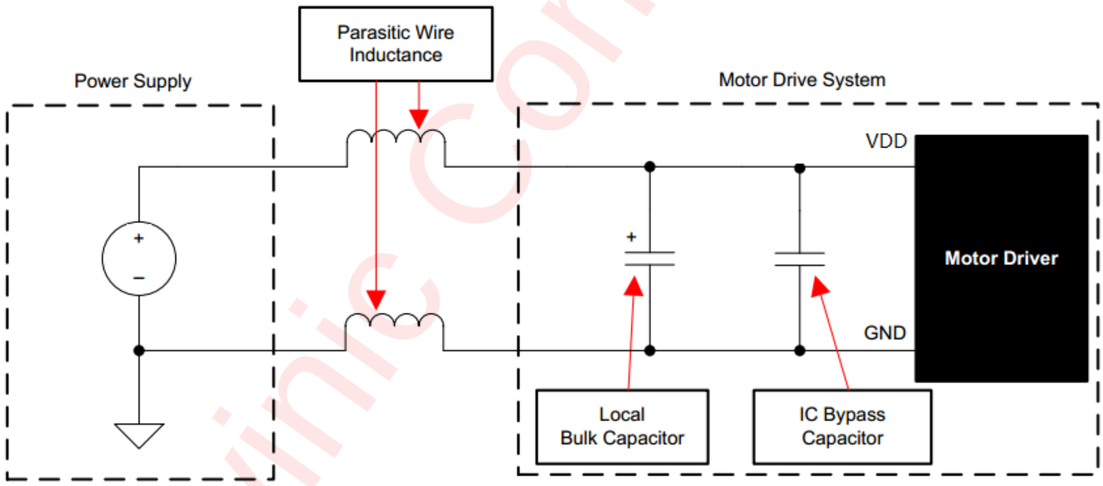


Figure 4 Example Setup of Motor Drive System With External Power Supply

The voltage rating for bulk capacitors should be higher than the operating voltage, to provide margin for cases when the motor transfers energy to the supply.

PCB Layout Consideration

EXTERNAL COMPONENTS PLANCEMENT

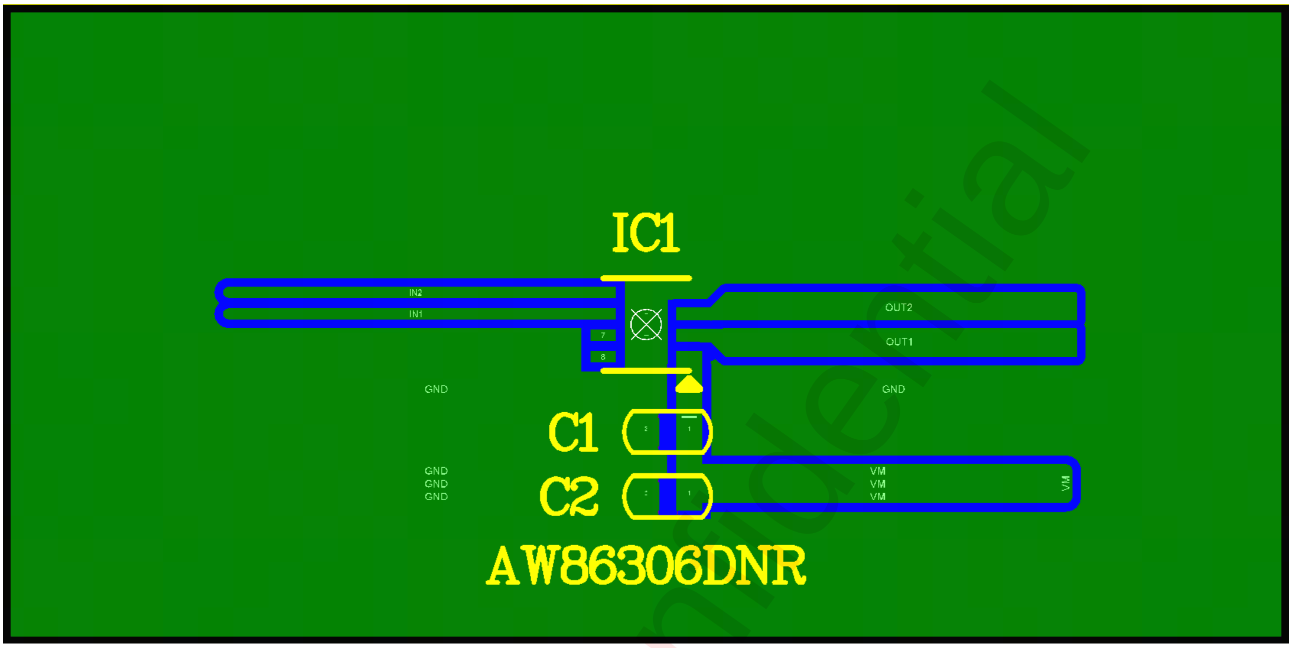


Figure 5 AW86306DNR External Components Placement

LAYOUT CONSIDERATIONS

This device is a high voltage driver chip. To obtain the optimal performance, PCB layout should be considered carefully. The suggested Layout is illustrated in the following diagram:

1. All of the external components close to IC in top layer PCB;
2. Create solid GND plane near and around the IC;
3. No via in traces from IC pin VM through C1/C2 to IC pin GND, keep the trace as short as possible;
4. Try to provide a separate short and thick power line to the device, the copper width is recommended to be larger than 0.75mm. The decoupling capacitors should be placed as close as possible to power supply pin;

POWER DISSIPATION

Power dissipation in the AW86306 is dominated by the power dissipated in the output FET resistance, or $R_{DS(on)}$. Use Equation to estimate the average power dissipation when running a stepper motor.

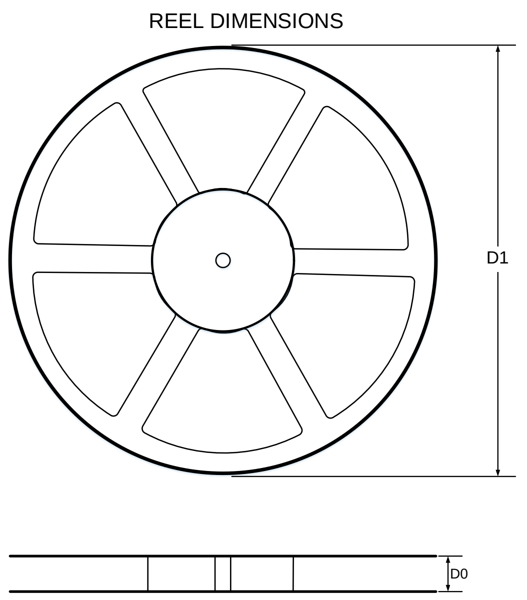
$$P_{TOT} = R_{DS(on)} \times (I_{OUT(rms)})^2$$

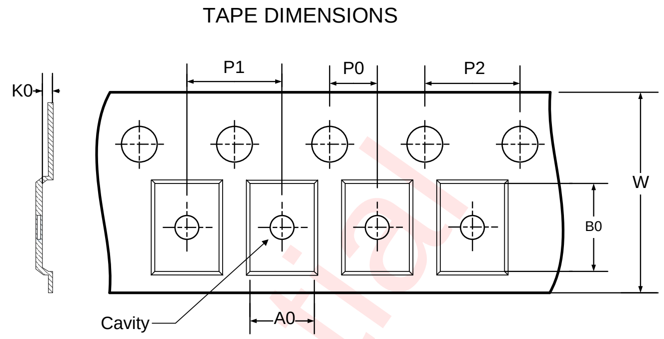
Where

- P_{TOT} is the total power dissipation
- $r_{DS(on)}$ is the resistance of the HS plus LS FETs
- $I_{OUT(rms)}$ is the rms or dc output current being supplied to the load

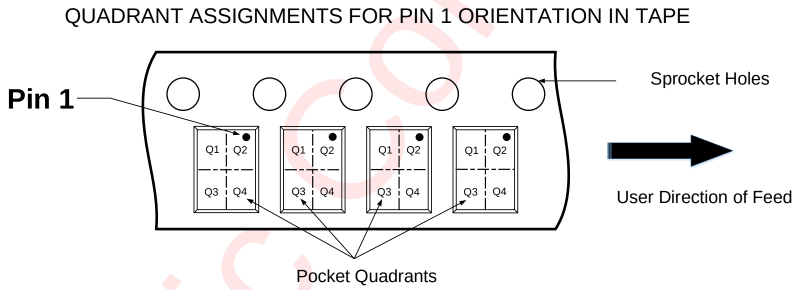
The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

Tape And Reel Information





A0：Dimension designed to accommodate the component width
B0：Dimension designed to accommodate the component length
K0：Dimension designed to accommodate the component thickness
W：Overall width of the carrier tape
P0：Pitch between successive cavity centers and sprocket hole
P1：Pitch between successive cavity centers
P2：Pitch between sprocket hole
D1：Reel Diameter
D0：Reel Width



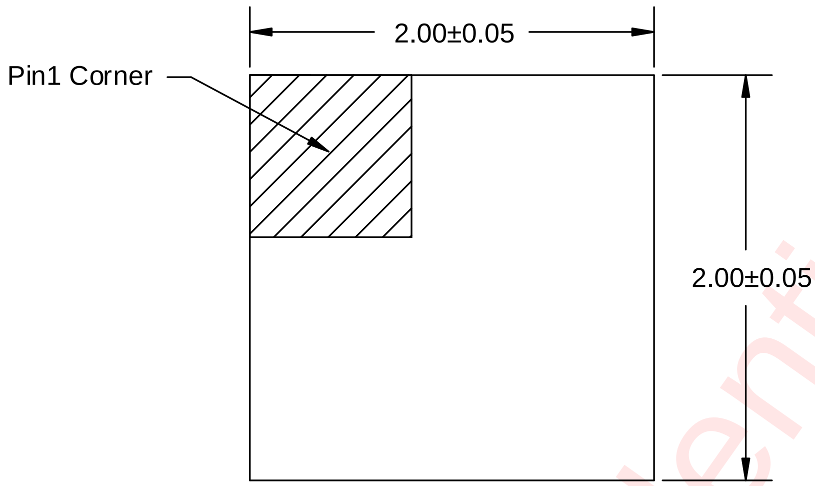
Note：The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

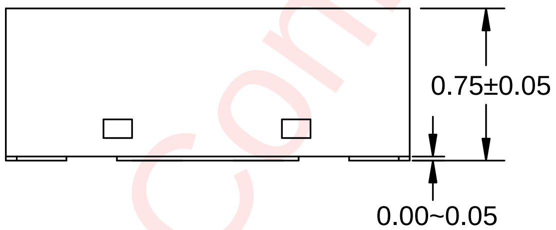
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178.0	8.40	2.30	2.30	1.00	2.00	4.00	4.00	8.00	Q2

All dimensions are nominal

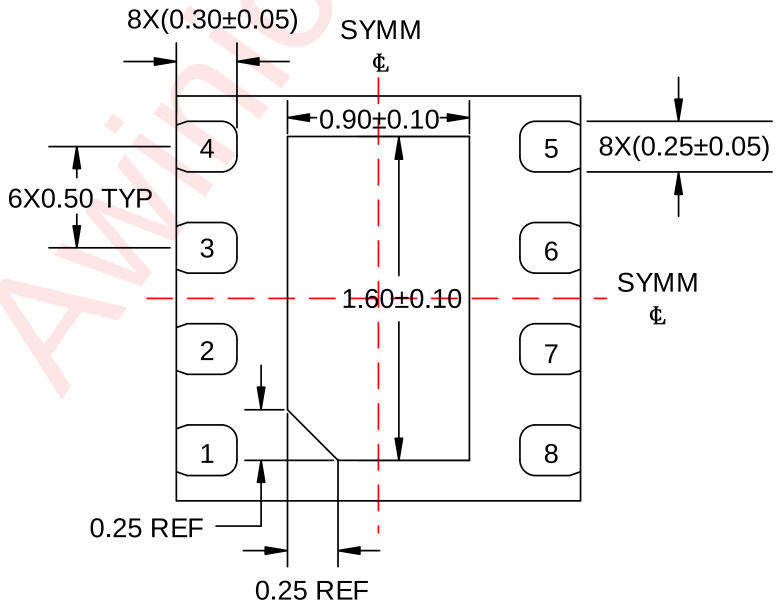
Package Description



TOP VIEW



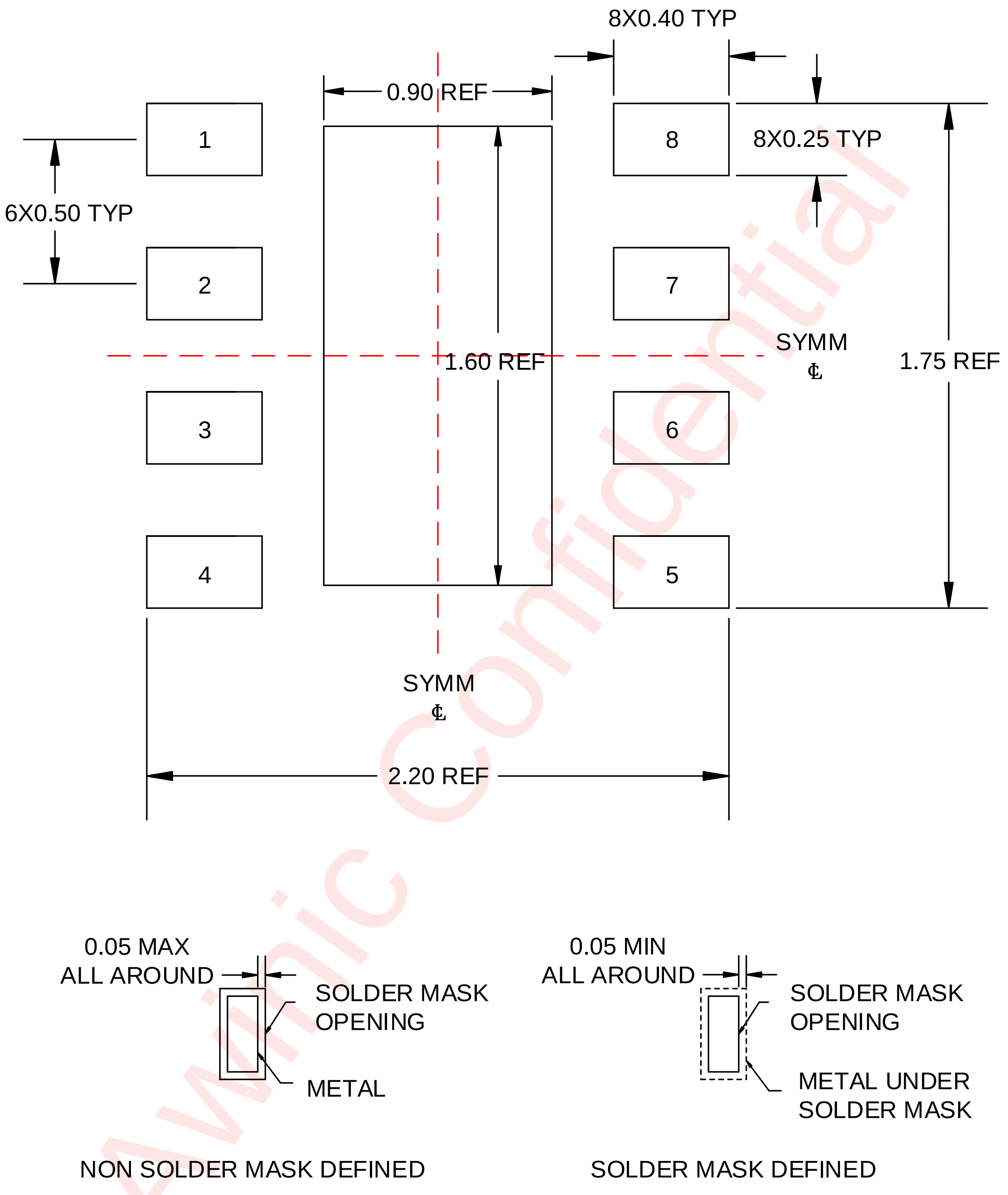
SIDE VIEW



BOTTOM VIEW

Unit： mm

Land Pattern Data



Unit： mm

Revision History

Version	Date	Change Record
V1.0	Jun. 2024	Initial release

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