# Low-Voltage H-Bridge Driver

## Features

- Maximum Drive Current: 1.8A
- Separate Motor and Logic Supply Pins:
  - -Motor VM: 0 to 14V
  - -Logic VCC: 2.5V to 7V
- H-Bridge Motor Driver
  - -DC Motor or Other Loads
  - -DFN2X2-8: HS+LS 250mΩ
  - -SOP8: HS+LS 320mΩ
- Low-Power Sleep Mode With 0.1μA TYP Sleep Current
- VCC Under-Voltage Lockout
- Over-Current Protection
- Thermal Shutdown Protection
- Lead-Free Packages: DFN2X2-8 and SOIC-8

## Applications

- DSLR Lenses
- Cameras
- Robotics
- Consumer Products, such as Toys, Smart Locks
- Medical Devices

## General Description

The HCR8837A/B is an integrated H-bridge driver designed for dc motors and coils bi-directional turning. Usually used for small current driving, such as camera, smart locks, toys, smart sweeper, electromagnetic valve, and other low-voltage or battery-powered motion control applications.

The HCR8837A/B can drive one DC motor or other devices like solenoids, supply up to 1.8A maximum output current. The output driver block consists of N-channel power MOSFET configured as an H-bridge to drive the motor winding. An internal charge pump generates needed gate drive voltages.

The HCR8837A/B operates on a motor power supply voltage from 0 to 14V, and a device power supply voltage of 2.5V to 7V. Also provide internal shutdown functions for over-current protection, short-circuit protection, under-voltage lockout and over-temperature.

DFN2X2-8 SOIC-8

Figure 1. Package Type of HCR8837A/B

## Low-Voltage H-Bridge Driver

### Pin Configuration

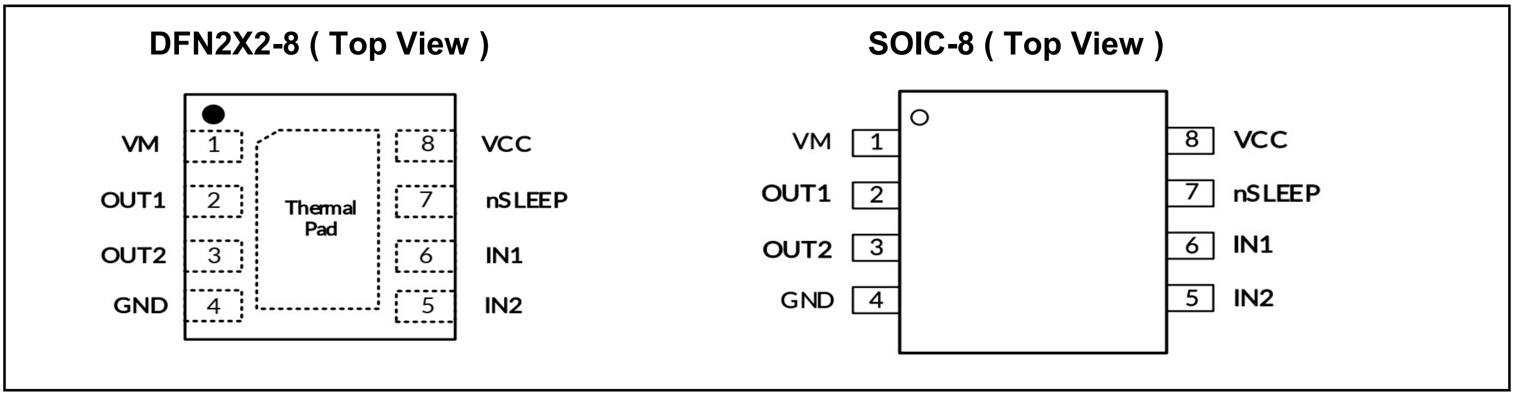
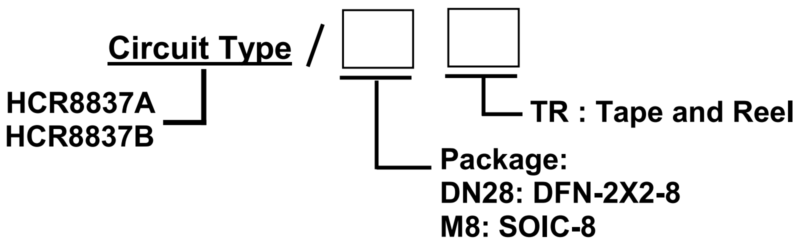



**Figure 2. Pin Configuration of HCR8837A/B (Top View )**

### Pin Function Table

| Name | Pin DFN2X2-8 /SOIC-8 | I/O note1 | Description |
|---|---|---|---|
| VM | 1 | I | Motor power supply:Bypass this pin to the GND pin with a 0.1μF ceramic capacitor rated for VM. |
| OUT1 | 2 | O | Motor output: Connect these pins to the motor winding. |
| OUT2 | 3 | O | |
| GND | 4 | - | Device ground (This pin must be connected to ground.) |
| IN2 | 5 | I | IN2 input |
| IN1 | 6 | I | IN1 input |
| nSLEEP | 7 | I | Sleep mode input: When this pin is in logic low, the device enters low-power sleep mode: When this pin is logic high, the device operates normally. |
| VCC | 8 | I | Logic power supply : Bypass this pin to the GND pin with a 0.1μF ceramic capacitor rated for VCC. |

### Ordering Information




### Ordering Code

| Part Number | Marking ID note2 | Temperature Range | Package | Quantity per Reel |
|---|---|---|---|---|
| HCR8837A/DN28TR | 8837XX | -40'C to +85'C | DFN2X2-8 | 3000pcs/TR |
| HCR8837B/M8TR | HCR8837XX | -40'C to +85'C | SOIC-8 | 4000pcs/TR |

Note 2: the "XX" is lot number code.

## Functional Block Diagram

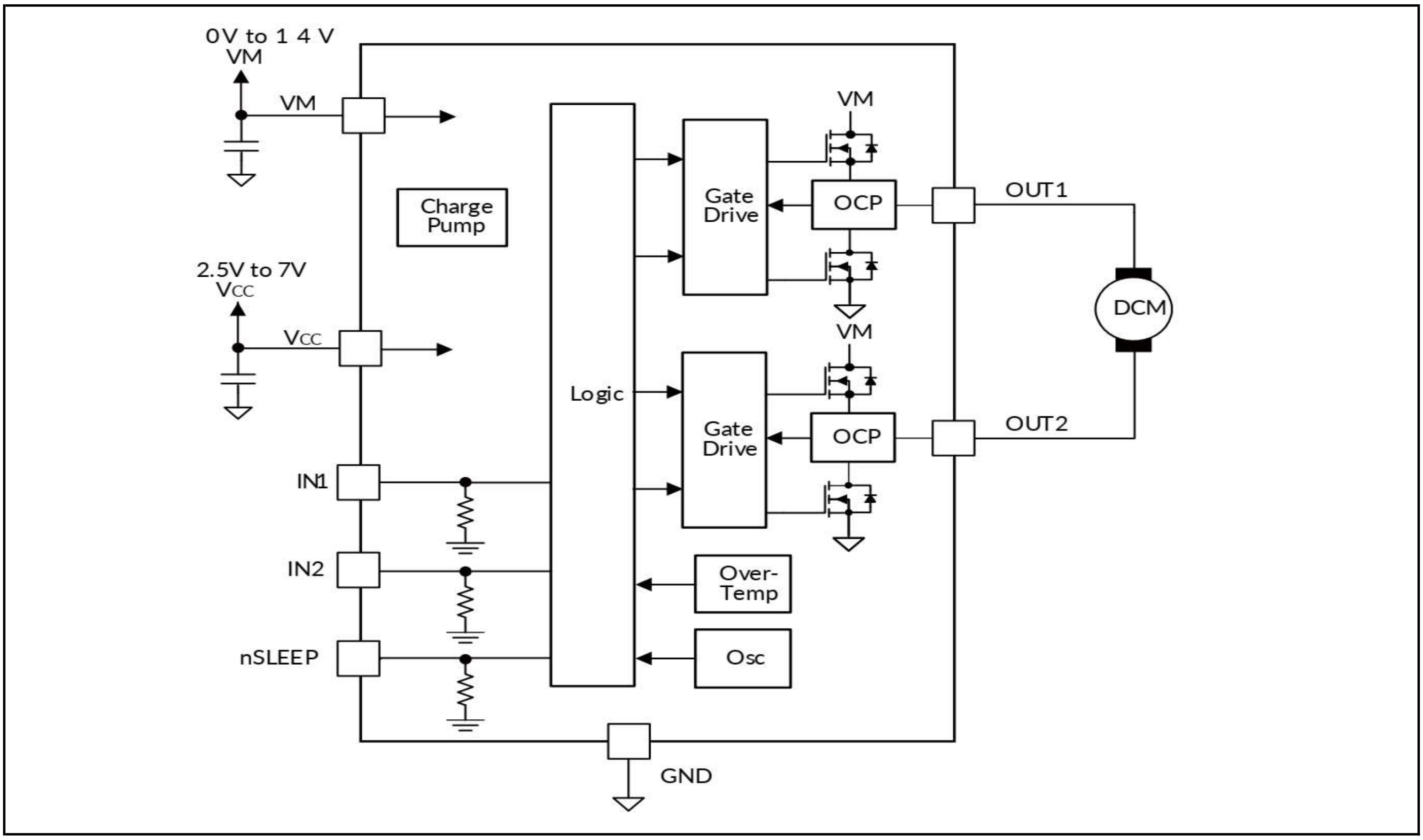



**Figure 3. Functional Block Diagram**

## Typical Application Circuit

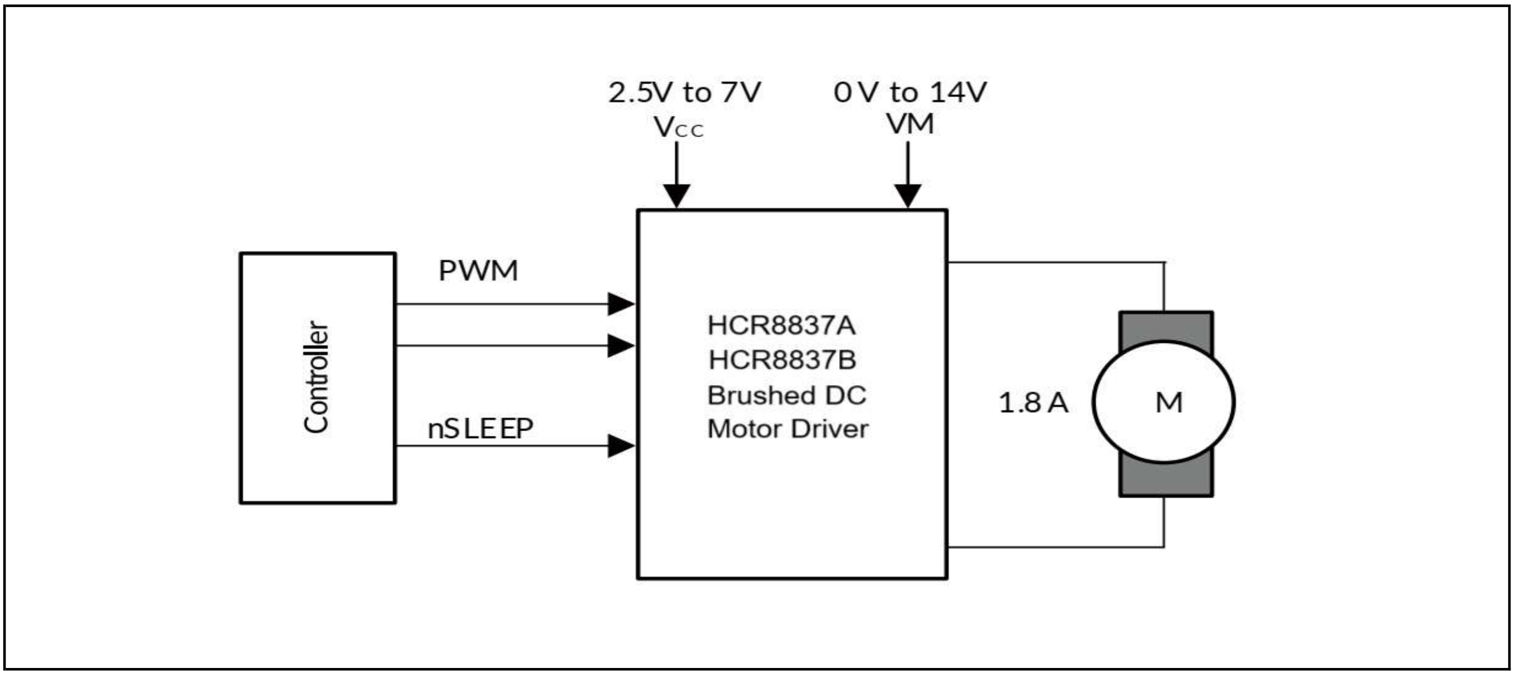



**Figure 4. Typical Application Circuit**

## Absolute Maximum Ratings

Over Operating free-air temperature range (unless otherwise [1/2]

| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Input Supply Voltage Range [3] | | VM | -0.3 to +16 | V |
| Logic Power-supply Voltage | | VCC | -0.3 to +7 | V |
| Control Pin Voltage | | nSLEEP | -0.5 to +7 | V |
| Control Pin Voltage | | IN1, IN2 | -0.5 to +5.5 | V |
| Peak drive Current | | OUT1, OUT2 | Internally limited 2.7A(Typ) | A |
| Package thermal impedance [4] | DFN2X2-8 | RθJA | 62 | 'C/W |
| | SOIC-8 | | 110.35 | 'C/W |
| Storage Temperature Range | | TSTG | -60 to +150 | 'C |
| Operating Junction Temperature [5] | | TJ | -40 to +125 | 'C |
| Lead Temperature (Soldering, 10s) | | TLEAD | 260 | 'C |
| Human Body Model for all pins | | VESD_HBM | ±4000 | V |
| Charge Device Model for all pins | | VESD_CDM | ±200 | V |

Note 1: Stresses beyond those listed under"Absolute maximum Ratings" may damage the device.

2: All voltages are with respect to the GND pin.

3: To protect the chip, the VM voltage should not exceed 16V under any operating conditions and the VM VM capacitance should be increased to suppress spikes when using inductive loads.

4: The package thermal impedance is calculated in accordance with JESD-51.

5: The maximum power dissipation is a function of TJ(MAX), RθJA, and TA. The maximum allowable power dissipation at any ambient temperature is PD=(TJ(MAX) -TA)/RθJA. All numbers apply for packages soldered directly onto a PCB.

## Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) (6).

| Parameter | Symbol | Test Condition | Min | Type | Max | Unit |
|---|---|---|---|---|---|---|
| Motor Power supply voltage | VM | | 0 | - | +14 | V |
| Logic Power-supply Voltage | VCC | | +2.5 | - | +7 | V |
| Motor peak Current | IOUT | | 0 | - | 1.8 | A |
| Externally applied PWM frequency | fPWM | | 0 | - | 250 | KHz |
| Logic level input voltage | VLOGIC | | -0.5 | - | +5.5 | V |
| OperatingTemperature | TA | | -40 | - | +85 | 'C |

Note 6: Power dissipation and thermal limits must be observed.

## Electrical Characteristics

(TA = +25°C, over recommended operating condition unless otherwise noted. (7).)

| Parameter | Symbol | Test Condition | Min.[8] | Typ.[9] | Max.[8] | Unit |
|---|---|---|---|---|---|---|
| Power Supplies (VM, VCC) | | | | | | |
| VM Operating Voltage | VM | | 0 | - | 14 | V |
| VM Operating Supply Current | IVM | VM=5V, VCC=3V, No PWM | - | 150 | 600 | uA |
| | | VM=5V, VCC=3V, 50KHz PWM | - | 510 | 600 | uA |
| VM Sleep Mode Supply Current | IVMQ | VM=5V, VCC=3V, nSLEEP=0 | - | 0.1 | 1.0 | uA |
| VCC Operating Voltage | VCC | - | 2.5 | - | 7.0 | V |
| VCC Operating Supply Current | IVCC | VM=5V, VCC=3V, No PWM | - | 260 | 350 | uA |
| | | VM=5V, VCC=3V, 50KHz PWM | - | 280 | 350 | uA |
| VCC Sleep Mode Supply Current | IVCCQ | VM=5V, VCC=3V, nSLEEP=0 | - | 0.1 | 1.0 | uA |
| Control Inputs(IN1, IN2, nSLEEP) | | | | | | |
| Input Logic-High Voltage Rising Threshold | VIH | nSLEEP | 1.3 | - | - | V |
| | | IN1, IN2 | 0.7XVCC | - | - | |
| Input Logic-Low Voltage Falling Threshold | VIL | nSLEEP | - | - | 0.8 | V |
| | | IN1, IN2 | - | - | 0.7XVCC | |
| Input Logic Low Current | IIL | VIN=0V | - | - | 1.0 | uA |
| Input Logic High Current | IIH | VIN=3.3V | - | 30 | - | uA |
| Pulldown Resistance | RPD | - | - | 100 | 110 | KΩ |
| MOTOR Driver Outputs (OUT1, OUT2) | | | | | | |
| HS+LS FET ON-Resistance DFN2X2-8 | RDS(ON) | VM=5V, VCC=3V, IO=0.8A, TJ=25'C | - | 250 | 500 | mΩ |
| HS+LS FET ON-Resistance SOIC-8 | | VM=5V, VCC=3V, IO=0.8A, TJ=25'C | - | 320 | 500 | mΩ |
| Off-state Leakage Current | IOFF | VOUT=0V | -200 | - | 200 | nA |
| Protection Circuits | | | | | | |
| VCC Undervoltage Lockout | VUVLO | VCC rising | - | 2.2 | - | V |
| | | VCC falling | - | 2.0 | - | V |
| Overcurrent Protection Trip level | IOCP | VM=5V, VCC=3V | 2.05 | 2.7 | - | A |
| Overcurrent Deglitch Time | tDEG | VM=5V, VCC=3V | - | 1 | - | us |
| Overcurrent Retry Time | tRETRY | VM=5V, VCC=3V | - | 1.2 | - | ms |
| Thermal Shutdown Temperature | TTSD | TJ temperature | - | 160 | - | 'C |
| Thermal Resume Temperature | TRES | - | - | 120 | - | 'C |

Note 7. Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

8. Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

9. Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

## Timing Requirements

(TA=25°C， VM=5V, VCC=3V， RL=20Ω between OUT1 and OUT2.)

| NUM | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| 1 | t1 | Output enable time IN1 high and IN2 Low to OUT1=0.97XVM | - | 285 | - | ns |
| 2 | t2 | Output disable time IN1 Low and IN2 Low to OUT2=0.9XVM | - | 170 | - | ns |
| 3 | t3 | Delay time, INX high to OUT x high IN1 low IN2 high to OUT2=0.5XVM | - | 125 | - | ns |
| 4 | t4 | Delay time, INX low to OUT x low IN1 low IN2 low to OUT1=0.5XVM | - | 110 | - | ns |
| 5 | t5 | Output rise time OUT1=0.2XVM to OUT1=0.8XVM | - | 165 | - | ns |
| 6 | t6 | Output fall time OUT2=0.8XVM to OUT1=0.2XVM | - | 40 | - | ns |
| twake | twake | Wake time, nSLEEP rising edge to part active | - | 9 | - | us |

## Wave picture

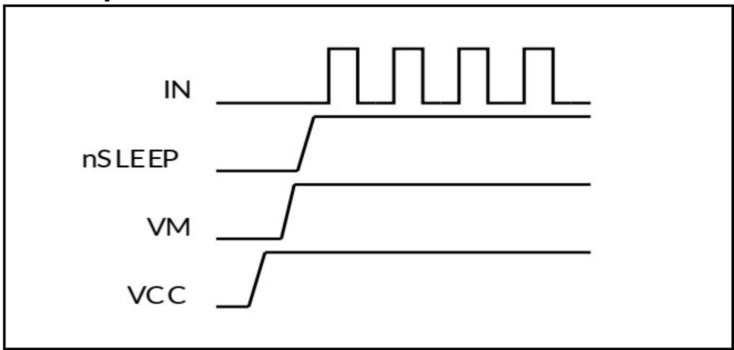



Figure 1. power-on sequence

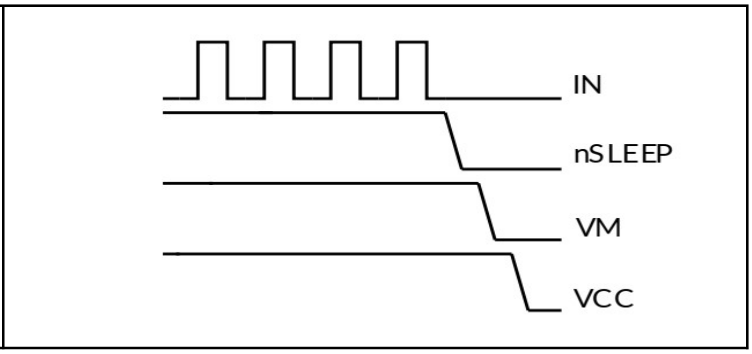



Figure 2. power-down sequence

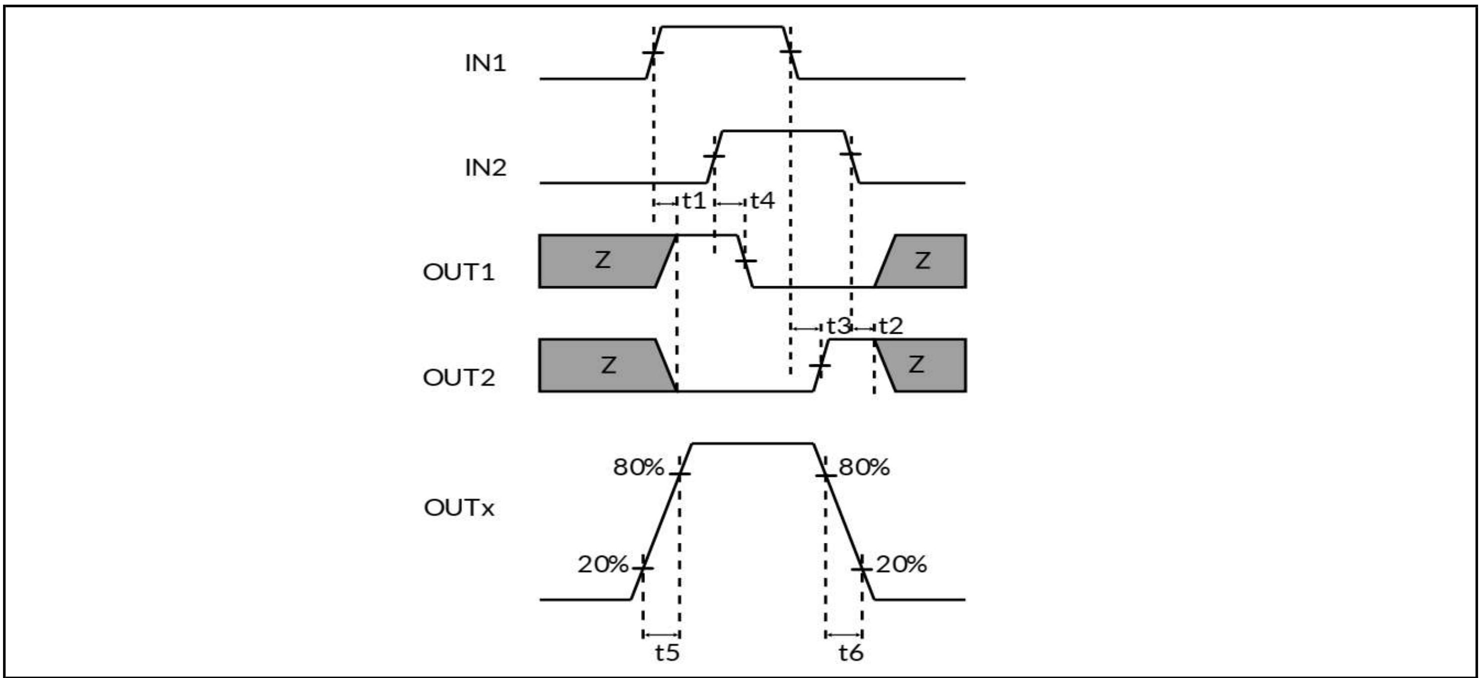



Figure 3. Input and Output Timing for HCR8837A/B

## Typical Characteristics

**NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.**

**At TA = +25℃, unless otherwise noted.**

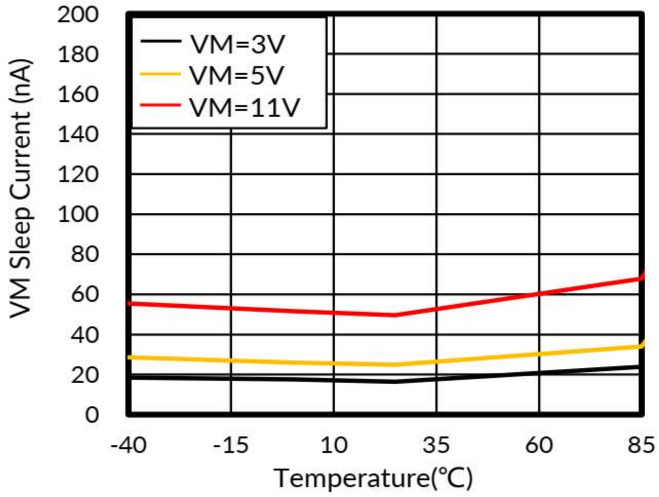



**Figure 4. $I_{VMQ}$ vs Temperature**

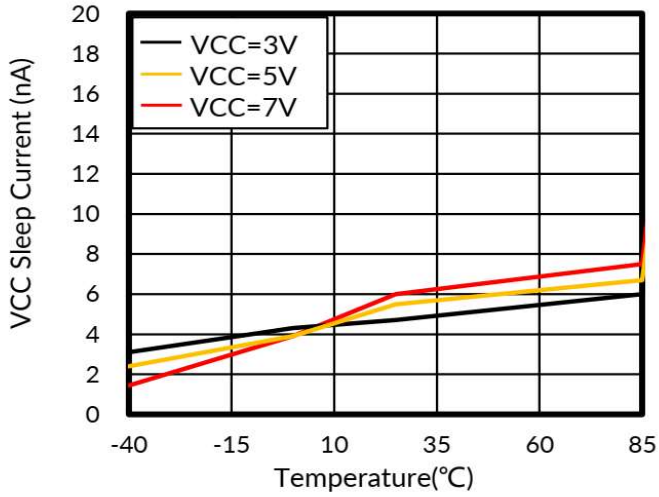



**Figure 5. $I_{VCCQ}$ vs Temperature**

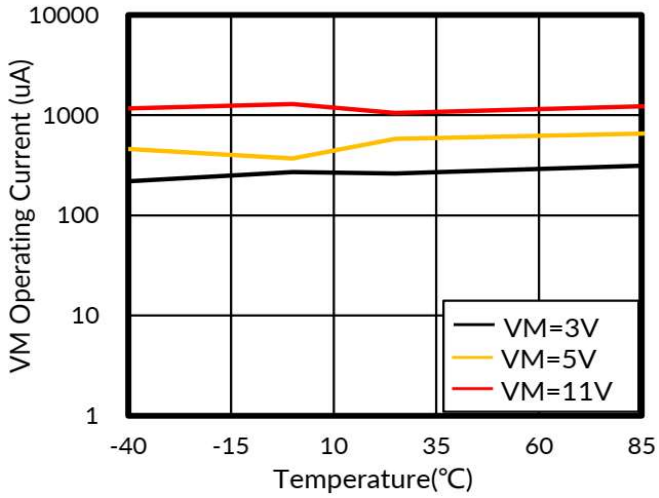



**Figure 6. $I_{VM}$ vs Temperature (50-kHz PWM)**

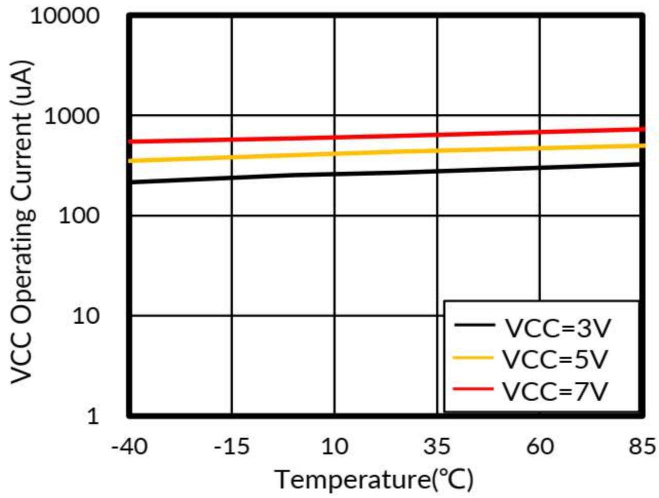



**Figure 7. $I_{VCC}$ vs Temperature (50-kHz PWM)**

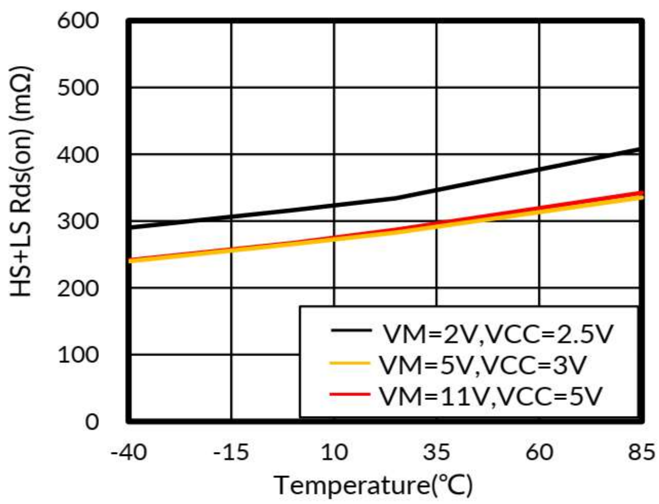



**Figure 8. HS+LS $R_{ds(on)}$ vs Temperature**

## Detailed Deacription

The HCR8837A/B is an H-bridge driver that can drive one dc motor or other devices like solenoids. The outputs are controlled using either a PWM interface (IN1 and IN2). A low-power sleep mode is included, which can be enabled using the nSLEEP pin.

These devices 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 HCR8837A/B adds protection features beyond traditional discrete implementations: undervoltage lockout, overcurrent protection, and thermal shutdown.

## Feature Description

### Bridge Control

The HCR8837A/B device is controlled using a PWM input interface, also called an IN-IN interface. Each output is controlled by a corresponding input pin. Table 1 shows the logic for the HCR8837A/B device.

Table 1. HCR8837A/B Device Logic

| nSLEEP | IN1 | IN2 | OUT1 | OUT2 | Function (DC MOTOR) |
|---|---|---|---|---|---|
| 0 | X | X | Z | Z | Coast |
| 1 | 0 | 0 | Z | Z | Coast |
| 1 | 0 | 1 | L | H | Reverse |
| 1 | 1 | 0 | H | L | Forward |
| 1 | 1 | 1 | L | L | Brake |

### Sleep Mode

If the nSLEEP pin is brought to a logic-low state, the HCR8837A/B enters a low-power sleep mode. In this state, all unnecessary internal circuitry is powered down.

### Power Supplies and Input Pins

The input pins can be driven within the recommended operating conditions with or without the VCC, VM, or both power supplies present. No leakage current path will exist to the supply. Each input pin has a weak pulldown resistor (approximately 100 kΩ) to ground.

The VCC and VM supplies can be applied and removed in any order. When the VCC supply is removed, the device enters a low-power state and draws very little current from the VM supply.

The VCC and VM pins can be connected together if the supply voltage is between 2.5V and 7V.

The VM voltage supply does not have any under voltage-lockout protection (UVLO) so as long as $V_{CC}$ > 2.2V; the internal device logic remains active, which means that the VM pin voltage can drop to 0 V. However, the load cannot be sufficiently driven at low VM voltages.

### Protection Circuits

The HCR8837A/B is fully protected against VCC undervoltage, overcurrent, and overtemperature events.

### VCC Undervoltage Lockout

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

### 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 tDEG, 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.

## Feature Description(con.)

### 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 2. Fault Behavior

| Fault | Condition | H-Bridge | Recovery |
|---|---|---|---|
| VCC undervoltage | VCC<2V | disable | VCC>2.2V |
| Over Current | $I_{OUT}$>2.7A(TYP) | disable | $t_{RETRY}$ elapses |
| Thermal Shutdown | $T_J$>160'C(TYP) | disable | TJ<120'C |

### Device Functional Modes

The HCR8837A/B is active unless the nSLEEP pin is brought logic low. In sleep mode, the H-bridge FETs are disabled Hi-Z. The HCR8837A/B is brought out of sleep mode automatically if nSLEEP is brought logic high.

The H-bridge outputs are disabled during under voltage lockout overcurrent and overtemperature fault conditions.

Table 3. Operation Modes

| Mode | Condition | H-Bridge |
|---|---|---|
| Operating | nSLEEP Pin=1 | Operating |
| Sleep mode | nSLEEP Pin=0 | Disabled |
| Fault encountered | Any fault condition met | Disabled |

## Application and Implementation

Information in the following applications sections is not part of the HEXINRONG component specification, and HEXINRONG does not warrant its accuracy or completeness. HEXINRONG's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### Application Information

The HCR8837A/B is device is used to drive one DC motor or other devices like solenoids. The following design procedure can be used to configure the HCR8837A/B.

### Typical Application

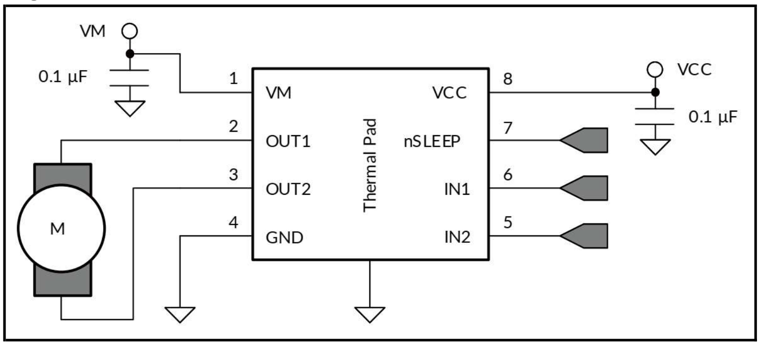



Figure 9. Schematic of HCR8837A/B Application

### Design Requirements

Table 4 lists the required parameters for a typical usage case.

Table 4. System Design Requirements

| Design Parameter | Reference | Example Value |
|---|---|---|
| Motor supply voltage | VM | 9V |
| Logic supply voltage | VCC | 3.3V |
| Target rms current | IOUT | 0.8A |

## Detailed Design Procedure

### Motor Voltage

The appropriate motor voltage depends on the ratings of the motor selected and the desired RPM. A higher voltage spins a brushed dc motor faster with the same PWM duty cycle applied to the power FETs. A higher voltage also increases the rate of current change through the inductive motor windings.

### Low-Power Operation

When entering sleep mode, HEXINRONG recommends setting all inputs as a logic low to minimize system power.

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

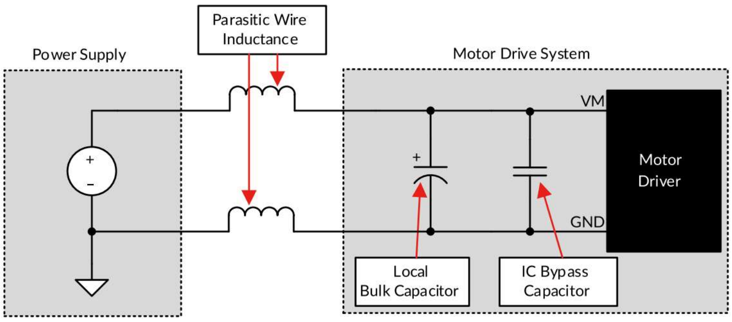



Figure 10. Example Setup of Motor Drive System With External Power Supply

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.

## Layout

### Layout Guidelines

The VM and VCC pins should be bypassed to GND using low-ESR ceramic bypass capacitors with a recommended value of 0.1μF rated for VM and VCC. These capacitors should be placed as close to the VM and VCC pins as possible with a thick trace or ground plane connection to the device GND pin.

### Layout Example

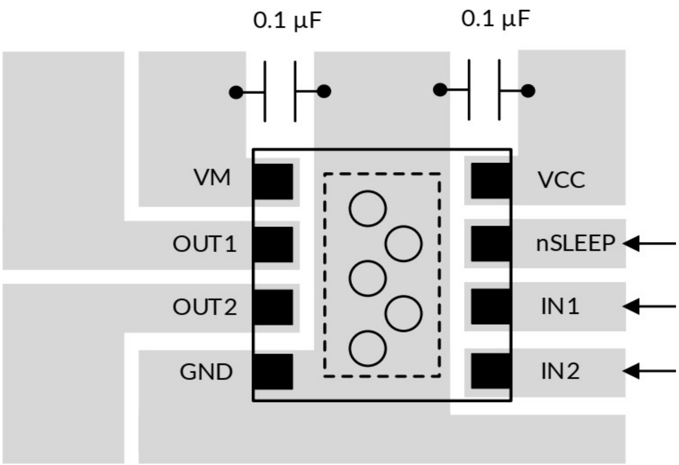



Figure 11. Simplified Layout Example

## Power Dissipation

Power dissipation in the HCR8837A/B is dominated by the power dissipated in the output FET resistance, or RDS(on). Use Equation 1 to estimate the average power dissipation when running a stepper motor.

$$P_{TOT} = R_{DS(on)} \times (I_{OUT(RMS)})^2 \qquad (1)$$

where

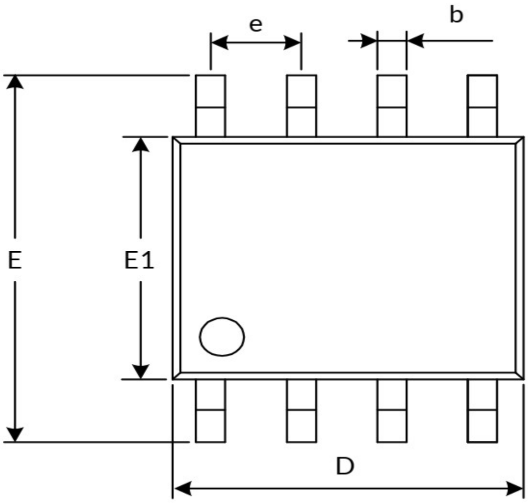
- $P_{TOT}$ is the total power dissipation
- $R_{DS(on)}$ is the resistance of the HS plus LS FETs
- $I_{OUT(RMS)}$ is the rms or dc output current being supplied to the load.

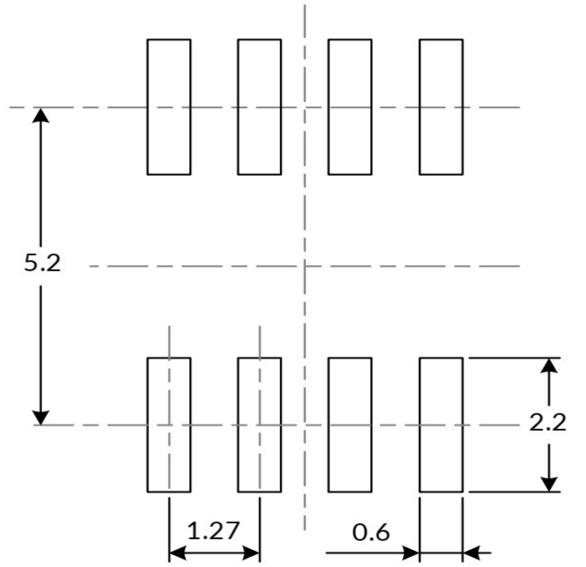
The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

The HCR8837A/B has thermal shutdown protection. If the die temperature exceeds approximately 160°C, the device is disabled until the temperature drops to a safe level. Any tendency of the device to enter thermal shutdown is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

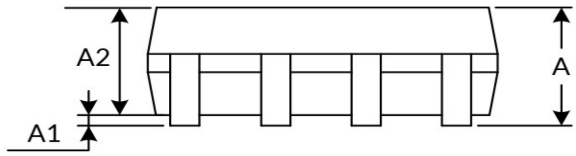
## Package Outline Dimensions

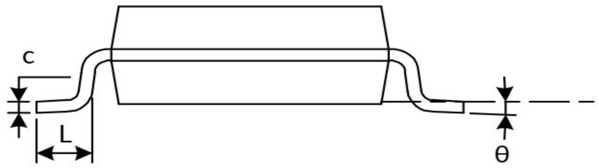
**Package: SOIC-8 (M8)**




**RECOMMENDED LAND PATTERN** (Unit: mm)



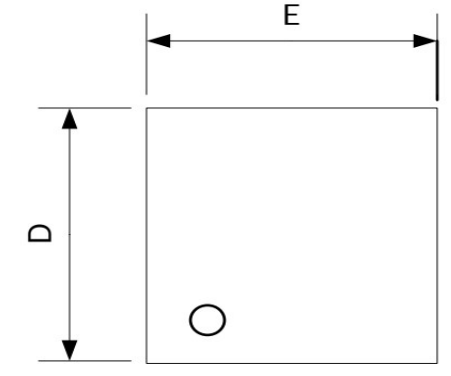

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A (1) | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| D (1) | 4.800 | 5.000 | 0.189 | 0.197 |
| e | 1.270 (BSC) (2) | | 0.050 (BSC) (2) | |
| E | 5.800 | 6.200 | 0.228 | 0.244 |
| E1 (1) | 3.800 | 4.000 | 0.150 | 0.157 |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

NOTE:

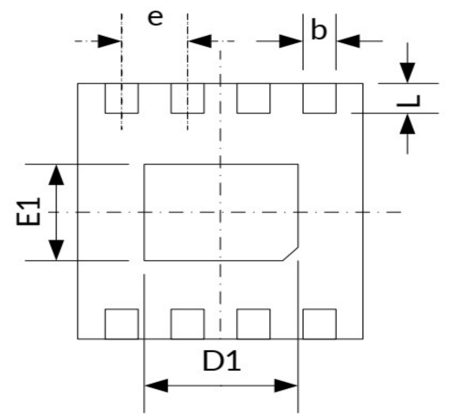
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

## Package Outline Dimensions(con.)

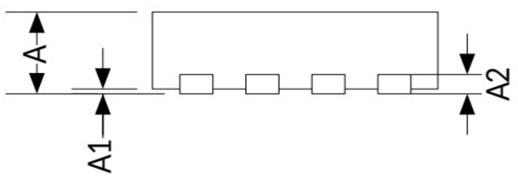
**Package: DFN2X2-8 (DN28)** **Unit: mm**



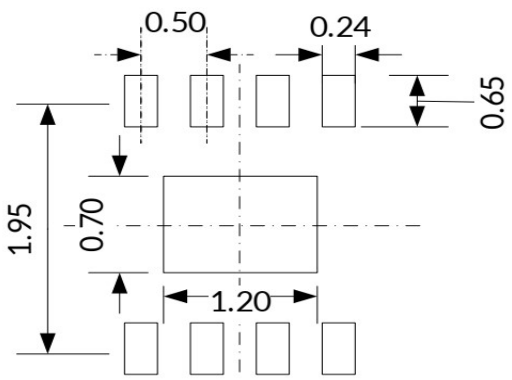

TOP VIEW




BOTTOM VIEW




SIDE VIEW




RECOMMENDED LAND PATTERN

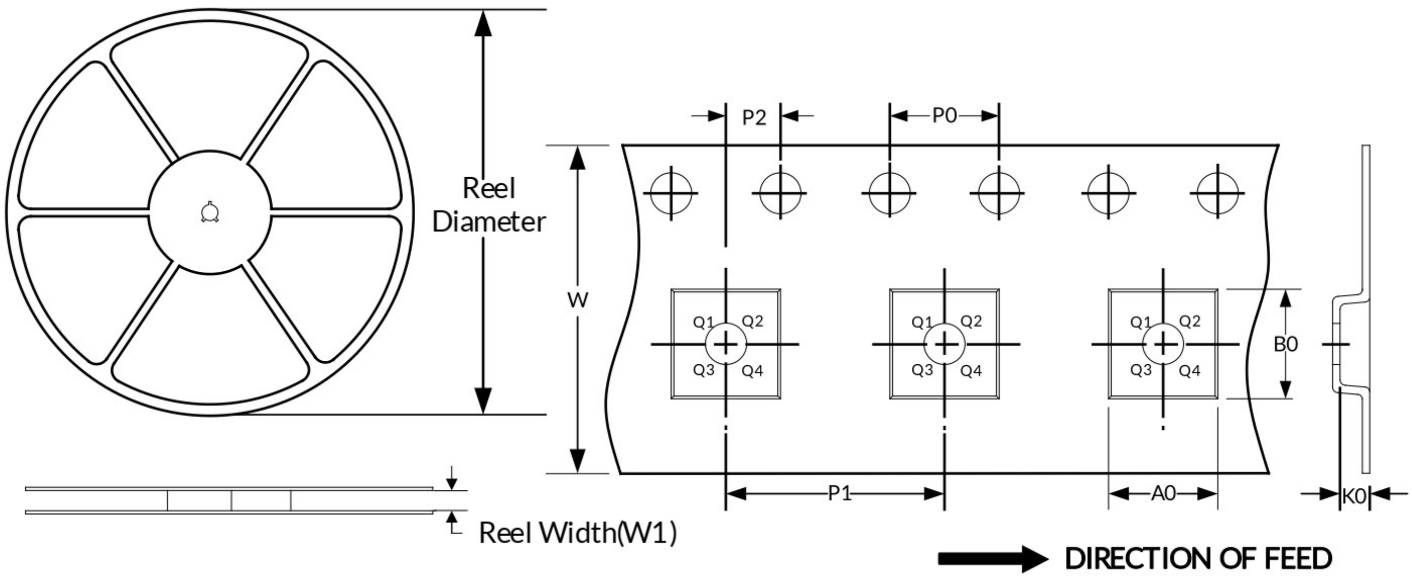
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A (1) | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203(TYP) | | 0.008(TYP) | |
| b | 0.180 | 0.300 | 0.007 | 0.012 |
| D (1) | 1.900 | 2.100 | 0.075 | 0.083 |
| D1 | 1.100 | 1.300 | 0.043 | 0.051 |
| E (1) | 1.900 | 2.100 | 0.075 | 0.083 |
| E1 | 0.600 | 0.800 | 0.024 | 0.031 |
| e | 0.500(TYP) | | 0.020(TYP) | |
| L | 0.250 | 0.450 | 0.010 | 0.018 |

NOTE:

1. Plastic or metal protrusions of 0.075mm maximum per side are not included.
2. This drawing is subject to change without notice.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS** **TAPE DIMENSION**



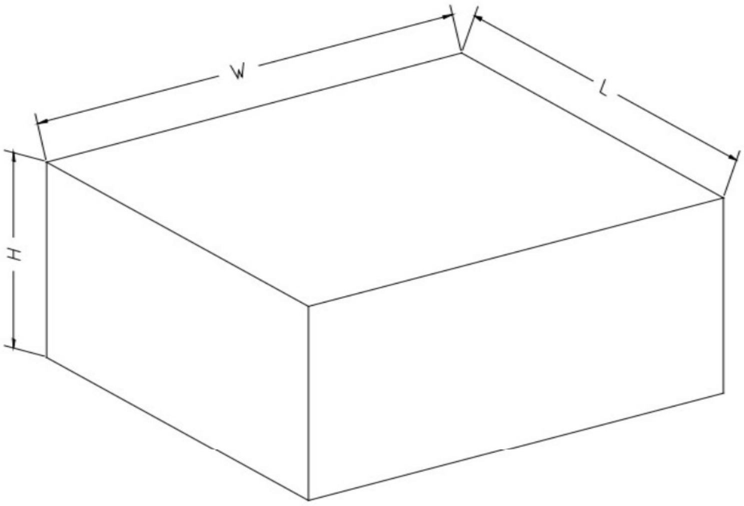

NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|
| SOIC-8 | 13" | 12.4 | 6.40 | 5.40 | 2.10 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |
| DFN2X2-8 | 7" | 9.5 | 2.30 | 2.30 | 1.10 | 4.0 | 4.0 | 2.0 | 8.0 | Q2 |

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

## 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 |
|---|---|---|---|---|
| 7″ (Option) | 368 | 227 | 224 | 8 |
| 7″ | 442 | 410 | 224 | 18 |
| 13″ | 386 | 280 | 370 | 5 |