# One Channel H-Bridge Motor Driver AM1016A

## Features and Benefits

- Wide Supply Voltage Range (2.0V~6.8V)
- 0.9A Continuous Current, 2A Peak Current
- Low Standby Mode Current (Typ=0.01μA)
- Low Quiescent Operation Current
- Low MOSFETs On-resistance 0.6Ω@Io=0.2A; 0.65Ω@Io=0.6A
- Provide Four Operation Modes: Forward/Reverse/Stop/Brake
- Thermal Shutdown Protection
- SOT23-6 Package for Small Size PCB Layout
- Pb-Free and Halogen-Free Green Product

## Applications

- Toys
- Small Appliances
- Robotics
- Consumer Products

## Description

The AM1016A is one channel H-Bridge driver. It provides integrated motor driver solution for toys, robotics, consumer products and other low voltage or battery-powered motion control applications.

The AM1016A can supply up to 0.9 A continuous current and 2.0 A peak current. There is internal shutdown function for over-temperature protection.

The small package, reducing 20% package size compared with SOP8 size, have a miniaturizing advantage even more.

Package material is Pb-Free and Halogen-Free (Green) for the purpose of environmental protection and for sustainable development of the Earth.

## Ordering Information

| Orderable Part Number | Package |
|---|---|
| AM1016A | SOT23-6 |

## Absolute Maximum Ratings ($T_A$ =25℃)

| Parameter | Symbol | Limits | Unit |
|---|---|---|---|
| Power Supply voltage | VCC | 7.0 | V |
| Output Continuous Current | $Io_{CONT}$ | 0.9 * | A |
| Output Peak Current | $Io_{Peak}$ | 2.0 | A |
| Operate Temperature Range | $T_{opr}$ | -40～+85 | ℃ |
| Storage Temperature Range | $T_{stg}$ | -40～+150 | ℃ |

*Based on 20x20 $mm^2$ FR4 PCB (1 oz.) at single side PCB

## Recommended operating conditions ($T_A$ =25℃)

(Set the power supply voltage taking allowable dissipation into considering)

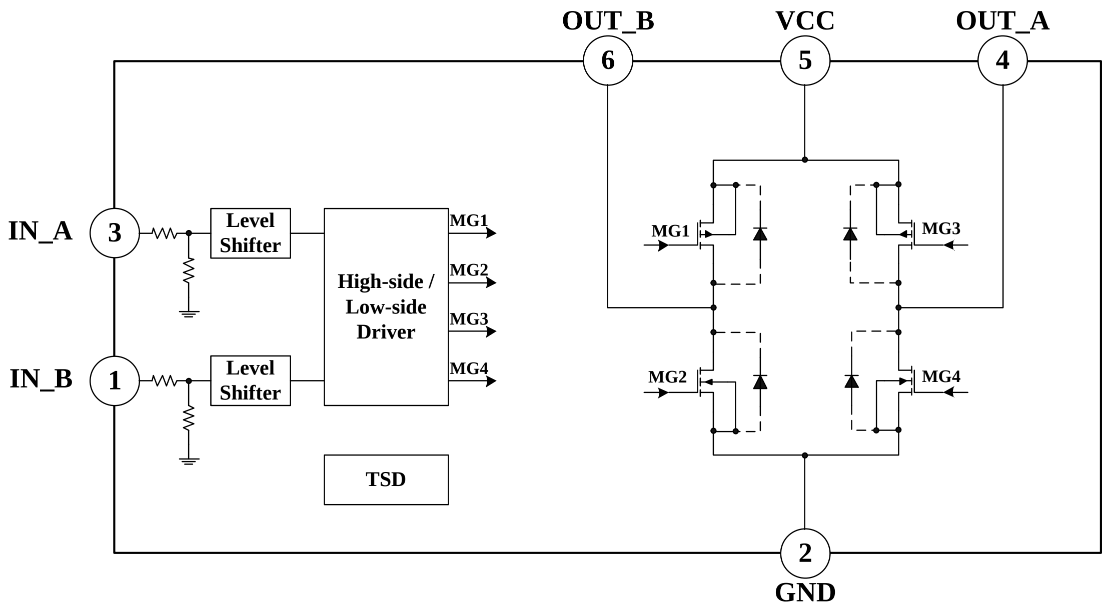
| Parameter | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Power Supply Voltage | VCC | 2.0 | | 6.8 | V |
| IN_A and IN_B | $V_{IN\_X}$ | -0.3 | | Vcc+0.3 | V |
| Output Continuous Current | Io | 0 | | 0.9 * | A |
| Externally Applied PWM Frequency | $F_{IN\_X}$ | 0.02 | | 65 | KHZ |

*Based on 20x20 $mm^2$ FR4 PCB (1 oz.) at single side PCB

- **Electrical Characteristics ( Unless otherwise specified, $T_A$ = 25℃,VCC=5V)**

| Parameter | Symbol | Limit | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| **Power Supplies** | | | | | | |
| Quiescent Operation Current | $I_{CC}$ | | 65 | | µA | Input signal IN_A/B= L/H or H/L or H/H, No load on OUT_A/B |
| Standby Current | $I_{STB}$ | | 0.01 | 1 | µA | Input signal IN_A/B= L/L, No load on OUT_A/B |
| **PWM Inputs** | | | | | | |
| Input H Level Voltage | $V_{IN\_XH}$ | 2.0 | | $V_{CC}$ | V | |
| Input L Level Voltage | $V_{IN\_XL}$ | -0.3 | | 0.7 | V | |
| Input H Level Current | $I_{IN\_X}$ | | 30 | | µA | VCC = 5 V , $V_{IN\_X}$ = 3 V |
| Input Frequency | $F_{IN\_X}$ | 0.02 | | 65 | kHz | |
| Input Pull-Down Resistance | $R_{IN\_X}$ | | 100 | | KΩ | |
| **H-Bridge FETs** | | | | | | |
| On-Resistance | $R_{ds(on)}$ | | 0.6 | | Ω | $I_O$ = 200mA<br>Upper and Lower total |
| On-Resistance | $R_{ds(on)}$ | | 0.65 | | Ω | $I_O$ = 600mA<br>Upper and Lower total |
| **TSD Protections** | | | | | | |
| Thermal Shutdown Protection | $TSD_p$ | | 150 | | ℃ | |
| Thermal Shutdown Release | $TSD_r$ | | 125 | | ℃ | |

- **Block Diagram**



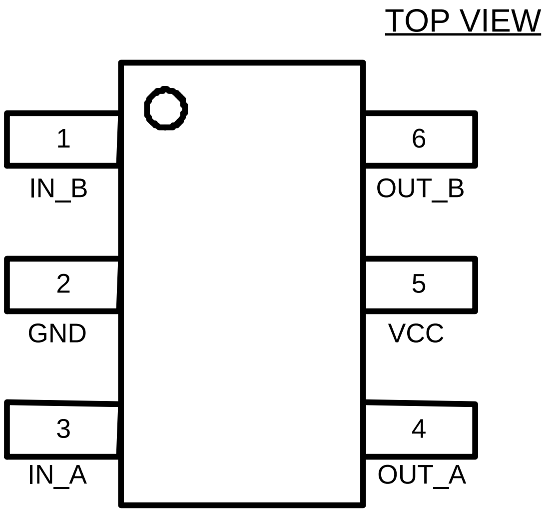

- **Input Logic Descriptions**

**Function truth table**

| IN_A | IN_B | OUT_A | OUT_B | Mode |
|---|---|---|---|---|
| L | L | Hi-Z | Hi-Z | Stop |
| L | H | L | H | Reverse |
| H | L | H | L | Forward |
| H | H | L | L | Brake |

**※Low standby mode current function when IN_A = IN_B = Low level**

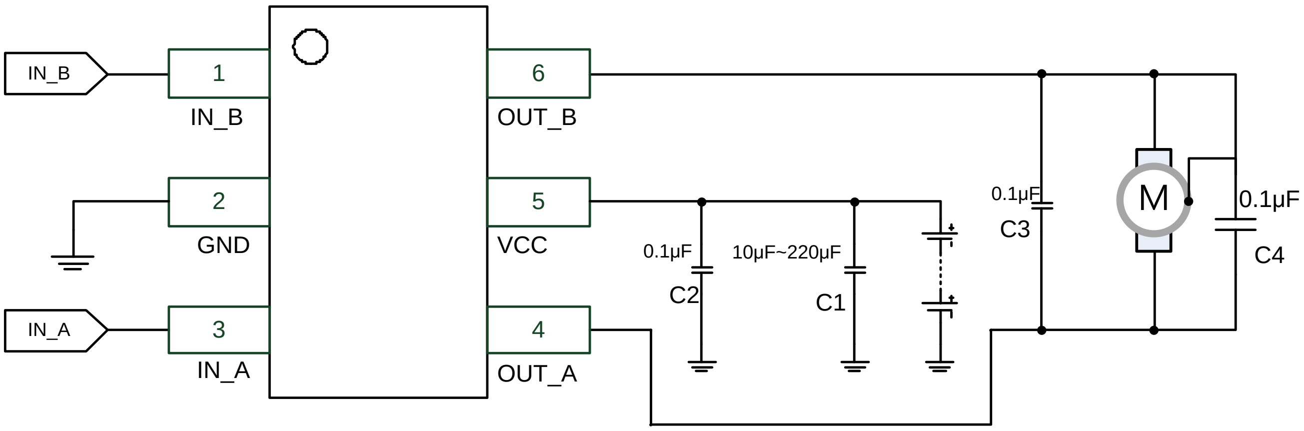
- **Pin configuration SOT23-6**




- **Pin Descriptions**

| PIN Number | Pin Name | I/O | Description |
|---|---|---|---|
| 1 | IN_B | I | Input Half Bridge B |
| 2 | GND | - | Ground Pin |
| 3 | IN_A | I | Input Half Bridge A |
| 4 | OUT_A | O | Output Half Bridge A |
| 5 | VCC | - | Power Supply |
| 6 | OUT_B | O | Output Half Bridge B |

## Application




## Circuit Descriptions

The function descriptions of capacitors on the application circuit:

C1、C2: Power supply VCC pin capacitor:

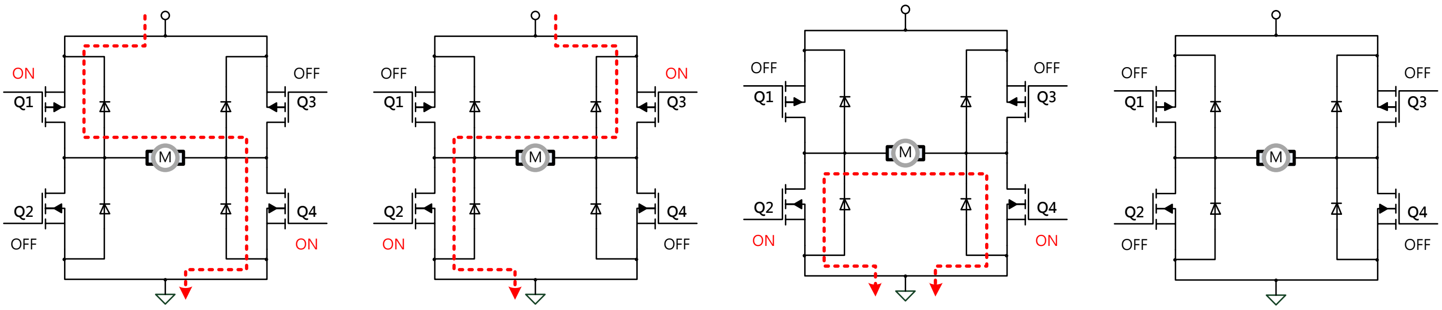
1) The capacitor can reduce the power spike when the motor is in motion. To avoid the IC directly damaged by the VCC peak voltage. It also can stabilize the power supply voltage and reduce its ripples.
2) The C1 capacitor can compensate power when motor starts running.
3) The capacitor value (μF) determines the stability of the VCC during motor in motion. If the large voltage power or a heavy loading motor is used, then a larger capacitor would be needed.
4) On the PCB configuration, the C1、C2 must be mounted as close as possible to VCC pin (PIN5).

C3: The across-output capacitor ;  C4: The across-motor capacitor

1) The capacitors can reduce the power spike of motor when operating. Therefore, a 0.1μF capacitor is recommended.
2) On the PCB configuration, the C3 must be mounted as close as possible to OUT_A&B (PIN 4&PIN 6).
3) The C4 capacitor single-ended can be welded on the motor shell.
4) The C3、C4 capacitor must be added to the general application.

## Operating Mode Descriptions

1) H-Bridge basic operating mode：
   a) Forward mode
      Definition：When IN_A=H，IN_B=L，then OUT_A=H，OUT_B=L
   b) Reverse mode
      Definition：When IN_A=L，IN_B=H，then OUT_A=L，OUT_B=H
   c) Stop/Brake mode
      Definition：When IN_A=IN_B= H，then OUT_A=OUT_B=L
   d) Stop mode
      Definition：When IN_A=IN_B= L，then OUT_A=OUT_B=Hi-Z




a) Forward mode  b) Reverse mode  c) Brake mode  d) Stop mode

## Protection Mechanisms Descriptions

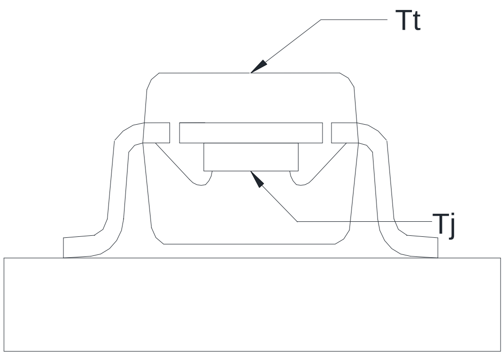
1) Over-temperature protection
   If the IC junction temperature exceeds 150° C (Typ.), the internal over-temperature protection function will be triggered, and all FETs in the H-bridge are disabled, that will ensure the safety of customers' products. If the IC junction temperature falls to 125° C(Typ.), the IC resumes automatically.

## Thermal Information

| | | |
|---|---|---|
| **θja** | junction-to-ambient thermal resistance | 277.78℃/W |
| **Ψjt** | junction-to-top characterization parameter | 20.6℃/W |

- **Θja** is obtained in a simulation on a JEDEC-standard 1s0p board as specified inJESD-51.
- The **Θja** number listed above gives an estimate of how much temperature rise is expected if the device was mounted on a standard JEDEC board.
- When mounted on the actual PCB, the **Θja** value of JEDEC board is totally different than the **Θja** value of actual PCB.
- **Ψjt** is extracted from the simulation data to obtain **Θja** using a procedure described in JESD-51, which estimates the junction temperature of a device in an actual PCB.

- The thermal characterization parameter, **Ψjt**, is proportional to the temperature difference between the top of the package and the junction temperature. Hence, it is useful value for an engineer verifying device temperature in an actual PCB environment as described in JEDEC JESD-51-12.
- When Greek letters are not available, **Ψjt** is written Psi-jt.
- Definition:




DFEINITION $\Psi_{jt} = (T_j - T_t) / P_d$

Where :

**Ψjt** (Psi-jt) = Junction-to-Top(of the package) °C/W
**Tj**= Die Junction Temp. °C
**Tt**= Top of package Temp at center. °C
**Pd**= Power dissipation. Watts

- Practically, most of the device heat goes into the PCB, there is a very low heat flow through top of the package, so the temperature difference between **Tj** and **Tt** shall be small, that is any error caused by PCB variation is small.

- This constant represents that **Ψjt** is completely PCB independent and could be used to predict the **Tj** in the environment of the actual PCB if **Tt** is measured properly.

## How to predict Tj in the environment of the actual PCB

Step 1 : Used the simulated **Ψjt** value listed above.

Step 2 : Measure **Tt** value by using

- **Thermocouple Method**

  We recommend use of a small ~40 gauge(3.15mil diameter) thermocouple. The bead and thermocouples wires should touch the top of the package and be covered with a minimal amount of thermally conductive epoxy. The wires should be heat-insulated to prevent cooling of the bead due to heat loss into wires. This is important towards preventing “too cool” **Tt** measurements, which would lead to the calculated **Tj** also being too cool.

- **IR Spot Method**

  An IR Spot method should be utilized only when using a tool with a small enough spot area to acquire the true top center “hot spot”.

  Many so-called “small spot size” tools still have a measurement area of 0~100+mils at “zero” distance of the tool from the surface. This spot area is too big for many smaller packages and likely would result in cooler readings than the small thermocouple method.

  Consequently, to match between spot area and package surface size is important while measuring **Tt** with IR sport method.

Step 3 : calculating power dissipation by

$$P \cong (VCC-|Vo_{\_Hi} - Vo_{\_Lo}|) \times I_{out} + VCC \times Icc$$

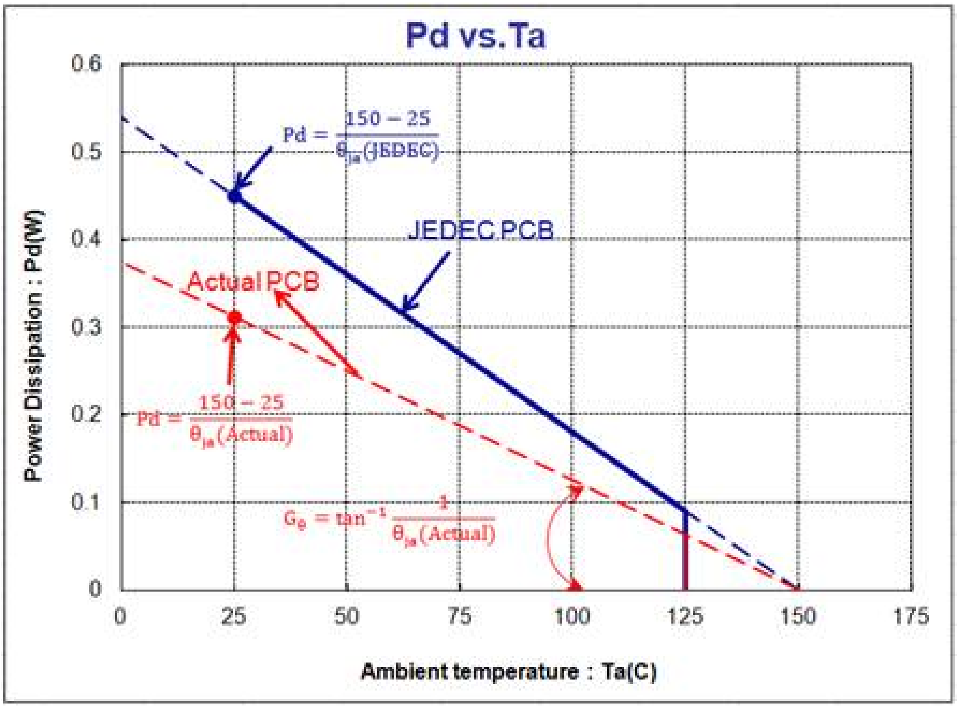
Step 4 : Estimate **Tj** value by

$$Tj = \Psi jt \times P + Tt$$

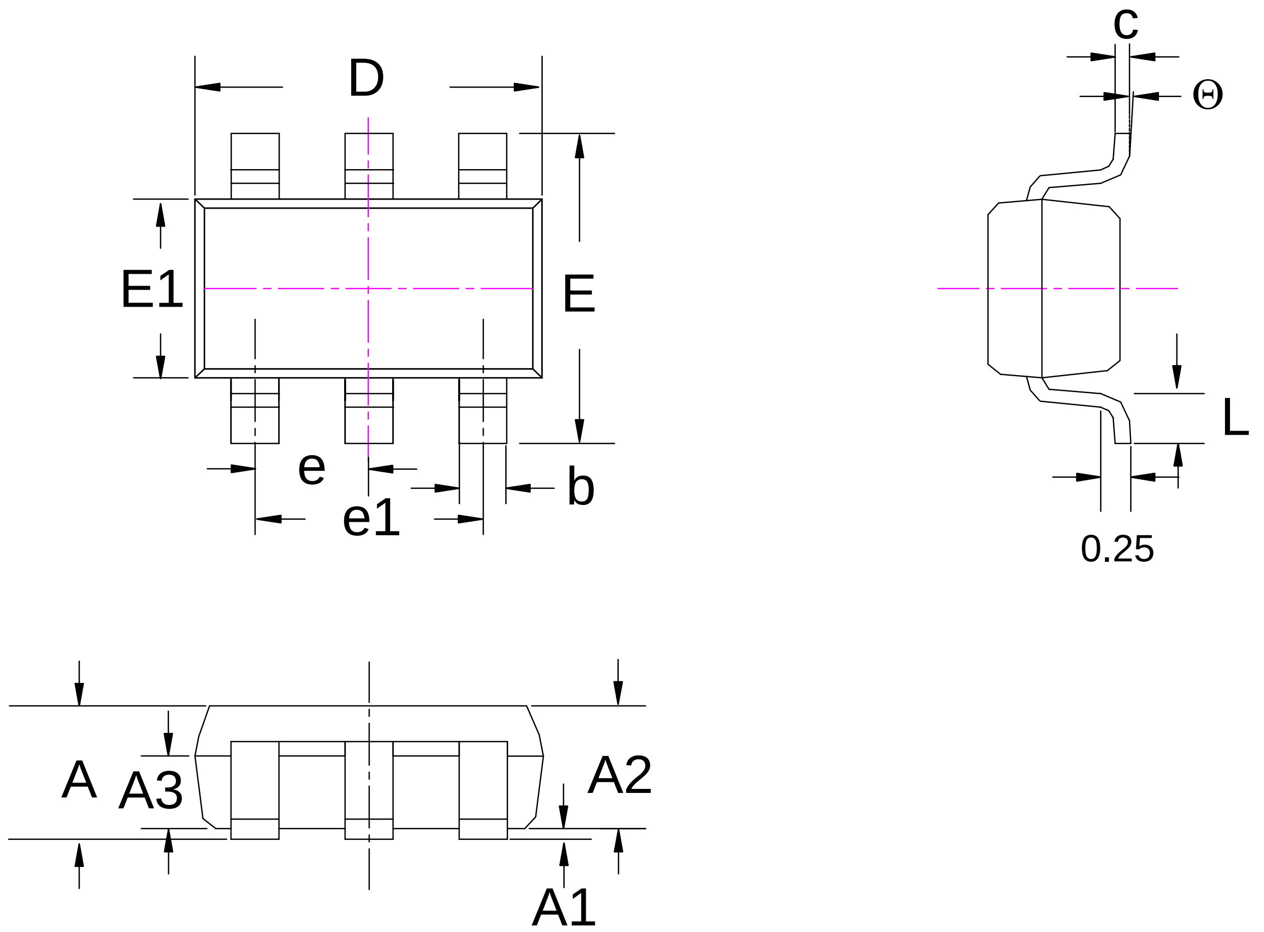
Step 5: Calculated Θja value of actual PCB by the known **Tj**

$$\Theta ja(actual) = (Tj-Ta)/P$$

- **Maximum Power Dissipation (de-rating curve) under JEDEC PCB & actual PCB**

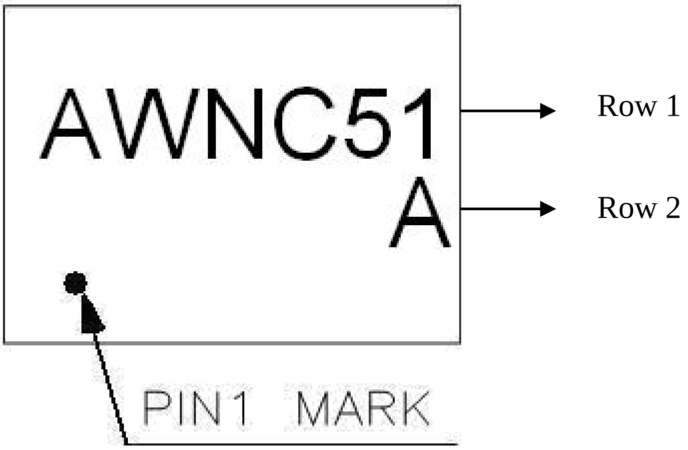


- **Packaging outline --- SOT23-6** **Unit: mm**



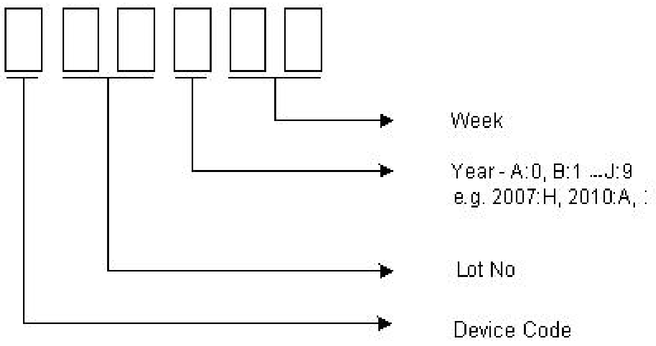

| SYMBOL | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | -- | 1.35 | -- | 0.053 |
| A1 | 0.04 | 0.15 | 0.002 | 0.006 |
| A2 | 1.00 | 1.20 | 0.039 | 0.047 |
| A3 | 0.55 | 0.75 | 0.022 | 0.030 |
| b | 0.34 | 0.43 | 0.013 | 0.017 |
| c | 0.15 | 0.21 | 0.006 | 0.008 |
| D | 2.72 | 3.12 | 0.107 | 0.123 |
| E | 2.60 | 3.00 | 0.102 | 0.118 |
| E1 | 1.40 | 1.80 | 0.055 | 0.071 |
| L | 0.3 | 0.6 | 0.012 | 0.024 |
| Θ | 0 | 8 | 0 | 0.315 |
| e | 0.95 BSC | | 0.037 BSC | |
| e1 | 1.90 BSC | | 0.075 BSC | |

## Marking Identification




Row 1

Device Code, Lot number & Date




Row 2

Customer specific difference code

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