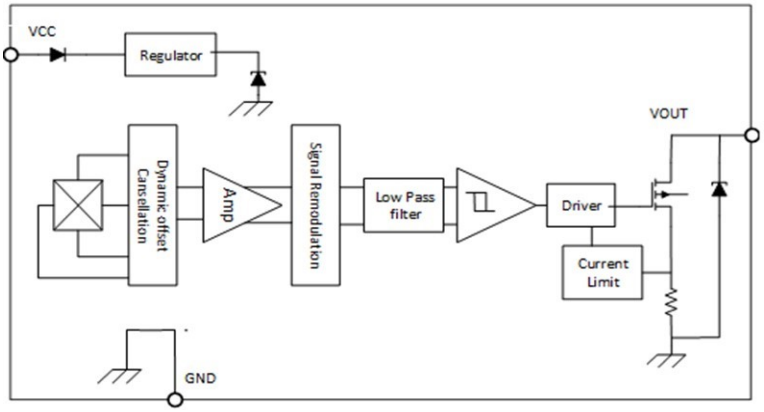
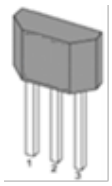
# HC941 Hall Effect IC

## FEATURES and FUNCTIONAL DIAGRAM

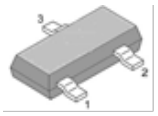
- Digital Unipolar-Switch Hall Sensor
- Superior Temperature Stability
- On board voltage regulator for 3.8V to 30V range
- Open Drain Output (20-mA Sink)
- Resistant to physical stress
- Output short-circuit protection
- Operation from unregulated supply
- Reverse-battery and freewheeling protection
- Solid-state reliability
- Wide Operating temperature range: -40 to 150 ºC
- Small package sizes TO-92S, SOT23 and SOT-89
- RoHS-compliant material meets directive 2011/65/EU



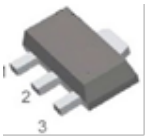

## PACKAGE



TO-92S



SOT-23-3L



SOT-89-3L

## APPLICATIONS

-Docking Detection
-Door Open and Close Detection
-Proximity Sensing
-Valve Positioning
-Pulse Counting
-Flow rate sensing -Robotic control (cylinder position monitoring) -Float-based fluid level sensing
-Speed and RPM sensing in fitness equipment

## DESCRIPTION

The HC941 Hall-effect sensor is extremely temperature-stable and stress-resistant sensor ICs, especially suited for operation over extended temperature ranges from -40°C to 150°C. Superior high temperature performance is possible through dynamic offset cancellation, which reduces the residual offset voltage normally caused by device over-molding, temperature dependencies, and thermal stress.

The device includes a voltage regulator, Hall-voltage generator, small-signal amplifier, chopper stabilization, Schmitt trigger, and a short circuit protected open-drain output to sink up to 25 mA.

An on-board regulator permits operation with supply voltages of 2.8 to 30 V. The advantage of operating down to 2.5V is that the device can used in 3.8V applications or with additional external resistance in series with the supply pin for greater protection against high-voltage transient events.

The HC941 series is digital unipolar Hall switch. When the applied magnetic flux density exceeds the BOP threshold, the chip open-drain output goes low. The output stays low until the field decreases to less than BRP, and then the output goes to high impedance.

The HC941 also integrated internal clamps against supply/output transients; output short circuits protection; reverse battery conditions.

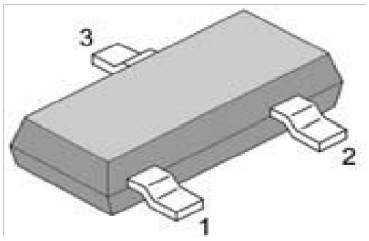
Three package styles provide a magnetically optimized package for most applications, SOT-23, TO-92S and SOT-89. Each package type is lead (Pb) free (suffix, –T), with a 100% matte-tin-plated lead-frame.

## 1.Product Family Members

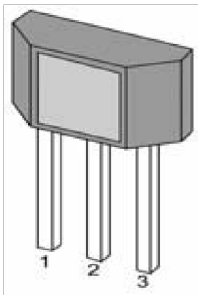
| Part Number | Marking ID | Description |
|---|---|---|
| HC941SR | HC941 | Unipolar-Switch, Hall-effect digital sensor IC, SOT-23-3L package, tape and reel packing (3000 units per reel) |
| HC941TB | HC941 | Unipolar-Switch, Hall-effect digital sensor IC, flat, TO-92S package, bulk packing (1000 units per bag) |
| HC411ER | HC941 | Unipolar-Switch, Hall-effect digital sensor IC, SOT-89-3L package, tape and reel packing (1000 units per reel) |

## 2.Pin Definitions and Descriptions

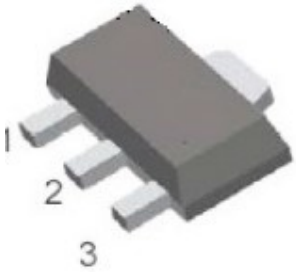
| SOT-23-3L (S) | TO-92S (T) | SOT-89-3L (E) | Name | Type | Function |
|---|---|---|---|---|---|
| 1 | 1 | 1 | VDD | Supply | Supply Voltage pin |
| 2 | 3 | 3 | OUT | Output | Open Collector Output pin |
| 3 | 2 | 2 | GND | Ground | Ground pin |




SOT-23-3L




TO-92S




SOT-89-3L

## 3.Absolute Maximum Ratings

| Parameter | Symbol | Min | Max | Units |
|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | - | 40 | V |
| VDD Reverse Voltage VDD | $V_{RDD}$ | - | -40 | V |
| Supply Current | $I_{DD}$ | - | 20 | mA |
| Output Voltage | $V_{OUT}$ | - | 40 | V |
| Output Current | $I_{OUT}$ | - | 20 | mA |
| Operating Ambient Temperature | $T_A$ | -40 | 150 | °C |
| Storage Temperature | $T_S$ | -50 | 150 | °C |
| Junction temperature | $T_J$ | -50 | 165 | °C |
| Magnetic Flux | B | No Limit | | Gauss |

Note: Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolutemaximum- rated conditions for extended periods may affect device reliability.

## 4.ESD Protections

| Parameter | Value | Unit |
|---|---|---|
| All pins 1) | +/-4000 | V |
| All pins 2) | +/-400 | V |
| All pins 3) | +/-1500 | V |

1) HBM (Human Body Mode) according to MIL-STD-883H Method 3015.8
2) MM (Machine Mode) according to JEDEC EIA/JESD22-A115
3) CDM (charged device mode) according to JEDEC EIA/JESD22-C101F

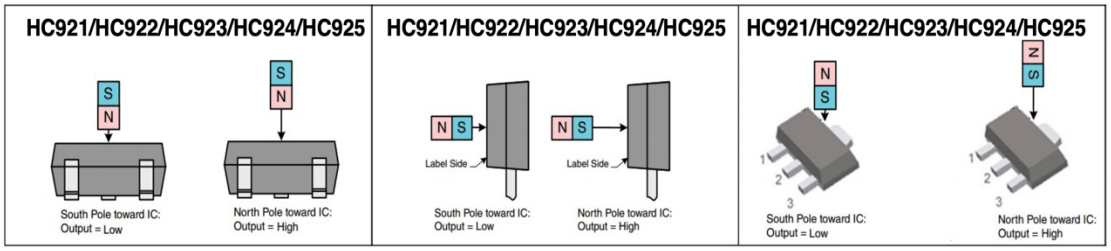
## 5. Function Description

The HC941 exhibits digital unipolar switching characteristics. Therefore, it requires only south poles or north poles (depend on the package type) to operate properly.

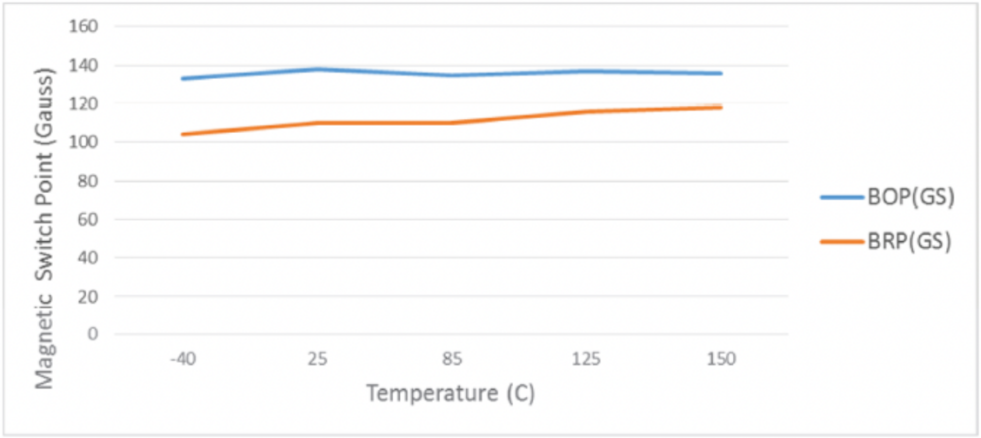
When the applied magnetic flux density exceeds the BOP threshold, the chip open-drain output goes low. The output stays low until the field decreases to less than BRP, and then the output goes to high impedance.

A magnetic hysteresis BHYST keeps BOP and BRP separated by a minimal value. This hysteresis prevents output oscillation near the switching point.

## 6. Magnetic Activation




## 7. Temperature Characteristics



8. Parameters Specification (VCC=3.8～30V supply, TA= -40 ºC to 150 ºC except where otherwise specified.)

| Symbol | Parameter | Test Condition | Min | Typ. | Max | Units |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply voltage | -40 °C to 150 °C | 3.8 | - | 30 | V |
| $I_{DD}$ | Supply Current | $V_{DD}$ = 3.3V | - | 3.5 | 8 | mA |
| $V_{ZSUPPLY}$ | Supply Zener Clamp Voltage | $I_{CC}$ =7 mA; TA = 25°C | 24 | | | V |
| $V_{ZOUT}$ | Output Zener Clamp Voltage | $I_{OUT}$ = 3mA | 24 | | | V |
| $V_{RCC}$ | Reverse Battery Zener | | | | -22 | V |
| $I_{RCC}$ | Reverse Battery Current | $V_{CC}$ = –22 V | -5 | | | mA |
| $F_C$ | Chopping Frequency | | | 500 | | KHz |
| $t_{PO}$ | Power-On Time | TA = 25°C; $C_{LOAD}$ = 10 pF | – | – | 30 | µs |
| $V_{DSon}$ | Output saturation voltage | at 20mA, Gauss >BOP | - | - | 0.4 | V |
| $I_{OFF}$ | Output Leakage Current | VOUT = 24 V; Switch state = Off | - | - | 10 | uA |
| $I_{OUT(lim)}$ | Output Current Limit | Short-Circuit Protection | 30 | – | 90 | mA |
| $T_R$ | Output rise time | $R_{LOAD}$ = 820 Ω, $C_{LOAD}$ = 10 pF; | - | 0.2 | 1.5 | uS |
| $T_F$ | Output fall time | $R_{LOAD}$ = 820Ω, $C_{LOAD}$ = 10 pF; | - | 0.1 | 21.5 | uS |
| $T_d$ | Output delay Time | B=Brp-100G to Bop+100G in 1us | | 13 | 25 | µs |
| $R_{TH}$ | Thermal resistance:<br>SOT-23-3L<br>TO-92S<br>SOT-89-3L | - | <br>-<br>-<br>- | <br>303<br>203<br>230 | <br>-<br>-<br>- | <br>°C /W<br>°C/W<br>°C/W |
| $F_{SW(2)}$ | Maximum Switching Frequency | | | 30 | | KHz |
| T | Operating temperature | - | -40 | - | 150 | °C |
| $T_S$ | Storage temperature: | - | -40 | - | 150 | °C |
| HC941 | | | | | | |
| $B_{OP}$ | Magnetic operating point | $T_A$=-40ºC to 150ºC | 100 | 150 | 190 | Gauss |
| $B_{RP}$ | Magnetic release point | $T_A$=-40ºC to 150ºC | 70 | 110 | 140 | Gauss |
| $B_{HYST}$ | Magnetic hysteresis window \|BOP-BRP\| | $T_A$=-40ºC to 150ºC | 20 | 40 | 60 | Gauss |
| $B_o$ | Magnetic offset; $B_O$ = (BOP + BRP) / 2 | $T_A$=-40ºC to 150ºC | | 130 | | Gauss |

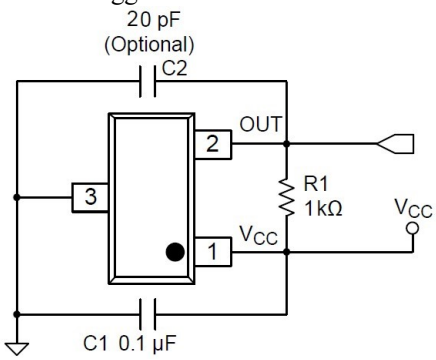
(1) 1 mT = 10 Gauss
(2) Bandwidth describes the fastest changing magnetic field that can be detected and translated to the output.

NOTICE
The magnetic field strength (Gauss) required to cause the switch to change state (operate and release) will be as specified in the magnetic characteristics. To test the switch against the specified magnetic characteristics, the switch must be placed in a uniform magnetic field.

# 9. Application Information

## 9.1 Typical Application

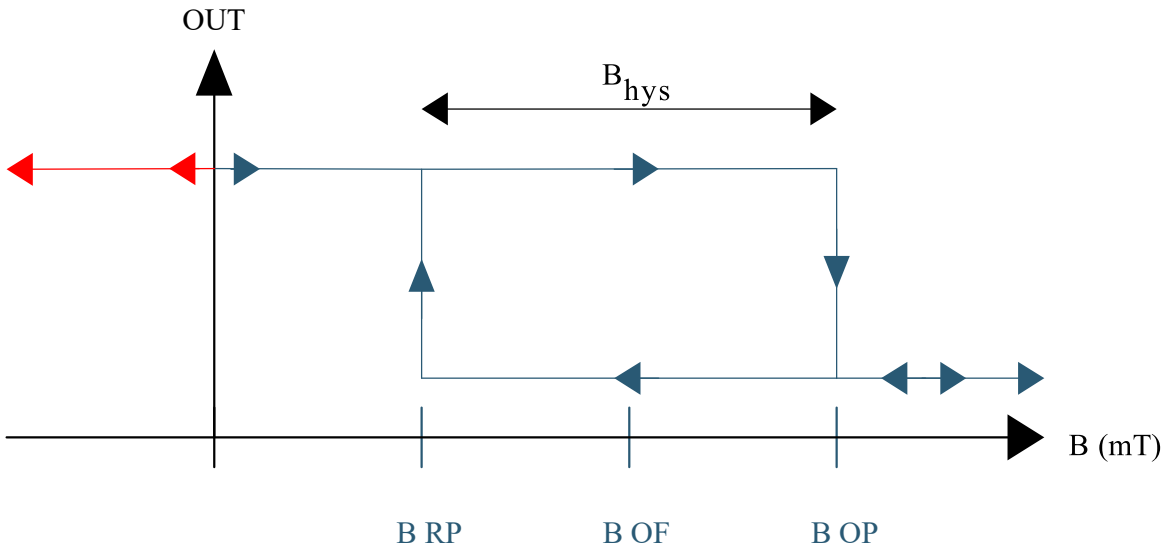
It is recommended that an external capacitor C1 is connected to the supply. This can reduce the noise injected into the device. Normal 0.1uF is suggested.




Typical Application Circuit

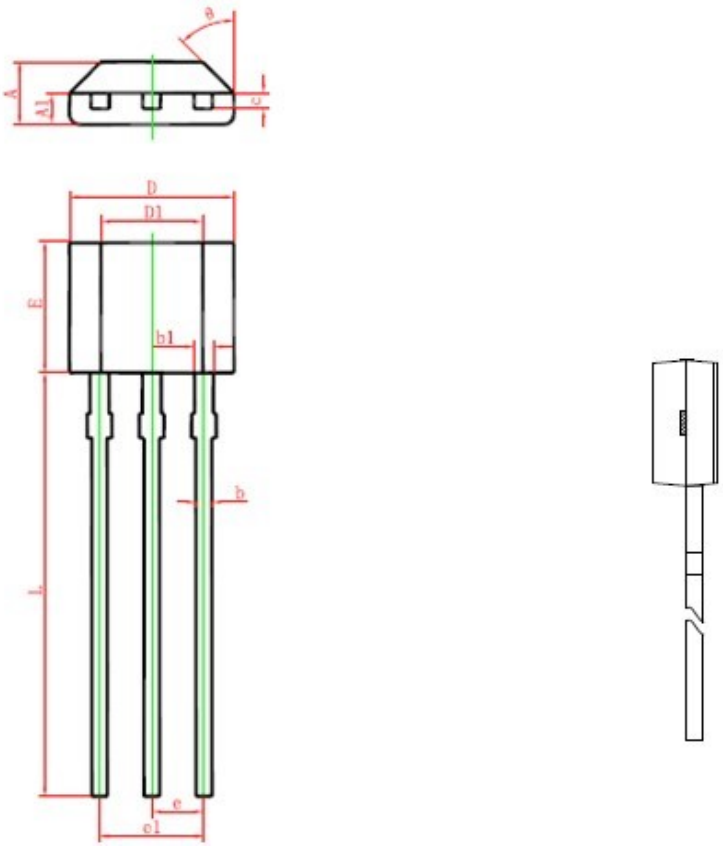
## 9.2 Device Output

If the device is powered on with a magnetic field strength between BRP and BOP, then the device output is indeterminate and can either be Hi-Z or Low. If the field strength is greater than BOP, then the output is pulled low. If the field strength is less than BRP, then the output is released.



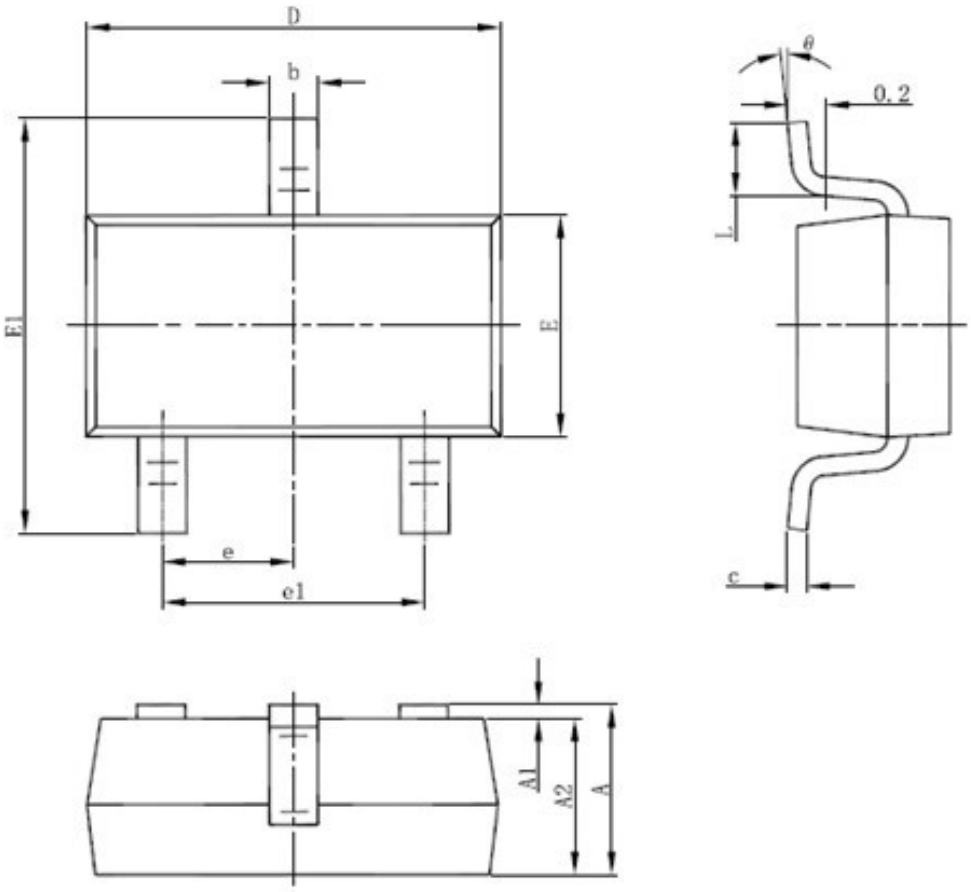
10. Package Information:

**PACKAGE DESIGNATOR**
TO-92S




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 1.420 | 1.620 | 0.056 | 0.064 |
| A1 | 0.660 | 0.860 | 0.026 | 0.034 |
| b | 0.350 | 0.480 | 0.014 | 0.019 |
| b1 | 0.400 | 0.550 | 0.016 | 0.022 |
| c | 0.360 | 0.510 | 0.014 | 0.020 |
| D | 3.900 | 4.100 | 0.154 | 0.161 |
| D1 | 2.280 | 2.680 | 0.090 | 0.106 |
| E | 3.050 | 3.250 | 0.120 | 0.128 |
| e | 1.270 TYP. | | 0.050 TYP. | |
| e1 | 2.440 | 2.640 | 0.096 | 0.104 |
| L | 15.100 | 15.500 | 0.594 | 0.610 |
| θ | 45° TYP. | | 45° TYP. | |

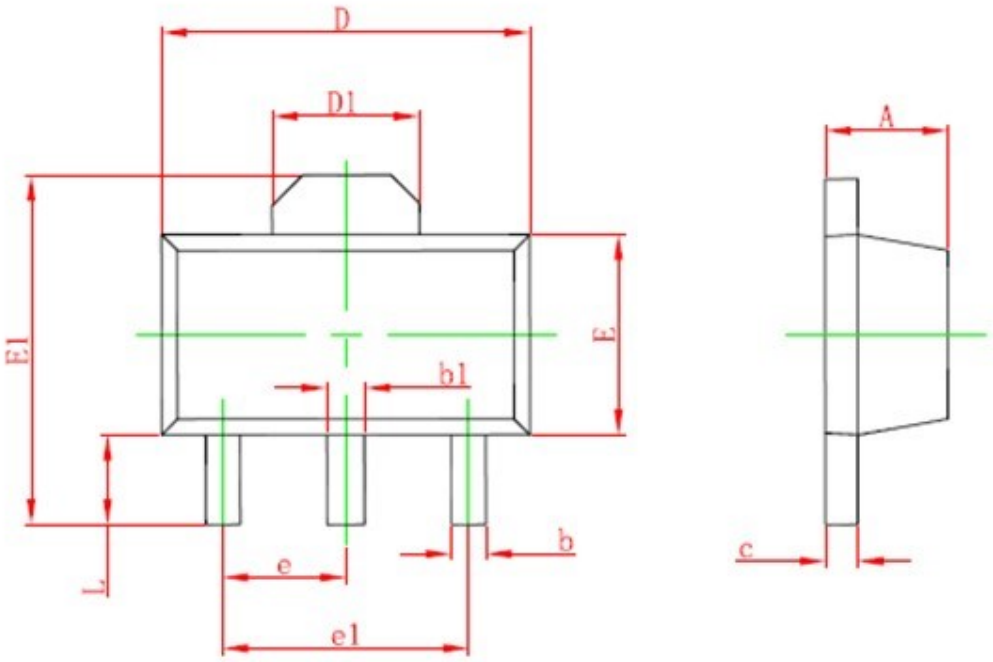
## PACKAGE DESIGNATOR
SOT-23-3L




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.950(BSC) | | 0.037(BSC) | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

## PACKAGE DESIGNATOR

**SOT-89-3L**




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 1.400 | 1.600 | 0.055 | 0.063 |
| b | 0.320 | 0.520 | 0.013 | 0.020 |
| b1 | 0.400 | 0.580 | 0.016 | 0.023 |
| c | 0.350 | 0.440 | 0.014 | 0.017 |
| D | 4.400 | 4.600 | 0.173 | 0.181 |
| D1 | 1.550 REF. | | 0.061 REF. | |
| E | 2.300 | 2.600 | 0.091 | 0.102 |
| E1 | 3.940 | 4.250 | 0.155 | 0.167 |
| e | 1.500 TYP. | | 0.060 TYP. | |
| e1 | 3.000 TYP. | | 0.118 TYP. | |
| L | 0.900 | 1.200 | 0.035 | 0.047 |