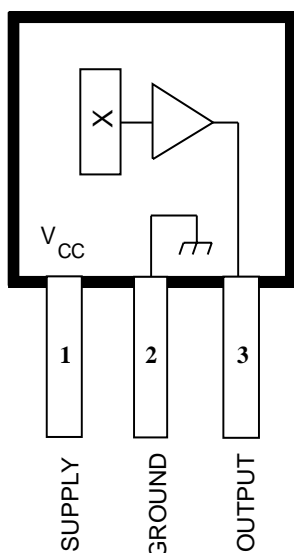


# 3506, 3507, AND 3508

## ***RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION***



Dwg. PH-006

Pinning is shown viewed from branded side.

### **ABSOLUTE MAXIMUM RATINGS**

Supply Voltage,  $V_{CC}$  ..... **6.0 V**

Output Voltage,  $V_O$  ..... **6.0 V**

Output Sink Current,  $I_O$  ..... **5.0 mA**

Magnetic Flux Density,  $B$  ..... **Unlimited**

Package Power Dissipation,

$P_D$  ..... **See Graph**

Operating Temperature Range,  $T_A$

Suffix S- ..... **-20°C to +85°C**

Suffix E- ..... **-40°C to +85°C**

Suffix L- ..... **-40°C to +150°C**

Storage Temperature Range,

$T_S$  ..... **-65°C to +170°C**

The A3506-, A3507-, and A3508- comprise a family of sensitive, temperature-stable linear Hall-effect sensors. Ratiometric, linear Hall-effect sensors provide a voltage output that is proportional to the applied magnetic field and have a quiescent output voltage that is approximately 50% of the supply voltage. These magnetic sensors are ideal for use in linear and rotary position sensing systems in the harsh environments of automotive and industrial applications over extended temperatures to -40°C and +150°C. The three devices in this series are similar except for temperature stability over the operating temperature range. See the Magnetic Characteristics table for complete, individual device parametrics.

Each monolithic circuit integrates a quadratic Hall element, improved temperature compensating circuitry to reduce the intrinsic sensitivity drift of the Hall element, a small-signal high-gain amplifier, and a rail-to-rail low-impedance output stage. Many problems normally associated with low-level analog signals are minimized by having the Hall element and amplifier in a single chip. Output precision is obtained by internal gain and offset trim adjustments during the manufacturing process.

These devices are supplied in a 3-pin mini-SIP "U" package or a 3-pin ultra-mini-SIP "UA" package.

### **FEATURES**

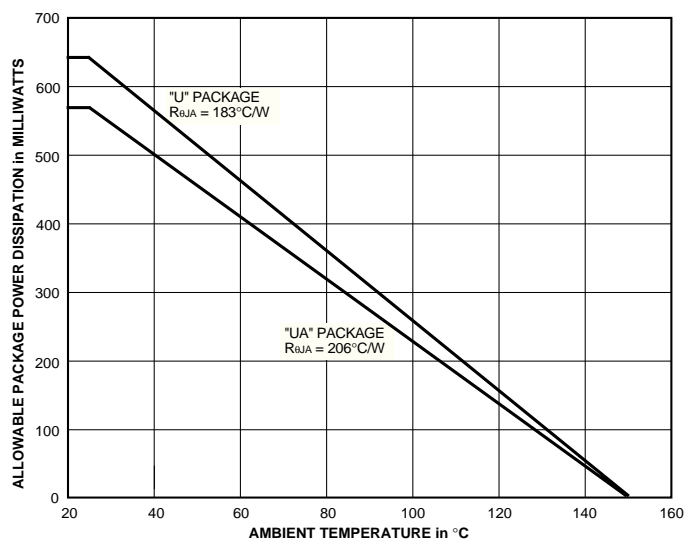
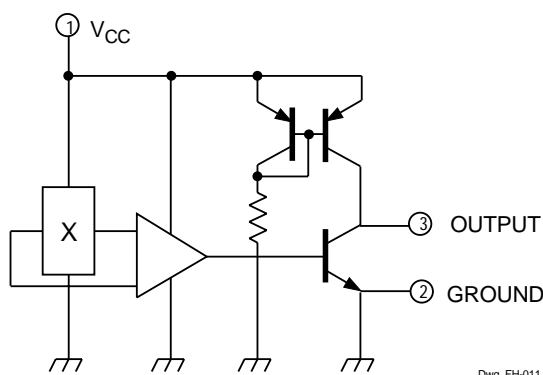
- Output Voltage Proportional to Applied Magnetic Field
- Ratiometric Rail-to-Rail Output
- Improved Sensitivity
- Superior Temperature Stability
- 4.5 V to 5.5 V Operation
- Small Package Size
- Solid-State Reliability

Always order by complete part number:

Operating Temperature Range	Output Offset with Temp., $\Delta V_{OQ(\Delta T)}$		
	$\pm 20$ G	$\pm 35$ G	$\pm 50$ G
-20°C to +85°C	—	—	<b>A3508SU A3508SUA</b>
-40°C to +85°C	—	<b>A3507EU A3507EUA</b>	—
-40°C to +150°C	<b>A3506LU A3506LUA</b>	<b>A3507LU A3507LUA</b>	—

# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

## FUNCTIONAL BLOCK DIAGRAM



## ELECTRICAL CHARACTERISTICS over operating temperature range, at $V_{CC} = 5\text{ V}$ (unless otherwise noted).

Characteristic	Symbol	Device Type*	Test Conditions	Limits			
				Min.	Typ.	Max.	Units
Supply Voltage	$V_{CC}$	All	Operating	4.5	5.0	5.5	V
Supply Current	$I_{CC}$	All	$B = 0$ , $V_{CC} = 5.5\text{ V}$ , $I_O = 0$	—	—	10	mA
Quiescent Voltage Output	$V_{OQ}$	3506	$B = 0$ , $I_O = 1\text{ mA}$ , $T_A = 25^\circ\text{C}$	2.25	2.50	2.75	V
		3507/08		2.0	2.5	3.0	V
		3506	$B = 0$ , $I_O = 1\text{ mA}$	2.10	2.50	2.90	V
		3507/08		1.8	2.5	3.2	V
Output Voltage	$V_{OH}$	All	$B = +X^\dagger$ , $I_O = 1\text{ mA}$	4.5	4.8	—	V
	$V_{OL}$	All	$B = -X^\dagger$ , $I_O = -1\text{ mA}$	—	0.2	0.5	V
Bandwidth (-3 dB)	BW	All		20	—	—	kHz
Output Resistance	$r_O$	All		—	2.5	10	$\Omega$
Wide-Band Output Noise	$e_o$	All	$B = 0$ , BW = 10 Hz to 10 kHz, $T_A = 25^\circ\text{C}$	—	125	—	$\mu\text{V}$

Negative current is defined as coming out of (sourcing) the output.

\* Complete part number includes the Allegro prefix "A", and a suffix to identify operating temperature range (S-, E-, or L-) and package type (-U or -UA). See first page for available combinations.

† This test requires positive and negative fields sufficient to swing the output driver between fully OFF and saturated (ON), respectively. It is NOT intended to indicate a range of linear operation.



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# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

**MAGNETIC CHARACTERISTICS** over operating temperature range, at  $V_{CC} = 5\text{ V}$ ,  $I_o = 1\text{ mA}$   
(unless otherwise noted).

Characteristic <sup>†</sup>	Part Numbers*												Units
	A3506L-			A3507L-			A3507E-			A3508S-			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Operating Temp. Range, T <sub>A</sub>	-40	–	+150	-40	–	+150	-40	–	+85	-20	–	+85	°C
Sensitivity at T <sub>A</sub> = 25°C	2.25	2.50	2.75	2.0	2.5	3.0	2.0	2.5	3.0	2.0	2.5	3.0	mV/G
over Oper. Temp. Range	2.00	2.50	3.00	1.7	2.5	3.3	1.7	2.5	3.3	1.7	2.5	3.3	mV/G
ΔSens <sub>(ΔT)</sub> <sup>‡</sup> at T <sub>A</sub> = Max.	-2.5	2.5	7.5	-5.0	2.5	10	-6.3	1.2	8.7	-10	–	10	%
at T <sub>A</sub> = Min.	-6.3	-1.3	3.7	-8.8	-1.3	6.2	-8.8	-1.3	6.2	-10	–	10	%
ΔV <sub>OQ(ΔT)</sub> <sup>§</sup>	–	–	±20	–	–	±35	–	–	±35	–	–	±50	G
Ratiometry, ΔV <sub>OQ(ΔV)</sub>	–	100	–	–	100	–	–	100	–	–	100	–	%
Ratiometry, ΔSens <sub>(ΔV)</sub>	–	100	–	–	100	–	–	100	–	–	100	–	%
Positive Linearity, Lin+	–	100	–	–	100	–	–	100	–	–	100	–	%
Negative Linearity, Lin–	–	100	–	–	100	–	–	100	–	–	100	–	%
Symmetry	–	100	–	–	100	–	–	100	–	–	100	–	%

Magnetic flux density is measured at most sensitive area of device located 0.015" (0.38 mm) below the branded face of the "U" package; 0.018" (0.46 mm) below the branded face of the "UA" package.

\* Complete part number includes a suffix to indicate package type (–U or –UA).

† See Characteristics Definitions for test conditions.

‡ The nominal sensitivity temperature stability is designed to compensate for the temperature coefficient of samarium-cobalt magnets ( $-0.02\%/^\circ\text{C}$ ).

§ This calculation (formula 1, next page) yields the device's equivalent accuracy, over the operating temperature range, in gauss.

# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

## CHARACTERISTICS DEFINITIONS

**Quiescent Voltage Output.** In the quiescent state (no magnetic field), the output is ideally equal to one-half of the supply voltage over the operating voltage and temperature range ( $V_{OQ} \approx V_{CC}/2$ ). Due to internal component tolerances and thermal considerations, there is a tolerance on the quiescent voltage output and on the quiescent voltage output as a function of supply voltage and ambient temperature. For purposes of specification, the quiescent voltage output as a function of temperature is defined as

$$\Delta V_{OQ(\Delta T)} = \frac{V_{OQ(TA)} - V_{OQ(25^\circ C)}}{Sens_{(25^\circ C)}} \quad (1)$$

This calculation yields the device's equivalent accuracy, over the operating temperature range, in gauss.

**Sensitivity.** The presence of a south-pole magnetic field perpendicular to the package face (the branded surface) will increase the output voltage from its quiescent value toward the supply voltage rail by an amount proportional to the magnetic field applied. Conversely, the application of a north pole will decrease the output voltage from its quiescent value. This proportionality is specified as the sensitivity of the device and is defined as

$$Sens = \frac{V_{O(500G)} - V_{O(-500G)}}{1000 \text{ G}} \quad (2)$$

The stability of sensitivity as a function of temperature is defined as

$$\Delta Sens_{(\Delta T)} = \frac{Sens_{(TA)} - Sens_{(25^\circ C)}}{Sens_{(25^\circ C)}} \times 100\% \quad (3)$$

**Ratiometry.** The A3506–, A3507–, and A3508– feature a ratiometric output. The quiescent voltage output and sensitivity are proportional to the supply voltage (ratiometric).

The per cent ratiometric change in the quiescent voltage output is defined as

$$\Delta V_{OQ(\Delta V)} = \frac{V_{OQ(VCC)} / V_{OQ(5V)}}{V_{CC} / 5 \text{ V}} \times 100\% \quad (4)$$

and the per cent ratiometric change in sensitivity is defined as

$$\Delta Sens_{(\Delta V)} = \frac{Sens_{(VCC)} / Sens_{(5V)}}{V_{CC} / 5 \text{ V}} \times 100\% \quad (5)$$

**Linearity and Symmetry.** The on-chip output stage is designed to provide a linear output to within 500 mV of either rail with a supply voltage of 5 V. This is equivalent to approximately  $\pm 800$  gauss of ambient field. Although application of stronger magnetic fields will not damage these devices, it will force the output into a non-linear region. Linearity in per cent is measured and defined as

$$Lin+ = \frac{V_{O(500G)} - V_{OQ}}{2 (V_{O(250G)} - V_{OQ})} \times 100\% \quad (6)$$

$$Lin- = \frac{V_{O(-500G)} - V_{OQ}}{2 (V_{O(-250G)} - V_{OQ})} \times 100\% \quad (7)$$

and output symmetry as

$$Sym = \frac{V_{O(500G)} - V_{OQ}}{V_{OQ} - V_{O(-500G)}} \times 100\% \quad (8)$$

# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

## APPLICATIONS INFORMATION

Calibrated linear Hall devices, which can be used to determine the actual flux density presented to the sensor in a particular application, are available.

For safe, reliable operation, the output should not be pulled above the supply voltage or pulled below the device ground.

For optimum performance, a 100 pF capacitor between the output and ground should be added.

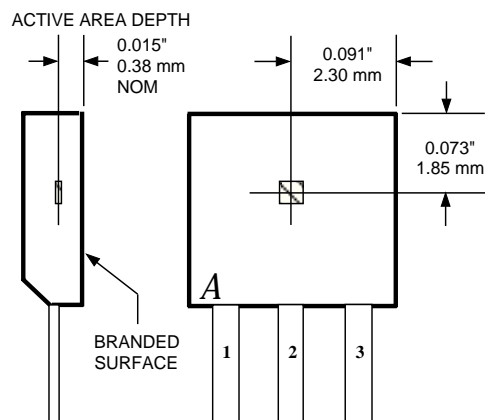
The nominal sensitivity is factory set to compensate for the temperature coefficient of samarium-cobalt magnets ( $-0.02\%/^{\circ}\text{C}$ ).

The ratiometric feature is especially valuable when these devices are used with an analog-to-digital converter. A/D converters typically derive their LSB step size by ratioing off a reference voltage line. If the reference voltage varies, the LSB will vary proportionally. This is a major error source in many sensing systems. The A3506/07/08— can eliminate this source of error by their ratiometric operation. Because their gain and offsets are proportional to the supply voltage, if they are powered from the A/D reference voltage, the sensor output voltage will track changes in the LSB value.

Extensive applications information on Hall-effect sensors and magnets is also available in the *Allegro Integrated and Discrete Semiconductors Data Book* or *Application Note 27701*.

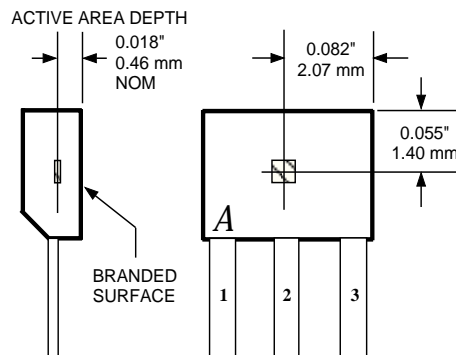
## SENSOR LOCATIONS

### SUFFIX “U”



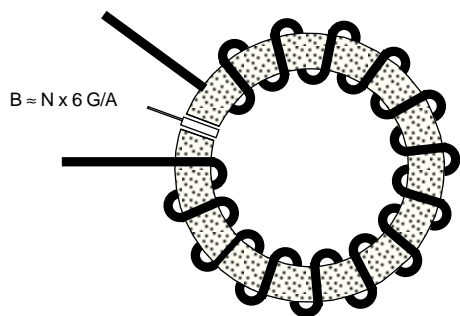
Dwg. MH-002-11A

### SUFFIX “UA”



Dwg. MH-011-6A

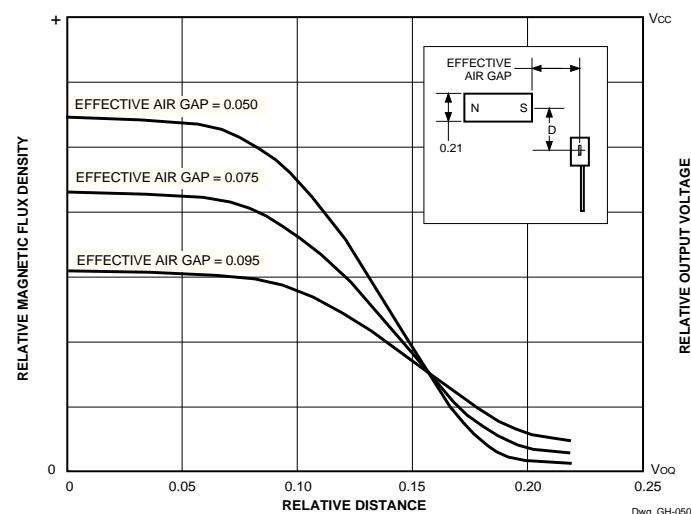
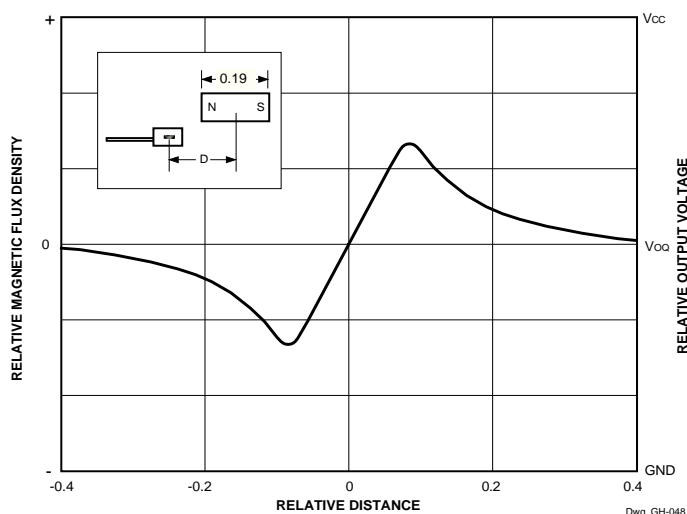
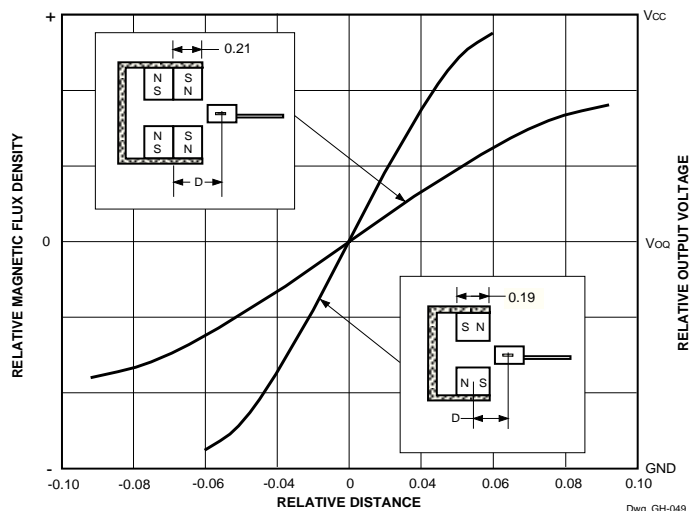
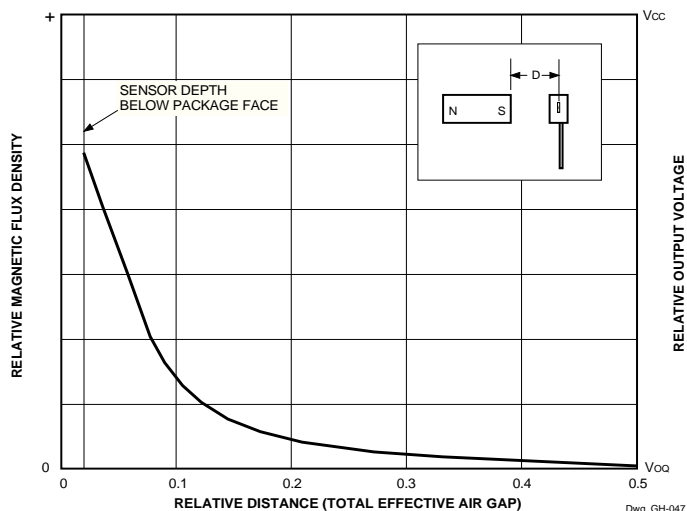
## TYPICAL CURRENT-SENSING APPLICATION



Dwg. AH-005

# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

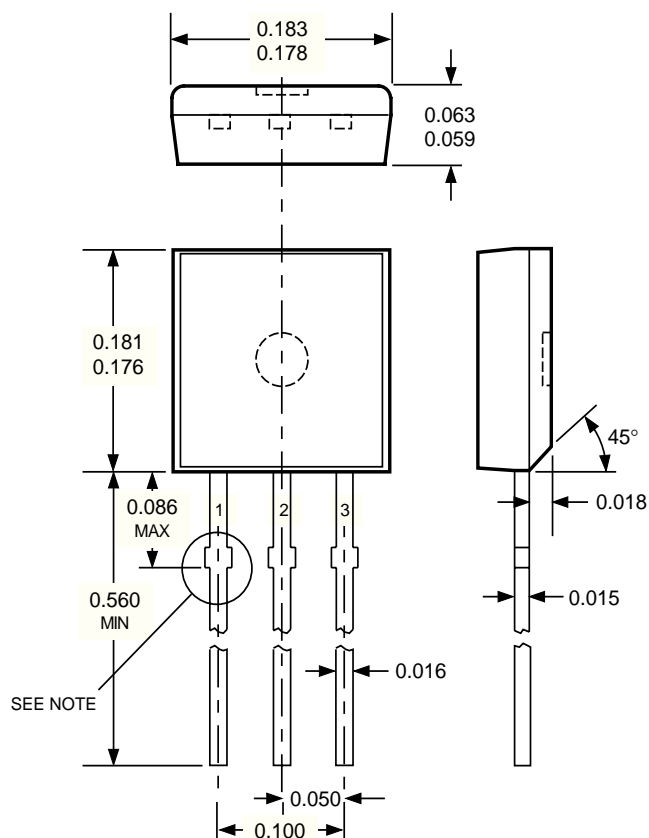
## TYPICAL POSITION-SENSING APPLICATIONS (Alnico 8, dimensions in inches)



# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

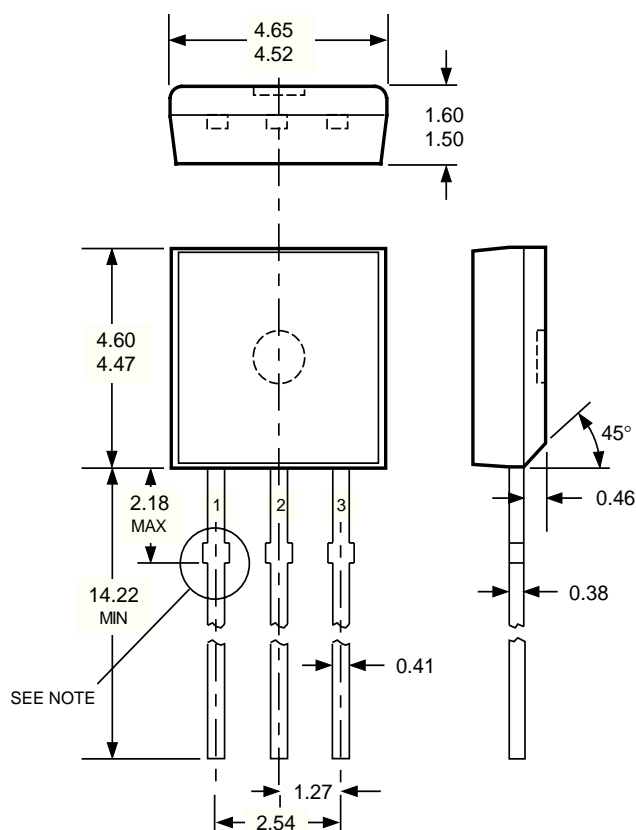
## PACKAGE DESIGNATOR U

### Dimensions in Inches



Dwg. MH-003C in

### Dimensions in Millimeters (Based on 1" = 25.4 mm)



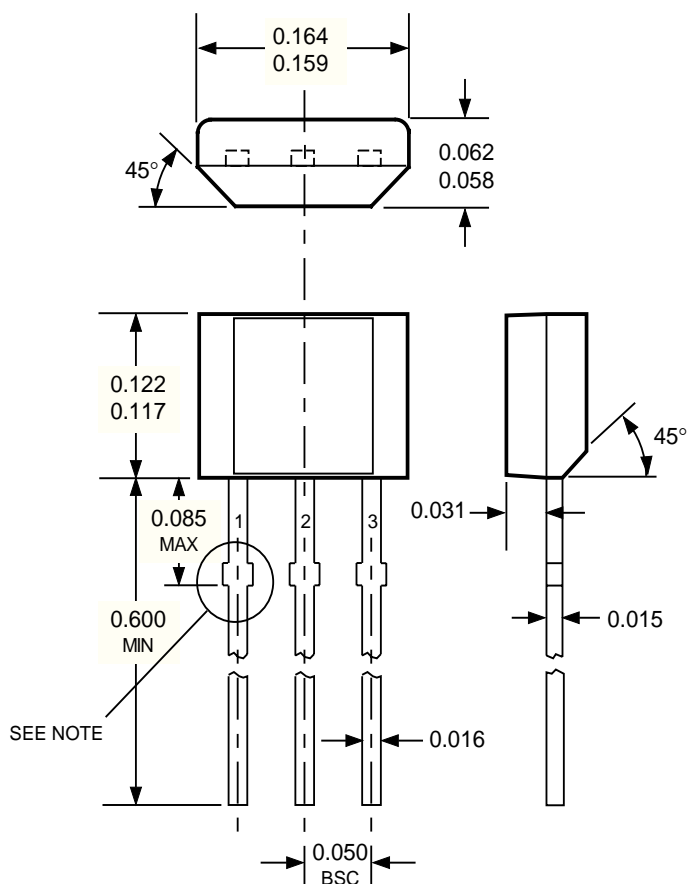
Dwg. MH-003C mm

- NOTES:
1. Tolerances on package height and width represent allowable mold offsets. Dimensions given are measured at the widest point (parting line).
  2. Exact body and lead configuration at vendor's option within limits shown.
  3. Height does not include mold gate flash.
  4. Recommended minimum PWB hole diameter to clear transition area is 0.035" (0.89 mm).

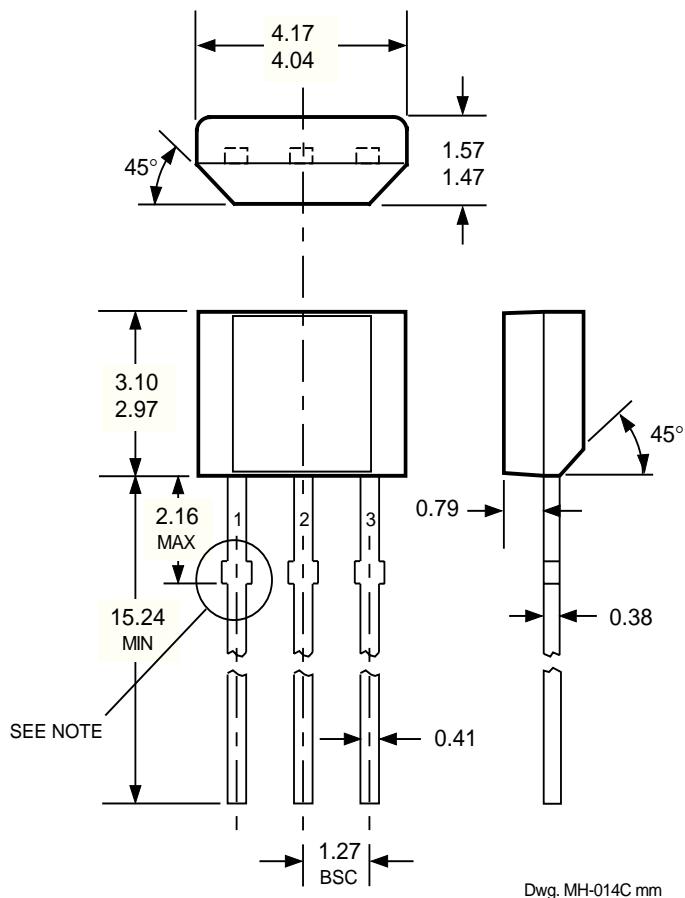
# 3506, 3507, AND 3508 RATIOMETRIC, LINEAR HALL-EFFECT SENSORS FOR HIGH-TEMPERATURE OPERATION

## PACKAGE DESIGNATOR UA

Dimensions in Inches



Dimensions in Millimeters  
(Based on 1" = 25.4 mm)



- NOTES: 1. Tolerances on package height and width represent allowable mold offsets. Dimensions given are measured at the widest point (parting line).
2. Exact body and lead configuration at vendor's option within limits shown.
3. Height does not include mold gate flash.

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