A3064

Hall Effect Gear Tooth Sensor IC, AC Coupled

Discontinued Product

These parts are no longer in production The device should not be purchased for new design applications. Samples are no longer available.

Date of status change: October 31, 2005

Recommended Substitutions:

For new customers and applications, refer to the A1421LK.
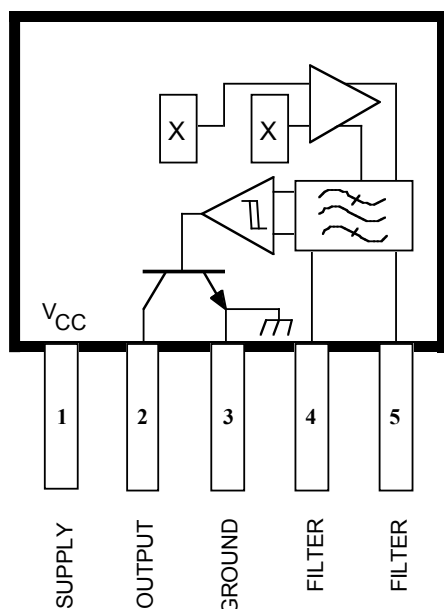
NOTE: For detailed information on purchasing options, contact your local Allegro field applications engineer or sales representative.

Allegro
MicroSystems, Inc.

3064

HALL-EFFECT GEAR-TOOTH SENSOR IC
—AC COUPLED

Dwg. PH-011-1

Pinning is shown viewed from branded side.

The A3064LKA ac-coupled Hall-effect gear-tooth sensor IC is a monolithic integrated circuit that switches in response to changing differential magnetic fields created by moving ferrous targets. This device is ideal for use in non-zero-speed, gear-tooth-based speed, position, and timing applications such as in anti-lock braking systems, transmissions, and crankshafts.

When coupled with a back-biasing magnet, the device can be configured to turn on or off with the leading or trailing edge of a gear-tooth or slot. Changes in fields on the magnet face caused by a moving ferrous mass affect the two Hall transducers and are differentially amplified by on-chip electronics. This differential design provides immunity to radial vibration within the device's operating air gap. Steady-state magnet and system offsets are eliminated using an on-chip differential band-pass filter. This filter also provides relative immunity to interference from RF and electro-magnetic sources. The on-chip temperature compensation and Schmitt trigger circuitry minimizes shifts in effective working air gaps and switch points over temperature, allowing operation to low frequencies over a wide range of air gaps and temperatures.

Each Hall-effect digital Integrated circuit includes a voltage regulator, two quadratic Hall-effect elements, temperature compensating circuitry, a low-level amplifier, band-pass filter, Schmitt trigger, and an open-collector output driver. The on-board regulator permits operation with supply voltages of 4.5 to 24 volts. The output stage can easily switch 20 mA over the full frequency response range of the device and is compatible with bipolar and MOS logic circuits.

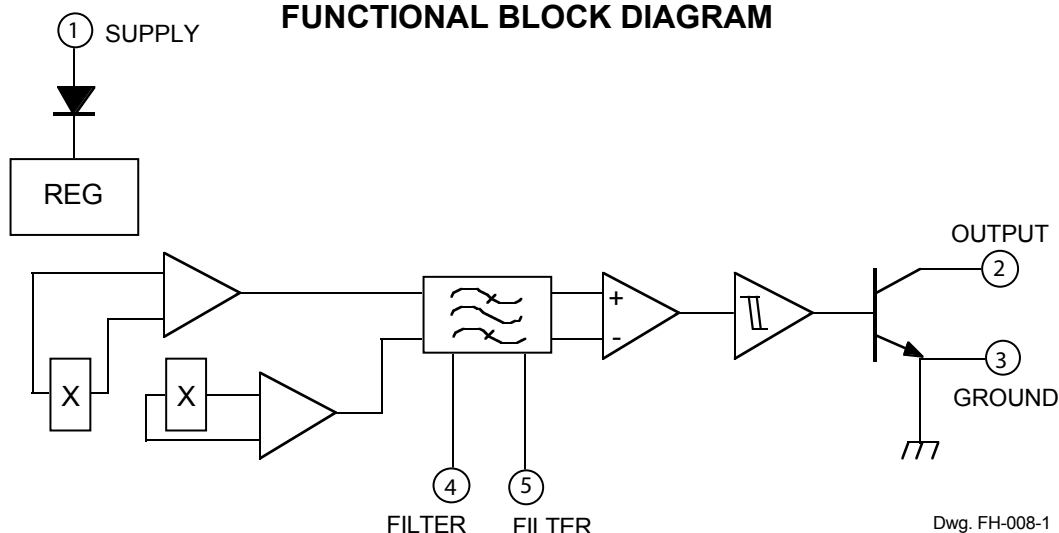The device is packaged in a 5-pin plastic SIP.

FEATURES

- For Sensing Motion of Ferrous Targets
- Wide Operating Temperature Range
- Operation to 30 kHz
- Resistant to EMI
- Large Effective Air Gap
- 4.5 V to 24 V Operation
- Output Compatible With All Logic Families
- Reverse Battery Protection
- Resistant to Physical Stress

Always order by complete part number, e.g., **A3064LKA** .

ABSOLUTE MAXIMUM RATINGS
at T_A = +25°C

Supply Voltage, V_{CC} .... **24 V**

Reverse Battery Voltage, V_{RCC} .... **-30 V**

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

Output Off Voltage, V_{OUT} .... **24 V**

Output Current, I_{OUT} .... **25 mA**

Package Power Dissipation,
   P_D .... **500 mW**

Operating Temperature Range,
   T_A .... **-40°C to +150°C**

Storage Temperature Range,
   T_S .... **-65°C to +170°C**

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MicroSystems, Inc.

3064
HALL-EFFECT
GEAR-TOOTH SENSOR IC
—AC COUPLED

FUNCTIONAL BLOCK DIAGRAM

Dwg. FH-008-1

ELECTRICAL CHARACTERISTICS over operating temperature and supply voltage range.

Characteristic	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
Supply Voltage	V_{CC}	Operating	4.5	—	24	V
Output Saturation Voltage	$V_{OUT(SAT)}$	I_{OUT} = 18 mA, B < B_{RP}	—	141	400	mV
Output Leakage Current	I_{OFF}	V_{OUT} = 24 V, B > B_{OP}	—	—	5.0	μA
Supply Current	I_{CC}	B < B_{RP}	—	11	20	mA
		B > B_{OP}	—	9.6	—	mA
High-Frequency Cutoff	f_{coh}	-3 dB	30	—	—	kHz
Output Rise time	t_r	V_{OUT} = 12 V, R_L = 820 Ω	—	0.04	0.2	μs
Output Fall time	t_f	V_{OUT} = 12 V, R_L = 820 Ω	—	0.18	0.3	μs

MAGNETIC CHARACTERISTICS over operating temperature and supply voltage range.

Characteristic	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
Operate Point	B_{OP}	Output switches on to off	0	15	27.5	G
Release Point	B_{RP}	Output switches off to on	-12.5	0	7.5	G
Hysteresis	B_{hys}	B_{OP} - B_{RP}	5.0	15	35	G

NOTES: 1. Magnetic switch points are specified as the difference in magnetic fields at the two Hall elements.
2. As used here, negative flux densities are defined as less than zero (algebraic convention).
3. Typical values are at T_A = 25°C and V_{CC} = 12 V.
4. 1 gauss (G) is exactly equal to 0.1 millitesla (mT).

TYPICAL OPERATING CHARACTERISTICS

SWITCH POINTS

Graph: DIFFERENTIAL FLUX DENSITY IN GAUSS (y-axis, -10 to 30) vs AMBIENT TEMPERATURE IN °C (x-axis, -50 to 150). $V_{CC} = 12$ V. Curves labeled OPERATE POINT and RELEASE POINT.
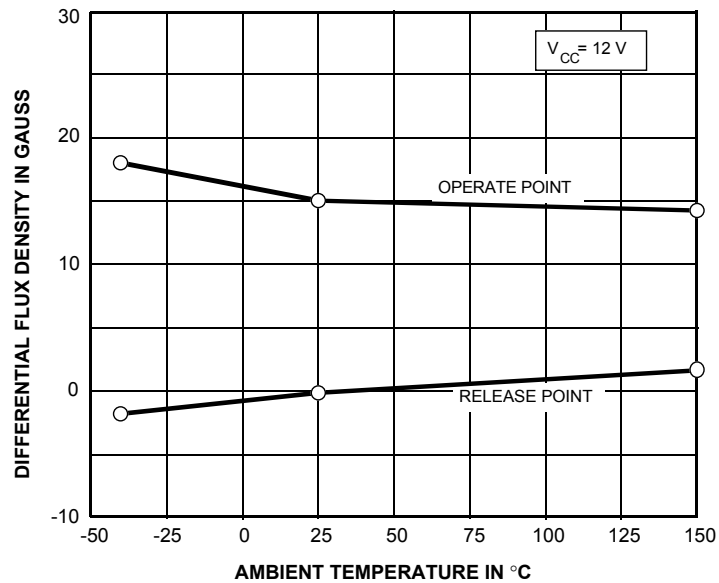
Dwg. GH-056-1

OUTPUT SATURATION VOLTAGE
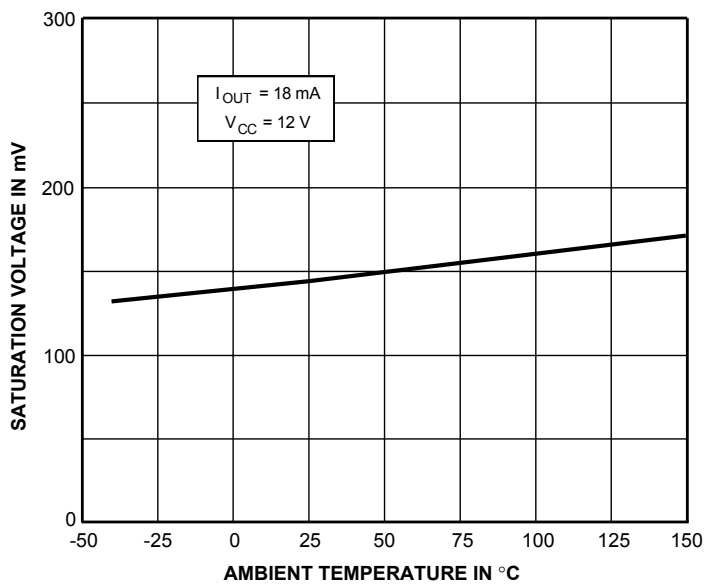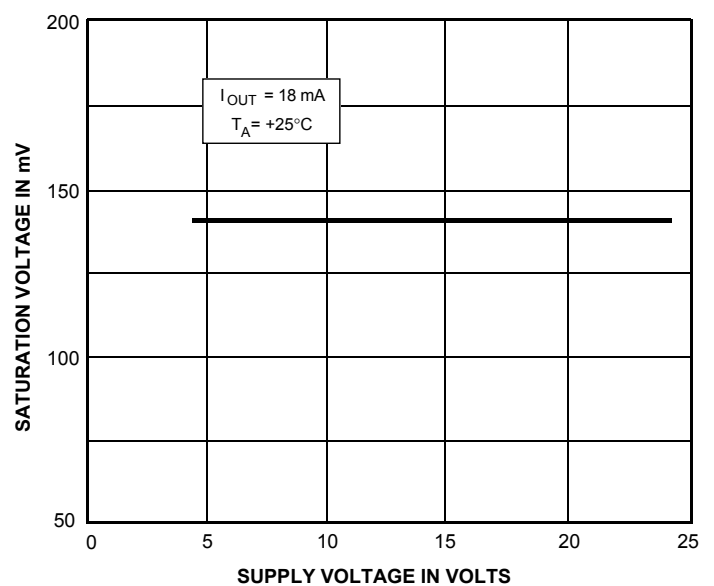
Graph left: SATURATION VOLTAGE IN mV (y-axis, 0 to 300) vs AMBIENT TEMPERATURE IN °C (x-axis, -50 to 150). $I_{OUT} = 18$ mA, $V_{CC} = 12$ V.

Dwg. GH-029-6

Graph right: SATURATION VOLTAGE IN mV (y-axis, 50 to 200) vs SUPPLY VOLTAGE IN VOLTS (x-axis, 0 to 25). $I_{OUT} = 18$ mA, $T_A = +25°C$.

Dwg. GH-055-2

TYPICAL OPERATING CHARACTERISTICS

SUPPLY CURRENT

V_{CC} = 24 V

B < B_{RP}

B > B_{OP}

SUPPLY CURRENT IN mA

AMBIENT TEMPERATURE IN °C

Dwg. GH-028-9

B < B_{RP}

B > B_{OP}

T_A = +25°C

SUPPLY CURRENT IN mA

SUPPLY VOLTAGE IN VOLTS
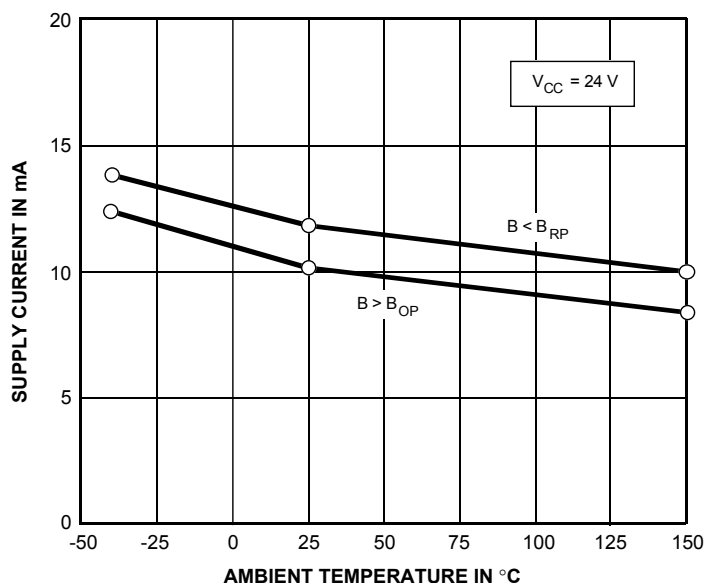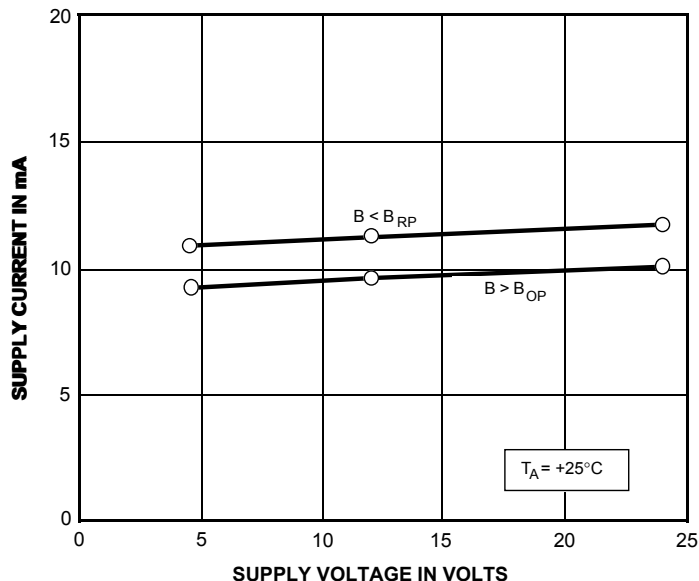
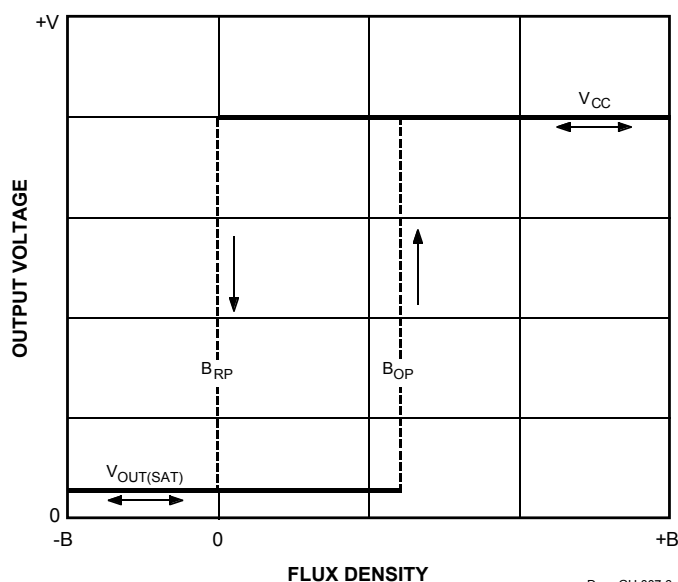Dwg. GH-031-3

APPLICATIONS INFORMATION

The A3064LKA is a versatile high-precision differential sensing device that can be used in a wide range of applications. Careful choice of the sensor IC, target material and shape, magnet material and shape, and assembly techniques enables large working air gaps and high switch-point accuracy over the system operating temperature range.

Magnet Biasing. To sense moving non-magnetized ferrous targets, these devices must be back biased by mounting the unbranded side on a small permanent magnet. Either magnetic pole (north or south) can be used.

The devices can be used without a back-biasing magnet. For example, the device can be used to detect a rotating ring magnet such as those found in brushless dc motors or in speed sensing applications.

Device **Operation.** These sensor ICs each contain two Hall transducers (E1 and E2) that are used to sense a magnetic field differential across the face of the IC (see Element Location drawing). Referring to the Typical Transfer Charac-teristic (Figure 1), the trigger switches the output off (output high) when B_{E1} - $B_{E2} > B_{OP}$ and switches the output on (output

Figure 1
TYPICAL TRANSFER CHARACTERISTIC

+V

V_{CC}

OUTPUT VOLTAGE

B_{RP}

B_{OP}

$V_{OUT(SAT)}$

-B   0   +B

FLUX DENSITY

Dwg. GH-007-6

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Worcester, Massachusetts 01615-0036 (508) 853-5000

APPLICATIONS INFORMATION (cont'd)

low) when $B_{E1} - B_{E2} < B_{RP}$. The difference between B_{OP} and B_{RP} is the hysteresis of the device.

Note that powering up in the absence of a differential magnetic field (less than the device B_{OP} and higher than the device B_{RP}) will allow an indeterminate output state. The correct output state is warranted after the first excursion beyond B_{OP} or B_{RP}.

Figure 2 relates the output state of a back-biased sensor IC, with switching characteristics shown in Figure 1, to the target gear profile and position. Assume a north pole back-bias configuration (equivalent to a south pole at the face of the device). The motion of the gear produces a phase-shifted field at E1 and E2 (Figure 2(a)); internal conditioning circuitry subtracts the fields at the two elements (Figure 2(b)); this differential field is band-pass filtered to remove dc offset components and then fed into a Schmitt trigger; the Schmitt trigger switches the output transistor at the thresholds B_{OP} and B_{RP}. As shown (Figure 2(c)), the IC output is low whenever E2 faces a (ferrous) gear tooth and element E1 faces air. The output is high when element E1 faces air and E2 faces a ferrous target.

AC-Coupled Operation. Steady-state magnet and system offsets are eliminated using an on-chip differential band-pass filter. The lower frequency cut-off of this patented filter is set using an external capacitor, the value of which can range from 0.01 µF to 10 µF. The high-frequency cut-off of this filter is set at 30 kHz by an internal integrated capacitor.

The differential structure of this filter improves the ability of the IC to reject single-ended noise on the ground or supply line and, as a result, makes it more resistant to radio-frequency and electromagnetic interference typically seen in hostile remote-sensing environments. This filter configuration also increases system tolerance to capacitor degradation at high temperatures, allowing the use of an inexpensive external ceramic capacitor.

Low-Frequency Operation. Low-frequency operation of the device is set by the value of an external capacitor. Ideally, the differential flux density range (determined by the applied target) vs. air gap assumes a perfect sinusoidal input. Figure 3 provides the low-frequency cut-off (-3 dB point) of the filter as a function of capacitance value. This information should be used with care. In reality, when used with gear teeth,

Figure 2

OUTPUT DUTY CYCLE ≈ 50%

Dwg. WH-003-3

Figure 3

Dwg. GH-025
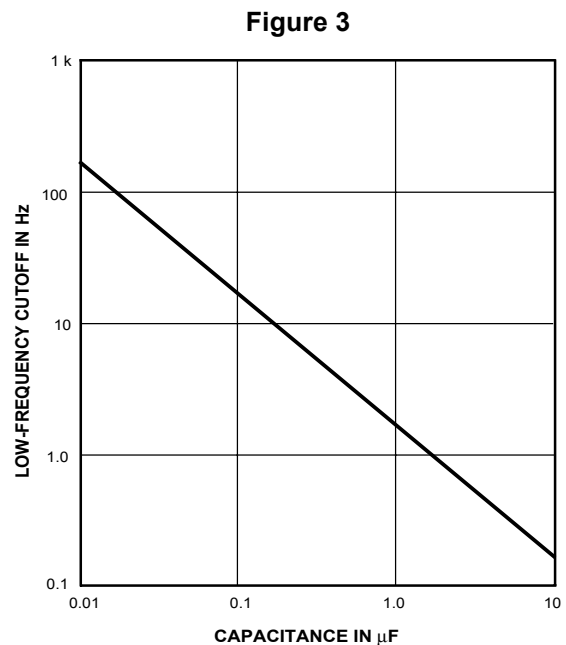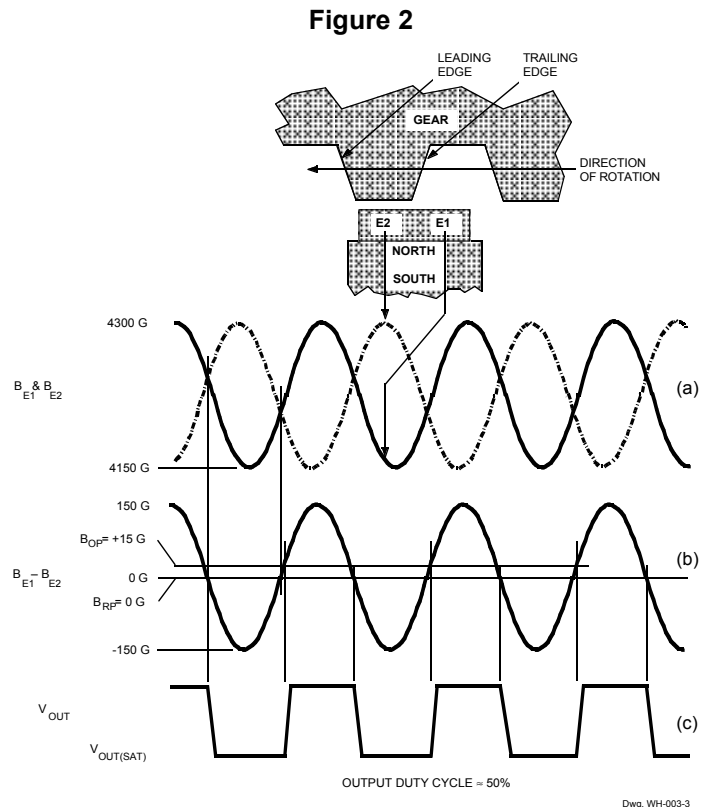
APPLICATIONS INFORMATION (cont'd)

the teeth create transitions in the magnetic field that have a much higher frequency content than the basic rotational speed of the target. This allows the device to work with speeds much lower than those indicated by the graph for a given capacitor value.

Capacitor Characteristics. The major requirement for the external capacitor is its ability to operate in a bipolar (non-polarized) mode. Another important requirement is the low leakage current of the capacitor (equivalent parallel resistance should be greater than 500 kΩ). To maintain proper operation with frequency, capacitor values should be held to within ±30% over the operating temperature range. The commonly available Z5U ceramic capacitor temperature code should not be used in this application.

Magnet Selection. The A3064LKA can be used with a wide variety of commercially available permanent magnets. The selection of the magnet depends on the operational and environmental requirements of the sensing system. For systems that require high accuracy and large working air gaps or an extended temperature range, the usual magnet material of choice is rare-earth samarium cobalt (SmCo). This magnet material has a high energy product and can operate over an extended temperature range. For systems that require low-cost solutions for an extended temperature range, AlNiCo 8 can be used. Due to its relatively low energy product, smaller operational air gaps can be expected. Neodymium iron boron (NeFeB) can be used over moderate temperature ranges when large working air gaps are required. Of these three magnet materials, AlNiCo 8 is the least expensive by volume and SmCo is the most expensive.

Extensive applications information for Hall-effect devices is available in:
• Hall-Effect IC Applications Guide, Application Note 27701;
• Hall-Effect Devices: Soldering, Gluing, Potting, Encapsulating, and Lead Forming, Application Note 27703.1;
• Soldering of Through-Hole Hall-Sensor Dervices, Application Note 27703; and
• Soldering of Surface-Mount Hall-Sensor Devices, Application Note 27703.2.
All are provided in Allegro Electronic Data Book, AMS-702. or at

www.allegromicro.com

Figure 4
ELEMENT LOCATIONS
(±0.005 [0.13 mm] die placement)
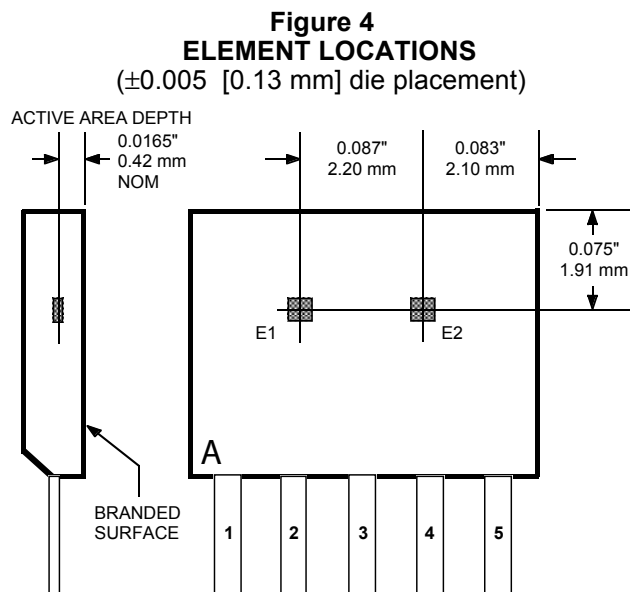
Dwg. MH-007E

CRITERIA FOR DEVICE QUALIFICATION

All Allegro devices are subjected to stringent qualification requirements prior to being released to production. To become qualified, except for the destructive ESD tests, no failures are permitted.

Qualification Test	Test Method and Test Conditions	Test Length	Samples	Comments
Biased Humidity (HAST)	JESD22-A101, RH = 85%	2000 hrs	320	$V_{CC} = V_{OUT}$ = 12 V 116 pcs at T_A = 25°C 116 pcs at T_A = 150°C
High-Temperature Operating Life (HTOL)	JESD22-A108, $T_J \leq 190°C$	2000 hrs	146	$V_{CC} = V_{OUT}$ = 12 V 116 pcs at T_A = 25°C 30 pcs at T_A = 150°C
Accelerated HTOL	T_A = 175°C, $T_J \leq 190°C$	500 hrs	50	$V_{CC} = V_{OUT}$ = 7.5 V
Autoclave, Unbiased	JESD22-A102, Condition C, T_A = 121°C at 15 psig	192 hrs	77	
Solder Heat			22	
High-Temperature (Bake) Storage Life	MIL-STD-883, Method 1008, T_A = 170°C	2000 hrs	77	
Temperature Cycle (unbiased)	MIL-STD-883, Method 1010, +25°C to +150°C	2000 cycles	153	
ESD, Human Body Model	MIL-STD-883, Method 3015	Pre/Post Reading	3 per test	Test to failure, All leads > 2 kV

Dimensions in Inches
(controlling dimensions)

0.252
0.247

0.063
0.059

0.181
0.176

0.083
MAX

0.600
0.560

SEE NOTE

45°

0.018

0.0173
0.0138

1   2   3   4   5

0.0189
0.0142

0.050
BSC

Dwg. MH-010H in
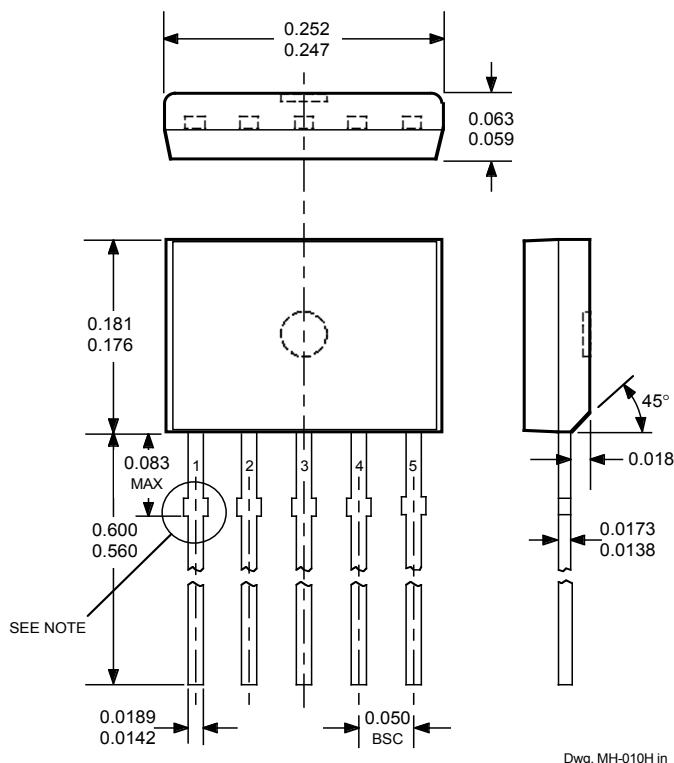
Dimensions in Millimeters
(for reference only)

6.40
6.27

1.60
1.50

4.60
4.47

2.11
MAX

15.24
14.23

SEE NOTE

45°

0.46

0.44
0.35

1   2   3   4   5

0.48
0.36

1.27
BSC

Dwg. MH-010H mm
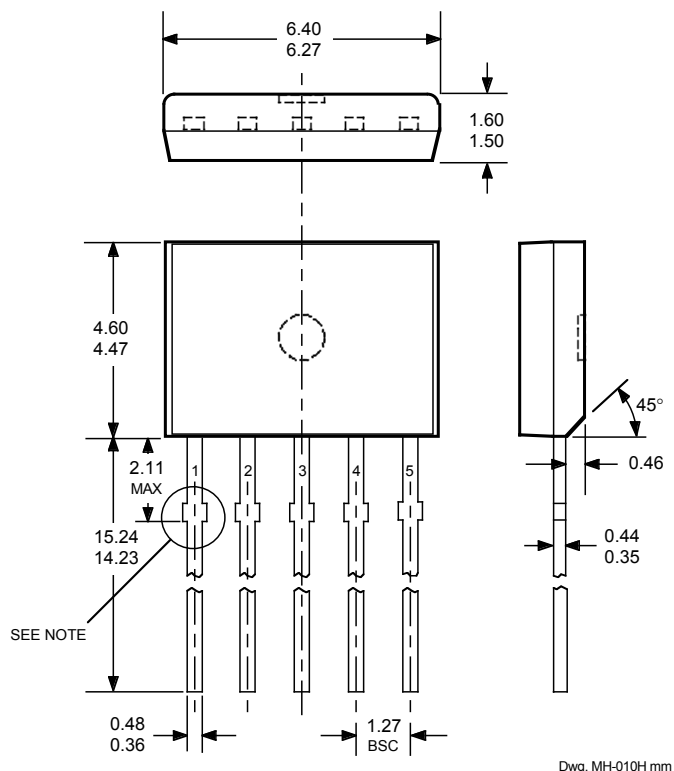
Horizontal-Mount Lead Form (order A3064LKA-TL)

0.095
±0.005

0.002
MAX

0.004
MAX

0°–8°

0.020
MIN
FLAT

Dwg. MH-015 in

2.41
±0.13

0.051
MAX

0.10
MAX

0°–8°

0.51
MIN
FLAT

Dwg. MH-015 mm
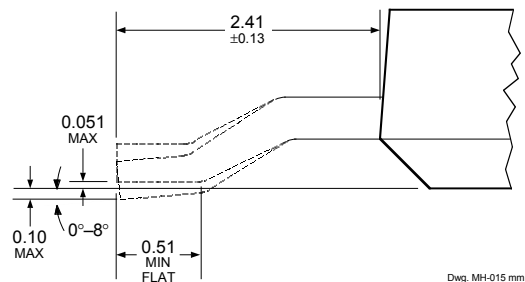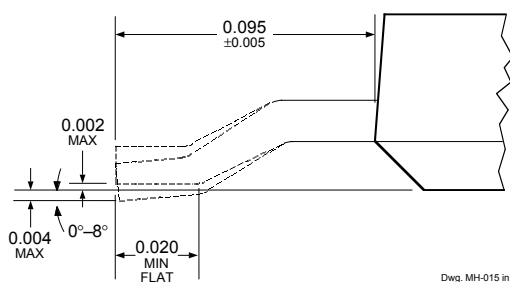
NOTES: 1. Tolerances on package height and width represent allowable mold offsets.
            Dimensions given are measured at the widest point (parting line).

    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).

    5. Where no tolerance is specified, dimension is nominal.

    6. Supplied in bulk pack (500 pieces per bag).