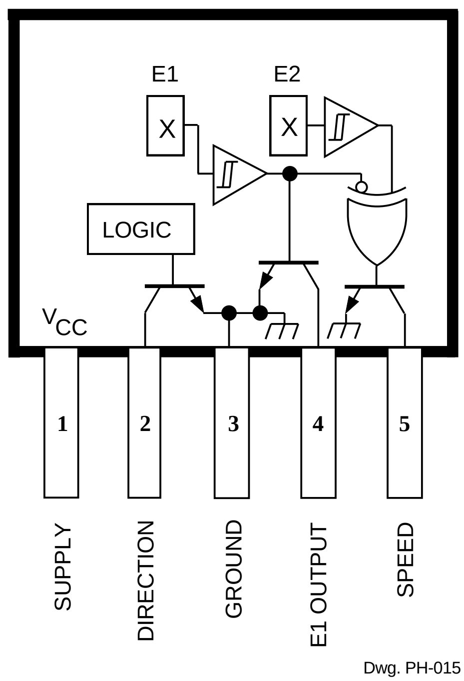
3422

Data Sheet
27650.1A*

PRELIMINARY INFORMATION
(subject to change without notice)
Februaryt 21, 2003

HALL-EFFECT, DIRECTION-DETECTION SENSORS



Pinning is shown viewed from branded side.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC} . . . . **18 V**
Magnetic Flux Density, B . . . . **Unlimited**
Output OFF Voltage, V_{OUT} . . . . **V_{CC}**
Output Sink Current, I_{OUT} . . . . **30 mA**
Package Power Dissipation,
P_D . . . . **500 mW**
Operating Temperature Range, T_A
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 A3422xKA Hall-effect, direction-detection sensor is a new generation of special-function integrated sensors that is capable of sensing the direction of rotation of a ring magnet. This transducer provides separate digital outputs that provide information on magnet rotation speed, direction, and magnet pole count. This device eliminates the major manufacturing hurdles encountered in fine-pitch direction-detection applications, namely maintaining accurate mechanical location between the two active Hall elements. Here, the two Hall elements are photolithographically aligned to better than 1 µm, as contrasted with 100 µm or worse mechanical location tolerance when manufactured discretely. This highly sensitive, temperature-stable, magnetic transducer is ideal for use in digital-encoder systems in the harsh environments of automotive or industrial applications. The A3422xKA is a high-sensitivity device optimized for use with high-density magnets.

The A3422xKA monolithic integrated circuit contains two independent Hall-effect latches whose digital outputs are internally coupled to CMOS logic circuitry that decodes signal speed and direction. Extremely low-drift BiCMOS circuitry is used for the amplifiers to ensure symmetry between the two latches so that signal quadrature can be maintained. An on-chip voltage regulator allows the use of this device from a 4.5 V to 18 V supply. The outputs are standard open-collector outputs.

Two operating temperature ranges are provided; suffix 'E–' is for the automotive and industrial temperature range of -40°C to +85°C, suffix 'L–' is for the automotive and military temperature range of -40°C to +150°C. The 5-pin 'KA' SIP package provides a cost-competitive solution to magnetic sensing in harsh environments.

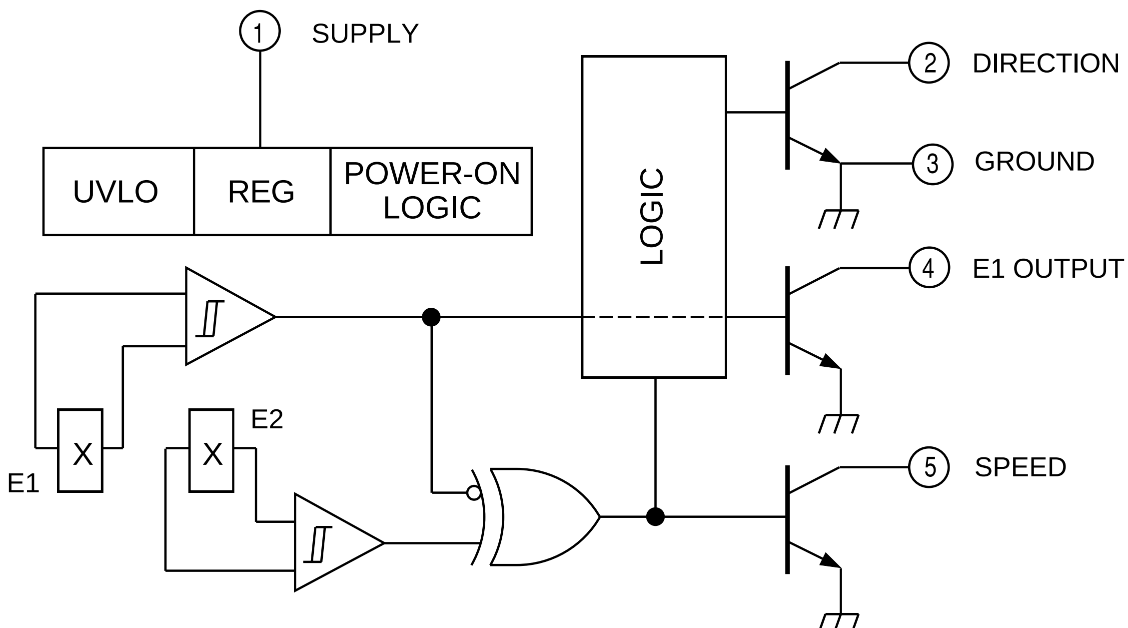
FEATURES

- Internal Direction-Decoding Circuitry
- Two Matched Hall Latches On A Single Substrate
- Superior Temperature Stability
- 4.5 V to 18 V Operation
  Electrically Defined Power-On State
  Under-Voltage Lockout

Always order by complete part number: the prefix 'A' + the basic four-digit part number + a suffix to indicate operating temperature range + a suffix to indicate package style, e.g., A3422EKA .

3422
HALL-EFFECT, DIRECTION-DETECTION SENSOR

FUNCTIONAL BLOCK DIAGRAM



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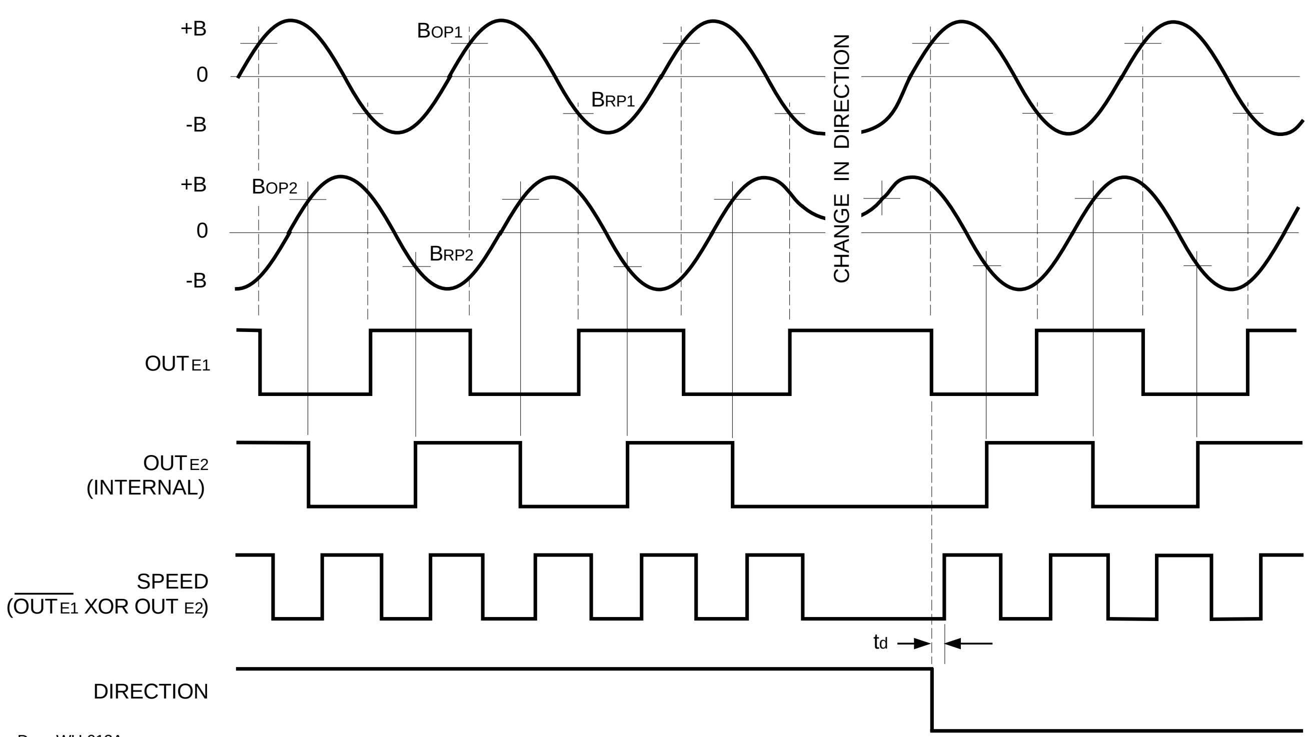
TIMING DIAGRAM



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115 Northeast Cutoff, Box 15036
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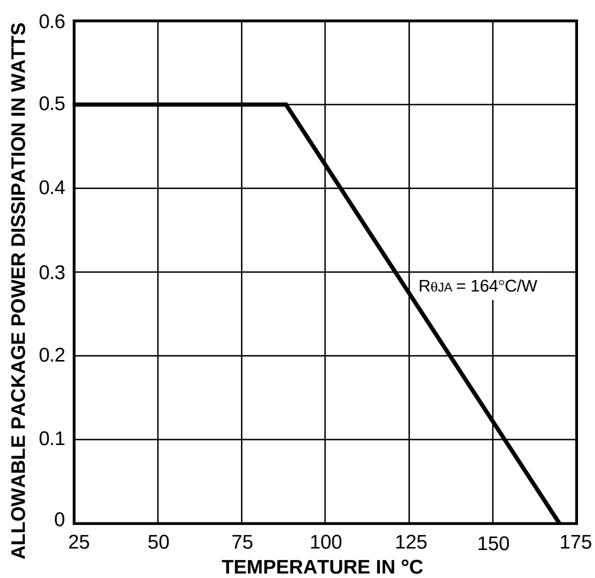
ELECTRICAL CHARACTERISTICS over operating temperature range.

Characteristic	Symbol	Test Conditions	Limits Min.	Typ.	Max.	Units
Supply Voltage Range	V_{CC}	Operating, T_J < 165°C[1]	4.5	—	18	V
Output Leakage Current	I_{OFF}	$V_{OUT} = V_{CC}$ = 18 V	—	<1.0	10	µA
Output Saturation Voltage	$V_{OUT(SAT)}$	I_{OUT} = 20 mA	—	0.21	0.50	V
Power-On State	POS	V_{CC} = 0 → 5 V, $B_{RP1} < B < B_{OP1}$, $B_{RP2} < B < B_{OP2}$	OFF	OFF	OFF	—
Under-Voltage Lockout	$V_{CC(UV)}$	I_{OUT} = 20 mA, V_{CC} = 0 → 5 V	—	3.5	—	V
Under-Voltage Hysteresis	$V_{CC(hys)}$	Lockout ($V_{CC(UV)}$) - Shutdown	—	0.5	—	V
Power-On Time	t_{po}	V_{CC} > 4.5 V	—	—	50	µs
Output Rise Time	t_r	C_L = 20 pF, R_L = 820 Ω	—	200	—	ns
Output Fall Time	t_f	C_L = 20 pF, R_L = 820 Ω	—	200	—	ns
Direction Change Delay	t_d	C_L = 20 pF, R_L = 820 Ω	0.5	1.0	5.0	µs
Supply Current	I_{CC}	V_{CC} = 8 V, All outputs OFF	5.0	9.0	18	mA

NOTES: 1. Maximum supply voltage must be adjusted for power dissipation and ambient temperature.
2. Typical Data is at V_{CC} = 12 V and T_A = +25°C and is for design information only.



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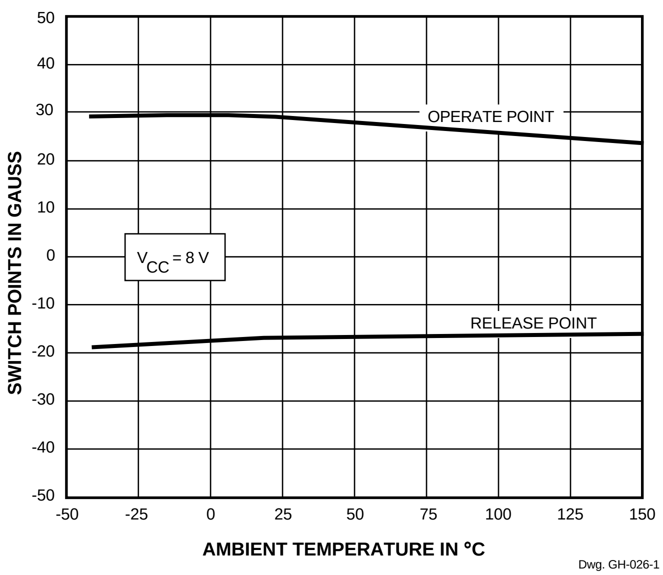
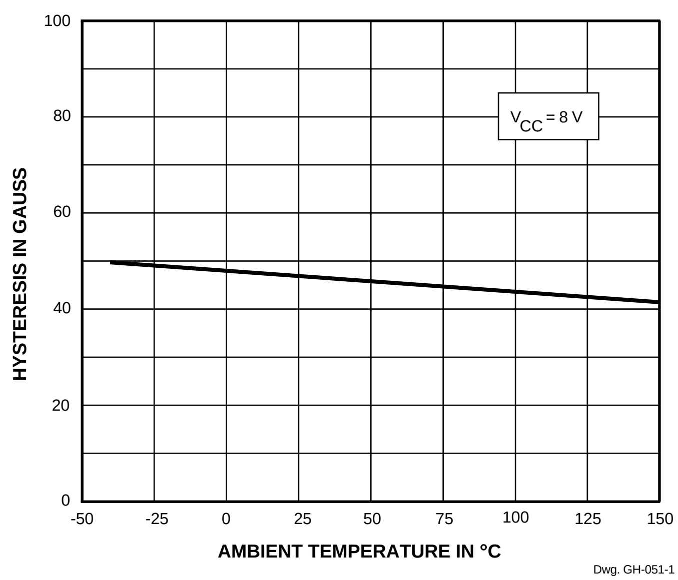
MAGNETIC CHARACTERISTICS over operating voltage range.

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Operate Point	B_{OP}	T_A = -40°C	—	—	85	G
		T_A = +25°C	—	29	75	G
		T_A = Maximum	—	—	75	G
Release Point[3]	B_{RP}	T_A = -40°C	-85	—	—	G
		T_A = +25°C	-75	-17	—	G
		T_A = Maximum	-75	—	—	G
Hysteresis	B_{hys}	T_A = -40°C	10	—	—	G
		T_A = +25°C	10	46	—	G
		T_A = Maximum	10	—	—	G
Operate Differential	—	B_{OP1} - B_{OP2}	—	—	±60	G
Release Differential	—	B_{RP1} - B_{RP2}	—	—	±60	G

NOTES: 1. Magnetic flux density is measured at most sensitive area of device, nominally located 0.0165” (0.42 mm) below the branded face of the package.
2. Typical Data is at V_{CC} = 12 V and T_A = +25°C and is for design information only.
3. As used here, negative flux densities are defined as less than zero (algebraic convention).

Typical Magnetic Characteristics





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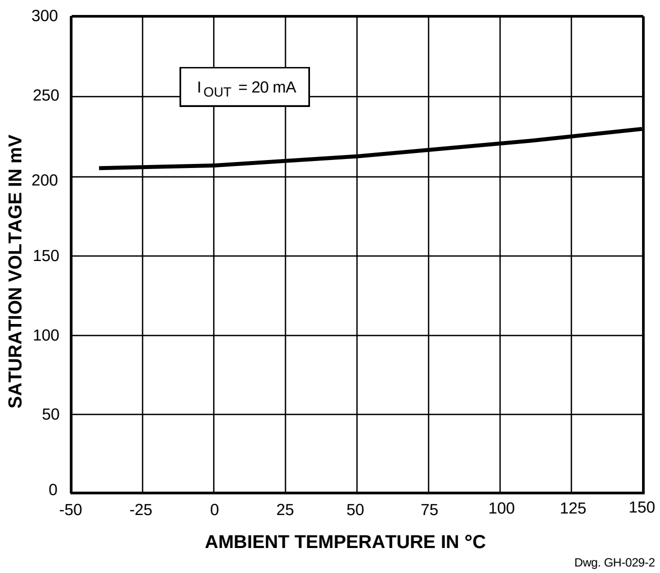
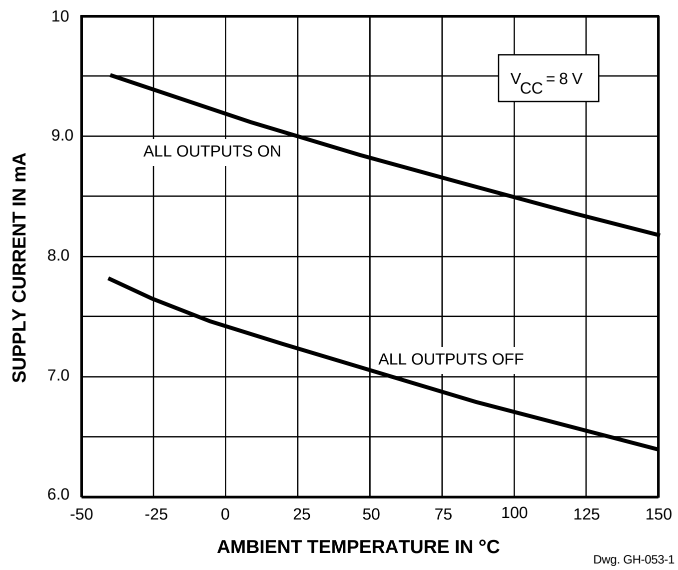
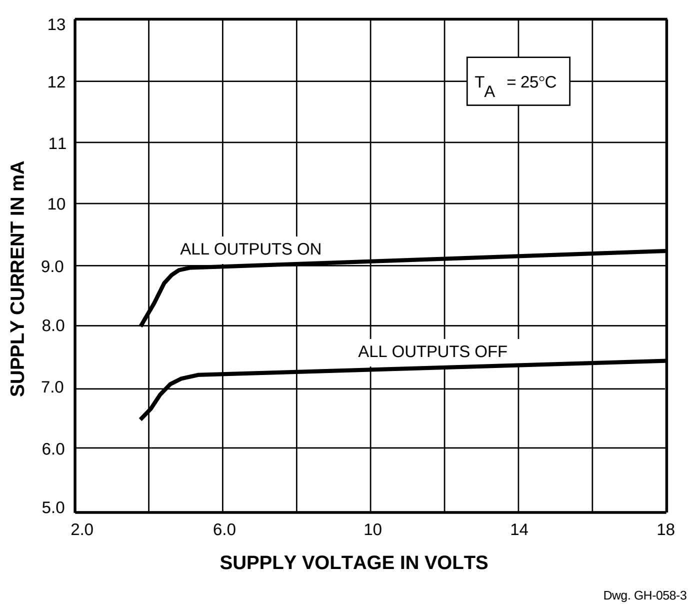
Typical Electrical Characteristics







Functional Description

The integrated circuit contains an internal voltage regulator that powers the Hall sensors and both the analog and digital circuitry. This regulator allows operation over a wide supply voltage range and provides some immunity to supply noise. The device also contains CMOS logic circuitry that decodes the direction of rotation of the ring magnet.

Quadrature/Direction Detection. Internal logic circuitry provides outputs representing speed and direction of the magnetic field across the face of the package. For the direction signal to be appropriately updated, a quadrature relationship must be maintained between the ring magnet pole width*, the sensor-to-sensor spacing, and, to a lesser extent, the magnetic switch points. For optimal design, the sensor should be actuated with a ring magnet pole width* two times the sensor-to-sensor spacing. This will produce a sinusoidal magnetic field whose period (denoted as *T*) is then four times the sensor-to-sensor spacing. A quadrature relationship can also be maintained for a ring magnet that has a period that satisfies the relationship $nT/4 = 1.5$ mm, where n is any odd integer. Therefore, ring magnets with pole-pair spacings equal to 6 mm (n = 1), 2 mm (n = 3), 1.2 mm (n = 5), etc. are permitted.

The response of the device to the magnetic field produced by a rotating ring magnet is shown on page 2. Note the phase shift between the two integrated sensors.

*"Pole" refers to a single pole (North or South) unless stated as "pole pair" (North and South).

Outputs. The device provides three saturated outputs: DIRECTION, E1 OUTPUT, and SPEED. DIRECTION provides the direction output of the sensor and is defined as OFF (high) for the direction E1 to E2 and ON (low) for the direction E2 to E1. SPEED provides an XOR'd output of the two sensors. Because of internal delays, DIRECTION will always be updated before SPEED and is updated at every transition of E1 OUTPUT and E2 OUTPUT (internal) allowing the use of up-down counters without the loss of pulses.

Power-On State. At power on, the logic circutry is reset to provide an OFF (high) at DIRECTION and an OFF (high) for E1 and E2 (internal) for magnetic fields less than B_{OP}. This eliminates ambiguity when the device is powered up and either sensor detects a field between B_{OP} and B_{RP}. If either sensor is subjected to a field greater than B_{OP}, the internal logic will set accordingly.

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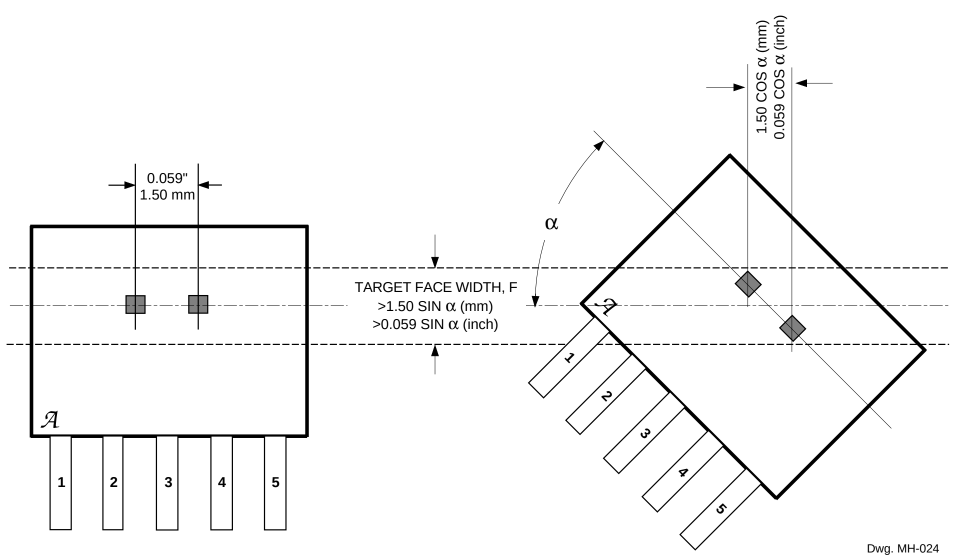
Applications Information

Operation with Fine-Pitch Ring Magnets. For targets with a circular pitch of less than 4mm, a performance improvement can be observed by rotating the front face of the sensor subassembly (see below). This sensor rotation decreases the effective sensor-to-sensor spacing, provided that the Hall elements are not rotated beyond the width of the target.

Applications. It is strongly recommended that an external 0.01 µF bypass capacitor be connected (in close proximity to the Hall sensor) between the supply and ground of the device to reduce both external noise and noise generated by the internal logic.

The simplest form of magnet that will operate these devices is a ring magnet. Other methods of operation, such as linear magnets, are possible. Extensive applications information on magnets and Hall-effect sensors is also available in the “Hall-Effect IC Applications Guide” which can be found in the latest issue of the *Allegro MicroSystems Electronic Data Book*, AMS-702 or *Application Note* 27701, or at

www.allegromicro.com



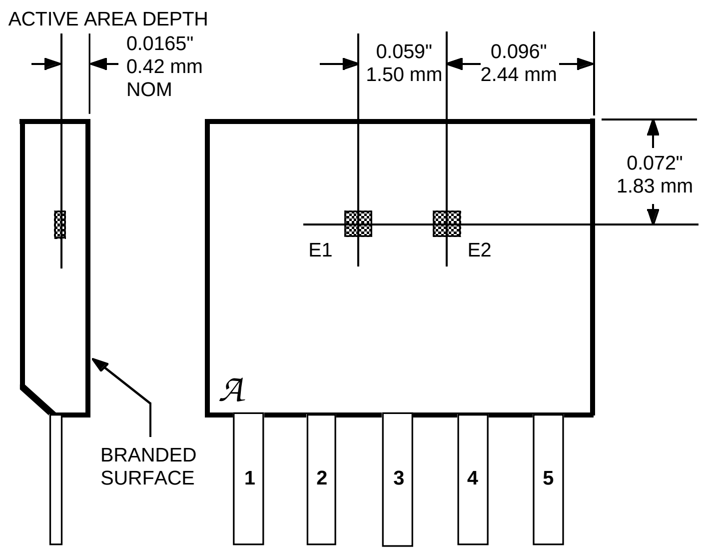
Rotated Sensor for Fine-Pitch Ring Magnets

Criteria for Device Qualification

All Allegro sensors 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 Per Lot	Comments
Temperature Humidity Bias Life	JESD22-A101, T_A = 85°C, RH = 85%	1000 hrs	77	Device biased for minimum power
Bias Life	JESD22-A108, T_A = 150°C, T_J = 165°C	1000 hrs	77	
(Surge Operating Life)	JESD22-A108, T_A = 175°C, T_J = 190°C	1000 hrs	77	
Autoclave, Unbiased	JESD22-A102, T_A = 121°C, 15 psig	96 hrs	77	
High-Temperature (Bake) Storage Life	JESD22-A103, T_A = 170°C	1000 hrs	77	
Temperature Cycle	JESD22-A104	1000 cycles	77	-55°C to +150°C
ESD, Human Body Model	CDF-AEC-Q100-002	Pre/Post Reading	3 per test	Test to failure All leads > 5 kV
ESD, Machine Model	JESD22-A115	Pre/Post Reading	3 per test	Test to failure All leads > 500 V

Sensor Locations
(±0.005” [0.13 mm] die placement)



Dwg. MH-007-1A

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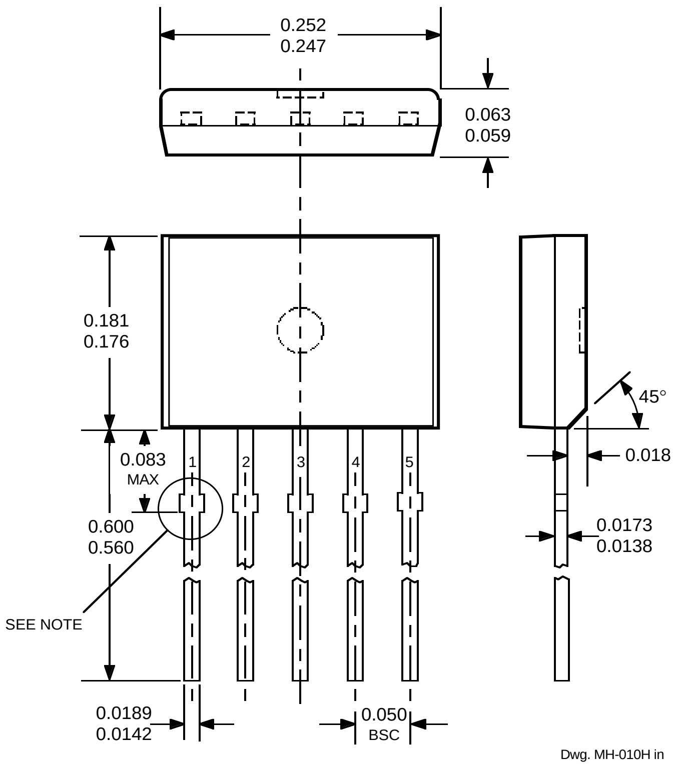
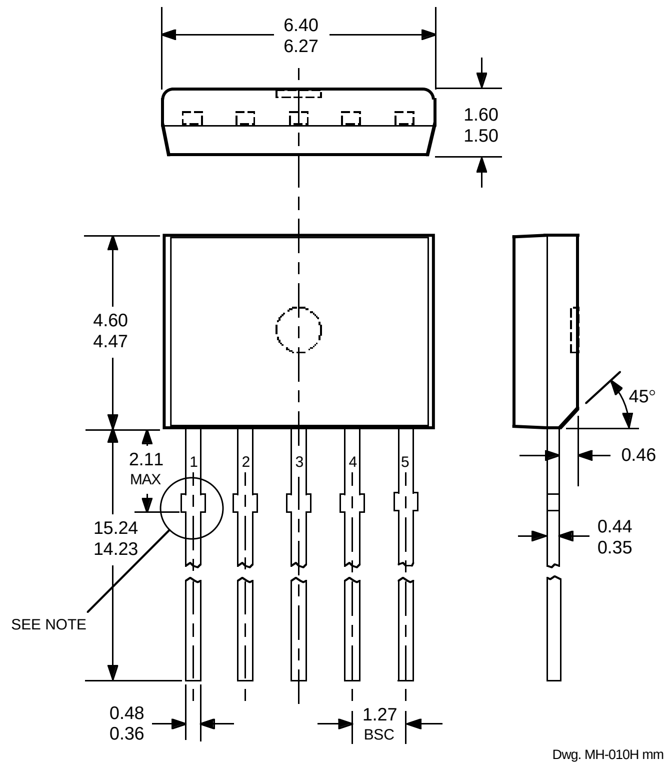
Package Designator 'KA'

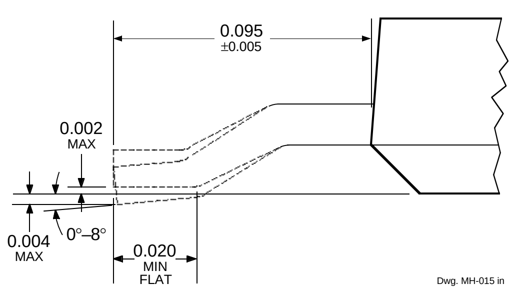
Dimensions in Inches
(controlling dimensions)

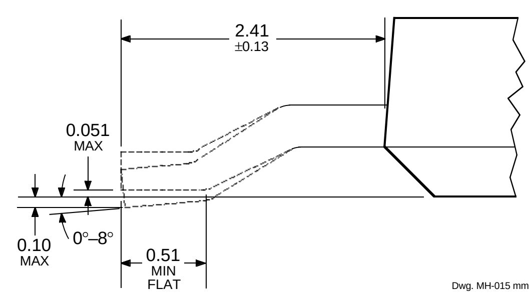


Dimensions in Millimeters
(for reference only)



Surface-Mount Lead Form (add '-TL' to part number)





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).

HALL-EFFECT SENSORS

DUAL-OUTPUT HALL-EFFECT DIGITAL SWITCHES						
Partial Part Number	Operate Point (G) Over Oper. Voltage & Temp. Range	Release Point (G)	Hysteresis (G)	Oper. Temp.	Package	Comments
UGN3235	35 to 200 -200 to -35	15 to 190 -190 to -15	15 to 110 15 to 110	S	K	independent switch outputs
UGN3275	15 to 250	-250 to -15	>100	S	K	complementary latch outputs

DIRECTION-DETECTING HALL-EFFECT DIGITAL SWITCHES						
Partial Part Number	Operate Point (G) Over Oper. Voltage & Temp. Range	Release Point (G)	Hysteresis (G)	Oper. Temp.	Package	Comments
A3422x	<85	>-85	>10	E, L	KA	direction and speed outputs
A3425L	<30	>-30	5 to 35	L	K	requires external logic

GEAR-TOOTH/RING MAGNET (DUAL ELEMENT) HALL-EFFECT SENSORS See also, Adaptive Threshold Sensors (modules containg sensor and magnet)							
Partial Part Number	Operate Point (G)	Release Point (G) Over Oper. Voltage & Temp. Range	Hysteresis (G)	Change in Trip Point (G)	Oper. Temp.	Package	Comments
A3056x	<150	>-150	15 to 90	<±75	E, L	U	zero-speed
A3058x	<250	>-250	150 to 250	<±50	E, L	U	zero-speed
UGS3059	10 to 100	-100 to -10	Typ130	—	S, K	KA	>0.2 Hz
UGx3060	5 to 35	-35 to -5	Typ 30	—	S, K	KA	>0.2 Hz
A3064L	0 to 27.5	-12.5 to 7.5	5 to 35	—	L	KA	>0.2 Hz

Notes: 1) Typical data is at T_A = +25°C and nominal operating voltage.
2) “x” = Operating Temperature Range [suffix letter or (prefix)]: S (UGN) = -20°C to +85°C, E = -40°C to +85°C, J = -40°C to +115°C, K (UGS) = -40°C to +125°C, L (UGL) = -40°C to +150°C.

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