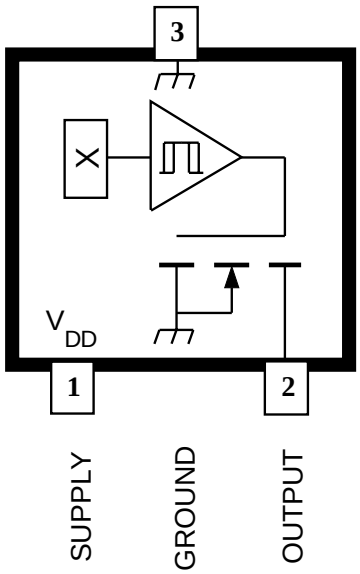
# 3210

Data Sheet
27622.60

PRELIMINARY INFORMATION
(subject to change without notice)
June 23, 1999

# *MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH*

**Package Suffix 'LH' Pinning**




Dwg. PH-016-1

Pinning is shown viewed from branded side.

## ABSOLUTE MAXIMUM RATINGS
**at $T_A$ = +25°C**

Supply Voltage, $V_{DD}$ ..... **5 V**
Magnetic Flux Density, B ..... **Unlimited**
Output OFF Voltage, $V_{OUT}$ ..... **5 V**
Output Current, $I_{OUT}$ ..... **1 mA**
Package Power Dissipation, $P_D$. **See Graph**
Junction Temperature, $T_J$ ..... **+170°C**
Operating Temperature Range,
$T_A$ ..... **-40°C to +85°C**
Storage Temperature Range,
$T_S$ ..... **-65°C to +170°C**

The A3210ELH and A3210EUA Hall-effect switches are ultra-sensitive, pole independent, Hall-effect switches with a latched digital output. They are especially suited for operation in battery-operated, hand-held equipment such as cellular and cordless telephones, pagers, and palmtop computers. 2.5 to 3.5 volt operation and a unique clocking scheme reduce the average operating power requirements to typically 30 µW!

Unlike other Hall-effect switches, either a north or south pole of sufficient strength will turn the output ON; in the absence of a magnetic field, the output is OFF. The polarity independence and minimal power requirement allows these devices to easily replace reed switches for superior reliability and ease of manufacturing, while eliminating the requirement for signal conditioning.

Improved stability is made possible through chopper stabilization (dynamic offset cancellation), which reduces the residual offset voltage normally caused by device overmolding, temperature dependencies, and thermal stress.

These devices include on a single silicon chip a Hall-voltage generator, small-signal amplifier, chopper stabilization, a latch, and a MOSFET output. Advanced BiCMOS processing is used to take advantage of low-voltage and low-power requirements, component matching, very low input-offset errors, and small component geometries.

The A3210ELH and A3210EUA are rated for operation over a temperature range of -40°C to +85°C. Two package styles provide a magnetically optimized package for most applications. Suffix '–LH' is a miniature low-profile surface-mount package while suffix '–UA' is a three-lead ultra-mini-SIP for through-hole or surface mounting.

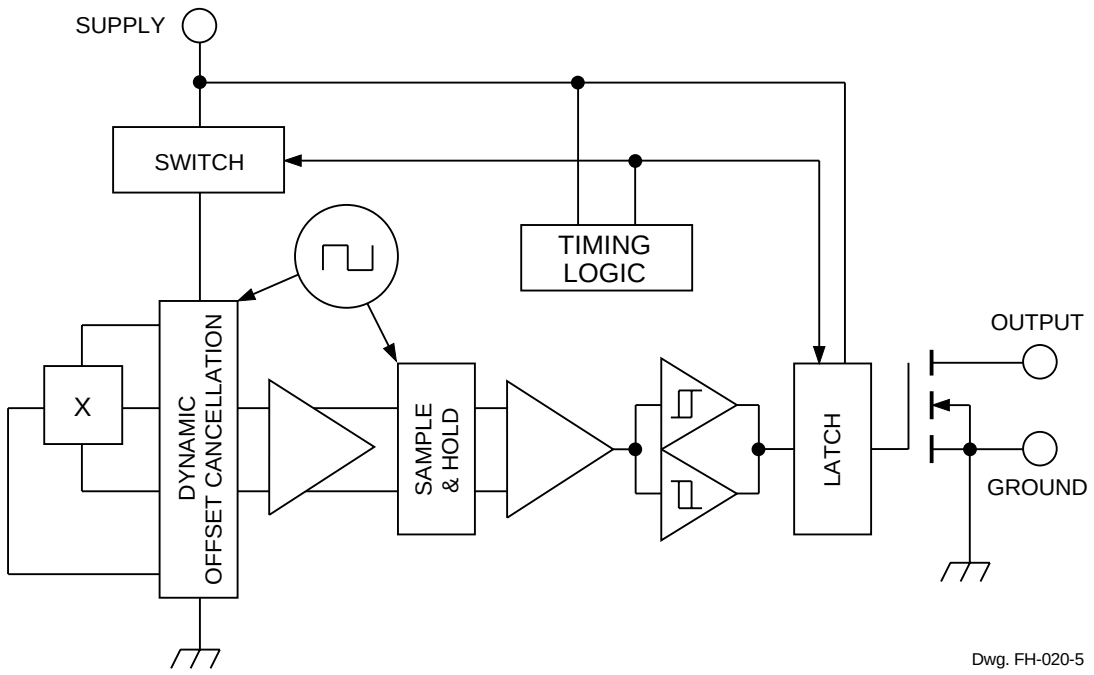
## FEATURES

- Micropower Operation
- Operate with North or South Pole
- 2.5 V to 3.5 V Battery Operation
- Chopper Stabilized
  Superior Temperature Stability
  Extremely Low Switch-Point Drift
  Insensitive to Physical Stress
- Solid-State Reliability
- Small Size
- Easily Manufacturable with
  Magnet Pole Independence

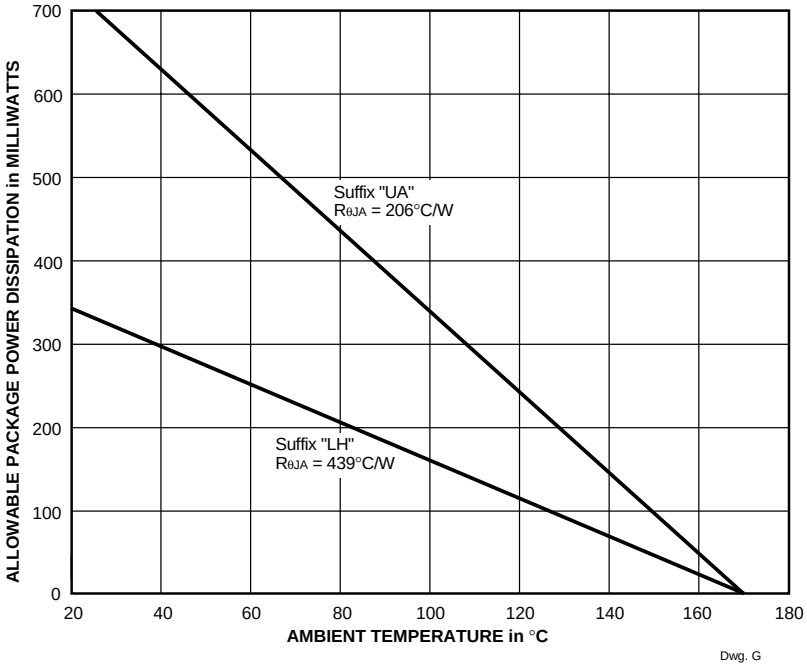
Always order by complete part number: the prefix 'A' + the basic four-digit part number + the suffix 'E' to indicate operating temperature range + a suffix to indicate package style, e.g., **A3210ELH** .

# 3210
## *MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH*

### FUNCTIONAL BLOCK DIAGRAM

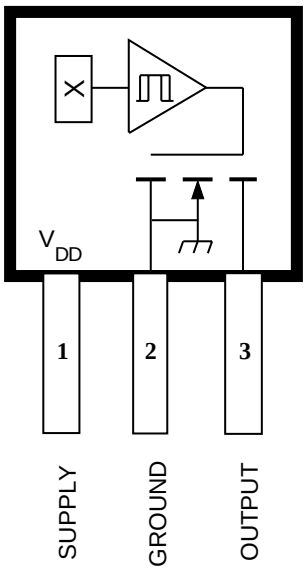



Dwg. FH-020-5




Dwg. G

### Package Suffix 'UA' Pinning




Dwg. PH-016


Allegro MicroSystems, Inc.

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## ELECTRICAL CHARACTERISTICS at $V_{DD}$ = 2.75 V, $C_{BYPASS}$ = 0.1 μF, and over operating temperature range.

| Characteristic | Symbol | Test Conditions | Limits | | | |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | Units |
| Supply Voltage Range | $V_{DD}$ | Operating[1)] | 2.5 | 2.75 | 3.5 | V |
| Output Leakage Current | $I_{OFF}$ | $V_{OUT}$ = 3.5 V, $B_{RPN} < B < B_{RPS}$ | – | «1.0 | 1.0 | μA |
| Output ON Voltage | $V_{OUT}$ | $I_{OUT}$ = 1 mA, $V_{DD}$ = 2.75 V | – | – | 400 | mV |
| Awake Time | $t_{awake}$ | | 30 | 60 | 90 | μs |
| Period | $t_{period}$ | | 30 | 60 | 90 | ms |
| Duty Cycle | d.c. | | – | 0.10 | – | % |
| Chopping Frequency | $f_C$ | | – | 340 | – | kHz |
| Supply Current ($2.5 \le V_{DD} \le 3.5$ V) | $I_{DD(EN)}$ | Chip awake (enabled) | 0.1 | – | 3.0 | mA |
| | $I_{DD(DIS)}$ | Chip asleep (disabled) | 1.0 | 10 | 50 | μA |
| | $I_{DD(AVG)}$ | $V_{DD}$ = 2.75 V | 2.0 | 8.8 | 25 | μA |
| | | $V_{DD}$ = 3.5 V | 2.0 | 13 | 60 | μA |

NOTES: 1. Operate and release points will vary with supply voltage.
2. $B_{OPx}$ = operate point (output turns ON); $B_{RPx}$ = release point (output turns OFF).
3. Typical Data is at $T_A$ = +25°C and $V_{DD}$ = 2.75 V and is for design information only.

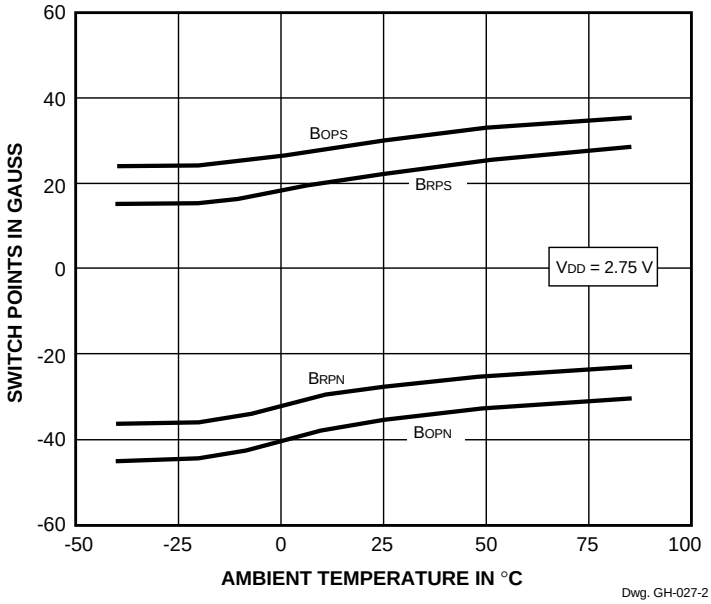
## MAGNETIC CHARACTERISTICS at $V_{DD}$ = 2.75 V, $C_{BYPASS}$ = 0.1 μF, and over operating temperature range.

| Characteristic | Symbol | Test Conditions | Limits | | | |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | Units |
| Operate Points | $B_{OPS}$ | | – | 30 | 70 | G |
| | $B_{OPN}$ | | -70 | -35 | – | G |
| Release Points | $B_{RPS}$ | | 5.0 | 22 | – | G |
| | $B_{RPN}$ | | – | -27 | -5.0 | G |
| Hysteresis | $B_{hys}$ | $B_{OPx} - B_{RPx}$ | – | 7.7 | – | G |

NOTES: 1. As used here, negative flux densities are defined as less than zero (algebraic convention) and -50 G is less than +10 G.
2. Typical Data is at $T_A$ = +25°C and $V_{DD}$ = 2.75 V and is for design information only.

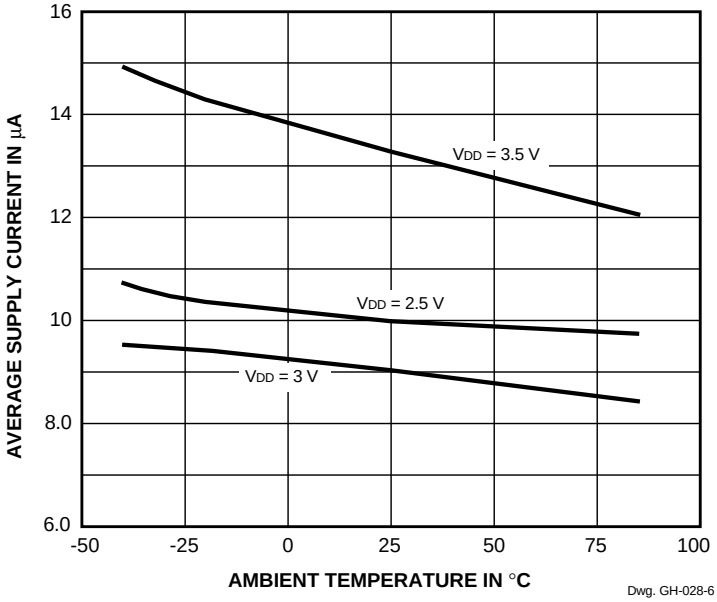
## TYPICAL OPERATING CHARACTERISTICS
### as a function of temperature

**SWITCH POINTS**




Dwg. GH-027-2

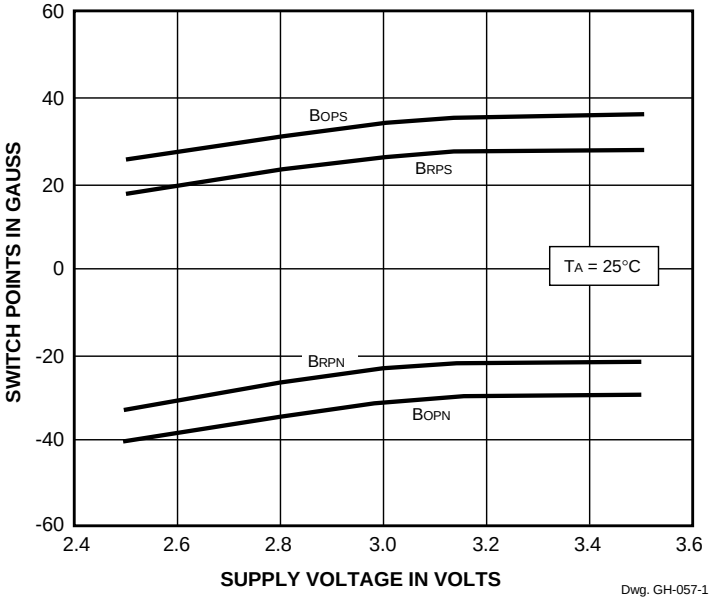
**SUPPLY CURRENT**




Dwg. GH-028-6

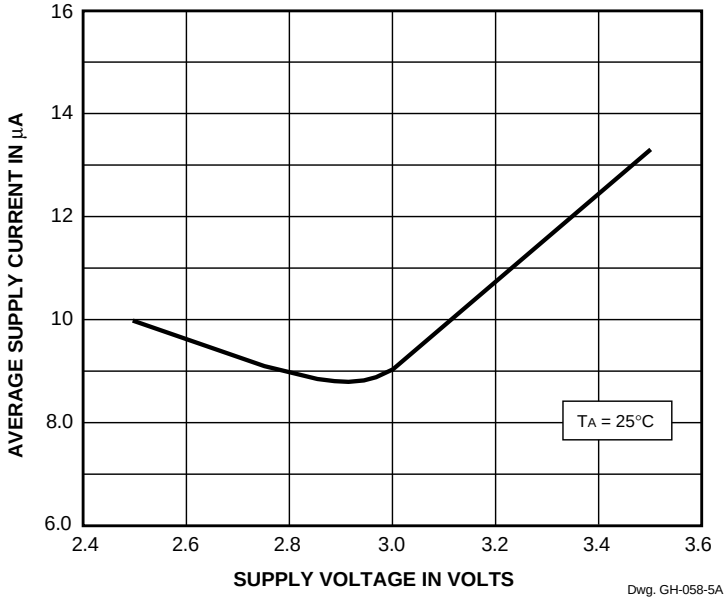
### as a function of supply voltage

**SWITCH POINTS**




Dwg. GH-057-1

**SUPPLY CURRENT**




Dwg. GH-058-5A

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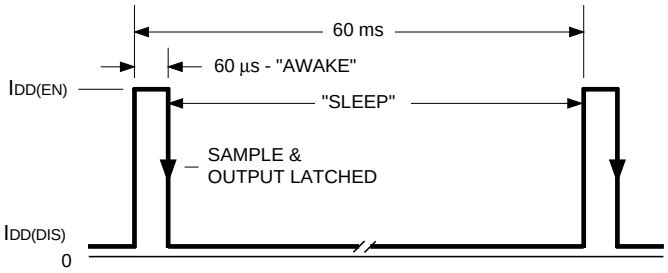
## CRITERIA FOR DEVICE QUALIFICATION

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 | Comments |
|---|---|---|---|---|
| Biased Humidity (HAST) | $T_A$ = 130°C, RH = 85% | 50 hrs | 77 | $V_{DD} = V_{OUT}$ = 3 V |
| High-Temperature Operating Life (HTOL) | JESD22-A108, $T_A$ = 150°C, $T_J$ = 165°C | 408 hrs | 77 | $V_{DD} = V_{OUT}$ = 3 V |
| Accelerated HTOL | JESD22-A108, $T_A$ = 175°C, $T_J$ = 190°C | 504 hrs | 77 | $V_{DD} = V_{OUT}$ = 3 V |
| Autoclave, Unbiased | JESD22-A102, Condition C, $T_A$ = 121°C, 15 psig | 96 hrs | 77 | |
| High-Temperature (Bake) Storage Life | MIL-STD-883, Method 1008, $T_A$ = 170°C | 1000 hrs | 77 | |
| Temperature Cycle | MIL-STD-883, Method 1010, -65°C to +150°C | 500 cycles | 77 | |
| Latch-Up | — | Pre/Post Reading | 6 | |
| Electro-Thermally Induced Gate Leakage | — | Pre/Post Reading | 6 | |
| ESD, Human Body Model | CDF-AEC-Q100-002 | Pre/Post Reading | x per test | Test to failure, All leads > TBD |
| Electrical Distributions | Per Specification | — | 30 | |

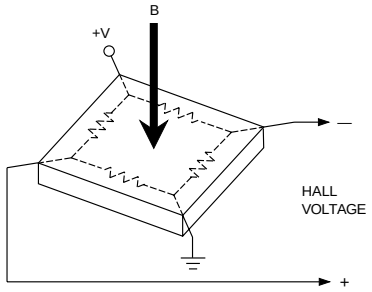
## FUNCTIONAL DESCRIPTION

**Low Average Power.** Internal timing circuitry activates the sensor for 60 µs and deactivates it for the remainder of the 60 ms period (approximately 0.1% duty cycle). A short "wake-up" allows for stabilization prior to the sensor sampling and data latching on the falling edge of the timing pulse. The output during the "sleep" time is latched in the last sampled state. The supply current is not affected by the output state.

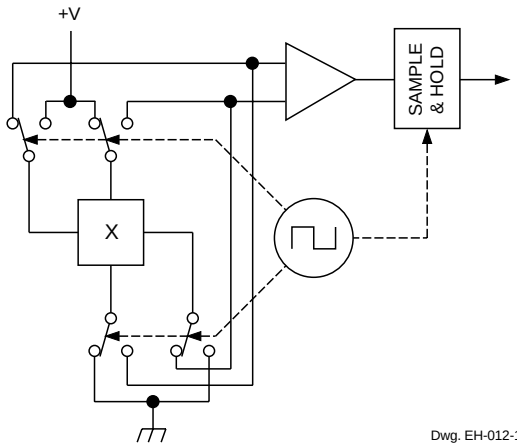



Dwg. WH-017

**Chopper-Stabilized Technique.** The Hall element can be considered as a resistor array similar to a Wheatstone bridge. A large portion of the offset is a result of the mismatching of these resistors. These devices use a proprietary dynamic offset cancellation technique, with an internal high-frequency clock to reduce the residual offset voltage of the Hall element that is normally caused by device overmolding, temperature dependencies, and thermal stress. The chopper-stabilizing technique cancels the mismatching of the resistors by changing the direction of the current flowing through the Hall plate and Hall voltage measurement taps, while maintaining the Hall-voltage signal that is induced by the external magnetic flux. The signal is, then, captured by a sample-and-hold circuit. This technique produces devices that have an extremely stable quiescent Hall output voltage, are immune to thermal stress, and have precise recoverability after temperature cycling. This technique will also slightly degrade the device output repeatability.



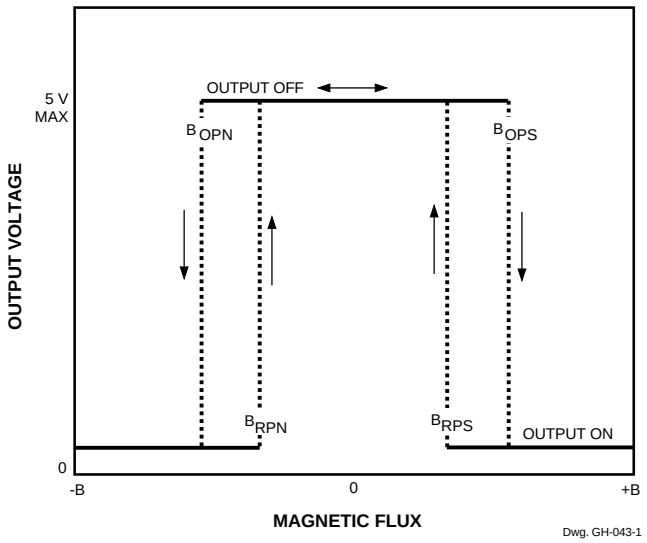

Dwg. AH-011-2




Dwg. EH-012-1

**Operation.** The output of these devices switch low (turn ON) when a magnetic field perpendicular to the Hall sensor exceeds the operate point $B_{OPS}$ (or is less than $B_{OPN}$). After turn-ON, the output is capable of sinking up to 1 mA and the output voltage is $V_{OUT(ON)}$. When the magnetic field is reduced below the release point $B_{RPS}$ (or increased above $B_{RPN}$), the device output goes high (turns OFF). The difference in the magnetic operate and release points is the hysteresis ($B_{hys}$) of the device. This built-in hysteresis allows clean switching of the output even in the presence of external mechanical vibration and electrical noise.

As used here, negative flux densities are defined as less than zero (algebraic convention) and -50 G is less than +10 G.



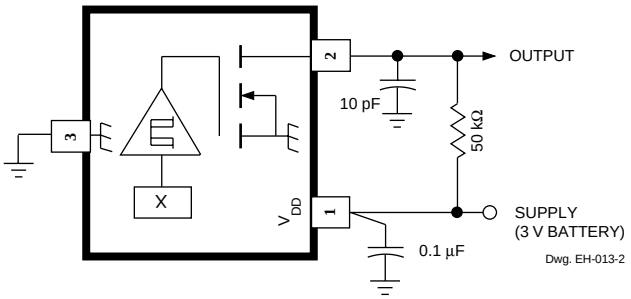

Dwg. GH-043-1

# 3210
# *MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH*

**Applications.** It is strongly recommended that an external 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 chopper-stabilization technique. This is especially true due to the relatively high impedance of battery supplies.

The simplest form of magnet that will operate these devices is a bar magnet with either pole near the branded surface of the device. Many other methods of operation are possible. Extensive applications information on magnets and Hall-effect sensors is also available in the *Allegro Electronic Data Book* AMS-702 or *Application Note* 27701, or at

www.allegromicro.com

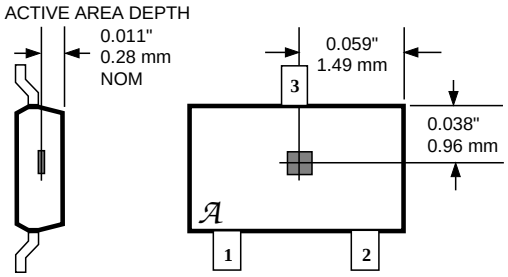


Dwg. EH-013-2

## SENSOR LOCATIONS

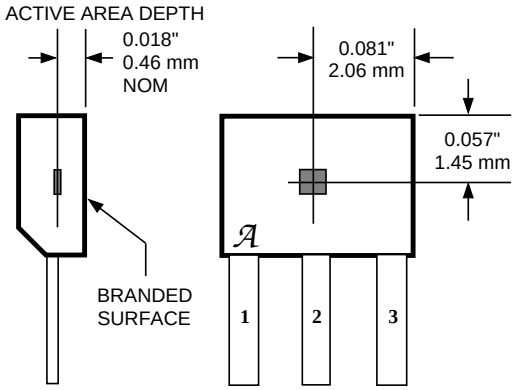
(±0.005” [0.13 mm] die placement)

### Package Designator ‘LH’



Dwg. MH-025

### Package Designators ‘UA’ and ‘UA-TL’



Dwg. MH-011-11

Although sensor location is accurate to three sigma for a particular design, product improvements may result in small changes to sensor location.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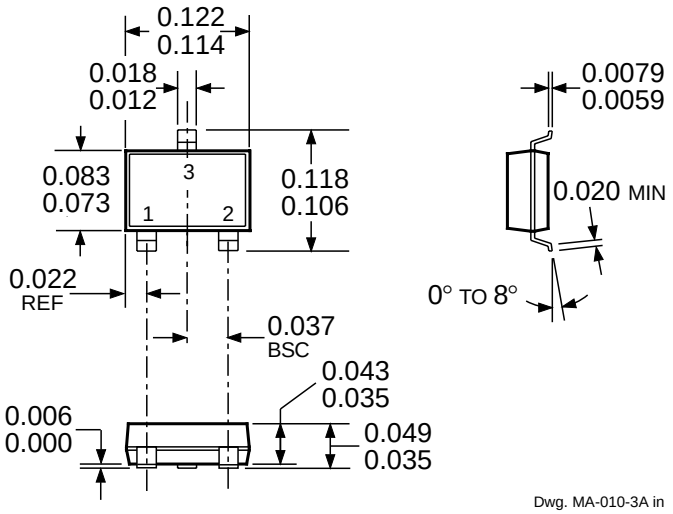
## PACKAGE DESIGNATOR 'LH'

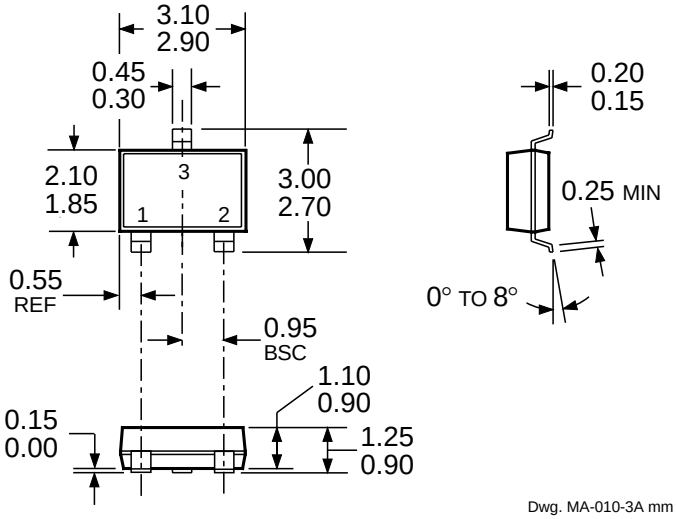
(fits SC-74A solder-pad layout)

**Dimensions in Inches**
(for reference only)

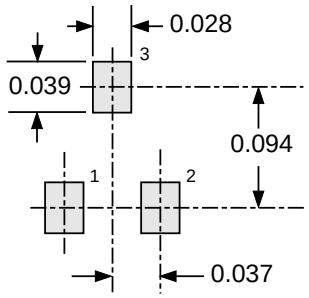



Dwg. MA-010-3A in

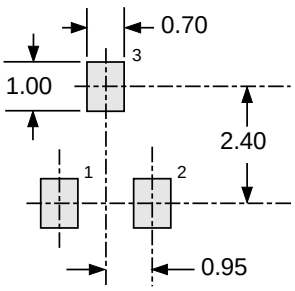
**Dimensions in Millimeters**
(controlling dimensions)




Dwg. MA-010-3A mm




Dwg. MA-011-3 in

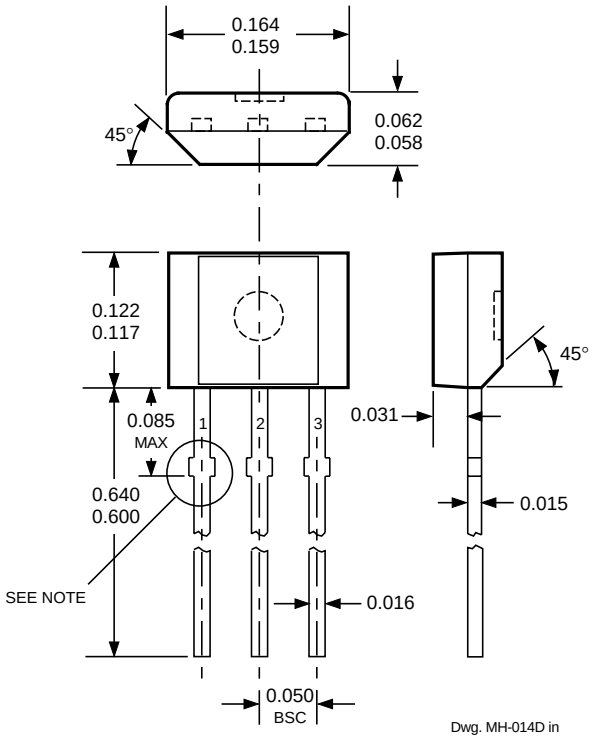



Dwg. MA-011-3 mm

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. Where no tolerance is specified, dimension is nominal.

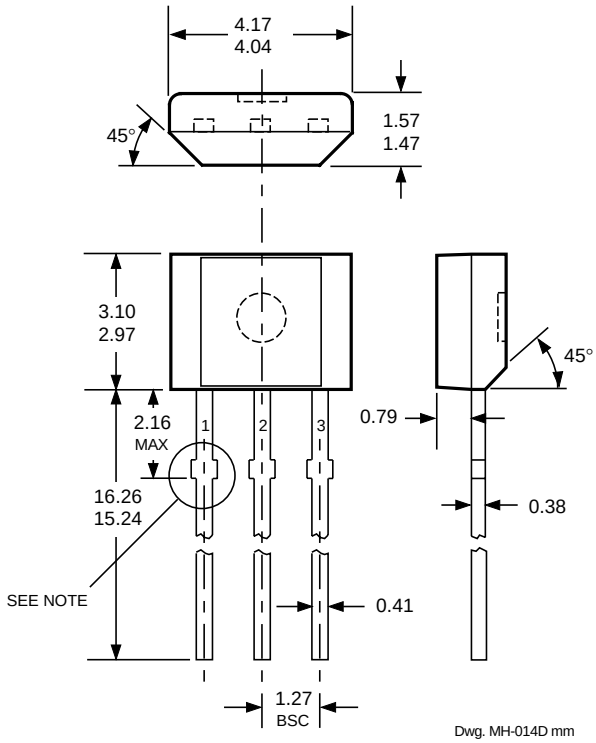
## PACKAGE DESIGNATOR 'UA'

**Dimensions in Inches**
(controlling dimensions)



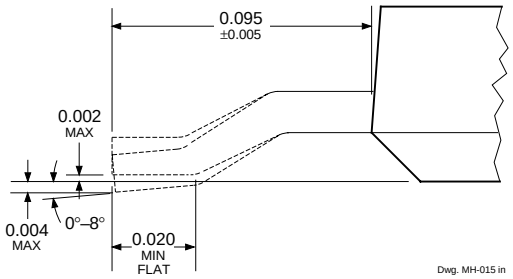

Dwg. MH-014D in

**Dimensions in Millimeters**
(for reference only)

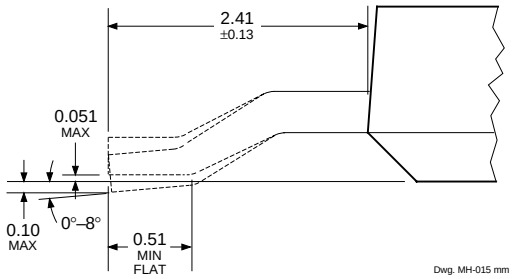



Dwg. MH-014D mm

### Surface-Mount Lead Form (Suffix '-TL')




Dwg. MH-015 in




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.

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**3210**
***MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH***

# *HALL-EFFECT SENSORS SELECTION GUIDE*

| Partial Part Number | Avail. Oper. Temp. | Characteristics at $T_A$ = +25°C $B_{OP(max)}$ | $B_{RP(min)}$ | $B_{hys(typ)}$ | Features | Notes |
|---|---|---|---|---|---|---|
| **HALL-EFFECT UNIPOLAR SWITCHES in order of $B_{OP}$ and $B_{hys}$** | | | | | | |
| 3240 | E/L | +50 | +5.0 | 10 | chopper stabilized | 1 |
| 3210 | E | ±70 | ±5.0 | 7.7 | micropower, chopper stabilized | |
| 3361 | E | +120 | +50 | 5.0* | 2-wire, chopper stabilized | |
| 3362 | E | +120 | +50 | 5.0* | 2-wire, chopper stabilized | |
| 3161 | E | +160 | +30 | 20 | 2-wire | |
| 3141 | E/L | +160 | +10 | 55 | | |
| 3235 | S | +175 | +25 | 15* | output 1 | 2 |
| | | -25 | -175 | 15* | output 2 | 2 |
| 5140 | E | +200 | +50 | 55 | 300 mA output | 1, 3 |
| 3142 | E/L | +230 | +75 | 55 | | |
| 3143 | E/L | +340 | +165 | 55 | | |
| 3144 | E/L | +350 | +50 | 55 | | |
| 3122 | E/L | +400 | +140 | 105 | | |
| 3123 | E/L | +440 | +180 | 105 | | |
| 3121 | E/L | +450 | +125 | 105 | | |
| 3150 | J | +40 to +850 | – | 20 | programmable, chopper stabilized | 1 |
| **HALL-EFFECT LATCHES & BIPOLAR SWITCHES† in order of $B_{OP}$ and $B_{hys}$** | | | | | | |
| 3260 | E/L | +30 | -30 | 20 | bipolar, chopper stabilized | |
| 3280 | E/L | +40 | -40 | 45 | chopper stabilized | |
| 3134 | E/L | +50 | -50 | 27 | bipolar switch | |
| 3133 | K/L/S | +75 | -75 | 52 | bipolar switch | |
| 3281 | E/L | +90 | -90 | 100 | chopper stabilized | |
| 3132 | K/L/S | +95 | -95 | 52 | bipolar switch | |
| 3187 | E/L | +150 | -150 | 100* | | |
| 3177 | S | +150 | -150 | 200 | | |
| 3625 | S | +150 | -150 | 200 | 900 mA outputs | 1, 3, 5 |
| 3626 | S | +150 | -150 | 200 | 400 mA outputs | 1, 3, 5 |
| 3195 | E/L | +160 | -160 | 220 | | 1, 4 |
| 3197 | L | +160 | -160 | 230 | | 1 |
| 3175 | S | +170 | -170 | 200 | | |
| 3188 | E/L | +180 | -180 | 200* | | |
| 3283 | E/L | +180 | -180 | 300 | chopper stabilized | |
| 3189 | E/L | +230 | -230 | 100* | | |
| 3275 | S | +250 | -250 | 100* | | 5 |
| 3185 | E/L | +270 | -270 | 340* | | |

Operating Temperature Ranges:
S = -20°C to +85°C, E = -40°C to +85°C, J = -40°C to +115°C, K = -40°C to +125°C, L = -40°C to +150°C

Notes 1. Protected.
2.Output 1 switches on south pole, output 2 switches on north pole for 2-phase, bifilar-wound, unipolar-driven brushless dc motor control.
3. Power driver output.
4.Active pull down.
5.Complementary outputs for 2-phase bifilar-wound, unipolar-driven brushless dc motor control.

* Minimum.

Latches will not switch on removal of magnetic field; bipolar switches may switch on removal of field but require field reversal for reliable operation over operating temperature range.

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