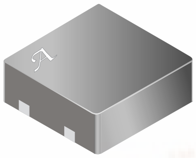
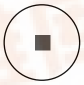
A3211 and A3212

MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCHES

2 x 2 mm MLPD
EL Package





Approximate actual size

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{DD}	**5 V**
Magnetic Flux Density, B	**Unlimited**
Output Off Voltage, V_{OUT}	**5 V**
Output Current, I_{OUT}	**1 mA**
Junction Temperature, T_J	**+170°C**
Operating Temperature, T_A	
Range 'E-'	**-40°C to +85°C**
Range 'L-'	**-40°C to +150°C**
Storage Temperature Range, T_S	**-65°C to +170°C**

The A 3211 and A3212 integrated circuits are ultra-sensitive, pole independent Hall-effect switches with latched digital output. These sensors are especially suited for operation in battery-operated, hand-held equipment such as cellular and cordless telephones, pagers, and palmtop computers. A 2.5 volt to 3.5 volt operation and a unique clocking scheme reduce the average operating power requirements to less than 15 µW with a 2.75 volt supply.

Unlike other Hall-effect switches, either a north or south pole of sufficient strength will turn the output on in the A3212, and in the absence of a magnetic field, the output is off. The A3211 provides an inverted output. The polarity independence and minimal power requirements allow 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.

This device includes 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.

Four package styles provide magnetically optimized solutions for most applications. Miniature low-profile surface-mount package types *EH* and *EL* (0.75 and 0.50 mm nominal height) are leadless, *LH* is a leaded low-profile SMD, and *UA* is a three-lead SIP for through-hole mounting. Packages are available in lead (Pb) free versions (suffix, *–T*) with 100% matte tin plated leadframe. EL package for limited release, engineering samples available.

FEATURES

- Micropower Operation
- Operation 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
- High ESD Protection
- Solid-State Reliability
- Small Size
- Easily Manufacturable with Magnet Pole Independence

A3211 and A3212
MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH

Product Selection Guide

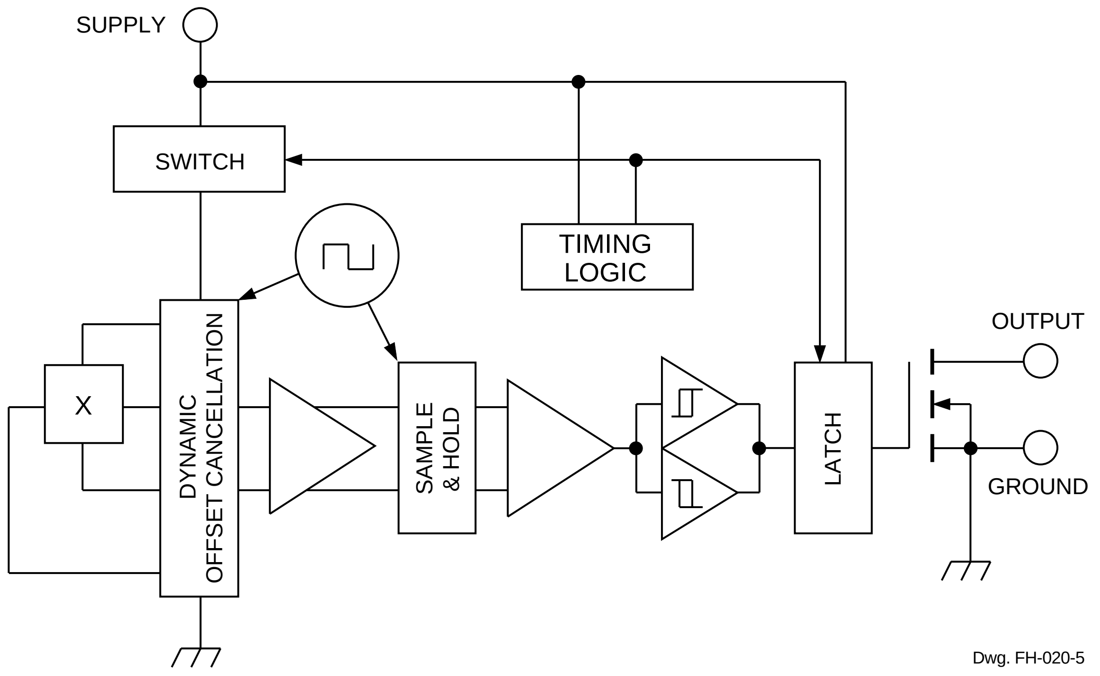
Use complete part numbers when ordering

Part Number	**Pb-free**	**Packing[1] (Units/Pack)**	**Package**	**Ambient Temperature T_A (°C)**
A3211EEHLT–T	Yes	Tape and Reel (3000)	Leadless Surface Mount	–40 to 85
A3211EELLT–T	Yes	Tape and Reel (3000)		
A3211ELHLT–T	Yes	Tape and Reel (3000)	3-Pin Surface Mount	
A3212EEHLT	–	Tape and Reel (3000)	Leadless Surface Mount	–40 to 85
A3212EEHLT–T	Yes	Tape and Reel (3000)		
A3212EELLT–T	Yes	Tape and Reel (3000)		
A3212ELHLT	–	Tape and Reel (3000)	3-Pin Surface Mount	
A3212ELHLT–T	Yes	Tape and Reel (3000)		
A3212EUA	–	Bulk Pack (500)	SIP-3 Through Hole, Straight Lead	
A3212EUA–T	Yes	Bulk Pack (500)		
~~A3212LLHLT~~[2]	–	Tape and Reel (3000)	3-Pin Surface Mount	–40 to 150
A3212LLHLT–T	Yes	Tape and Reel (3000)		
~~A3212LUA~~[2]	–	Bulk Pack (500)	SIP-3 Through Hole, Straight Lead	
A3212LUA–T	Yes	Bulk Pack (500)		

[1] Contact Allegro for additional packaging and handling options.

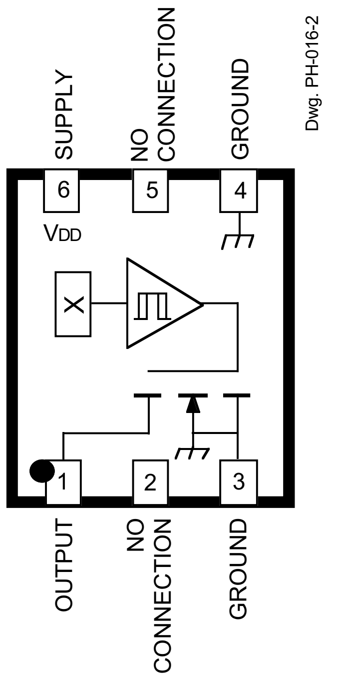
[2] These variants are in production but have been determined to be NOT FOR NEW DESIGN. This classification indicates that sale of this device is currently restricted to existing customer applications. The device should not be purchased for new design applications because obsolescence in the near future is probable. Samples are no longer available. Status date change October 31, 2005.

FUNCTIONAL BLOCK DIAGRAM

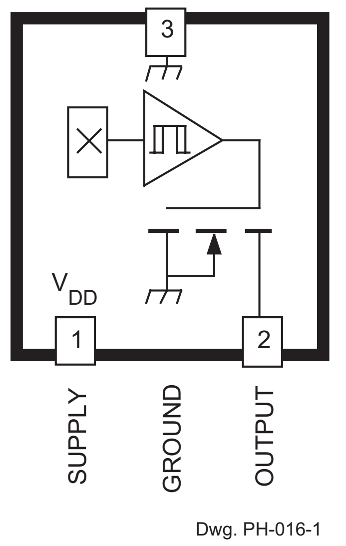


Dwg. FH-020-5

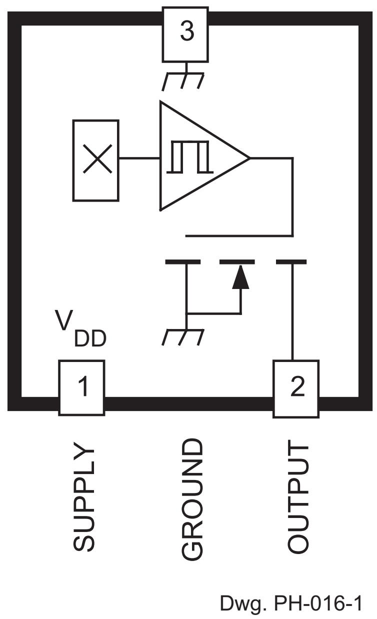
Package Suffix 'EH' Pinning
(Leadless Chip Carrier)



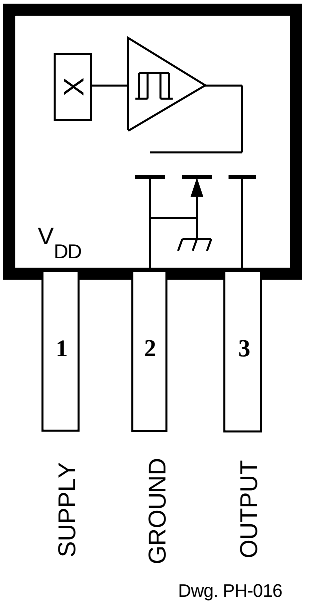
Package Suffix 'EL' Pinning
(Leadless Chip Carrier)



Package Suffix 'LH' Pinning
(SOT23W)



Package Suffix 'UA' Pinning
(SIP)



Pinning is shown viewed from branded side.

A3211 and A3212
MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH

ELECTRICAL CHARACTERISTICS over operating voltage and temperature range (unless otherwise specified).

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.*	Max.	Units
Supply Voltage Range	V_{DD}	Operating	2.5	2.75	3.5	V
Output Leakage Current	I_{OFF}	V_{OUT} = 3.5 V, Output off	–	<1.0	1.0	µA
Output On Voltage	V_{OUT}	I_{OUT} = 1 mA, V_{DD} = 2.75 V	–	100	300	mV
Awake Time	t_{awake}		–	45	90	µs
Period	t_{period}		–	45	90	ms
Duty Cycle	d.c.		–	0.1	–	%
Chopping Frequency	f_C		–	340	–	kHz
Supply Current	$I_{DD(EN)}$	Chip awake (enabled)	–	–	2.0	mA
	$I_{DD(DIS)}$	Chip asleep (disabled)	–	–	8.0	µA
	$I_{DD(AVG)}$	V_{DD} = 2.75 V	–	5.1	10	µA
		V_{DD} = 3.5 V	–	6.7	10	µA

* Typical data is at T_A = 25°C and V_{DD} = 2.75 V, and is for design information only.

3211 MAGNETIC CHARACTERISTICS over operating voltage and temperature range (unless otherwise specified)

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Operate Points	B_{OPS}	South pole to branded side; B > B_{OP}, V_{OUT} = High (Output Off)	–	37	55	G
	B_{OPN}	North pole to branded side; B > B_{OP}, V_{OUT} = High (Output Off)	–55	–40	–	G
Release Points	B_{RPS}	South pole to branded side; B < B_{RP}, V_{OUT} = Low (Output On)	10	31	–	G
	B_{RPN}	North pole to branded side; B < B_{RP}, V_{OUT} = Low (Output On)	–	–34	–10	G
Hysteresis	B_{HYS}	$\|B_{OPx} - B_{RPx}\|$	–	5.9	–	G

NOTES: 1. Negative flux densities are defined as less than zero (algebraic convention), i.e., -50 G is less than +10 G.
2. B_{OPx} = operate point (output turns off); B_{RPx} = release point (output turns on).
3. Typical Data is at T_A = +25°C and V_{DD} = 2.75 V and is for design information only.
4. 1 gauss (G) is exactly equal to 0.1 millitesla (mT).

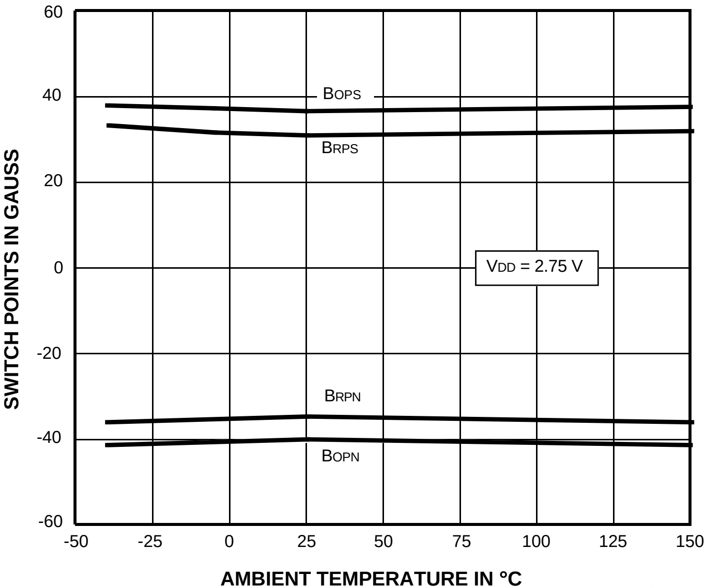
3212 MAGNETIC CHARACTERISTICS over operating voltage and temperature range (unless otherwise specified)

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Operate Points	B_{OPS}	South pole to branded side; B > B_{OP}, V_{OUT} = Low (Output On)	–	37	55	G
	B_{OPN}	North pole to branded side; B > B_{OP}, V_{OUT} = Low (Output On)	–55	–40	–	G
Release Points	B_{RPS}	South pole to branded side; B < B_{RP}, V_{OUT} = High (Output Off)	10	31	–	G
	B_{RPN}	North pole to branded side; B < B_{RP}, V_{OUT} = High (Output Off)	–	–34	–10	G
Hysteresis	B_{HYS}	$\|B_{OPx} - B_{RPx}\|$	–	5.9	–	G

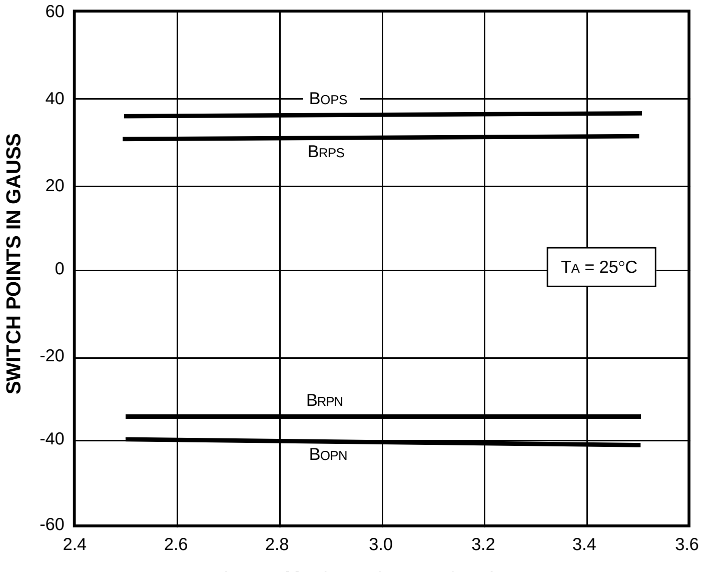
NOTES: 1. Negative flux densities are defined as less than zero (algebraic convention), i.e., -50 G is less than +10 G.
2. B_{OPx} = operate point (output turns on); B_{RPx} = release point (output turns off).
3. Typical Data is at T_A = +25°C and V_{DD} = 2.75 V and is for design information only.
4. 1 gauss (G) is exactly equal to 0.1 millitesla (mT).

TYPICAL OPERATING CHARACTERISTICS

SWITCH POINTS

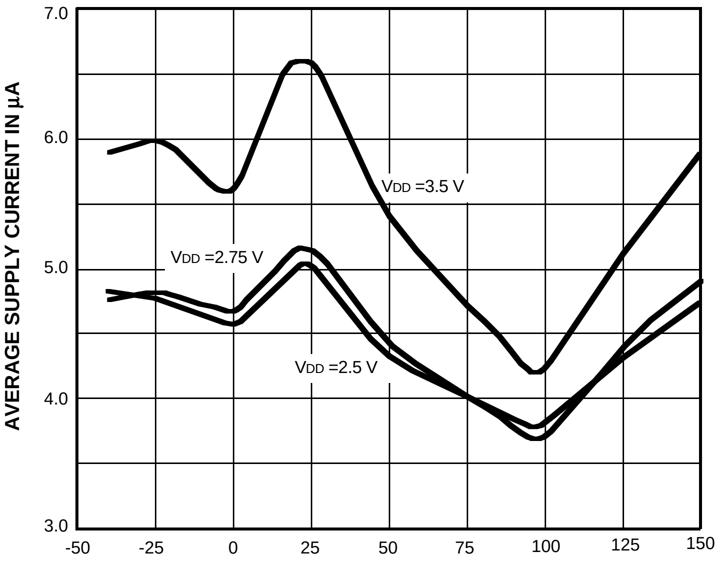


Dwg. GH-027-3

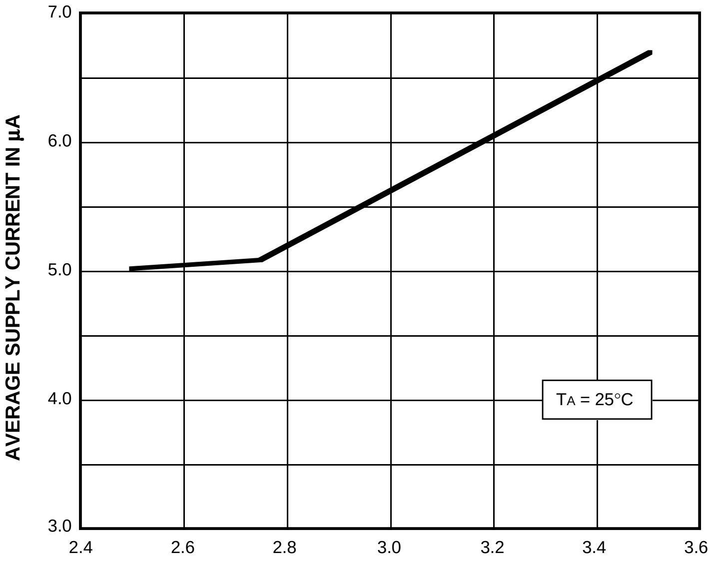


Dwg. GH-057-2

SUPPLY CURRENT



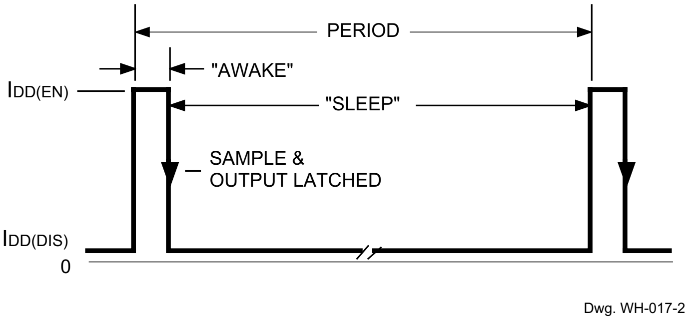
Dwg. GH-028-11

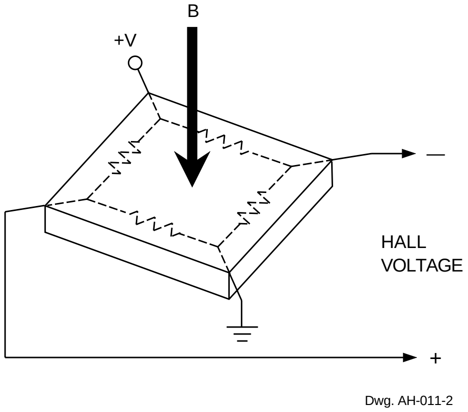


Dwg. GH-058-7

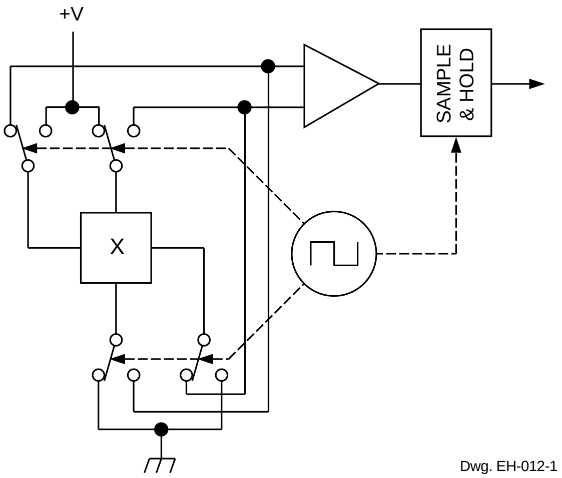
FUNCTIONAL DESCRIPTION

Low Average Power. Internal timing circuitry activates the sensor for 45 μs and deactivates it for the remainder of the period (45 ms). A short "awake" time 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.





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 resistor circuit by changing the direction of the current flowing through the Hall plate using CMOS switches and Hall voltage measurement taps, while maintaing the Hall-voltage signal that is induced by the external magnetic flux. The signal is then captured by a sample-and-hold circuit and further processed using low-offset bipolar circuitry. 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. A relatively high sampling frequency is used for faster signal processing capability can be processed.



More detailed descriptions of the circuit operation can be found in: Technical Paper STP 97-10, *Monolithic Magnetic Hall Sensor Using Dynamic Quadrature Offset Cancellation* and Technical Paper STP 99-1, *Chopper-Stabilized Amplifiers With A Track-and-Hold Signal Demodulator*.

FUNCTIONAL DESCRIPTION (cont'd)

Operation. The output of the A3212 switches low (turns 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 switches 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. The A3211 functions in the same manner, except the output voltage is reversed from the A3212, as shown in the figures to the right.

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

Applications. Allegro's pole-independent sensing technique allows for operation with either a north pole or south pole magnet orientation, enhancing the manufacturability of the device. The state-of-the-art technology provides the same output polarity for either pole face.

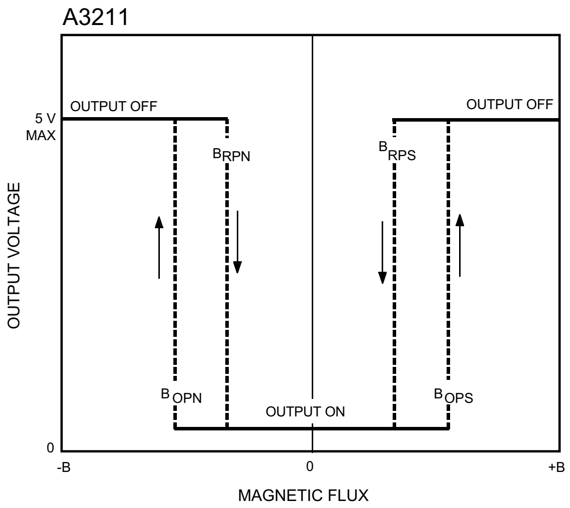
It is strongly recommended that an external bypass capacitor be connected (in close proximity to the Hall sensor) between the supply and ground of the device to reduce both external noise and noise generated by the chopper-stabilization technique. This is especially true due to the relatively high impedance of battery supplies.

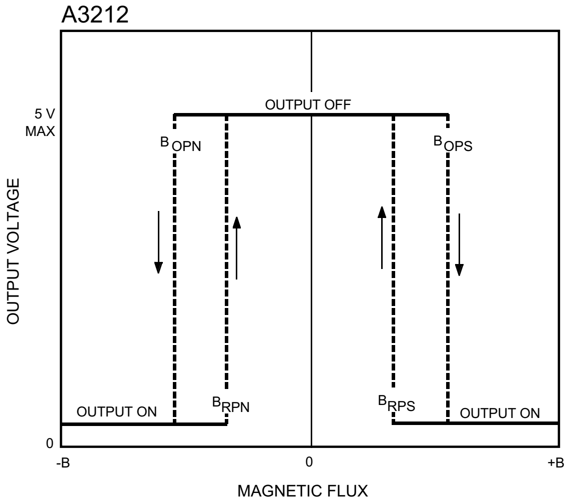
The simplest form of magnet that will operate these devices is a bar magnet with either pole near the branded surface of the device. Many other methods of operation are possible. Extensive applications information for Hall-effect sensors is available in:

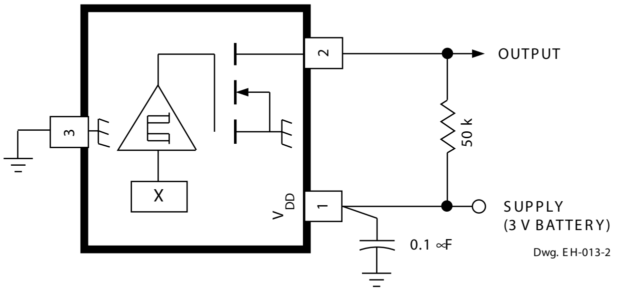
- *Hall-Effect IC Applications Guide*, Application Note 27701;
- *Hall-Effect Devices: Soldering, Gluing, Potting, Encapsulating, and Lead Forming*, Application Note 27703.1;
- *Soldering of Through-Hole Hall-Sensor Dervices*, Application Note 27703; and
- *Soldering of Surface-Mount Hall-Sensor Devices*, Application Note 27703.2.

All are provided at

www.allegromicro.com

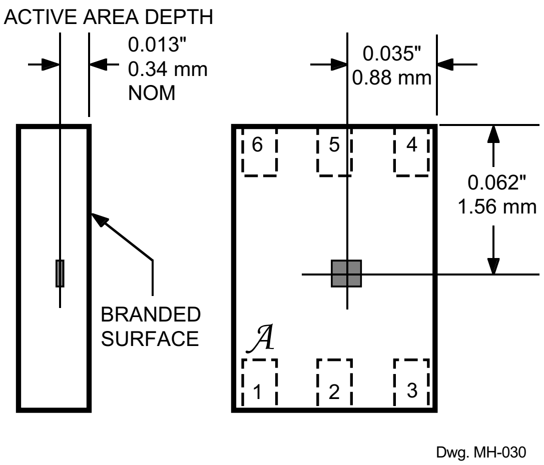




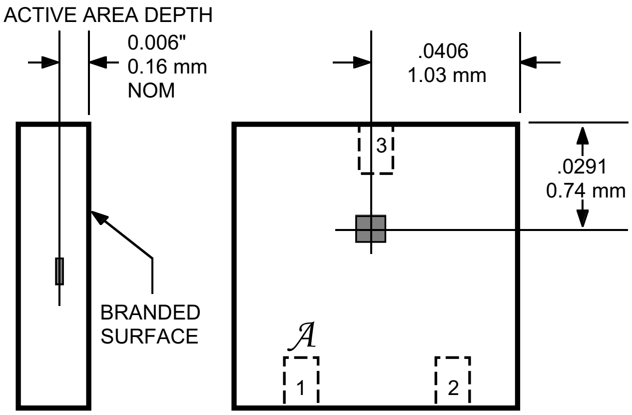


SENSOR LOCATIONS

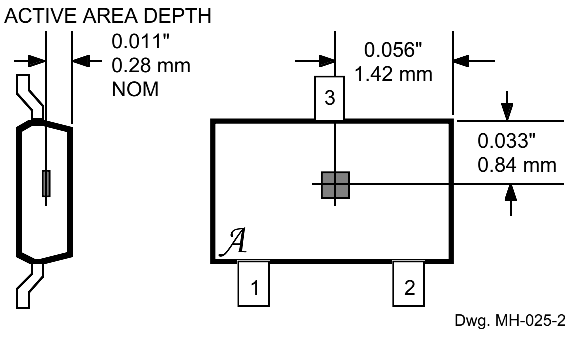
Package Designator 'EH'



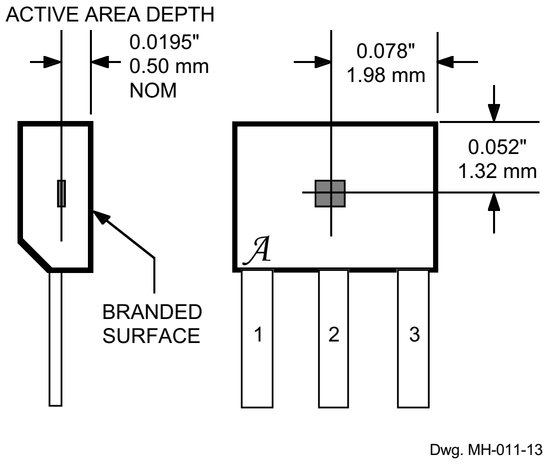
Package Designator 'EL'



Package Designator 'LH'

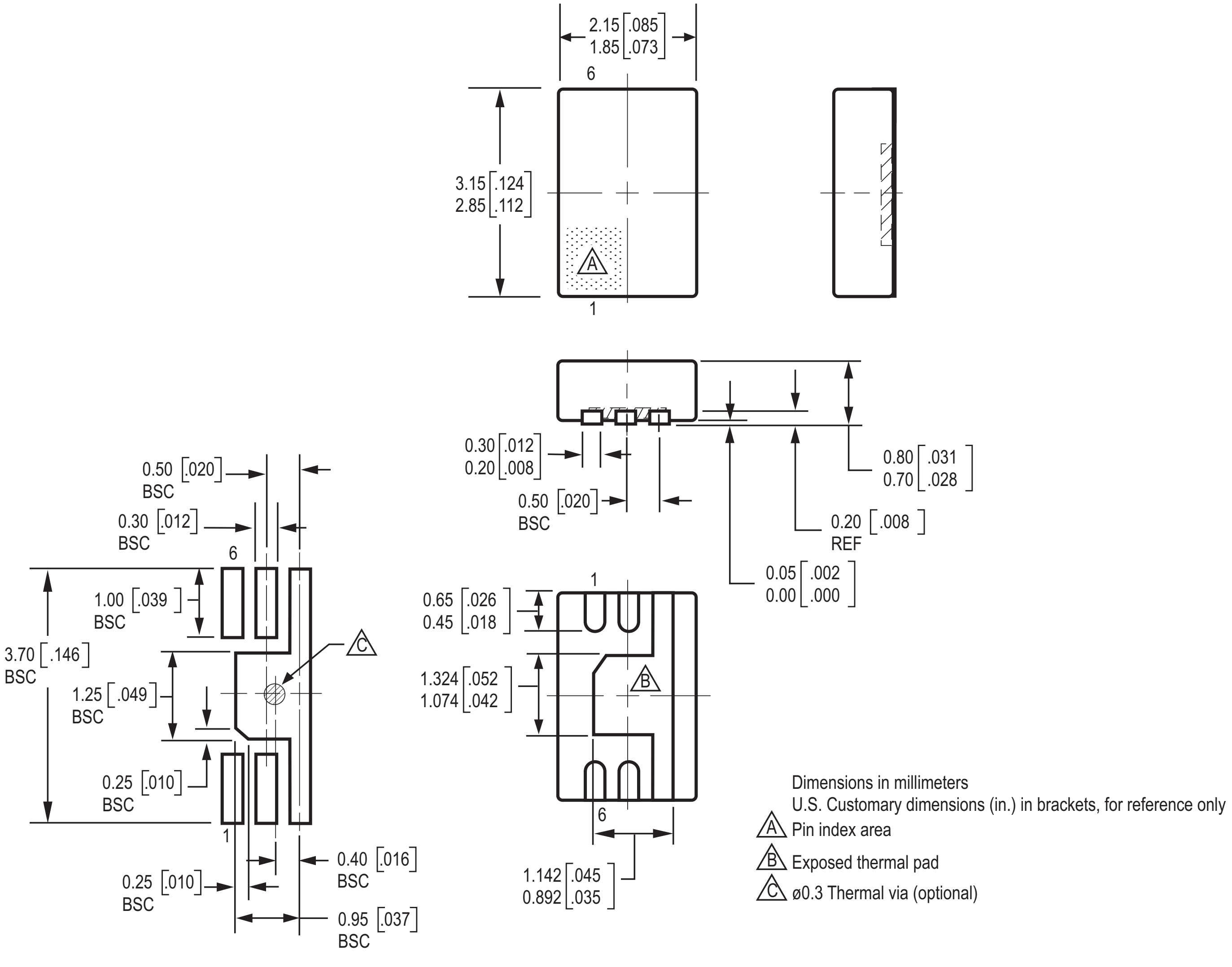


Package Designator 'UA'



PACKAGE DESIGNATOR ‘EH'

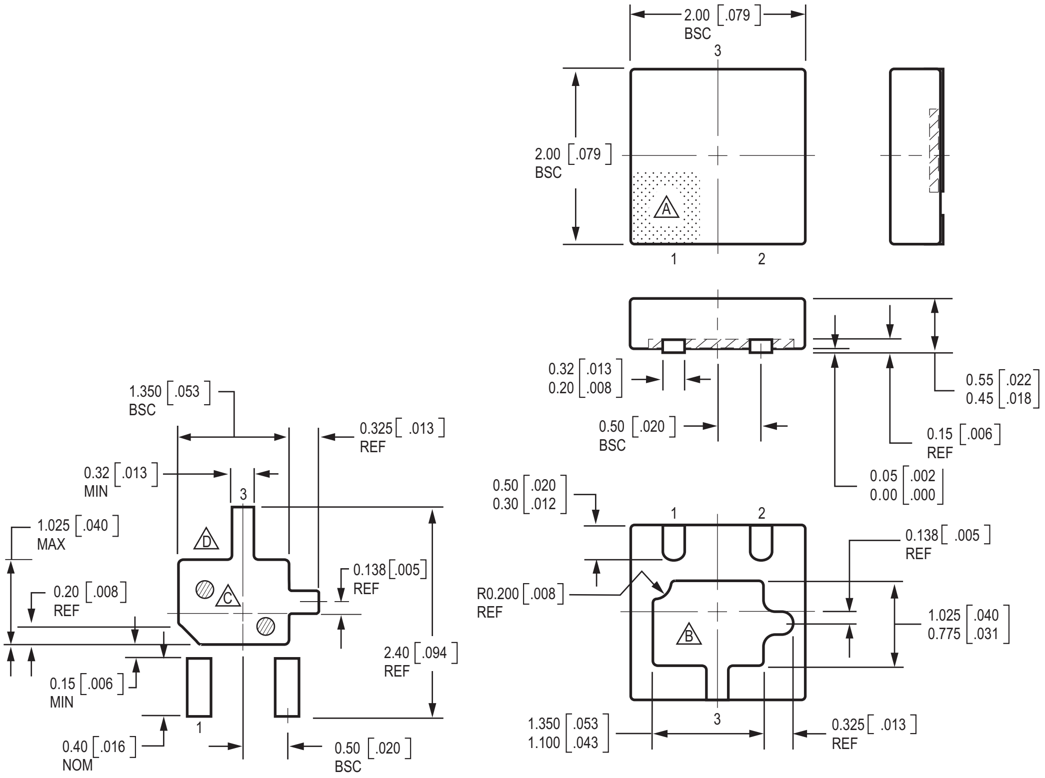
(Reference MO-229C WCED-1)



Dimensions in millimeters
U.S. Customary dimensions (in.) in brackets, for reference only
A Pin index area
B Exposed thermal pad
C ø0.3 Thermal via (optional)

PACKAGE DESIGNATOR ‘EL'

MLPD 3 Contact



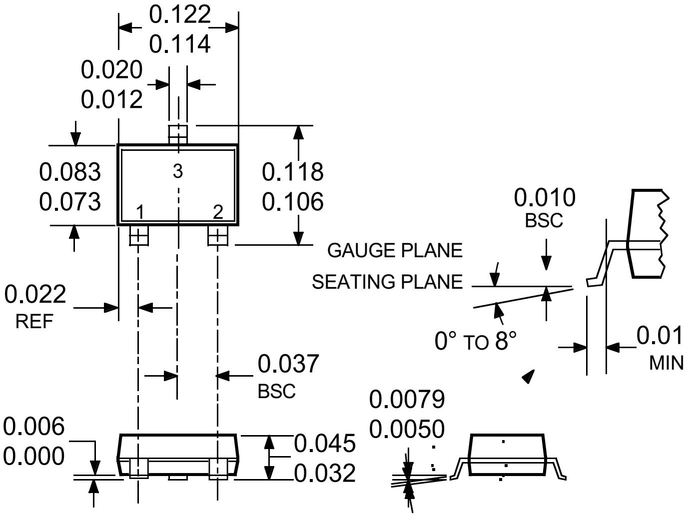
Dimensions in millimeters
U.S. Customary dimensions (in.)
in brackets, for reference only

- △A Pin index area
- △B Exposed thermal pad
- △C Optional thermal vias, ∅0.30 [.012], pitch 1.2 [.047]
- △D Typical pad layout; adjust as necessary to meet application process requirements

PACKAGE DESIGNATOR 'LH'

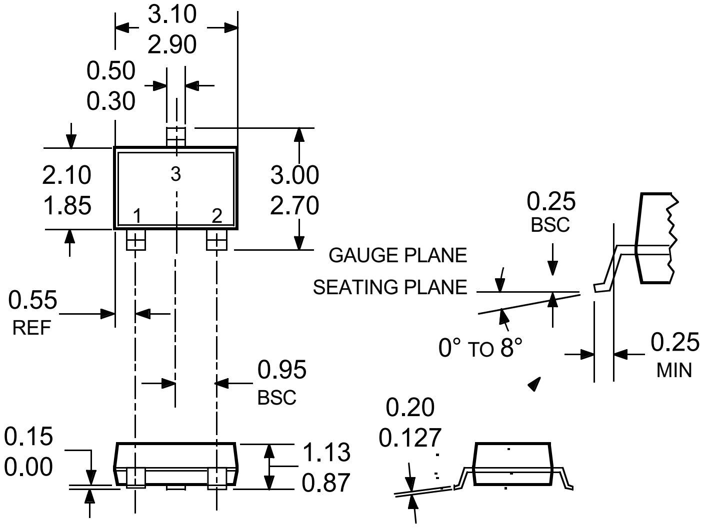
(SOT23W, fits SC-59A solder-pad layout)

Dimensions in Inches
(for reference only)

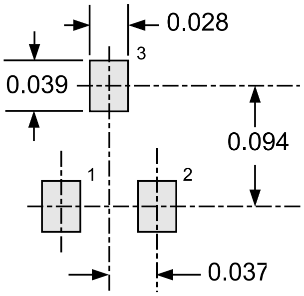


Dwg. MA-010-3D in

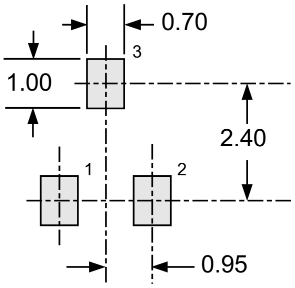
Dimensions in Millimeters
(controlling dimensions)



Dwg. MA-010-3D mm



Dwg. MA-011-3 in

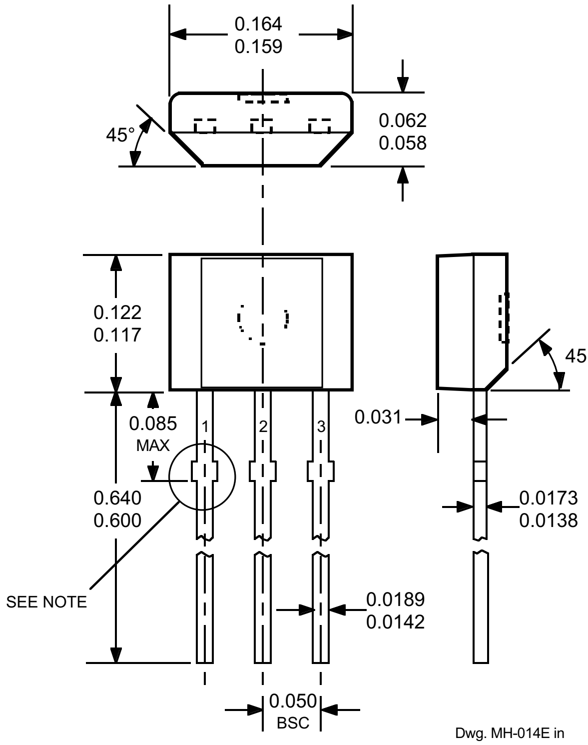


Dwg. MA-011-3 mm

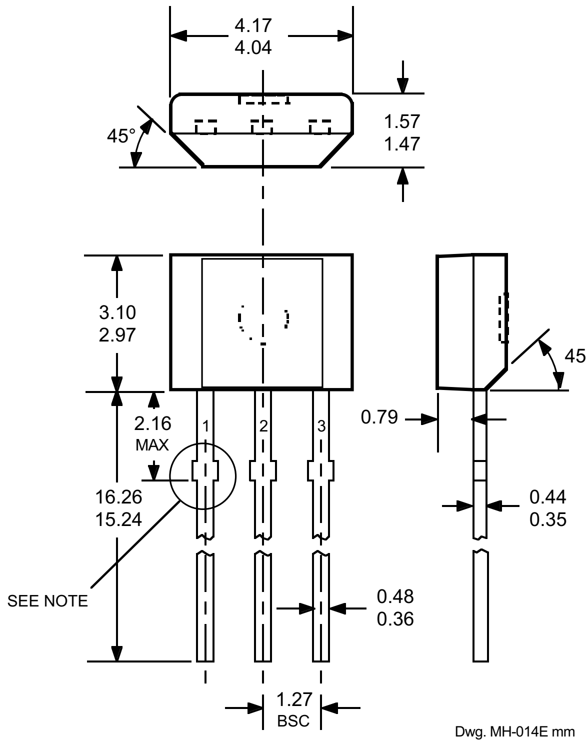
NOTES:
1. Tolerances on package height and width represent allowable mold offsets. Dimensions given are measured at the widest point (parting line).
2. Exact body and lead configuration at vendor's option within limits shown.
3. Height does not include mold gate flash.
4. Where no tolerance is specified, dimension is nominal.

PACKAGE DESIGNATOR 'UA'

Dimensions in Inches
(controlling dimensions)



Dimensions in Millimeters
(for reference only)



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.

A3211 and A3212
MICROPOWER, ULTRA-SENSITIVE HALL-EFFECT SWITCH

The products described herein are manufactured under one or more of the following U.S. patents: 5,045,920; 5,264,783; 5,442,283; 5,389,889; 5,581,179; 5,517,112; 5,619,137; 5,621,319; 5,650,719; 5,686,894; 5,694,038; 5,729,130; 5,917,320; and other patents pending.