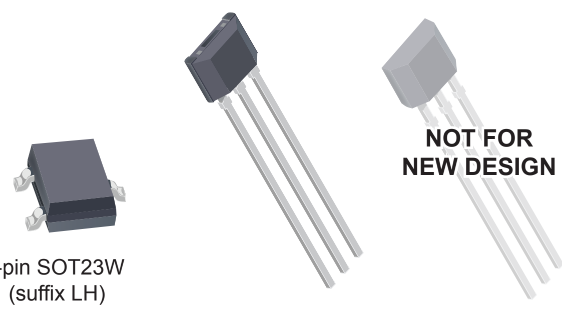
Chopper-Stabilized, Precision Hall-Effect Switch for Consumer and Industrial Applications

FEATURES AND BENEFITS

- Resistant to physical stress
- Superior temperature stability
- Output short-circuit protection
- Operation from unregulated supply
- Reverse battery protection
- Solid-state reliability
- Small package size

PACKAGES:

Not to scale



3-pin SOT23W (suffix LH)

3-pin SIP, matrix HD style (suffix UA)

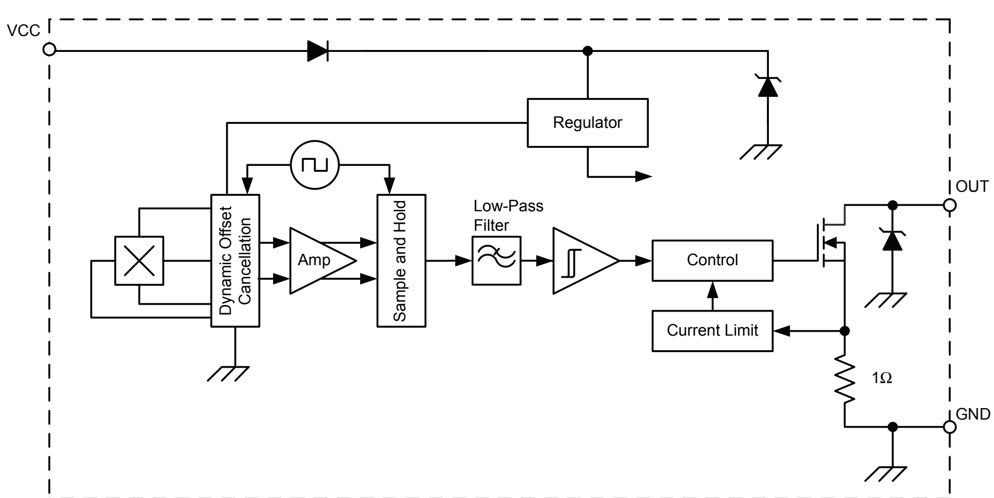
3-pin SIP, chopper style (suffix UA)

DESCRIPTION

The A3295 Hall-effect switch is an extremely temperature-stable and stress-resistant sensor IC unipolar switch, especially suited for operation over extended temperature ranges (up to 125°C). Superior high-temperature performance is made possible through dynamic offset cancellation, which reduces the residual offset voltage normally caused by device package overmolding, temperature dependencies, and thermal stress. The device is not intended for automotive applications.

The device includes, on a single silicon chip, a voltage regulator, a Hall voltage generator, a small-signal amplifier, chopper stabilization, a Schmitt trigger, and a short-circuit protected open-drain output to sink up to 25 mA. A south polarity magnetic field of sufficient strength is required to turn the output on. An onboard regulator permits operation with supply voltages in the range of 3 to 24 V.

Two package styles provide a magnetically optimized package for most applications: type LH is a miniature SOT23W low-profile surface-mount package, and type UA is a three-lead ultramini SIP for through-hole mounting. Both packages are lead (Pb) free, with 100% matte-tin-plated leadframes.



Functional Block Diagram

SPECIFICATIONS

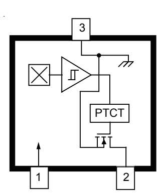
SELECTION GUIDE

Part Number	Packing [1]	Package Type	Magnetic Switchpoints [2]	
			Operate, B_{OP} (G)	Release, B_{RP} (G)
A3295KLHLT-T	3000 pieces per 7-in. reel	Surface-mount SOT23W	75 (max)	5 (min)
A3295KLHLX-T	10000 pieces per 13-in. reel	Surface-mount SOT23W		
A3295KUA-T [3]	500 pieces per bulk bag	Through-hole ultramini SIP		

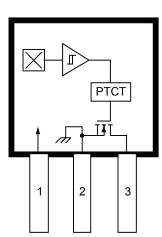
[1] Contact Allegro for additional packing options.
[2] 1 G (gauss) = 0.1 mT (millitesla).
[3] The chopper-style UA package is not for new design; the matrix HD style UA package is recommended for new designs.

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V_{CC}		26.5	V
Reverse Battery Voltage	V_{RCC}		–30	V
Output Off Voltage	V_{OUT}		26	V
Continuous Output Current	I_{OUT}	Device provides internal current limiting to help protect itself from output short circuits	25	mA
Reverse Output Current	I_{ROUT}		–50	mA
Magnetic Flux Density	B		Unlimited	G
Operating Ambient Temperature	T_A	Range K	–40 to 125	°C
Maximum Junction Temperature	T_J(max)		165	°C
Storage Temperature	T_{stg}		–65 to 170	°C



Package LH, 3-Pin SOT23W Pinout Diagram



Package UA, 3-Pin SIP Pinout Diagram

Terminal List

Name	Number		Function
	LH	UA	
VCC	1	1	Power supply
OUT	2	3	Output
GND	3	2	Ground

ELECTRICAL CHARACTERISTICS: Over operating temperature range, unless otherwise noted

Characteristic	Symbol	Test Conditions	Min.	Typ.[1]	Max	Units
Supply Voltage Range [2]	V_{CC}	Operating, T_J < 165°C	3.0	–	24	V
Output Leakage Current	I_{OFF}	V_{OUT} = 24 V, B < B_{RP}	–	–	10	µA
Output Saturation Voltage	$V_{OUT(SAT)}$	I_{OUT} = 20 mA, B > B_{OP}	–	185	500	mV
Output Current Limit	I_{ON}	B > B_{OP}	30	–	60	mA
Power-On Time	t_{PO}	V_{CC} > 3.0 V	–	–	50	µs
Chopping Frequency	f_C		–	800	–	kHz
Output Rise Time	t_R	R_{LOAD} = 820 Ω, C_{LOAD} = 20 pF	–	0.2	2.0	µs
Output Fall Time	t_F	R_{LOAD} = 820 Ω, C_{LOAD} = 20 pF	–	0.1	2.0	µs
Supply Current	I_{CC}	B < B_{RP}, V_{CC} = 12 V	–	3.0	8.0	mA
		B > B_{OP}, V_{CC} = 12 V	–	4.0	8.0	mA
Reverse Battery Current	I_{RCC}	V_{RCC} = –20 V	–	–	–5.0	mA
Zener Voltage	$V_Z + V_D$	I_{CC} = 15 mA, T_A = 25°C	28	–	–	V
Zener Impedance	$Z_Z + Z_D$	I_{CC} = 15 mA, T_A = 25°C	–	50	–	Ω

[1] Typical data at T_A = 25°C, 12 V.
[2] Maximum V_{CC} must be derated for power dissipation and junction temperature. See Application Information.

MAGNETIC CHARACTERISTICS: Over V_{CC} range, unless otherwise noted

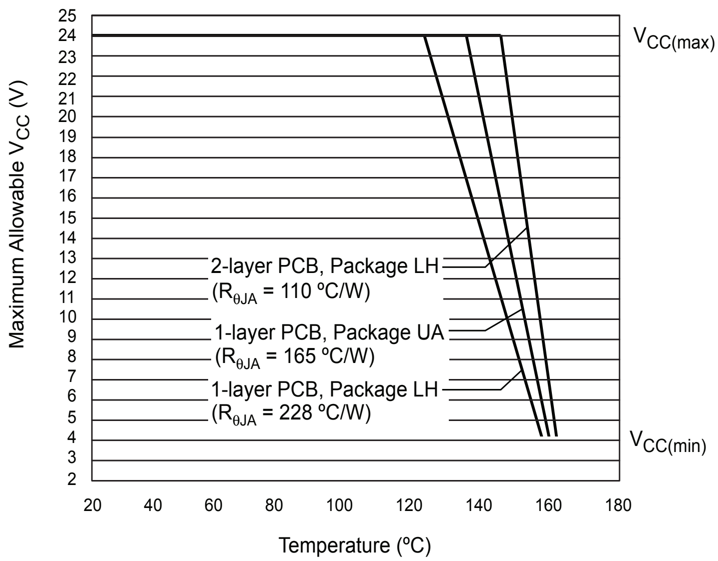
Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Operate Point	B_{OP}		–	–	75	G
Release Point	B_{RP}		5	–	–	G
Hysteresis	B_{HYS}	$B_{OP} – B_{RP}$	–	–	70	G

THERMAL CHARACTERISTICS: May require derating at maximum conditions; see application information

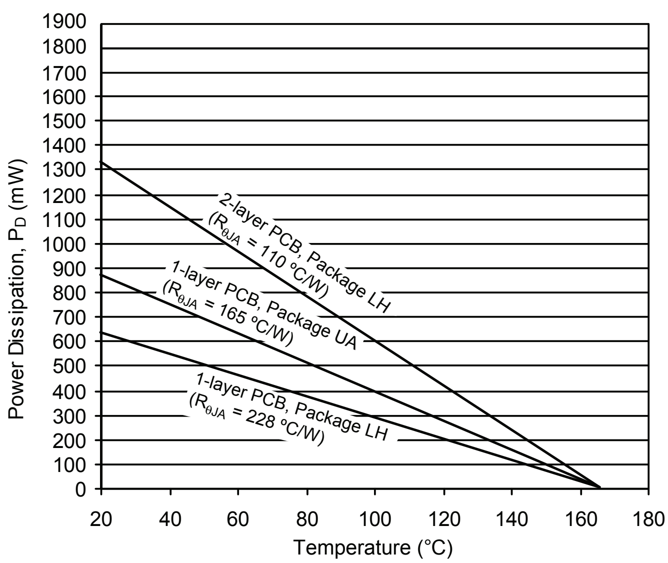
Characteristic	Symbol	Test Conditions [1]	Value	Units
Package Thermal Resistance	$R_{\theta JA}$	Package LH, 1-layer PCB with copper limited to solder pads	228	°C/W
		Package LH, 2-layer PCB with 0.463 in.^{2} of copper area each side connected by thermal vias	110	°C/W
		Package UA, 1-layer PCB with copper limited to solder pads	165	°C/W

[1] Additional thermal information available on Allegro website.

Power Derating Curve



Power Dissipation versus Ambient Temperature



FUNCTIONAL DESCRIPTION

Chopper-Stabilized Technique

The Hall element can be considered as a resistor array similar to a Wheatstone bridge. A basic circuit is shown in figure 1, demonstrating the effect of the magnetic field flux density, B, impinging on the Hall element. When using Hall effect technology, a limiting factor for switchpoint accuracy is the small signal voltage, V_{HALL}, developed across the Hall element. This voltage is disproportionally small relative to the offset that can be produced at the output of the Hall device, caused by device overmolding, temperature dependencies, and thermal stress.

A large portion of the offset is a result of the mismatching of these resistors. The A3295 uses a dynamic offset cancellation technique, with an internal high-frequency clock, to reduce the residual offset, see figure 2. The chopper-stabilizing technique cancels the mismatching of the resistor circuit by changing the direction of the current flowing through the Hall element. To do so, CMOS switches and Hall voltage measurement taps are used, while maintaining V_{HALL} 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. This technique will also slightly degrade the device output repeatability. A relatively high sampling frequency is used in order to process faster signals.

More detailed descriptions of the circuit operation can be found on the Allegro website, including: Technical Paper STP 97-10, *Monolithic Magnetic Hall Sensing Using Dynamic Quadrature Offset Cancellation*, and Technical Paper STP 99-1, *Chopper-Stabilized Amplifiers with a Track-and-Hold Signal Demodulator*.

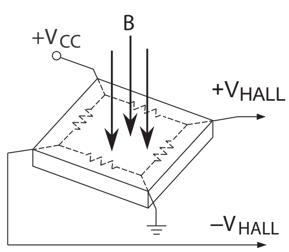


Figure 1: Hall Element, Basic Circuit Operation

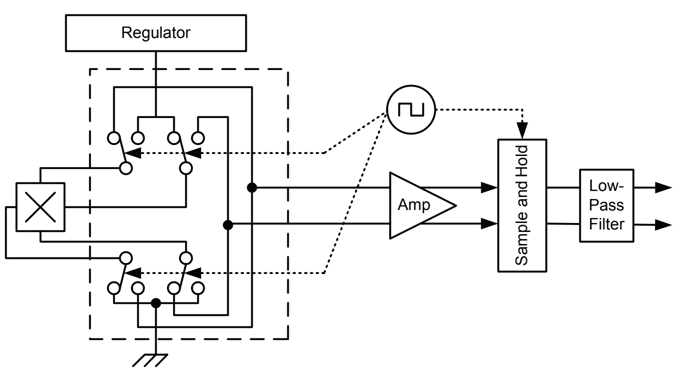


Figure 2: Chopper Stabilization Circuit (Dynamic Quadrature Offset Cancellation)

Operation

The output of the A3295 switches low (turns on) when a magnetic field perpendicular to the Hall element transitions through and exceeds the Operate Point threshold, B_{OP}. This is illustrated in figure 3. After turn-on, the output is capable of sinking 25 mA, and the output voltage reaches $V_{OUT(SAT)}$.

Note that after a south (+) polarity magnetic field of sufficient strength impinging on the branded face of the device turns on the device, the device remains on until the magnetic field is reduced below the Release Point threshold, B_{RP}. At that transition, 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.

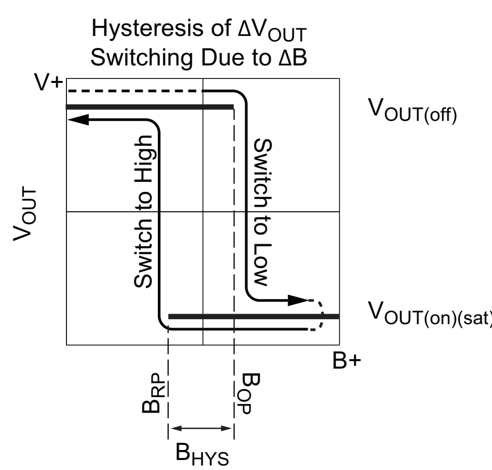


Figure 3: Output Voltage Responds to Magnetic Flux Density.

When the device is powered on, if the ambient magnetic field has an intensity that is between B_{OP} and B_{RP}, the initial output state is indeterminate. The first time that the level of B either rises through B_{OP}, or falls through B_{RP}, however, the correct output state is obtained.

APPLICATION INFORMATION

It is strongly recommended that an external bypass capacitor be connected (in close proximity to the Hall element) between the supply and ground of the device to reduce both external noise and noise generated by the chopper stabilization technique. This configuration is shown in figure 4.

The simplest form of magnet that will operate these devices is a ring magnet. Other methods of operation, such as linear magnets, are possible.

The device must be operated below the maximum junction temperature of the device, $T_{J(max)}$. Under certain combinations of peak conditions, reliable operation may require derating supplied power or improving the heat dissipation properties of the application. The Package Thermal Resistance, $R_{\theta JA}$, is a figure of merit summarizing the ability of the application and the device to dissipate heat from the junction (die), through all paths to the ambient air. Its primary component is the Effective Thermal Conductivity, K, of the printed circuit board, including adjacent devices and traces. Radiation from the die through the device case, $R_{\theta JC}$, is relatively small component of $R_{\theta JA}$. Ambient air temperature, T_A, and air motion are significant external factors, damped by overmolding. Sample power dissipation results are given in the Thermal Characteristics section. Additional thermal data is also available on the Allegro website.

Extensive applications information for Hall-effect devices is available in: *Hall-Effect IC Applications Guide*, Application Note 27701 and *Guidelines for Designing Subassemblies Using Hall-Effect Devices*, Application Note 27703.1.

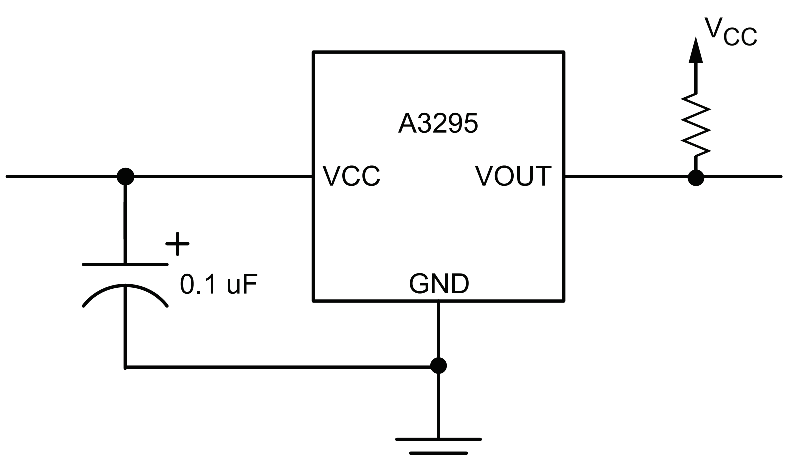


Figure 4: Typical Basic Application Circuit
A bypass capacitor is highly recommended.

CUSTOMER PACKAGE DRAWINGS

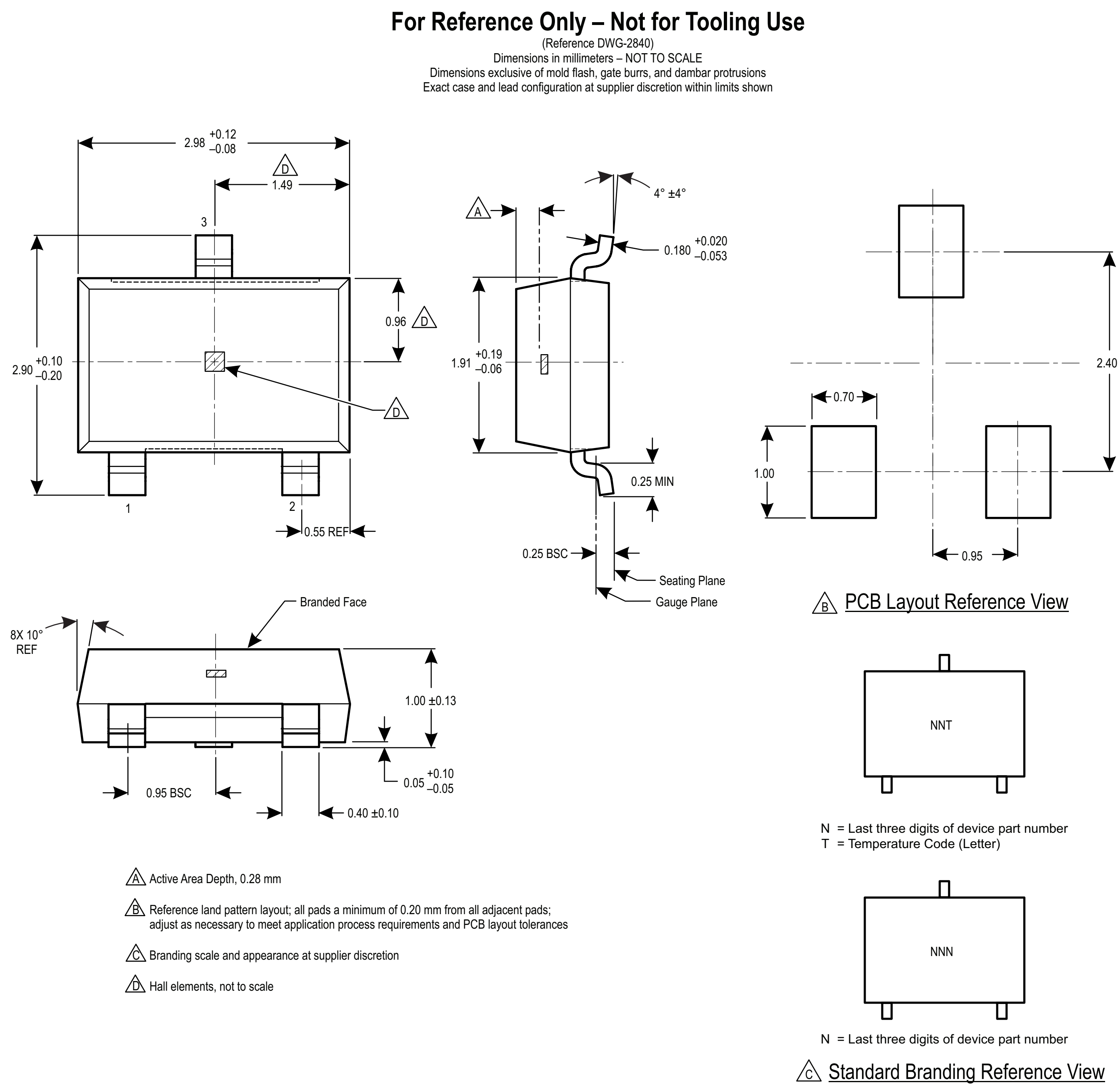


Figure 5: Package LH, 3-Pin SOT23W

For Reference Only – Not for Tooling Use

(Reference DWG-9049)
Dimensions in millimeters – NOT TO SCALE
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown

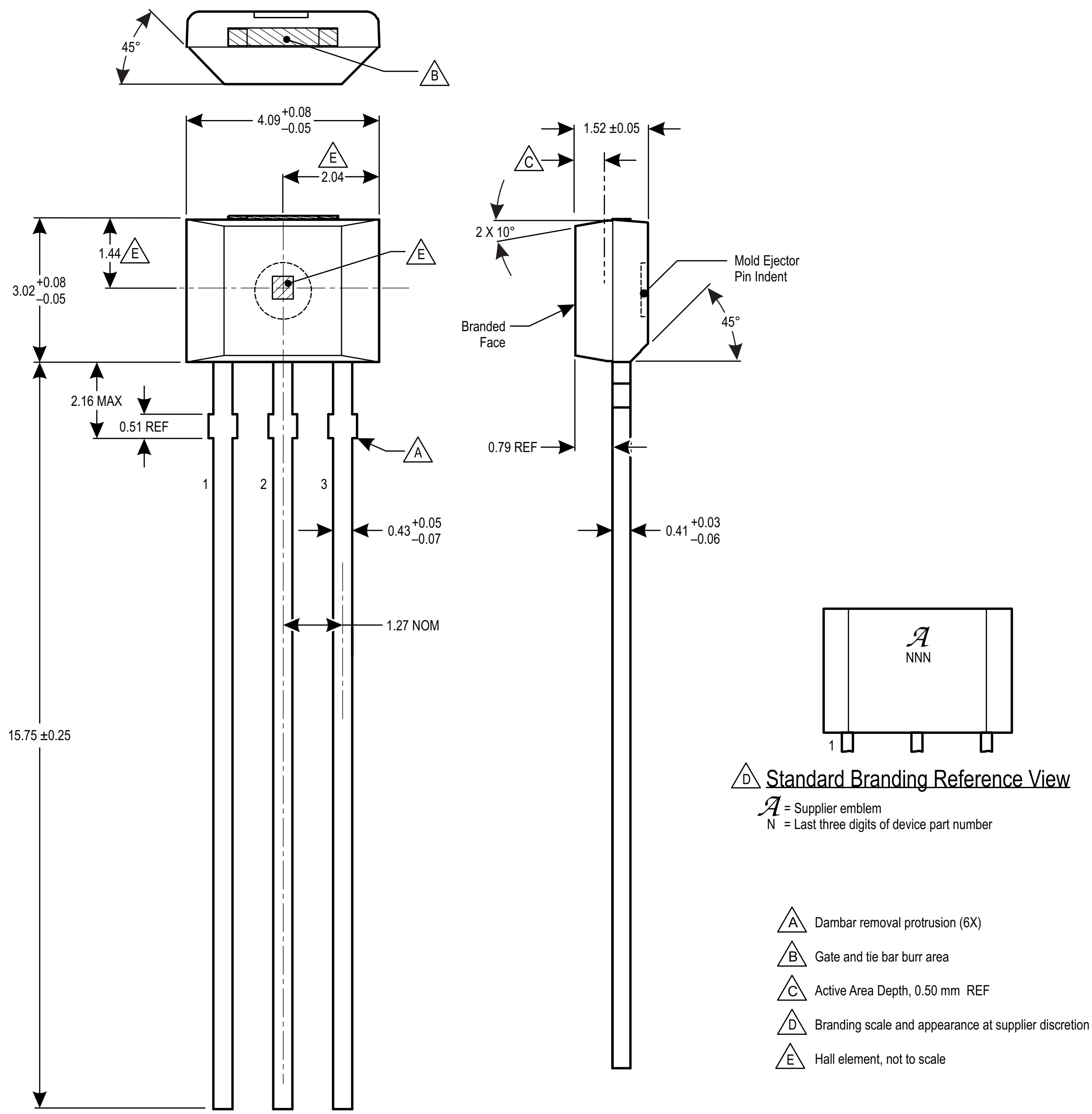


Figure 6: Package UA, 3-Pin SIP, Matrix Style

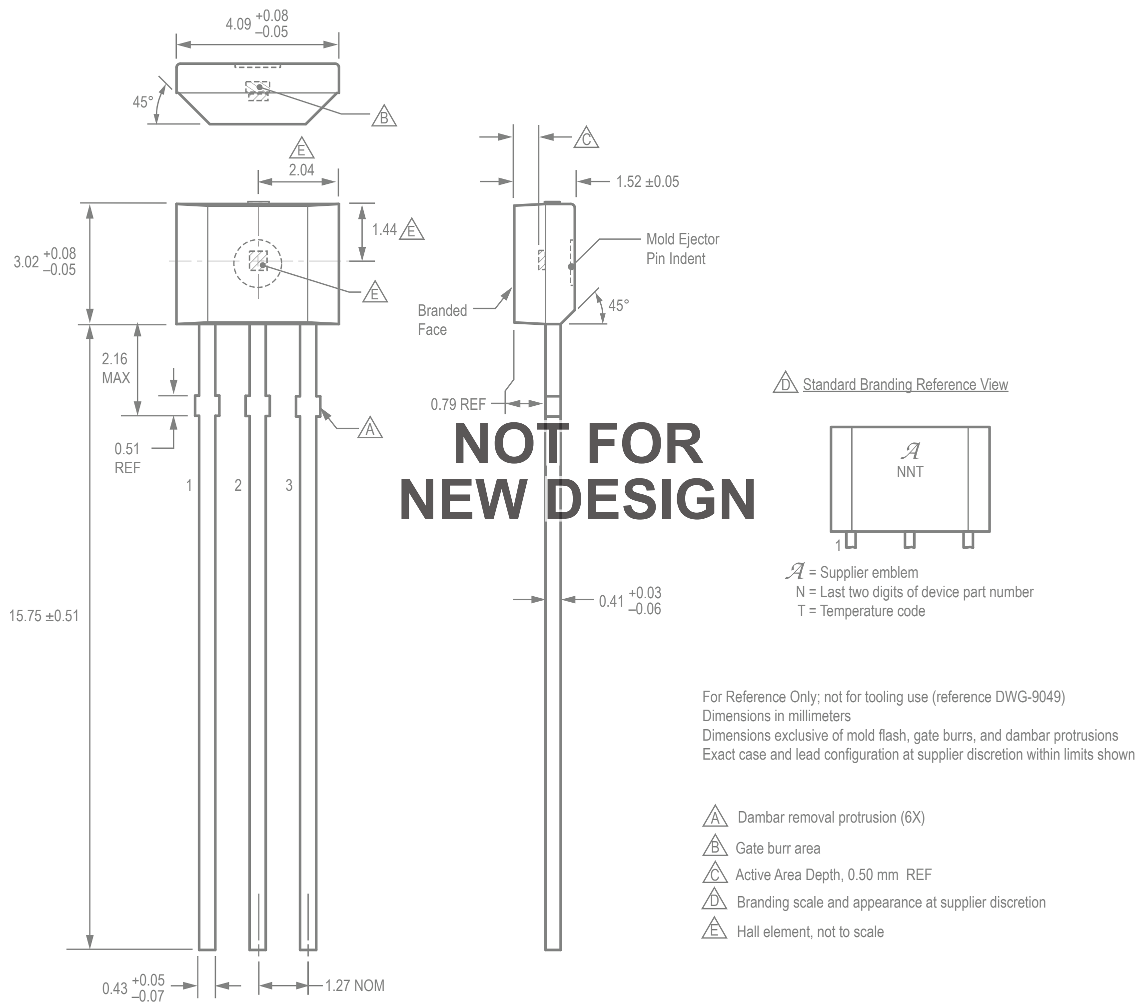


Figure 7: Package UA, 3-Pin SIP, Chopper Style

Revision History

Number	Date	Description
9	November 11, 2012	Conform Description
10	January 2, 2015	Added LX option to Selection Guide
11	July 13, 2015	Corrected LH package Active Area Depth value
12	January 14, 2016	Updated Reverse Supply Current test conditions in Electrical Characteristics table
13	November 4, 2016	Chopper-style UA package designated as not for new design
14	September 21, 2017	Updated Power-On Time test conditions (p. 3)

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Allegro MicroSystems, LLC
115 Northeast Cutoff
Worcester, Massachusetts 01615-0036 U.S.A.
1.508.853.5000; www.allegromicro.com