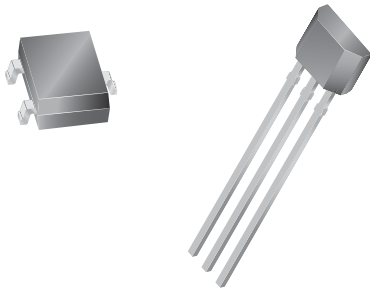


## Continuous-Time Switch Family

### Features and Benefits

- Continuous-time operation
  - Fast power-on time
  - Low noise
- Stable operation over full operating temperature range
- Reverse battery protection
- Solid-state reliability
- Factory-programmed at end-of-line for optimum performance
- Robust EMC performance
- High ESD rating
- Regulator stability without a bypass capacitor

**Packages: 3 pin SOT23W (suffix LH), and 3 pin SIP (suffix UA)**



*Not to scale*

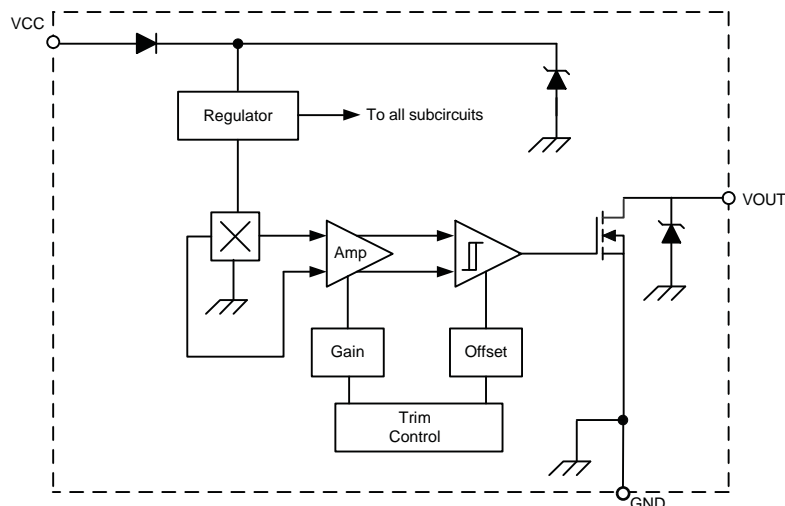
### Description

The Allegro® A1101-A1104 and A1106 Hall-effect switches are next generation replacements for the popular Allegro 312x and 314x lines of unipolar switches. The A110x family, produced with BiCMOS technology, consists of devices that feature fast power-on time and low-noise operation. Device programming is performed after packaging, to ensure increased switchpoint accuracy by eliminating offsets that can be induced by package stress. Unique Hall element geometries and low-offset amplifiers help to minimize noise and to reduce the residual offset voltage normally caused by device overmolding, temperature excursions, and thermal stress.

The A1101-A1104 and A1106 Hall-effect switches include the following on a single silicon chip: voltage regulator, Hall-voltage generator, small-signal amplifier, Schmitt trigger, and NMOS output transistor. The integrated voltage regulator permits operation from 3.8 to 24 V. The extensive on-board protection circuitry makes possible a  $\pm 30$  V absolute maximum voltage rating for superior protection in automotive and industrial motor commutation applications, without adding

*Continued on the next page...*

### Functional Block Diagram



**Description (continued)**

external components. All devices in the family are identical except for magnetic switchpoint levels.

The small geometries of the BiCMOS process allow these devices to be provided in ultrasmall packages. The package styles available

provide magnetically optimized solutions for most applications. Package LH is an SOT23W, a miniature low-profile surface-mount package, while package UA is a three-lead ultramini SIP for through-hole mounting. Each package is lead (Pb) free, with 100% matte tin plated leadframes.

**Selection Guide**

| Part Number  | Packing*                     | Mounting                   | Ambient, T <sub>A</sub> | B <sub>RP</sub> (Min) | B <sub>OP</sub> (Max) |
|--------------|------------------------------|----------------------------|-------------------------|-----------------------|-----------------------|
| A1101ELHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 85°C           | 10                    | 175                   |
| A1101EUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |
| A1101LLHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 150°C          |                       |                       |
| A1101LUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |
| A1102ELHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 85°C           | 60                    | 245                   |
| A1102EUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |
| A1102LLHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 150°C          |                       |                       |
| A1102LUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |
| A1103ELHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 85°C           | 150                   | 355                   |
| A1103LLHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 150°C          |                       |                       |
| A1103LUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |
| A1104EUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     | −40°C to 85°C           | 25                    | 450                   |
| A1104LLHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 150°C          |                       |                       |
| A1104LUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |
| A1106EUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     | −40°C to 85°C           | 160                   | 430                   |
| A1106LLHLT-T | 7-in. reel, 3000 pieces/reel | 3-pin SOT23W surface mount | −40°C to 150°C          |                       |                       |
| A1106LUA-T   | Bulk, 500 pieces/bag         | 3-pin SIP through hole     |                         |                       |                       |

\*Contact Allegro for additional packing options.

**Absolute Maximum Ratings**

| Characteristic                | Symbol        | Notes   | Rating     | Units |
|-------------------------------|---------------|---------|------------|-------|
| Supply Voltage                | $V_{CC}$      |         | 30         | V     |
| Reverse Supply Voltage        | $V_{RCC}$     |         | -30        | V     |
| Output Off Voltage            | $V_{OUT}$     |         | 30         | V     |
| Reverse Output Voltage        | $V_{ROUT}$    |         | -0.5       | V     |
| Output Current                | $I_{OUTSINK}$ |         | 25         | mA    |
| Magnetic Flux Density         | B             |         | Unlimited  | G     |
| Operating Ambient Temperature | $T_A$         | Range E | -40 to 85  | °C    |
|                               |               | Range L | -40 to 150 | °C    |
| Maximum Junction Temperature  | $T_J(max)$    |         | 165        | °C    |
| Storage Temperature           | $T_{stg}$     |         | -65 to 170 | °C    |



**ELECTRICAL OPERATING CHARACTERISTICS** over full operating voltage and ambient temperature ranges, unless otherwise noted

| Characteristic                    | Symbol         | Test Conditions  | Min. | Typ. | Max. | Units         |
|-----------------------------------|----------------|--|------|------|------|---------------|
| Supply Voltage <sup>1</sup>       | $V_{CC}$       | Operating, $T_J < 165^\circ\text{C}$   | 3.8  | –    | 24   | V             |
| Output Leakage Current            | $I_{OUTOFF}$   | $V_{OUT} = 24\text{ V}$ , $B < B_{RP}$   | –    | –    | 10   | $\mu\text{A}$ |
| Output On Voltage                 | $V_{OUT(SAT)}$ | $I_{OUT} = 20\text{ mA}$ , $B > B_{OP}$  | –    | 215  | 400  | mV            |
| Power-On Time <sup>2</sup>        | $t_{PO}$       | Slew rate $(dV_{CC}/dt) < 2.5\text{ V}/\mu\text{s}$ , $B > B_{OP} + 5\text{ G}$ or $B < B_{RP} - 5\text{ G}$ | –    | –    | 4    | $\mu\text{s}$ |
| Output Rise Time <sup>3</sup>     | $t_r$          | $V_{CC} = 12\text{ V}$ , $R_{LOAD} = 820\ \Omega$ , $C_S = 12\text{ pF}$                                     | –    | –    | 400  | ns            |
| Output Fall Time <sup>3</sup>     | $t_f$          | $V_{CC} = 12\text{ V}$ , $R_{LOAD} = 820\ \Omega$ , $C_S = 12\text{ pF}$                                     | –    | –    | 400  | ns            |
| Supply Current                    | $I_{CCON}$     | $B > B_{OP}$   | –    | 4.1  | 7.5  | mA            |
|                                   | $I_{CCOFF}$    | $B < B_{RP}$   | –    | 3.8  | 7.5  | mA            |
| Reverse Battery Current           | $I_{RCC}$      | $V_{RCC} = -30\text{ V}$   | –    | –    | -10  | mA            |
| Supply Zener Clamp Voltage        | $V_Z$          | $I_{CC} = 10.5\text{ mA}$ ; $T_A = 25^\circ\text{C}$   | 32   | –    | –    | V             |
| Supply Zener Current <sup>4</sup> | $I_Z$          | $V_Z = 32\text{ V}$ ; $T_A = 25^\circ\text{C}$   | –    | –    | 10.5 | mA            |

<sup>1</sup> Maximum voltage must be adjusted for power dissipation and junction temperature, see *Power Derating* section.

<sup>2</sup> For  $V_{CC}$  slew rates greater than  $250\text{ V}/\mu\text{s}$ , and  $T_A = 150^\circ\text{C}$ , the Power-On Time can reach its maximum value.

<sup>3</sup>  $C_S$  = oscilloscope probe capacitance.

<sup>4</sup> Maximum current limit is equal to the maximum  $I_{CC(max)} + 3\text{ mA}$ .

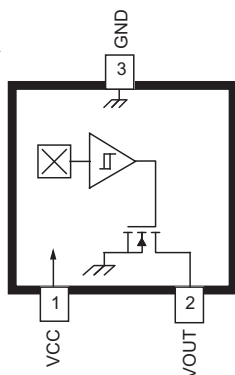
## DEVICE QUALIFICATION PROGRAM

Contact Allegro for information.

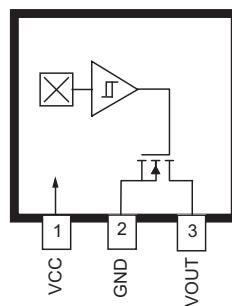
## EMC (Electromagnetic Compatibility) REQUIREMENTS

Contact Allegro for information.

Package LH



Package UA, 3-pin SIP



Terminal List

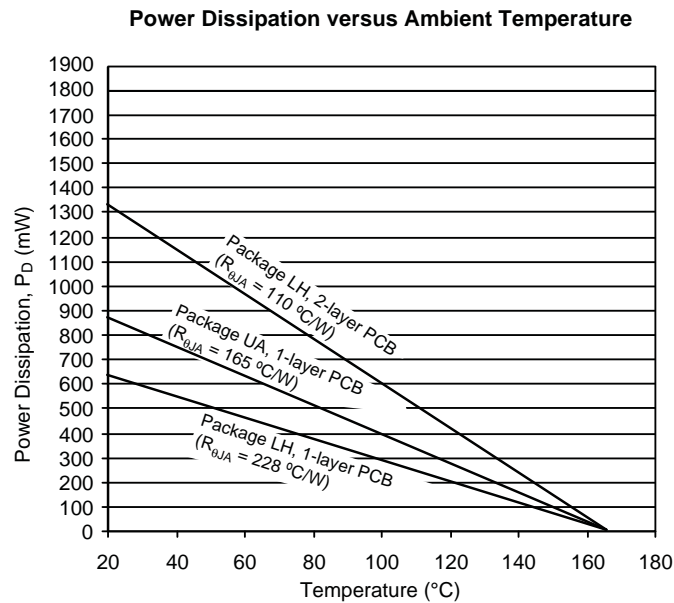
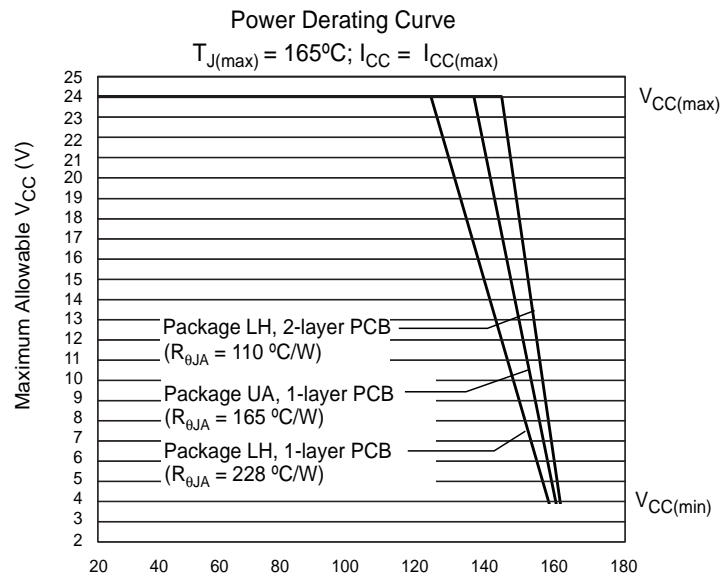
| Name | Description                   | Number     |            |
|------|-------------------------------|------------|------------|
|      |                               | Package LH | Package UA |
| VCC  | Connects power supply to chip | 1          | 1          |
| VOUT | Output from circuit           | 2          | 3          |
| GND  | Ground                        | 3          | 2          |

**MAGNETIC OPERATING CHARACTERISTICS<sup>1</sup>** over full operating voltage and ambient temperature ranges, unless otherwise noted

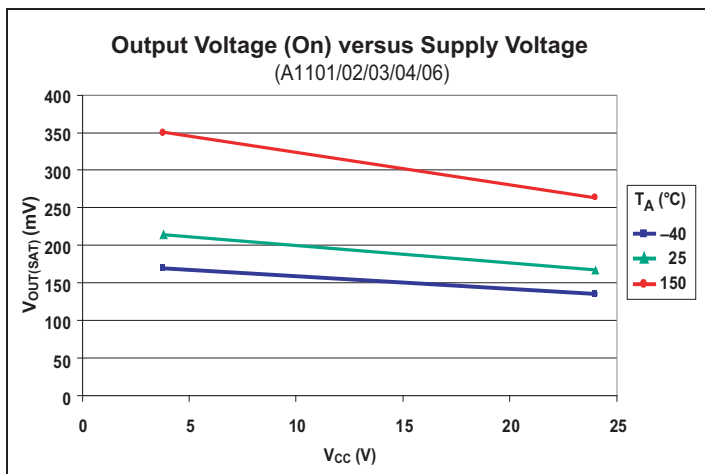
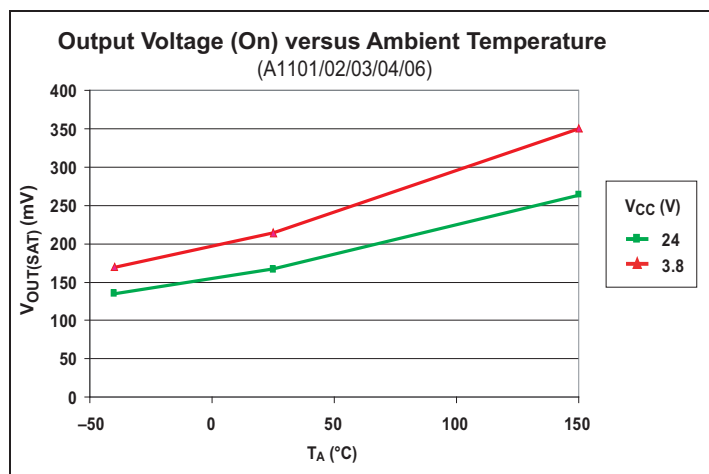
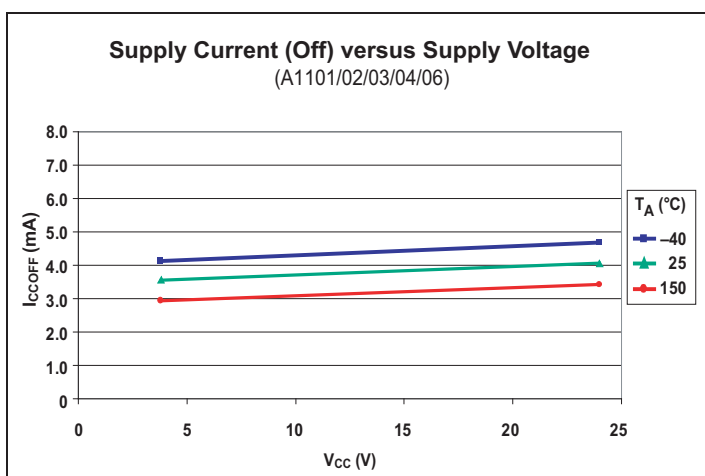
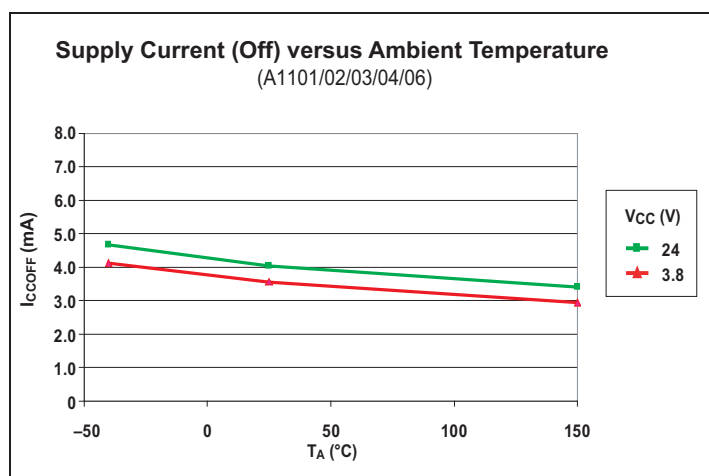
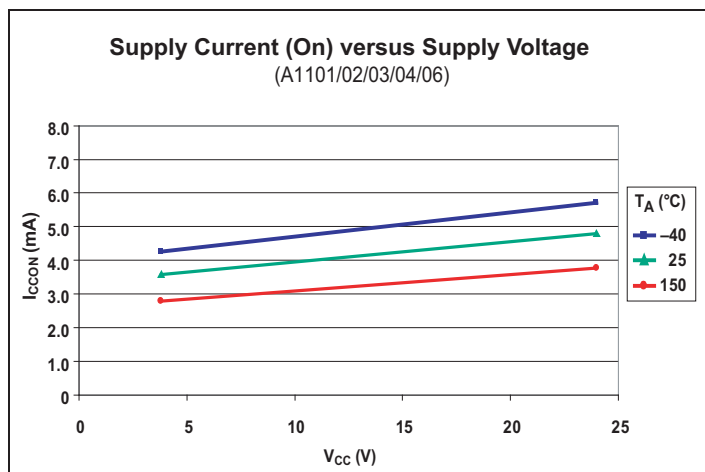
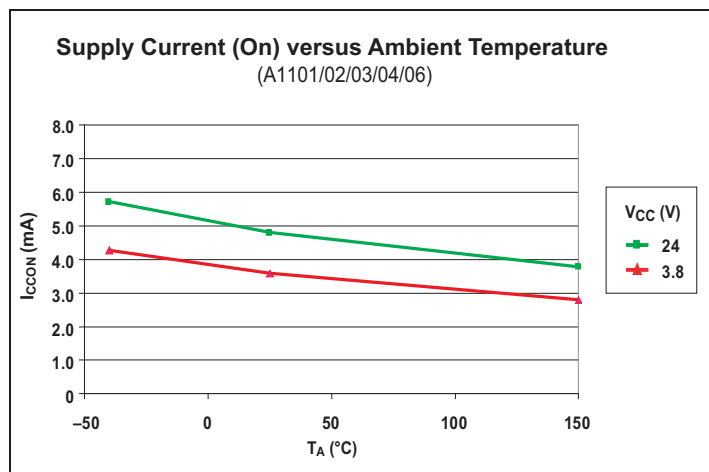
| Characteristic | Symbol    | Test Conditions |                             | Min. | Typ. | Max. | Units |
|----------------|-----------|-----------------|-----------------------------|------|------|------|-------|
| Operate Point  | $B_{OP}$  | A1101           | $T_A = 25^\circ\text{C}$    | 50   | 100  | 160  | G     |
|                |           |                 | Operating Temperature Range | 30   | 100  | 175  | G     |
|                |           | A1102           | $T_A = 25^\circ\text{C}$    | 130  | 180  | 230  | G     |
|                |           |                 | Operating Temperature Range | 115  | 180  | 245  | G     |
|                |           | A1103           | $T_A = 25^\circ\text{C}$    | 220  | 280  | 340  | G     |
|                |           |                 | Operating Temperature Range | 205  | 280  | 355  | G     |
|                |           | A1104           | $T_A = 25^\circ\text{C}$    | 70   | –    | 350  | G     |
|                |           |                 | Operating Temperature Range | 35   | –    | 450  | G     |
|                |           | A1106           | $T_A = 25^\circ\text{C}$    | 280  | 340  | 400  | G     |
|                |           |                 | Operating Temperature Range | 260  | 340  | 430  | G     |
| Release Point  | $B_{RP}$  | A1101           | $T_A = 25^\circ\text{C}$    | 10   | 45   | 130  | G     |
|                |           |                 | Operating Temperature Range | 10   | 45   | 145  | G     |
|                |           | A1102           | $T_A = 25^\circ\text{C}$    | 75   | 125  | 175  | G     |
|                |           |                 | Operating Temperature Range | 60   | 125  | 190  | G     |
|                |           | A1103           | $T_A = 25^\circ\text{C}$    | 165  | 225  | 285  | G     |
|                |           |                 | Operating Temperature Range | 150  | 225  | 300  | G     |
|                |           | A1104           | $T_A = 25^\circ\text{C}$    | 50   | –    | 330  | G     |
|                |           |                 | Operating Temperature Range | 25   | –    | 430  | G     |
|                |           | A1106           | $T_A = 25^\circ\text{C}$    | 180  | 240  | 300  | G     |
|                |           |                 | Operating Temperature Range | 160  | 240  | 330  | G     |
| Hysteresis     | $B_{HYS}$ | A1101           | $T_A = 25^\circ\text{C}$    | 20   | 55   | 80   | G     |
|                |           |                 | Operating Temperature Range | 20   | 55   | 80   | G     |
|                |           | A1102           | $T_A = 25^\circ\text{C}$    | 30   | 55   | 80   | G     |
|                |           |                 | Operating Temperature Range | 30   | 55   | 80   | G     |
|                |           | A1103           | $T_A = 25^\circ\text{C}$    | 30   | 55   | 80   | G     |
|                |           |                 | Operating Temperature Range | 30   | 55   | 80   | G     |
|                |           | A1104           | $T_A = 25^\circ\text{C}$    | 20   | 55   | –    | G     |
|                |           |                 | Operating Temperature Range | 20   | 55   | –    | G     |
|                |           | A1106           | $T_A = 25^\circ\text{C}$    | 70   | 105  | 140  | G     |
|                |           |                 | Operating Temperature Range | 70   | 105  | 140  | G     |

<sup>1</sup> Magnetic flux density, B, is indicated as a negative value for north-polarity magnetic fields, and as a positive value for south-polarity magnetic fields. This so-called algebraic convention supports arithmetic comparison of north and south polarity values, where the relative strength of the field is indicated by the absolute value of B, and the sign indicates the polarity of the field (for example, a –100 G field and a 100 G field have equivalent strength, but opposite polarity).

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



Characteristic Data



## Functional Description

### OPERATION

The output of these devices switches low (turns on) when a magnetic field (south polarity) perpendicular to the Hall element exceeds the operate point threshold,  $B_{OP}$ . After turn-on, the output is capable of sinking 25 mA and the output voltage is  $V_{OUT(SAT)}$ . When the magnetic field is reduced below the release point,  $B_{RP}$ , 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.

Powering-on the device in the hysteresis region, less than  $B_{OP}$  and higher than  $B_{RP}$ , allows an indeterminate output state. The correct state is attained after the first excursion beyond  $B_{OP}$  or  $B_{RP}$ .

### CONTINUOUS-TIME BENEFITS

Continuous-time devices, such as the A110x family, offer the fastest available power-on settling time and frequency response. Due to offsets generated during the IC packaging process, continuous-time devices typically require programming after

packaging to tighten magnetic parameter distributions. In contrast, chopper-stabilized switches employ an offset cancellation technique on the chip that eliminates these offsets without the need for after-packaging programming. The tradeoff is a longer settling time and reduced frequency response as a result of the chopper-stabilization offset cancellation algorithm.

The choice between continuous-time and chopper-stabilized designs is solely determined by the application. Battery management is an example where continuous-time is often required. In these applications,  $V_{CC}$  is chopped with a very small duty cycle in order to conserve power (refer to figure 2). The duty cycle is controlled by the power-on time,  $t_{PO}$ , of the device. Because continuous-time devices have the shorter power-on time, they are the clear choice for such applications.

For more information on the chopper stabilization technique, refer to 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*.

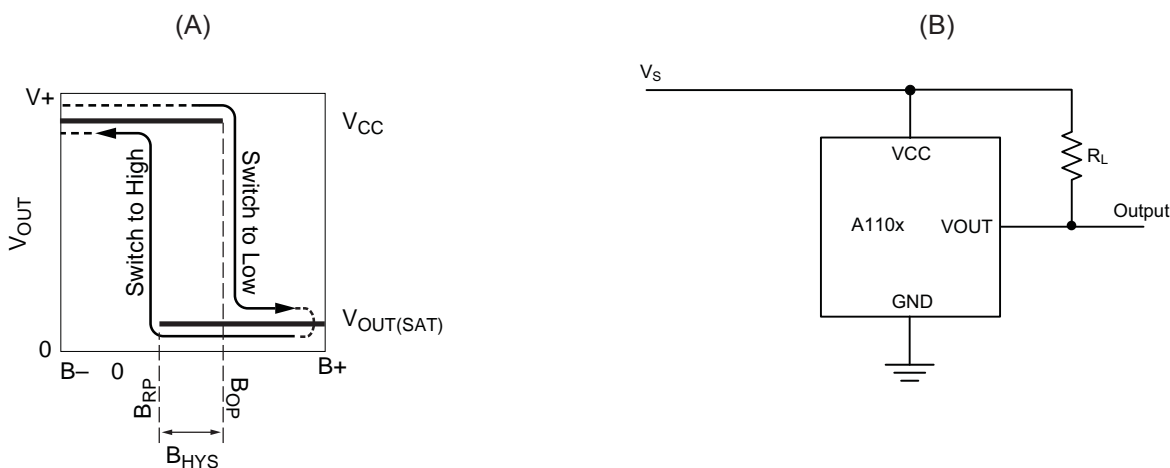


Figure 1. Switching Behavior of Unipolar Switches. On the horizontal axis, the  $B+$  direction indicates increasing south polarity magnetic field strength, and the  $B-$  direction indicates decreasing south polarity field strength (including the case of increasing north polarity). This behavior can be exhibited when using a circuit such as that shown in Panel B.

## ADDITIONAL APPLICATIONS INFORMATION

Extensive applications information for Hall-effect devices is available in:

- *Hall-Effect IC Applications Guide*, Application Note 27701
- *Hall-Effect Devices: Gluing, Potting, Encapsulating, Lead Welding and Lead Forming*, Application Note 27703.1
- *Soldering Methods for Allegro's Products – SMT and Through-Hole*, Application Note 26009

All are provided in *Allegro Electronic Data Book*, AMS-702, and the Allegro Web site, [www.allegromicro.com](http://www.allegromicro.com).

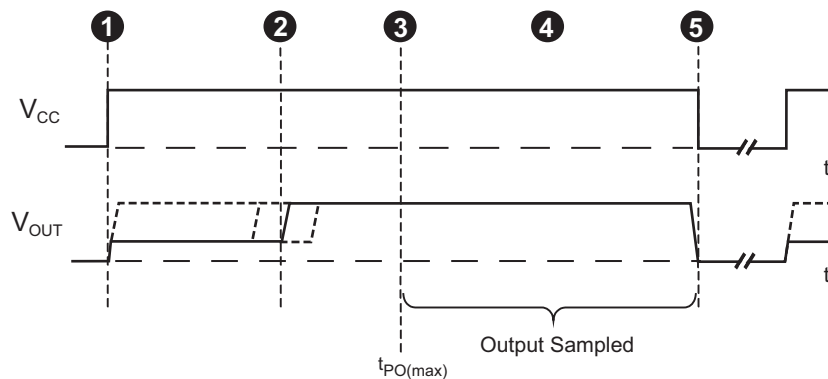


Figure 2. Continuous-Time Application,  $B < B_{RP}$ . This figure illustrates the use of a quick cycle for chopping  $V_{CC}$  in order to conserve battery power. Position 1, power is applied to the device. Position 2, the output assumes the correct state at a time prior to the maximum Power-On Time,  $t_{PO(max)}$ . The case shown is where the correct output state is HIGH. Position 3,  $t_{PO(max)}$  has elapsed. The device output is valid. Position 4, after the output is valid, a control unit reads the output. Position 5, power is removed from the device.



## Power Derating

### Power Derating

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. This section presents a procedure for correlating factors affecting operating  $T_J$ . (Thermal data is also available on the Allegro MicroSystems Web site.)

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.

The effect of varying power levels (Power Dissipation,  $P_D$ ), can be estimated. The following formulas represent the fundamental relationships used to estimate  $T_J$ , at  $P_D$ .

$$P_D = V_{IN} \times I_{IN} \quad (1)$$

$$\Delta T = P_D \times R_{\theta JA} \quad (2)$$

$$T_J = T_A + \Delta T \quad (3)$$

For example, given common conditions such as:  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{ V}$ ,  $I_{CC} = 4\text{ mA}$ , and  $R_{\theta JA} = 140^\circ\text{C/W}$ , then:

$$P_D = V_{CC} \times I_{CC} = 12\text{ V} \times 4\text{ mA} = 48\text{ mW}$$

$$\Delta T = P_D \times R_{\theta JA} = 48\text{ mW} \times 140^\circ\text{C/W} = 7^\circ\text{C}$$

$$T_J = T_A + \Delta T = 25^\circ\text{C} + 7^\circ\text{C} = 32^\circ\text{C}$$

A worst-case estimate,  $P_{D(max)}$ , represents the maximum allowable power level ( $V_{CC(max)}$ ,  $I_{CC(max)}$ ), without exceeding  $T_{J(max)}$ , at a selected  $R_{\theta JA}$  and  $T_A$ .

*Example:* Reliability for  $V_{CC}$  at  $T_A = 150^\circ\text{C}$ , package UA, using minimum-K PCB.

Observe the worst-case ratings for the device, specifically:  $R_{\theta JA} = 165^\circ\text{C/W}$ ,  $T_{J(max)} = 165^\circ\text{C}$ ,  $V_{CC(max)} = 24\text{ V}$ , and  $I_{CC(max)} = 7.5\text{ mA}$ .

Calculate the maximum allowable power level,  $P_{D(max)}$ . First, invert equation 3:

$$\Delta T_{max} = T_{J(max)} - T_A = 165^\circ\text{C} - 150^\circ\text{C} = 15^\circ\text{C}$$

This provides the allowable increase to  $T_J$  resulting from internal power dissipation. Then, invert equation 2:

$$P_{D(max)} = \Delta T_{max} \div R_{\theta JA} = 15^\circ\text{C} \div 165^\circ\text{C/W} = 91\text{ mW}$$

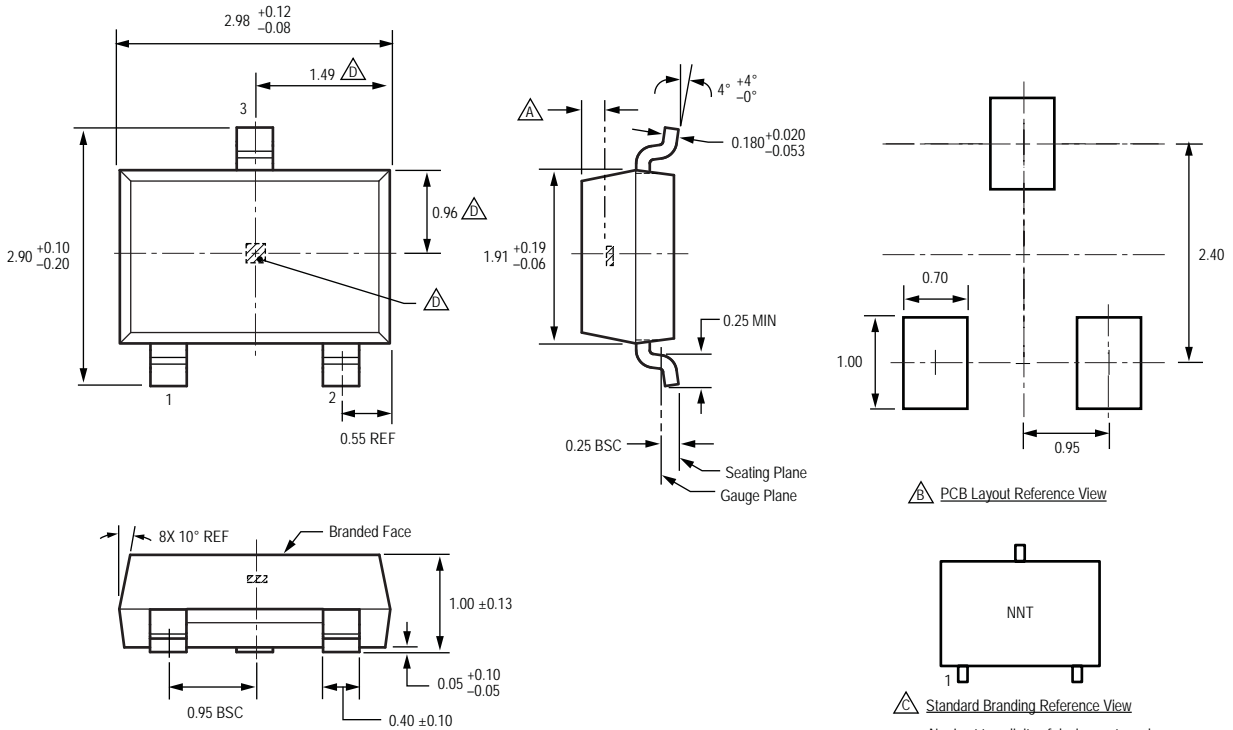
Finally, invert equation 1 with respect to voltage:

$$V_{CC(est)} = P_{D(max)} \div I_{CC(max)} = 91\text{ mW} \div 7.5\text{ mA} = 12.1\text{ V}$$

The result indicates that, at  $T_A$ , the application and device can dissipate adequate amounts of heat at voltages  $\leq V_{CC(est)}$ .

Compare  $V_{CC(est)}$  to  $V_{CC(max)}$ . If  $V_{CC(est)} \leq V_{CC(max)}$ , then reliable operation between  $V_{CC(est)}$  and  $V_{CC(max)}$  requires enhanced  $R_{\theta JA}$ . If  $V_{CC(est)} \geq V_{CC(max)}$ , then operation between  $V_{CC(est)}$  and  $V_{CC(max)}$  is reliable under these conditions.

Package LH, 3-Pin (SOT-23W)

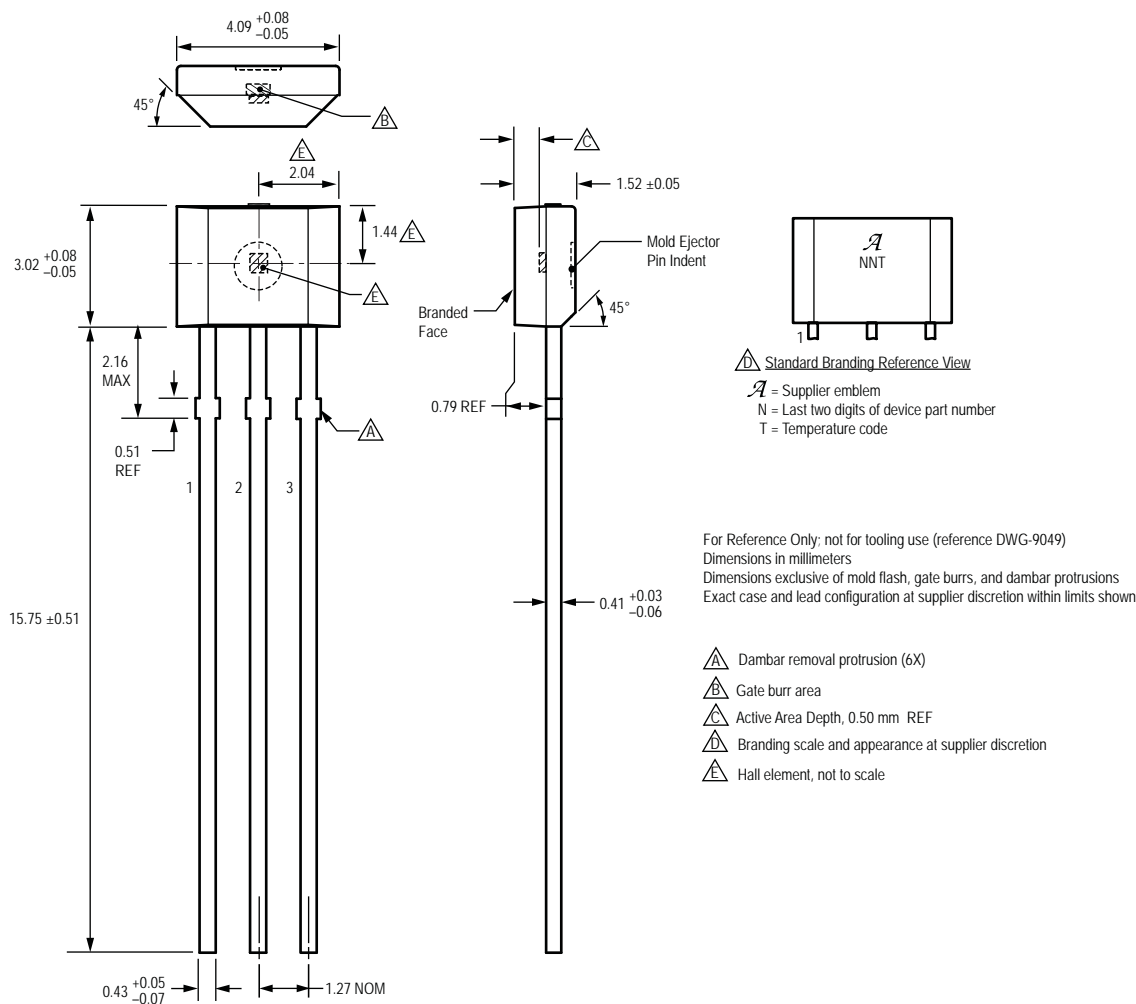


For Reference Only; not for tooling use (reference dwg. 802840)  
Dimensions in millimeters  
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions  
Exact case and lead configuration at supplier discretion within limits shown

- Active Area Depth, 0.28 mm REF
- Reference land pattern layout  
All pads a minimum of 0.20 mm from all adjacent pads; adjust as necessary to meet application process requirements and PCB layout tolerances
- Branding scale and appearance at supplier discretion
- Hall element, not to scale

PCB Layout Reference View  
 Standard Branding Reference View  
N = Last two digits of device part number  
T = Temperature code

Package UA, 3-Pin SIP



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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.

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