The A1301 and A1302 are continuous-time, ratiometric, linear Hall-effect sensors. They are optimized to accurately provide a voltage output that is proportional to an applied magnetic field. These devices have a quiescent output voltage that is 50% of the supply voltage. Two output sensitivity options are provided: 2.5 mV/G typical for the A1301, and 1.3 mV/G typical for the A1302.

The Hall-effect integrated circuit included in each device includes a Hall sensing element, a linear amplifier, and a CMOS Class A output structure. Integrating the Hall sensing element and the amplifier on a single chip minimizes many of the problems normally associated with low voltage level analog signals.

High precision in output levels is obtained by internal gain and offset trim adjustments made at end-of-line during the manufacturing process.

These features make the A1301 and A1302 ideal for use in position sensing systems, for both linear target motion and rotational target motion. They are well-suited for industrial applications over extended temperature ranges, from –40°C to 125°C.

Two device package types are available: LH, a 3-pin SOT23W type for surface mount, and UA, a 3-pin ultramini SIP for through-hole mount. They are lead (Pb) free (suffix, –T) with 100% matte tin plated leadframes.

### Features and Benefits
- Low-noise output
- Fast power-on time
- Ratiometric rail-to-rail output
- 4.5 to 6.0 V operation
- Solid-state reliability
- Factory-programmed at end-of-line for optimum performance
- Robust ESD performance

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

Not to scale

---

### Functional Block Diagram

---

A1301-DS, Rev. 5
A1301 and A1302

Continuous-Time Ratiometric Linear Hall Effect Sensors

Selection Guide

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Pb-free1</th>
<th>Packing2</th>
<th>Package</th>
<th>Ambient, $T_A$</th>
<th>Sensitivity (Typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1301ELHLT-T</td>
<td>Yes</td>
<td>7-in. tape and reel, 3000 pieces/reel</td>
<td>Surface Mount</td>
<td>$-40^\circ C$ to $85^\circ C$</td>
<td>2.5 mV/G</td>
</tr>
<tr>
<td>A1301EUA-T</td>
<td>Yes</td>
<td>Bulk, 500 pieces/bag</td>
<td>SIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1301KLHLT-T</td>
<td>Yes</td>
<td>7-in. tape and reel, 3000 pieces/reel</td>
<td>Surface Mount</td>
<td>$-40^\circ C$ to $125^\circ C$</td>
<td></td>
</tr>
<tr>
<td>A1301KUA-T</td>
<td>Yes</td>
<td>Bulk, 500 pieces/bag</td>
<td>SIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1302ELHLT-T</td>
<td>Yes</td>
<td>7-in. tape and reel, 3000 pieces/reel</td>
<td>Surface Mount</td>
<td>$-40^\circ C$ to $85^\circ C$</td>
<td>1.3 mV/G</td>
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<tr>
<td>A1302EUA-T</td>
<td>Yes</td>
<td>Bulk, 500 pieces/bag</td>
<td>SIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1302KLHLT-T</td>
<td>Yes</td>
<td>7-in. tape and reel, 3000 pieces/reel</td>
<td>Surface Mount</td>
<td>$-40^\circ C$ to $125^\circ C$</td>
<td></td>
</tr>
<tr>
<td>A1302KUA-T</td>
<td>Yes</td>
<td>Bulk, 500 pieces/bag</td>
<td>SIP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Pb-based variants are being phased out of the product line. Certain variants cited in this footnote are no longer in production. The variants should not be purchased for new design applications. Samples are no longer available. Status change: May 1, 2006. These variants include: A1301ELHLT, A1301EUA, A1301KLHLT, A1301KUA, A1302ELHLT, A1302EUA, A1302KLHLT, and A1302KUA.

2Contact Allegro for additional packing options.

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Notes</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC}$</td>
<td>8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>$V_{OUT}$</td>
<td>8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse Supply Voltage</td>
<td>$V_{RCC}$</td>
<td>$-0.1$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse Supply Voltage</td>
<td>$V_{RCC}$</td>
<td>$-0.1$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output Sink Current</td>
<td>$I_{OUT}$</td>
<td>10</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Operating Ambient Temp.</td>
<td>$T_A$</td>
<td>Range E</td>
<td>$-40$ to $85$</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range K</td>
<td>$-40$ to $125$</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Junction Temp.</td>
<td>$T_J(\text{max})$</td>
<td>165</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temp.</td>
<td>$T_{STG}$</td>
<td>$-65$ to $170$</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>
### DEVICE CHARACTERISTICS over operating temperature range, $T_A$, and $V_{CC} = 5$ V, unless otherwise noted

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC}$</td>
<td>Running, $T_J &lt; 165°C$</td>
<td>4.5</td>
<td>–</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>$I_{CC}$</td>
<td>Output open</td>
<td>–</td>
<td>–</td>
<td>11</td>
<td>mA</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>$V_{OUT(High)}$</td>
<td>$I_{SOURCE} = -1$ mA, Sens = nominal</td>
<td>4.65</td>
<td>4.7</td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>$V_{OUT(Low)}$</td>
<td>$I_{SINK} = 1$ mA, Sens = nominal</td>
<td>–</td>
<td>0.2</td>
<td>0.25</td>
<td>V</td>
</tr>
<tr>
<td>Output Bandwidth</td>
<td>$BW$</td>
<td></td>
<td>–</td>
<td>20</td>
<td>–</td>
<td>kHz</td>
</tr>
<tr>
<td>Power-On Time</td>
<td>$t_{PO}$</td>
<td>$V_{CC(min)}$ to 0.95 $V_{OUT}$; $B = \pm 1400$ G; Slew rate = 4.5 V/µs to 4.5 V/100 ns</td>
<td>–</td>
<td>3</td>
<td>5</td>
<td>µs</td>
</tr>
<tr>
<td>Output Resistance</td>
<td>$R_{OUT}$</td>
<td>$I_{SINK} \leq 1$ mA, $I_{SOURCE} \geq -1$ mA</td>
<td>–</td>
<td>2</td>
<td>5</td>
<td>Ω</td>
</tr>
<tr>
<td>Wide Band Output Noise, rms</td>
<td>$V_{OUTN}$</td>
<td>External output low pass filter $\leq 10$ kHz; Sens $= $ nominal</td>
<td>–</td>
<td>150</td>
<td>–</td>
<td>µV</td>
</tr>
<tr>
<td><strong>Ratiometry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiescent Output Voltage Error with respect to $\Delta V_{CC}$(^1)</td>
<td>$\Delta V_{OUTQ(V)}$</td>
<td>$T_A = 25°C$</td>
<td>–</td>
<td>–</td>
<td>±3.0</td>
<td>%</td>
</tr>
<tr>
<td>Magnetic Sensitivity Error with respect to $\Delta V_{CC}$(^2)</td>
<td>$\Delta Sens(V)$</td>
<td>$T_A = 25°C$</td>
<td>–</td>
<td>–</td>
<td>±3.0</td>
<td>%</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linearity</td>
<td>Lin</td>
<td>$T_A = 25°C$</td>
<td>–</td>
<td>–</td>
<td>±2.5</td>
<td>%</td>
</tr>
<tr>
<td>Symmetry</td>
<td>Sym</td>
<td>$T_A = 25°C$</td>
<td>–</td>
<td>–</td>
<td>±3.0</td>
<td>%</td>
</tr>
<tr>
<td><strong>Magnetic Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiescent Output Voltage</td>
<td>$V_{OUTQ}$</td>
<td>$B = 0$ G; $T_A = 25°C$</td>
<td>2.4</td>
<td>2.5</td>
<td>2.6</td>
<td>V</td>
</tr>
<tr>
<td>Quiescent Output Voltage over Operating Temperature Range</td>
<td>$V_{OUTQ(T_A)}$</td>
<td>$B = 0$ G</td>
<td>2.2</td>
<td>–</td>
<td>2.8</td>
<td>V</td>
</tr>
<tr>
<td>Magnetic Sensitivity</td>
<td>Sens</td>
<td>$A1301; T_A = 25°C$</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td>mV/G</td>
</tr>
<tr>
<td>A1302; $T_A = 25°C$</td>
<td>1.0</td>
<td>1.3</td>
<td>1.6</td>
<td>mV/G</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic Sensitivity over Operating Temperature Range</td>
<td>Sens(_{T_A})</td>
<td>$A1301$</td>
<td>1.8</td>
<td>–</td>
<td>3.2</td>
<td>mV/G</td>
</tr>
<tr>
<td>$A1302$</td>
<td>0.85</td>
<td>–</td>
<td>1.75</td>
<td>mV/G</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Refer to equation (4) in Ratiometric section on page 4.

\(^2\)Refer to equation (5) in Ratiometric section on page 4.
**Continuous-Time Ratiometric Linear Hall Effect Sensors**

**A1301 and A1302**

**Characteristic Definitions**

**Quiescent Output Voltage.** In the quiescent state (no significant magnetic field: \( B = 0 \)), the output, \( \text{VOUTQ} \), equals one half of the supply voltage, \( \text{VCC} \), throughout the entire operating ranges of \( \text{VCC} \) and ambient temperature, \( T_A \). Due to internal component tolerances and thermal considerations, there is a tolerance on the quiescent output voltage, \( \Delta \text{VOUTQ} \), which is a function of both \( \Delta \text{VCC} \) and \( \Delta T_A \). For purposes of specification, the quiescent output voltage as a function of temperature, \( \Delta \text{VOUTQ}(\Delta T_A) \), is defined as:

\[
\Delta \text{VOUTQ}(\Delta T_A) = \frac{\text{VOUT}(T_A) - \text{VOUT}(25^\circ\text{C})}{\text{Sens}(25^\circ\text{C})}
\]  

(1)

where Sens is in mV/G, and the result is the device equivalent accuracy, in gauss (G), applicable over the entire operating temperature range.

**Sensitivity.** The presence of a south-polarity (+B) magnetic field, perpendicular to the branded face of the device package, increases the output voltage, \( \text{VOUT} \), in proportion to the magnetic field applied, from \( \text{VOUTQ} \) toward the \( \text{VCC} \) rail. Conversely, the application of a north polarity (–B) magnetic field, in the same orientation, proportionally decreases the output voltage from its quiescent value. This proportionality is specified as the magnetic sensitivity of the device and is defined as:

\[
\text{Sens} = \frac{\text{VOUT}(+B) - \text{VOUT}(+B)}{2B}
\]  

(2)

The stability of the device magnetic sensitivity as a function of ambient temperature, \( \Delta \text{Sens}(\Delta T_A) \) (%), is defined as:

\[
\Delta \text{Sens}(\Delta T_A) = \frac{\text{Sens}(T_A) - \text{Sens}(25^\circ\text{C})}{\text{Sens}(25^\circ\text{C})} \times 100\%
\]  

(3)

**Ratiometric.** The A1301 and A1302 feature a ratiometric output. This means that the quiescent voltage output, \( \text{VOUTQ} \), and the magnetic sensitivity, \( \text{Sens} \), are proportional to the supply voltage, \( \text{VCC} \).

The ratiometric change (%) in the quiescent voltage output is defined as:

\[
\Delta \text{VOUTQ} = \frac{\text{VOUTQ(VCC)} / \text{VOUTQ(5V)}}{\text{VCC} / 5\text{V}} \times 100\%
\]  

(4)

and the ratiometric change (%) in sensitivity is defined as:

\[
\Delta \text{Sens} = \frac{\text{Sens(VCC)} / \text{Sens(5V)}}{\text{VCC} / 5\text{V}} \times 100\%
\]  

(5)

**Linearity and Symmetry.** The on-chip output stage is designed to provide linear output at a supply voltage of 5 V. Although the application of very high magnetic fields does not damage these devices, it does force their output into a nonlinear region. Linearity in percent is measured and defined as:

\[
\text{Lin} = \frac{\text{VOUT}(+B) - \text{VOUTQ}}{2(\text{VOUT}(+B) / \text{VOUTQ})} \times 100\%
\]  

(6)

\[
\text{Lin} = \frac{\text{VOUT}(+B) - \text{VOUTQ}}{2(\text{VOUT}(+B) / \text{VOUTQ})} \times 100\%
\]  

(7)

and output symmetry as:

\[
\text{Sym} = \frac{\text{VOUT}(+B) - \text{VOUTQ}}{\text{VOUTQ} - \text{VOUT}(+B)} \times 100\%
\]  

(8)
Continuous-Time Ratiometric Linear Hall Effect Sensors

A1301 and A1302

Typical Characteristics
(30 pieces, 3 fabrication lots)

Continued on the next page...
Typical Characteristics, continued
(30 pieces, 3 fabrication lots)

1301 Device $V_{OUTQ}$ vs. Supply Voltage

1302 Device $V_{OUTQ}$ vs. Supply Voltage

1301 Device $V_{OUTQ}$ vs. Supply Voltage

1302 Device $V_{OUTQ}$ vs. Supply Voltage

1301 Device Symmetry vs. Supply Voltage

1302 Device Symmetry vs. Supply Voltage

1301 Device Symmetry vs. Supply Voltage

1302 Device Symmetry vs. Supply Voltage
Continuous-Time Ratiometric Linear Hall Effect Sensors

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

Terminal List

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC</td>
<td>1</td>
<td>Package LH: 1 Connects power supply to chip</td>
</tr>
<tr>
<td>VOUT</td>
<td>2</td>
<td>Package LH: 2 Connects power supply to chip</td>
</tr>
<tr>
<td>GND</td>
<td>3</td>
<td>Package LH: 3 Connects power supply to chip</td>
</tr>
</tbody>
</table>

Preliminary dimensions, for reference only
Dimensions in millimeters
U.S. Customary dimensions (in.) in brackets, for reference only
(reference JEDEC TO-236 AB, except case width and terminal tip-to-tip)
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown

Hall element (not to scale)
Active Area Depth 0.28 [.011]

Pin-out Drawings
Continuous-Time Ratiometric Linear Hall Effect Sensors

A1301 and A1302

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; 5,621,319; 5,650,719; 5,686,894; 5,694,038; 5,729,130; 5,917,320; and other patents pending.

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