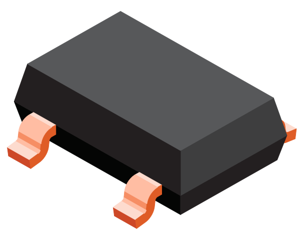
Micropower Ultrasensitive 3D Hall-Effect Switch

FEATURES AND BENEFITS

- True 3D sensing
- 2.5 V to 5.5 V operation
- Low supply current
- High sensitivity, B_{OP} typically 25 G
- Omnipolar operation with either north or south pole
- Chopper stabilized offset cancellation
  - □ Superior temperature stability
  - □ Extremely low switch-point drift
  - □ Insensitive to Physical Stress
- Solid-state reliability
- Choice of output format
  - □ Separate X, Y, and Z outputs
  - □ Combined (X+Y+Z) output
- Tiny SOT-23 package

PACKAGE:

5-Pin SOT23-W (Suffix LH)



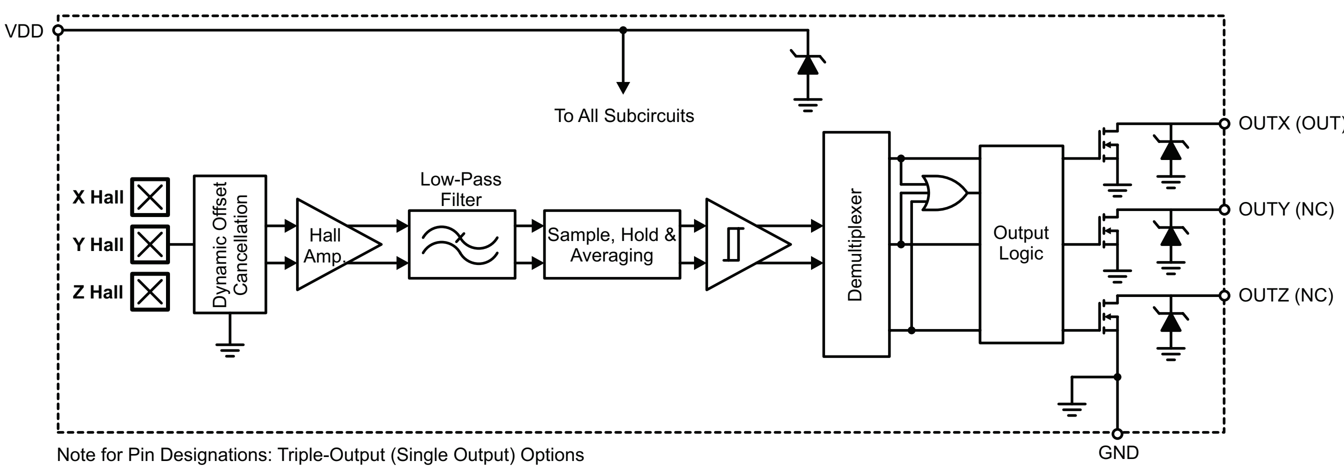
Not to scale

DESCRIPTION

The A1266 integrated circuit is an ultrasensitive, Hall effect switch with 3D omnipolar magnetic actuation. The single silicon chip includes: three Hall plates, multiplexer, small-signal amplifier, chopper stabilization, Schmitt trigger, and NMOS output transistors. The device outputs turn on when a magnetic field of sufficient strength is applied to the sensor in any orientation. Removal of the magnetic field will turn the output off.

Two versions of the A1266 offer a choice of output format: separate X, Y, and Z outputs or a combined X+Y+Z output. The low operating supply voltage, 2.5 to 5.5 V, and unique clocking algorithm assist in reducing the average power consumption, making it ideal for battery operation. For example, the power consumption is less than 25 µW with a 3.3 V supply.

The small geometries of the BiCMOS process allow for ultrasmall packages suitable for even space-constrained applications. In this case, a modified SOT23-W surface mount package magnetically optimized for use in a variety of orientations. The packages are lead (Pb) free and RoHS-compliant with 100% matte tin leadframe plating.



Functional Block Diagram

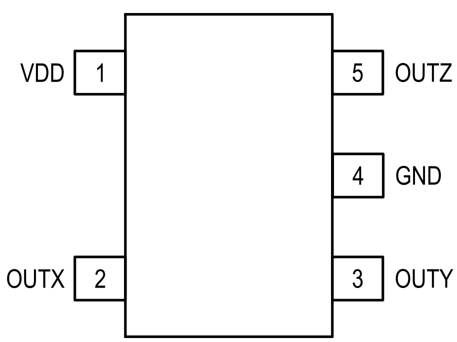
SPECIFICATIONS

Selection Guide

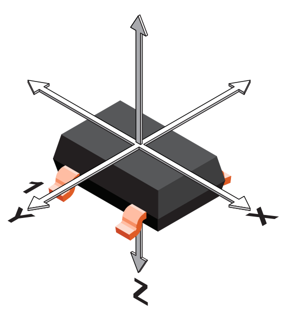
Part Number	Packing	Package	Description
A1266ELHLT-T	7-in. reel, 3000 pieces/reel	LH5	3 Outputs of X, Y and Z
A1266ELHLX-T	13-in. reel, 10000 pieces/reel	LH5	3 Outputs of X, Y and Z
A1266ELHLT-SO-T	7-in. reel, 3000 pieces/reel	LH5	Single Output of OR (X,Y and Z)
A1266ELHLX-SO-T	13-in. reel, 10000 pieces/reel	LH5	Single Output of OR (X,Y and Z)

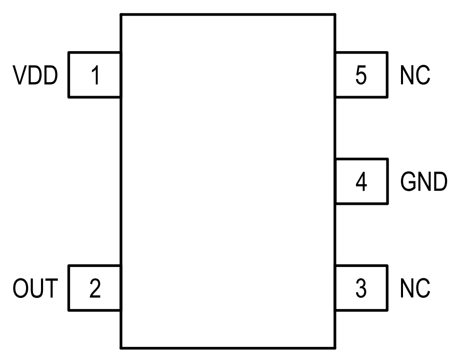
Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Unit
Forward Supply Voltage	V_{DD}		5.5	V
Reverse Supply Voltage	V_{RDD}		-0.3	V
Magnetic Flux Density	B		Unlimited	G
Output off voltage	V_{OUT}		5.5	V
Reverse Output Voltage	V_{ROUT}		-0.3	V
Continuous Output Current	I_{OUT}		3	mA
Reverse Output Current	I_{ROUT}		-3	mA
Operating Ambient Temperature	T_A	Range E	-40 to 85	°C
Maximum Junction Temperature	$T_{J(MAX)}$		165	°C
Storage Temperature	T_S		-65 to 170	°C



A1266ELHLT-T and A1266ELHLX-T Pin-outs





A1266ELHLT-SO-T and A1266ELHLX-SO-T Pin-outs

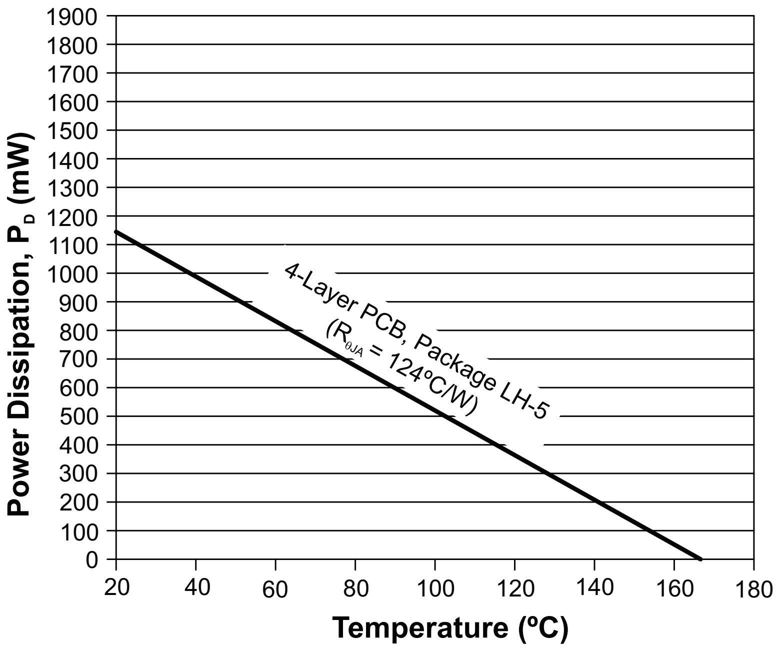
Terminal List Table

Pin Number	A1266ELHLT-T & A1266ELHLX-T		A1266ELHLT-SO-T & A1266ELHLX-SO-T	
	Symbol	Description	Symbol	Description
1	VDD	Power Supply	VDD	Power Supply
2	OUTX	Output of X magnetic field direction	OUT	X+Y+Z output
3	OUTY	Output of Y magnetic field direction	NC	No connection
4	GND	Ground	GND	Ground
5	OUTZ	Output of Z magnetic field direction	NC	No connection

Thermal Characteristics

The A1266's power consumption is extremely low. On-chip power dissipation will not be an issue under normal operating conditions.

Characteristic	Symbol	Notes	Rating	Unit
Package Thermal Resistance	$R_{\theta JA}$	Package LH5, 4-layer board based on the JEDEC standard.	124	°C/W



Maximum Power Dissipation versus Ambient Temperature

ELECTRICAL CHARACTERISTICS: valid over V_{DD} = 2.5 to 5 V and full operating temperature range (unless otherwise specified)

Characteristics	Symbol	Test Conditions	Min.	Typ.[1]	Max.	Unit
Supply Voltage	V_{DD}	Operating, T_J < 165°C	2.5	3.3	5.5	V
Output Leakage Current	I_{OUTOFF}	B < B_{RP}	-	-	10	µA
Output On Voltage	$V_{OUT(SAT)}$	I_{OUT} = 2 mA, B > B_{OP}	-	50	500	mV
Awake Time	t_{awake}		-	300	-	µs
Mode Cycle Period	t_{period}		-	165	-	ms
Chopping Frequency	f_C		-	800	-	kHz
Supply Current	$I_{DD(EN)}$	Chip Awake (Enabled)	-	-	3.0	mA
	$I_{DD(DIS)}$	Chip Asleep (Disabled), V_{DD} = 2.5 V, T_A = 25°C	-	-	15	µA
	$I_{DD(AVG)}$	V_{DD} = 2.5 V, T_A = 25°C	-	6.7	21	µA
		V_{DD} = 5 V, T_A = 25°C	-	9.6	40	µA

MAGNETIC CHARACTERISTICS: valid over V_{DD} = 2.5 to 5 V and full operating temperature range (unless otherwise specified)

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit[2]
Operate Point[3]	B_{OPS}	South Pole to left, bottom or branded face side (see Figure 1)	-	25	40	G
	B_{OPN}	North Pole to left, bottom or branded face side (see Figure 1)	-40	-25	-	G
Release Point[3]	B_{RPS}	South Pole to left, bottom or branded face side (see Figure 1)	5	17.5	-	G
	B_{RPN}	North Pole to left, bottom or branded face side (see Figure 1)	-	-17.5	-5	G
Hysteresis[3]	B_{HYS}	B_{OPS} - B_{RPS}, B_{OPN} – B_{RPN}	-	7.5	-	G

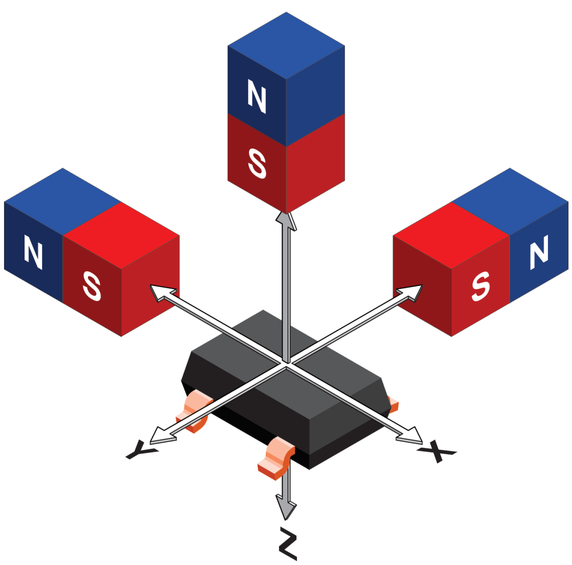
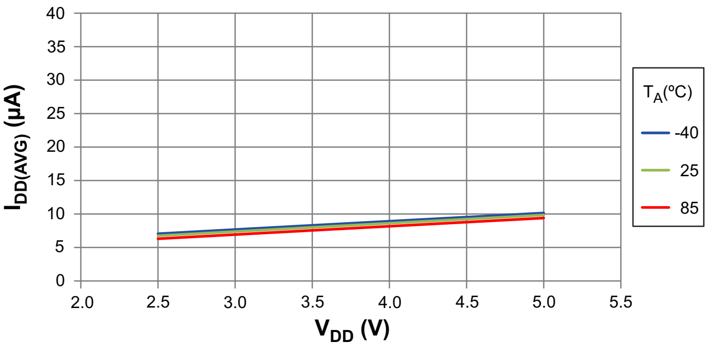


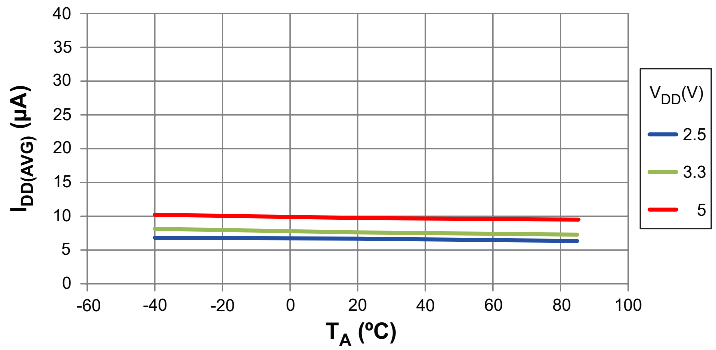
Figure 1: Three Dimensions of Magnet Orientation

[1] Typical data are at T_A = 25°C and V_{DD} = 3.3 V (unless otherwise noted).
[2] 1 G (gauss) = 0.1 mT (millitesla)
[3] Applicable to all directions (X, Y and Z)

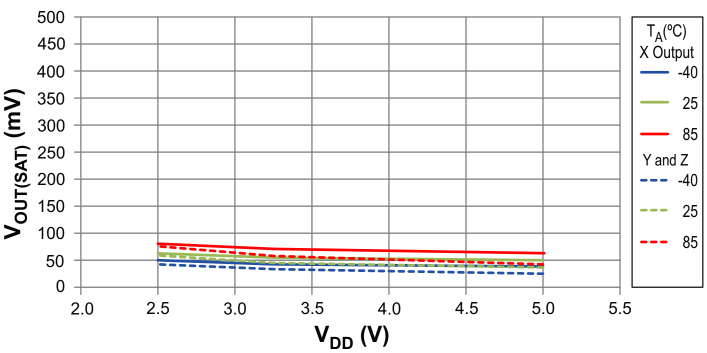
CHARACTERISTIC DATA



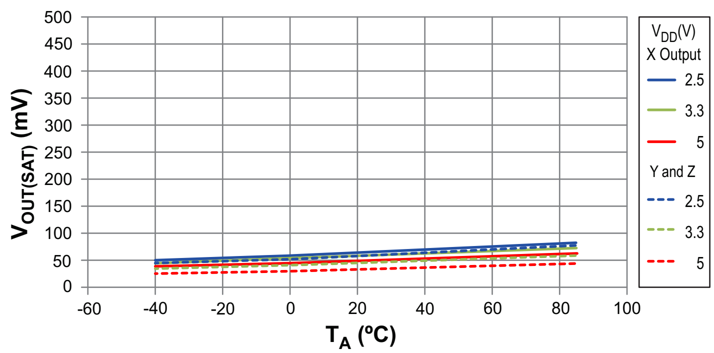
Average Supply Current vs. Supply Voltage



Average Supply Current vs. Ambient Temperature

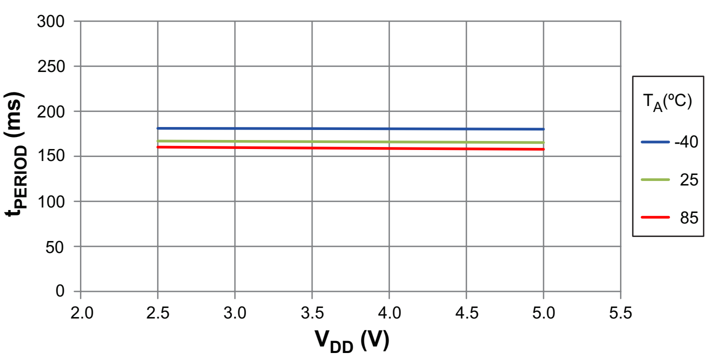


Average Low Output Voltage vs. Supply Voltage

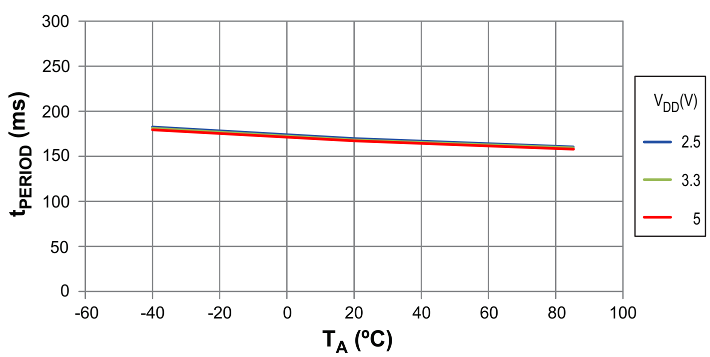


Average Low Output Voltage vs. Ambient Temperature

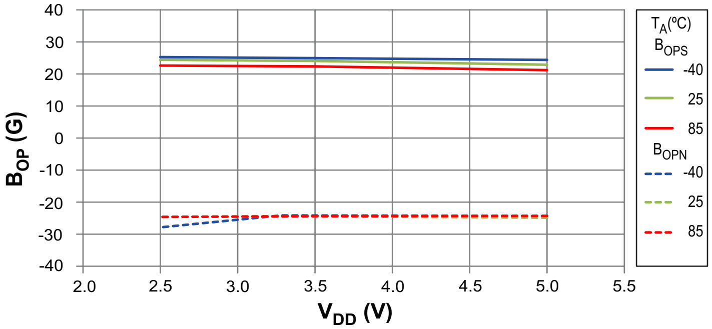
I_{OUT} = 20 mA



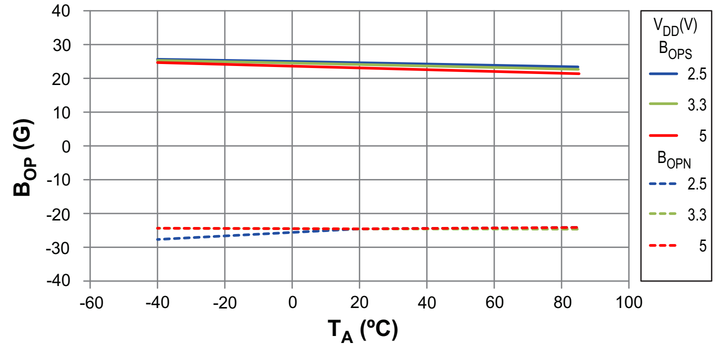
Average Period vs. Supply Voltage



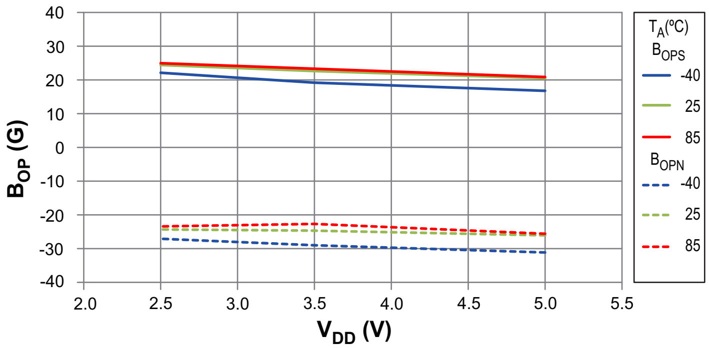
Average Period vs. Ambient Temperature



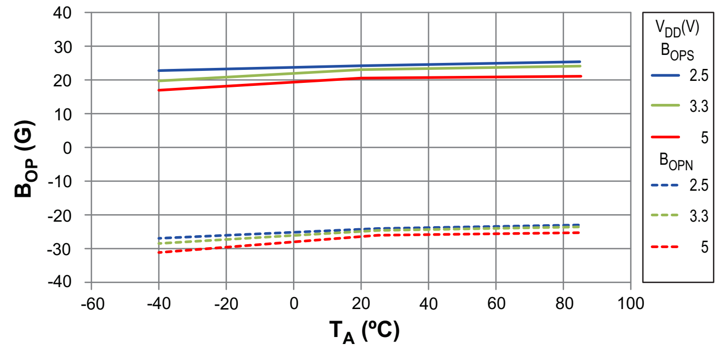
Average X-Axis Operate Point vs. Supply Voltage



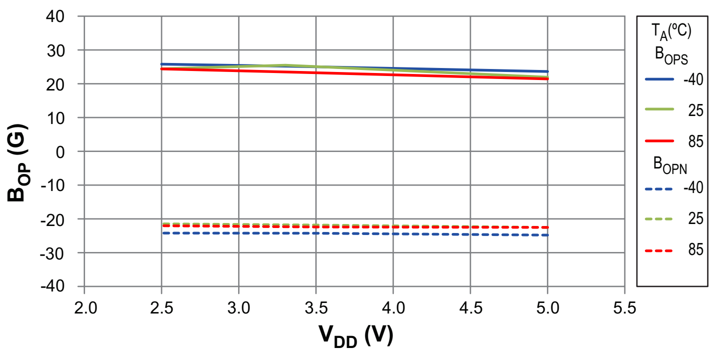
Average X-Axis Operate Point vs. Ambient Temperature



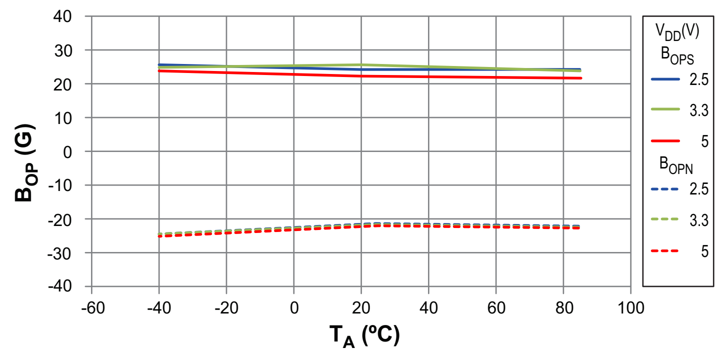
Average Y-Axis Operate Point vs. Supply Voltage



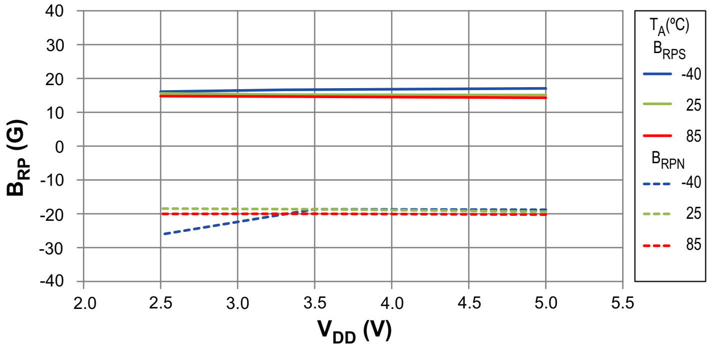
Average Y-Axis Operate Point vs. Ambient Temperature



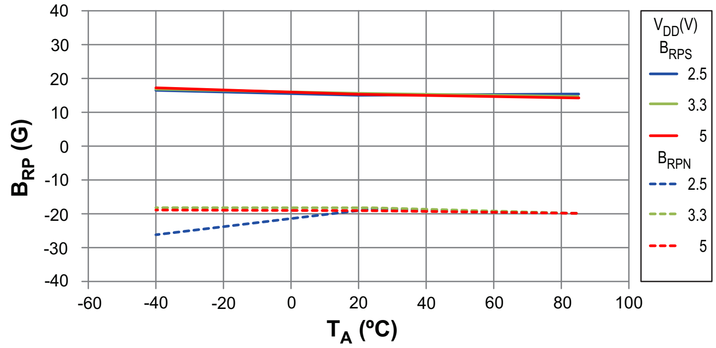
Average Z-Axis Operate Point vs. Supply Voltage



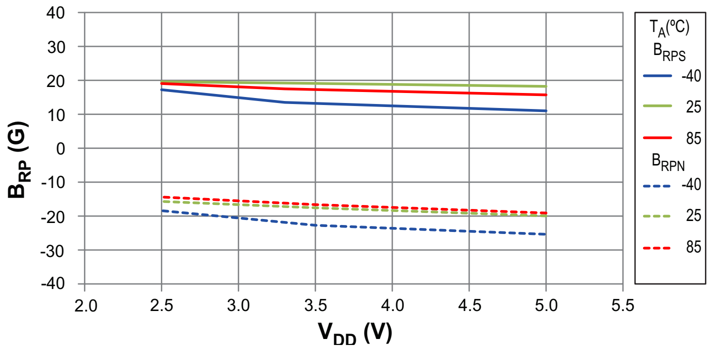
Average Z-Axis Operate Point vs. Ambient Temperature



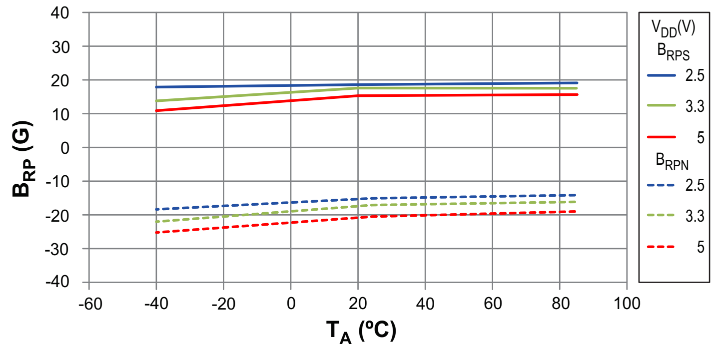
Average X-Axis Release Point vs. Supply Voltage



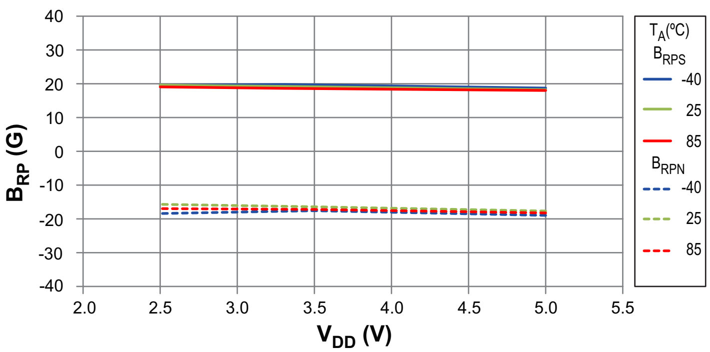
Average X-Axis Release Point vs. Ambient Temperature



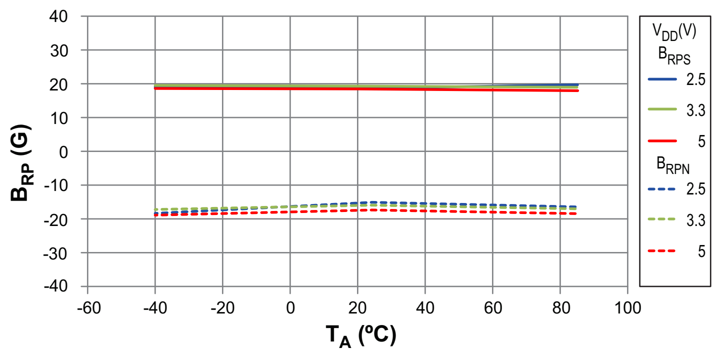
Average Y-Axis Release Point vs. Supply Voltage



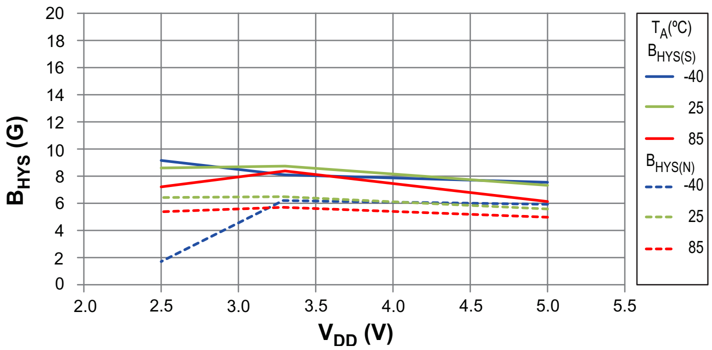
Average Y-Axis Release Point vs. Ambient Temperature



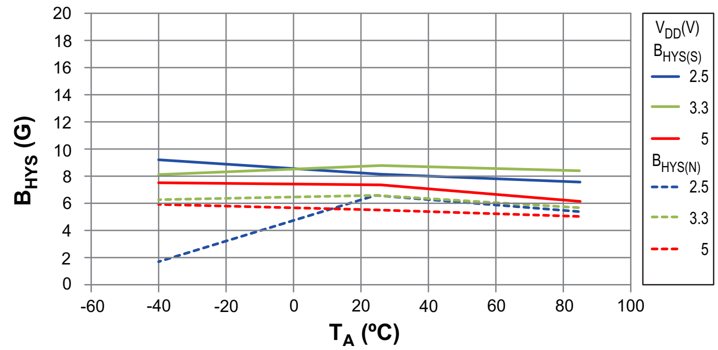
Average Z-Axis Release Point vs. Supply Voltage



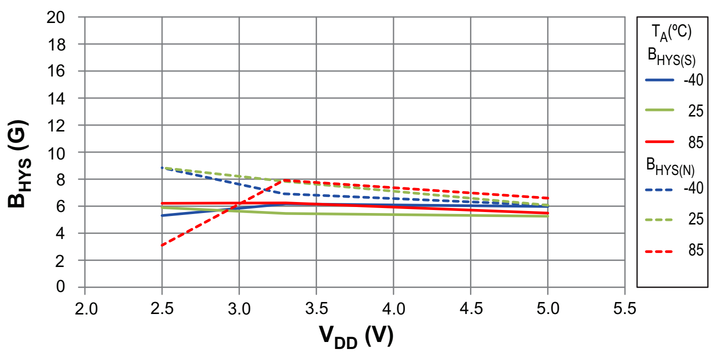
Average Z-Axis Release Point vs. Ambient Temperature



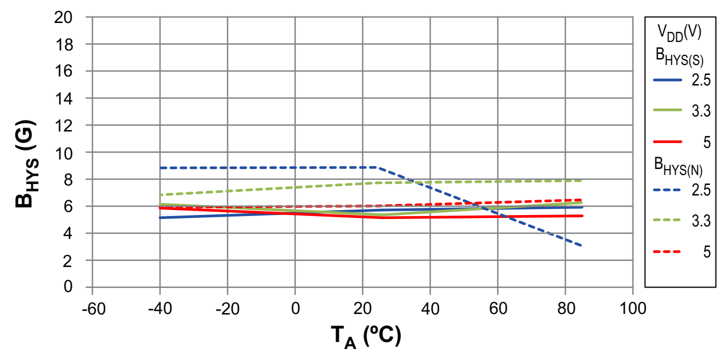
Average X-Axis Hysteresis vs. Supply Voltage



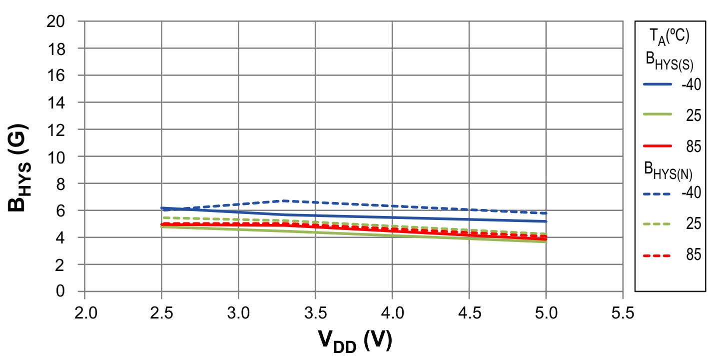
Average X-Axis Hysteresis vs. Ambient Temperature



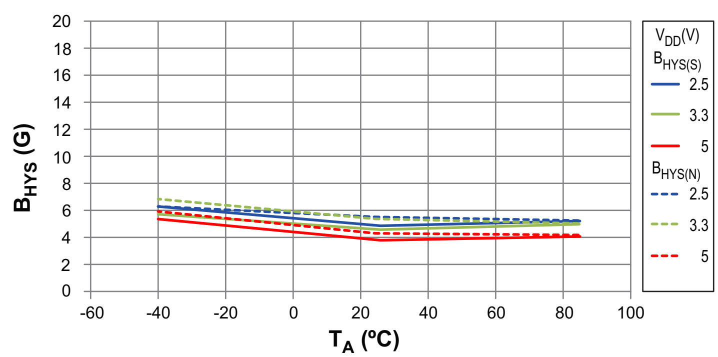
Average Y-Axis Hysteresis vs. Supply Voltage



Average Y-Axis Hysteresis vs. Ambient Temperature



Average Z-Axis Hysteresis vs. Supply Voltage



Average Z-Axis Hysteresis vs. Ambient Temperature

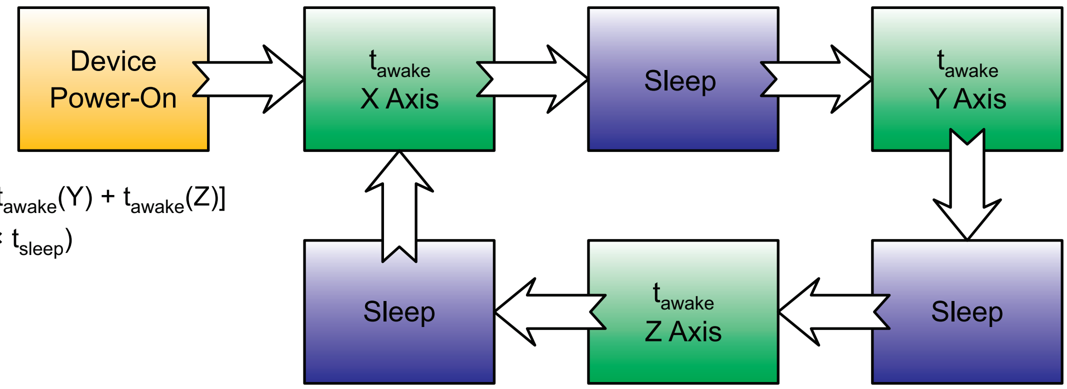
FUNCTIONAL DESCRIPTION

t_{awake} = 300 μs [t_{awake}(X) + t_{awake}(Y) + t_{awake}(Z)]

t_{period} = 165 ms (t_{awake} + 3 × t_{sleep})

$t_{sleep} = (t_{period} - t_{awake})/3$

t_{sleep} = 54.9 ms



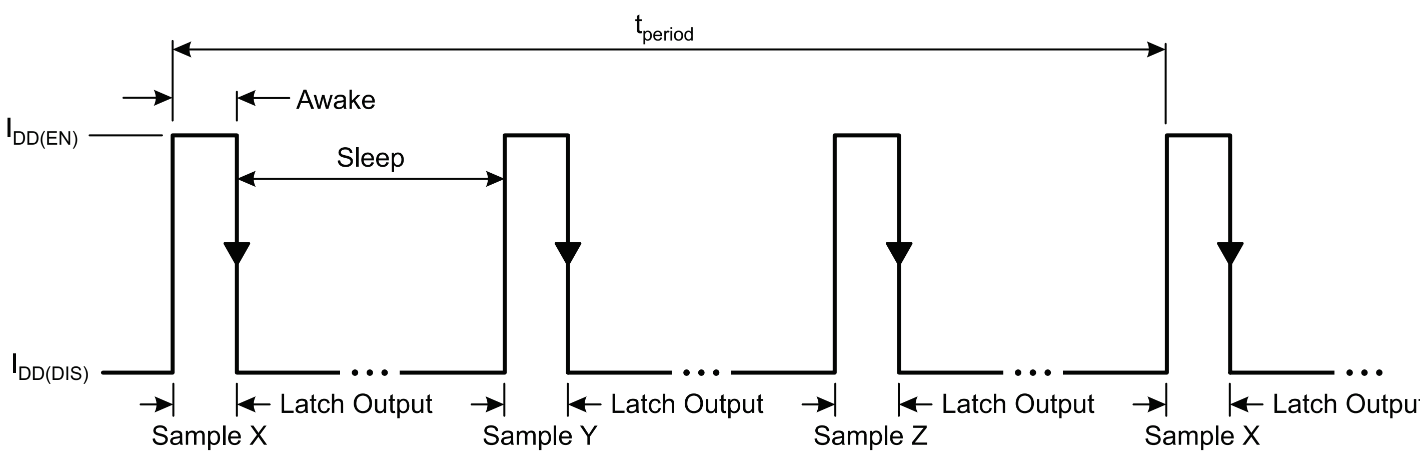


Figure 2: Device Sleep and Awake Mode Cycle

Low Average Power

To keep average power low, internal timing circuitry activates each axis' sensor for 100 µs (followed by a low power sleep time, t_{sleep}, of 54.9 ms). This awake and sleep cycle occurs three times for each t_{period}, such that all three axes are sampled in t_{period}. The short "awake" time allows for stabilization prior to the sensor sampling and data latching at the end of each t_{awake} cycle. The outputs during each t_{sleep} cycle are latched in the last sampled state. The supply current is not affected by the output states.

Operation

For the Single Output option of the A1266, the output switches low (turns on) when a magnetic field perpendicular to one of the three Hall sensors, either the X, Y or Z direction, exceeds the operate point, B_{OPS} (or is less than B_{OPN}). The A1266 Triple Output option is configured with three separate outputs (X, Y or Z), which switch low (turns on) when a magnetic field perpendicular to the corresponding Hall sensor (X, Y or Z) exceeds the operate point, B_{OPS} (or is less than B_{OPN}). 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.

After turn-on, the output voltage is V_{OUT}. Powering-on the device in the hysteresis region, between B_{OP} and B_{RP}, allows an indeterminate output state. The correct state is attained after the first excursion beyond B_{OP} or B_{RP}.

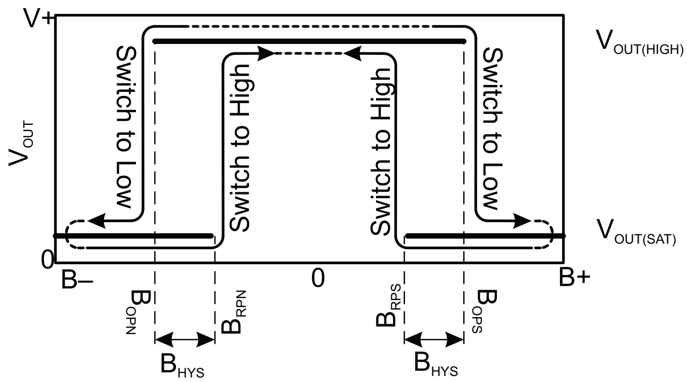


Figure 3: Switching Behavior of Omnipolar Switches

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)

Applications

It is strongly recommended that an external 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. As shown in Figure 4, a 0.1 µF capacitor is typical.

Extensive applications information on magnets and Hall-effect sensors is available in:

- *Hall-Effect IC Applications Guide, AN27701,*
- *Hall-Effect Devices: Gluing, Potting, Encapsulating, Lead Welding and Lead Forming AN27703.1*
- *Soldering Methods for Allegro's Products – SMT and Through-Hole, AN26009*

All are provided on the Allegro Web site:

www.allegromicro.com

Typical Application Circuits

A1266ELHLT-SO-T AND A1266ELHLX-SO-T

For sensors configured with the single output option, one pin reports the output state from any of the three Hall elements.

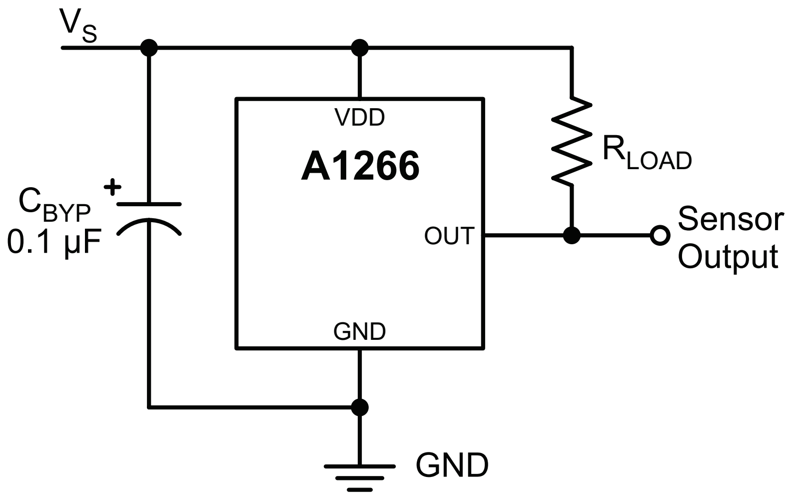


Figure 4: Typical Application Circuit for the Single Output Selection

A1266ELHLT-T AND A1266ELHLX-T

For sensors configured with the triple output option, the three separate open drain outputs report the output state from the corresponding Hall elements.

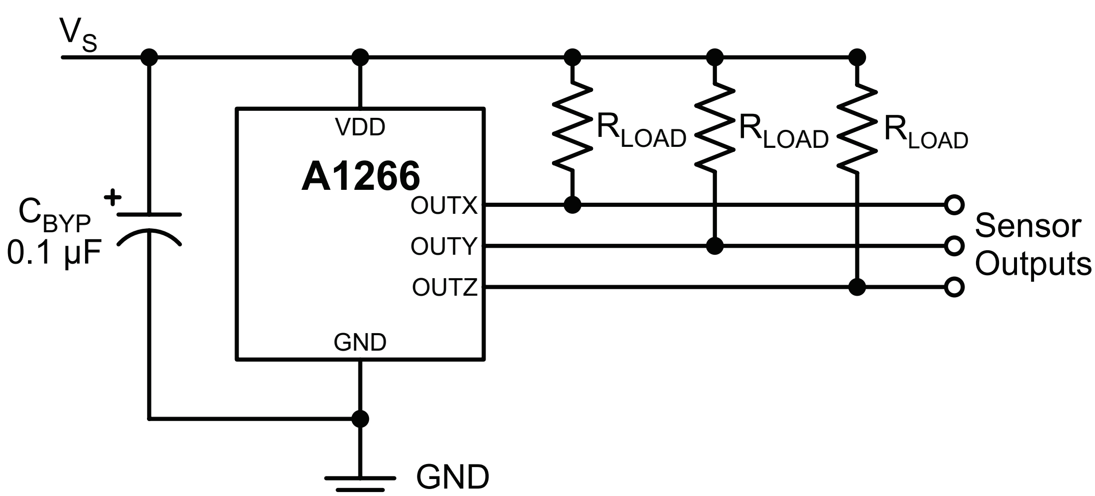


Figure 5: Typical Application Circuit for the Triple Output Selection

Chopper Stabilization

A limiting factor for switch point accuracy when using Hall-effect technology is the small signal voltage developed across the Hall plate. This voltage is proportionally small relative to the offset that can be produced at the output of the Hall sensor. This makes it difficult to process the signal and maintain an accurate, reliable output over the specified temperature and voltage range. Chopper Stabilization is a proven approach used to minimize Hall offset.

The Allegro patented technique, dynamic quadrature offset cancellation, removes key sources of the output drift induced by temperature and package stress. This offset reduction technique is based on a signal modulation-demodulation process. Figure 6: Model of Chopper Stabilization Circuit (Dynamic Offset Cancellation) illustrates how it is implemented.

The undesired offset signal is separated from the magnetically induced signal in the frequency domain through modulation. The subsequent demodulation acts as a modulation process for the offset causing the magnetically induced signal to recover its original spectrum at baseband while the dc offset becomes a high frequency signal. Then, using a low-pass filter, the signal passes while the modulated DC offset is suppressed. Allegro's innovative chopper-stabilization technique uses a high frequency clock. The high-frequency operation allows a greater sampling rate that produces higher accuracy, reduced jitter, and faster signal processing. Additionally, filtering is more effective and results in a lower noise analog signal at the sensor output. Devices such as the A1266 that utilize this approach have an extremely stable quiescent Hall output voltage, are immune to thermal stress, and have precise recoverability after temperature cycling. This technique is made possible through the use of a BiCMOS process which allows the use of low offset and low noise amplifiers in combination with high-density logic and sample and hold circuits.

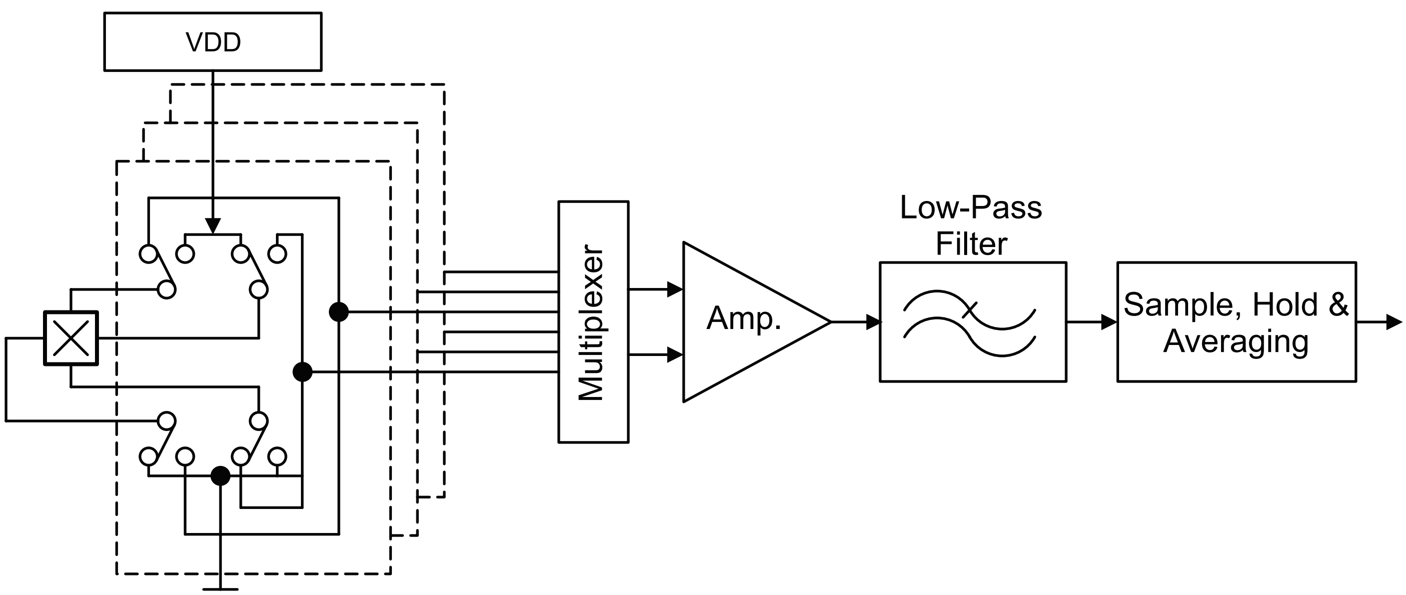
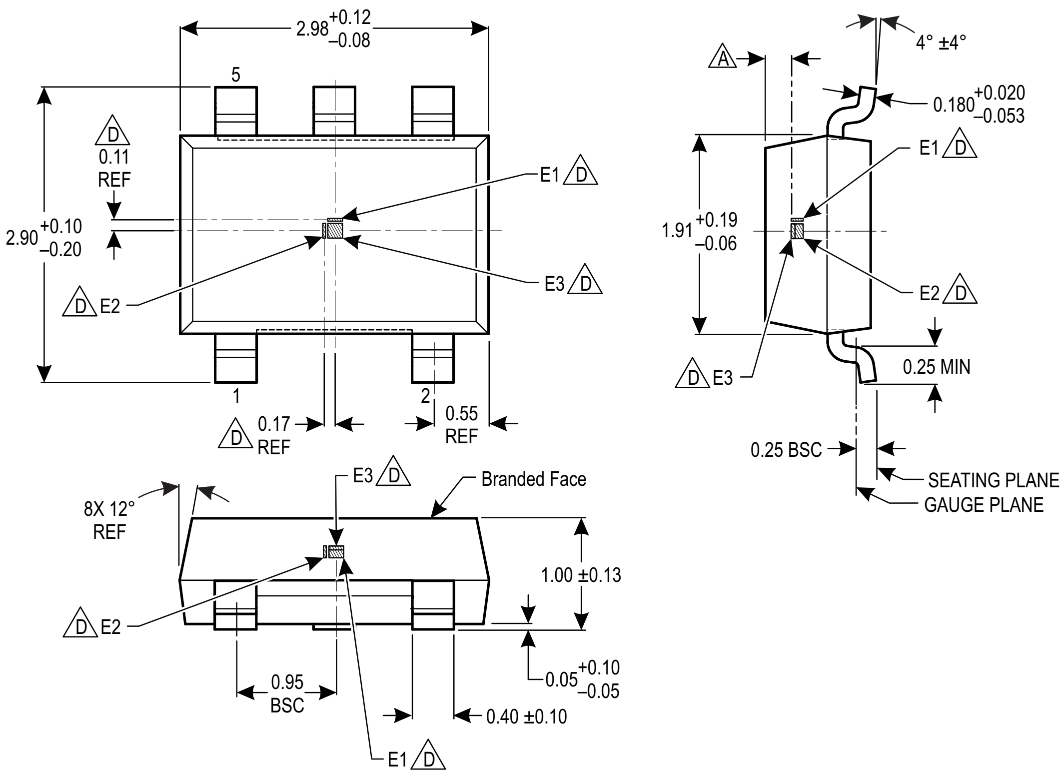


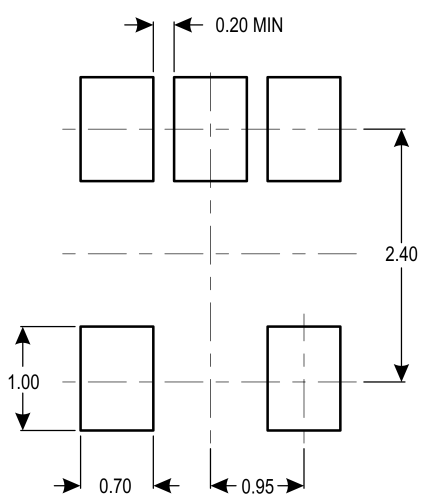
Figure 6: Model of Chopper Stabilization Circuit (Dynamic Offset Cancellation)

PACKAGE OUTLINE DRAWING

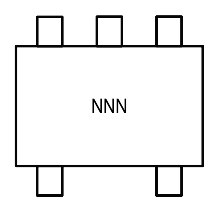
For Reference Only – Not for Tooling Use

(Reference DWG-9069)
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





B PCB Reference Layout View



C Standard Branding Reference View

A Active Area Depth, 0.28 ±0.04

B 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

C Branding Scale and appearance at supplier discretion

D Hall Elements (E1, E2, and E3), not to scale

Figure 7: Package LH, 5-Pin SOT23-W

Revision History

Revision	Revision Date	Description of Revision
–	March 20, 2015	Initial Release