DRV5011 Low-Voltage, Digital-Latch Hall Effect Sensor

1 Features

- Ultra-small X2SON, SOT-23, DSBGA or TO-92 package
- High magnetic sensitivity: ±2 mT (typical)
- Robust hysteresis: 4 mT (typical)
- Fast sensing bandwidth: 30-kHz
- V_{CC} operating range: 2.5-V to 5.5-V
- Push-pull CMOS output
  - Capable of 5-mA sourcing, 20-mA sinking
- Operating temperature: –40°C to +135°C

2 Applications

- Brushless dc motor sensors
- Incremental rotary encoding:
  - Brushed dc motor feedback
  - Motor speed (tachometer)
  - Mechanical travel
  - Fluid measurement
  - Knob turning
  - Wheel speed
- E-bikes
- Flow meters

3 Description

The DRV5011 device is a digital-latch Hall effect sensor designed for motors and other rotary systems.

The device has an efficient low-voltage architecture that operates from 2.5 V to 5.5 V. The device is offered in standard SOT-23, low-profile X2SON, DSBGA and TO-92 packages. The output is a push-pull driver that requires no pullup resistor, enabling more compact systems.

When a south magnetic pole is near the top of the package and the B_{OP} threshold is exceeded, the device drives a low voltage. The output stays low until a north pole is applied and the B_{RP} threshold is crossed, which causes the output to drive a high voltage. Alternating north and south poles are required to toggle the output, and integrated hysteresis separates B_{OP} and B_{RP} to provide robust switching.

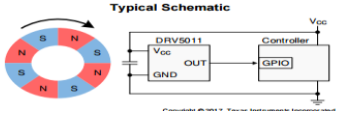
The device produces consistent performance across a wide ambient temperature range of –40°C to +135°C.

Device Information(1)

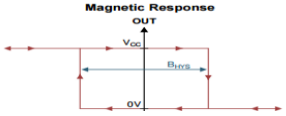
PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV5011	DSBGA (4)	0.80 mm × 0.80 mm
	SOT-23 (3)	2.92 mm × 1.30 mm
	X2SON (4)	1.10 mm × 1.40 mm
	TO-92 (3)	4.00 mm × 3.15 mm

(1) For all available packages, see the package option addendum at the end of the data sheet.

Typical Schematic

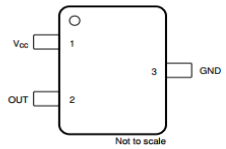


Magnetic Response

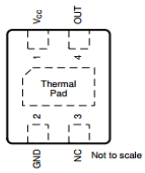


5 Pin Configuration and Functions

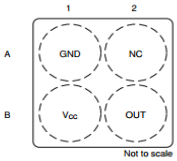
DBZ Package
3-Pin SOT-23
Top View



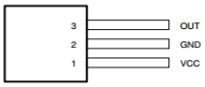
DMR Package
4-Pin X2SON With Exposed Thermal Pad
Top View



YBH Package
4-Pin DSBGA
Top View



LPG Package
3-Pin TO-92
Top View



Pin Functions

PIN					I/O	DESCRIPTION
NAME	DSBGA	SOT-23	X2SON	TO-92		
GND	A1	3	2	2	—	Ground reference
NC	A2	—	3	—	—	No-connect. This pin is not connected to the silicon. Leave this pin floating or tied to ground, and soldered to the board for mechanical support.
OUT	B2	2	4	3	O	Push-pull CMOS output. Drives a V_{CC} or ground level.
V_{CC}	B1	1	1	1	—	2.5-V to 5.5-V power supply. TI recommends connecting this pin to a ceramic capacitor to ground with a value of at least 0.01 µF.
Thermal Pad	—	—	Thermal Pad	—	—	Leave thermal pad floating or tied to ground, and soldered to the board for mechanical support.

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_{CC}	Power-supply voltage	V_{CC}	–0.3	5.5	V
	Power-supply voltage slew rate	V_{CC}	Unlimited		V/µs
V_O	Output voltage	OUT	–0.3	V_{CC} + 0.3	V
I_O	Output current	OUT	–5	30	mA
B	Magnetic flux density		Unlimited		T
T_J	Operating junction temperature			140	°C
T_A	Operating ambient temperature	For SOT-23 (DBZ), X2SON (DMR) and TO-92 (LPG)	–40	135	°C
		For DSBGA (YBH)	–40	125	
T_{stg}	Storage temperature		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±6000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±750	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Power supply voltage	V_{CC}	2.5	5.5	V
V_O	Output voltage	OUT	0	V_{CC}	V
I_O	Output current(1)	OUT	–5	20	mA
T_J	Operating junction temperature			140	°C
T_A	Operating ambient temperature	For SOT-23 (DBZ), X2SON (DMR) and TO-92 (LPG)	–40	135	°C
		For DSBGA (YBH)	-40	125	

(1) Device-sourced current is negative. Device-sunk current is positive.

6.4 Thermal Information

THERMAL METRIC[1]		DRV5011				UNIT
		DBZ (SOT-23)	DMR (X2SON)	YBH (DSBGA)	LPG (TO-92)	
		3 PINS	4 PINS	4 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	356	159	194.1	183.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	128	77	1.6	74.2	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	94	102	68	158.8	°C/W
ψ_{JT}	Junction-to-top characterization parameter	11.4	0.9	0.8	15.2	°C/W
ψ_{JB}	Junction-to-board characterization parameter	92	100	67.9	158.8	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

6.5 Electrical Characteristics

for V_{CC} = 2.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC}	Operating supply current			2.3	3	mA
t_{ON}	Power-on time (see Figure 10)			40	70	µs
t_d	Propagation delay time	From change in B to change in OUT		13	25	µs
V_{OH}	High-level output voltage	I_O = –1 mA	V_{CC} – 0.35	V_{CC} – 0.1		V
V_{OL}	Low-level output voltage	I_O = 20 mA		0.15	0.4	V

6.6 Magnetic Characteristics

for V_{CC} = 2.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{BW}	Sensing bandwidth			30		kHz
B_{OP}	Magnetic threshold operate point (see Figure 8)		0.6	2	3.8	mT
B_{RP}	Magnetic threshold release point (see Figure 8)		–3.8	–2	–0.6	mT
B_{HYS}	Magnetic hysteresis: $\lvert B_{OP} - B_{RP} \rvert$		2	4	6	mT

7.3 Feature Description

7.3.1 Magnetic Flux Direction

The DRV5011 is sensitive to the magnetic field component that is perpendicular to the top of the package, as shown in Figure 6.

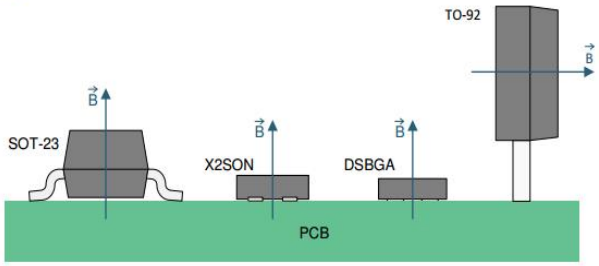


Figure 6. Direction of Sensitivity

shows the tolerances and side-view dimensions.

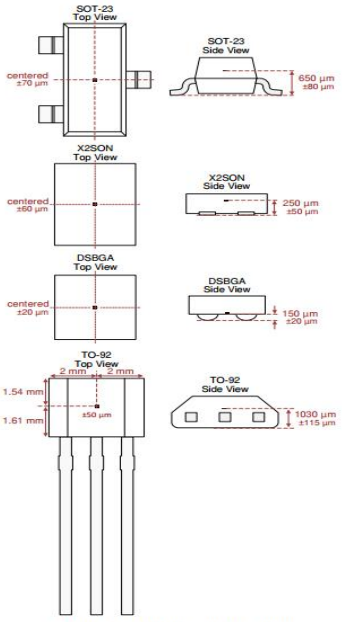


Figure 11. Hall Element Location

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DRV5011ADDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADDMRR	ACTIVE	X2SON	DMR	4	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADDMRT	ACTIVE	X2SON	DMR	4	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADLPG	PREVIEW	TO-92	LPG	3	1000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-40 to 135	11AD	
DRV5011ADLPGM	PREVIEW	TO-92	LPG	3	3000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-40 to 135	11AD	
DRV5011ADYBHR	ACTIVE	DSBGA	YBH	4	3000	Green (RoHS & no Sb/Br)	SAC396	Level-1-260C-UNLIM	-40 to 125	A	Samples
DRV5011ADYBHT	ACTIVE	DSBGA	YBH	4	250	Green (RoHS & no Sb/Br)	SAC396	Level-1-260C-UNLIM	-40 to 125	A	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV5011ADDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5011ADDBZT	SOT-23	DBZ	3	250	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5011ADDMRR	X2SON	DMR	4	3000	180.0	8.4	1.27	1.57	0.5	4.0	8.0	Q1
DRV5011ADDMRT	X2SON	DMR	4	250	180.0	8.4	1.27	1.57	0.5	4.0	8.0	Q1
DRV5011ADYBHR	DSBGA	YBH	4	3000	180.0	8.4	0.85	0.89	0.51	2.0	8.0	Q2
DRV5011ADYBHT	DSBGA	YBH	4	250	180.0	8.4	0.85	0.89	0.51	2.0	8.0	Q2