High Sensitive Digital-Bipolar Hall Effect Sensor

FEATURES

- Ultra-high sensitivity
- High chopping frequency
- Supports a wide voltage range

  --2.5 to 24V

  --Operation from unregulated supply
- Wide operating temperature range
- Solid-state reliability
- Small package

  --3-pin SIP -(UA)

  --3-pin SOT23 -(SO)

APPLICATIONS

- Power tools
- Flow meters
- Valve and solenoid status
- BLDC motors with sensors
- Proximity sensing
- Tachometers

DESCRIPTION

The SC2402 is a Hall-effect latch designed in mixed signal BiCMOS technology. The device integrates a voltage regulator, Hall sensor with dynamic offset cancellation system, Schmitt trigger and an open-drain output driver, all in a single package.

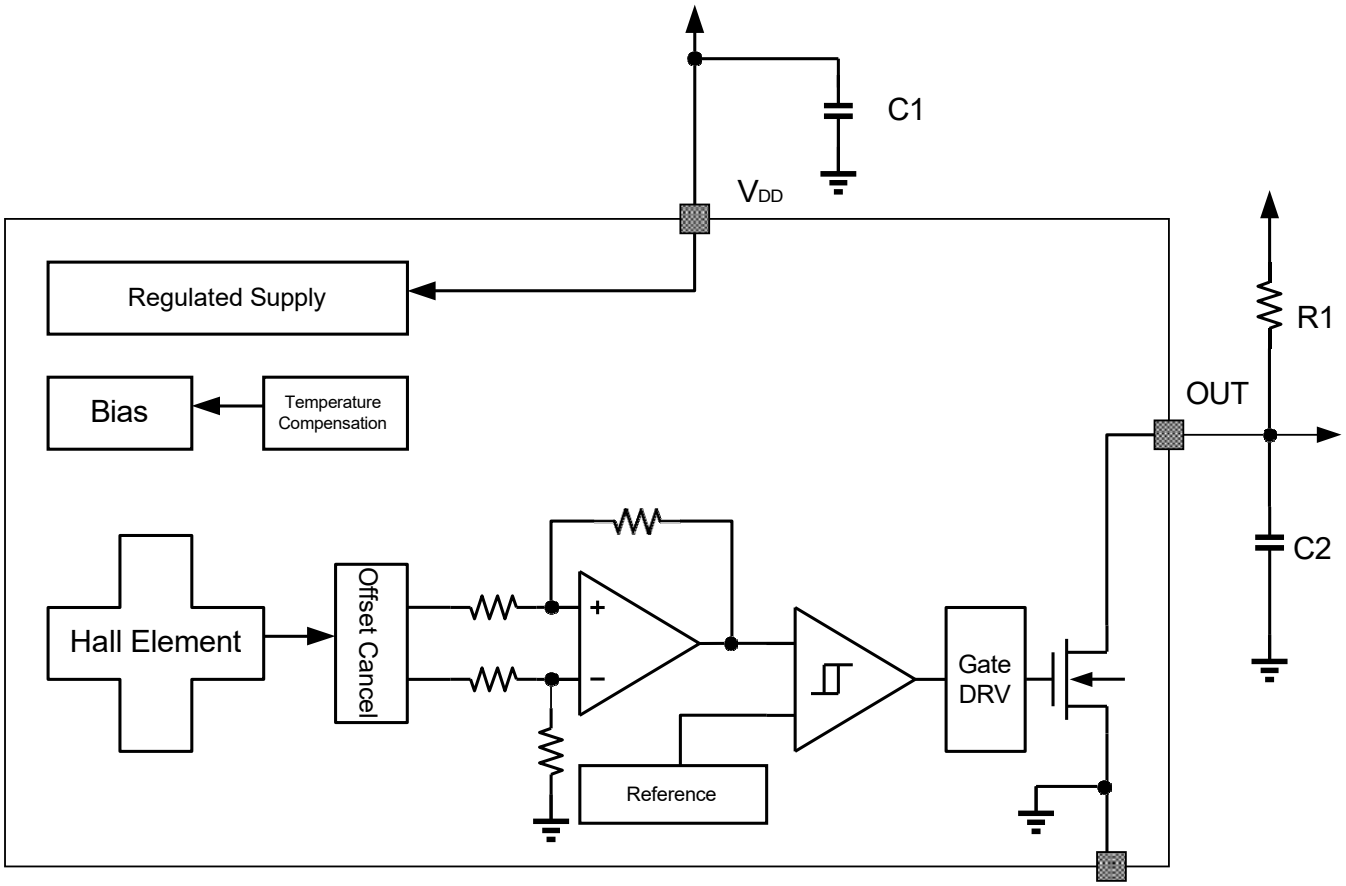
The low operating voltage and extended choice of temperature range make it suitable for use in automotive, industrial and consumer low voltage applications.

An onboard regulator permits with supply voltages of 2.5 to 24V which makes the device suitable for a wide range of industrial and automotive applications

The device is available in a 3-pin SIP package (UA) and a 3-pin SOT-23 style package (SO). Both are lead (Pb) free, with 100% matte tin leadframe plating.

CONTENTS

BLOCK DIAGRAM

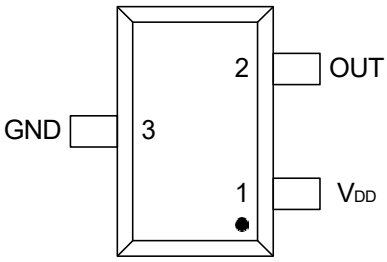


ORDERING INFORMATION

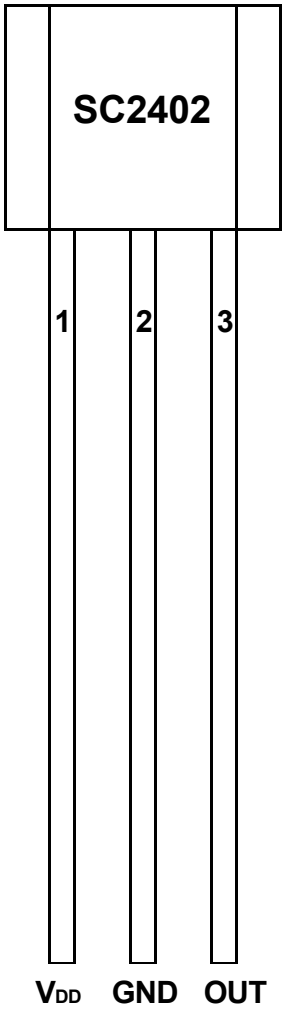
Part Number	Packing	Mounting	Ambient, T_A	B_{OP}(Typ.)	B_{RP}(Typ.)
SC2402UA	Bulk, 1000 pieces/bag	3-pin SIP	-40℃ to 150℃	+1.8mT	-1.8mT
SC2402SO-N	Reel, 3000pieces/reel	3-pin SOT23		-1.8mT	+1.8mT

TERMINAL CONFIGURATION

3-Terminal SOT-23
SO Package
(Top View)



3-Terminal SIP
UA Package
(Top View)



Terminal			Type	Description
Name	Number			
	UA	SO		
V_{DD}	1	1	PWR	2.5V~24 V power supply
GND	2	3	Ground	Ground terminal
OUT	3	2	Output	Open-drain output. The open drain requires a pull-up resistor

ABSOLUTE MAXIMUM RATINGS

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

Parameter	Symbol	Min.	Max.	Units
Power supply voltage	V_{DD}	-0.5	28	V
Output terminal voltage	V_{OUT}	-0.5	28	V
Output terminal current sink	I_{SINK}	0	30	mA
Operating ambient temperature	T_A	-40	150	℃
Maximum junction temperature	T_J	-55	165	℃
Storage temperature	T_{STG}	-65	175	℃

(1) Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD PROTECTION

Human Body Model (HBM) tests according to: standard AEC-Q100-002

Parameter	Symbol	Min.	Max.	Units
ESD-Protection	V_{ESD}	-3	+3	KV

THERMAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	Rating	Units
$R_{\theta JA}$	UA Package thermal resistance	Single-layer PCB, with copper limited to solder pads	166	℃/W
$R_{\theta JA}$	SO Package thermal resistance	Single-layer PCB, with copper limited to solder pads	228	℃/W

OPERATING CHARACTERISTICS

Electrical Characteristics

over operating free-air temperature range (V_{DD} = 5.0V, unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_{DD}	Operating voltage (1)	$T_J < T_{J(Max.)}$	2.5	--	24	V
$I_{DD\ (off)}$	Operating supply current	V_{DD}=2.5 to 24 V, T_A=25℃	0.8	1.3	2.0	mA
$I_{DD\ (on)}$		V_{DD}=2.5 to 24 V, T_A=25℃	0.8	1.4	2.0	mA
t_{on}	Power-on time		--	35	50	μS
I_{QL}	Off-state leakage current	Output Hi-Z	--	--	1	μA
$R_{DS\ (on)}$	FET on-resistance	V_{DD}=5V, I_O=10mA, T_A=25℃	--	20	--	Ω
		V_{DD}=5V, I_O=10mA, T_A=125℃	--	30	--	Ω
t_d	Output delay time	B=B_{RP} to B_{OP}	--	15	25	μS
t_r	Output rise time (10% to 90%)	R1=1Kohm Co=50pF	--	--	0.5	μS
t_f	Output fall time (90% to 10%)	R1=1Kohm Co=50pF	--	--	0.2	μS

(1) Maximum voltage must be adjusted for power dissipation and junction temperature, see Thermal Characteristics

Magnetic Characteristics

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

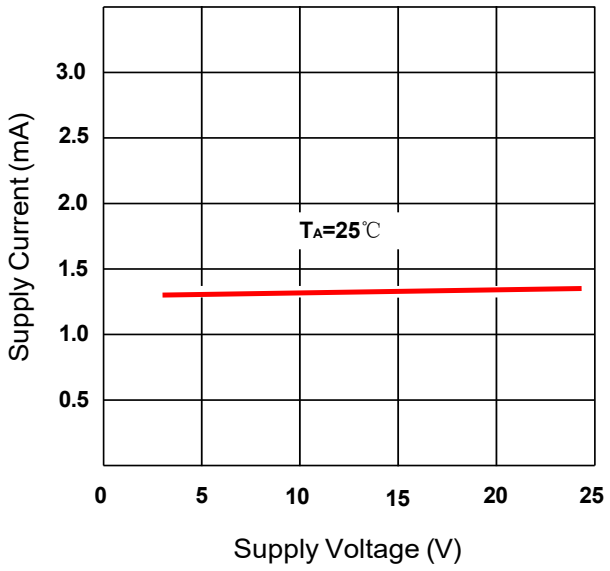
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_{BW}	Bandwidth		20	--	--	kHz
B_{OP}	Operated point	T_A=-40℃ to 150℃	--	+1.8	+3.0	mT
B_{RP}	Release point		-3.0	-1.8	--	mT
B_{HYS}	Hysteresis		--	3.6	--	mT
B_O	Magnetic offset	B_O=(B_{OP}+B_{RP})/2	-1.0	0	+1.0	mT

1mT=10Gs

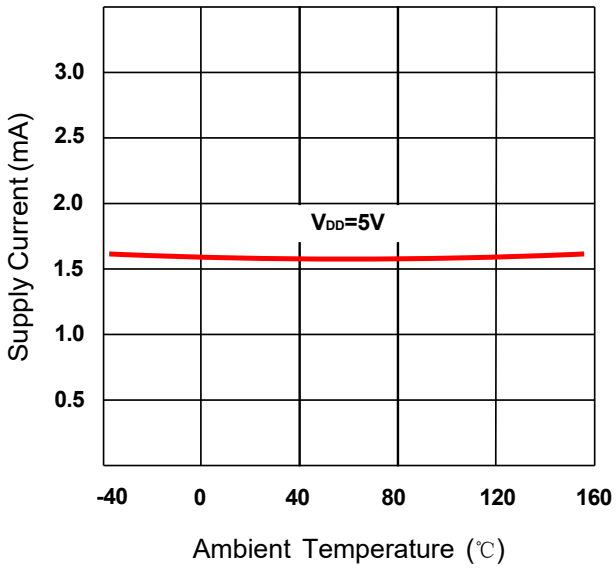
Magnetic flux density, B, is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

TYPICAL CHARACTERISTIC

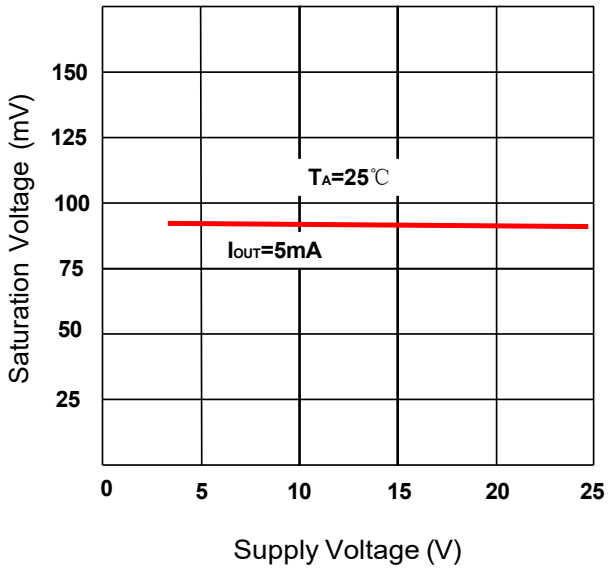
I_{DD} vs V_{DD}



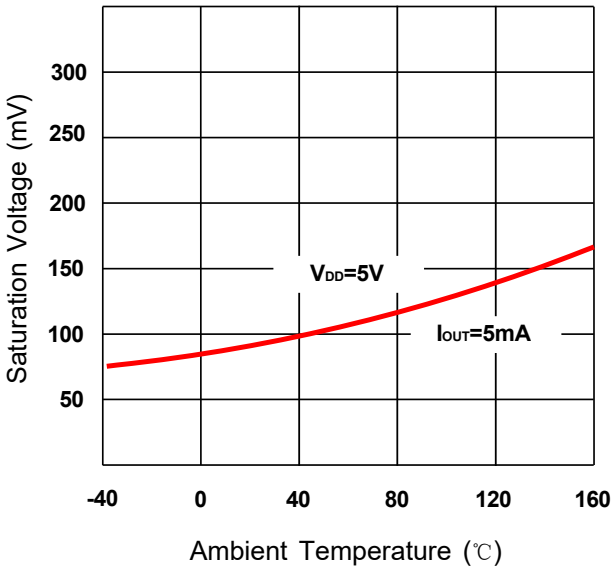
I_{DD} vs T_A



$V_{Q(sat)}$ vs V_{DD}

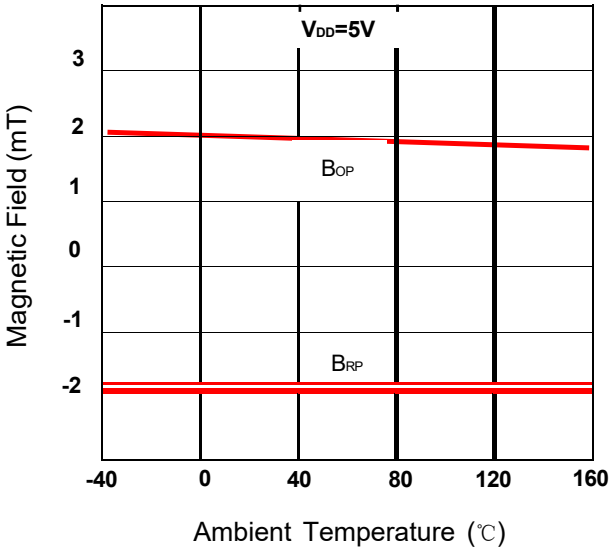


$V_{Q(sat)}$ vs T_A

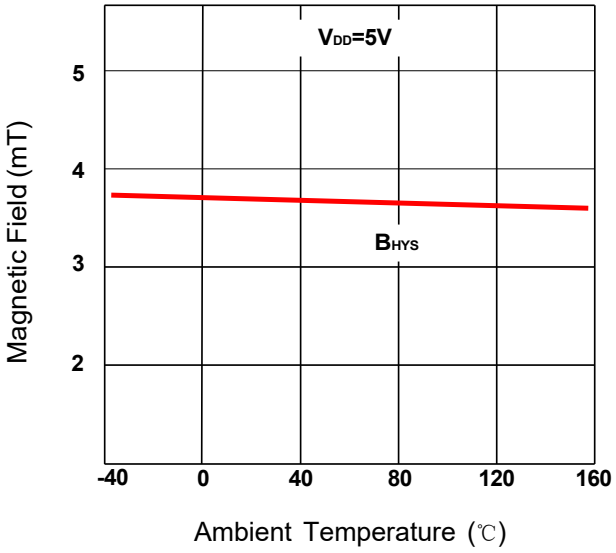


TYPICAL CHARACTERISTIC (Continued)

B_{OP} and B_{RP} vs T_A



B_{HYS} vs T_A



FUNCTION DESCRIPTION

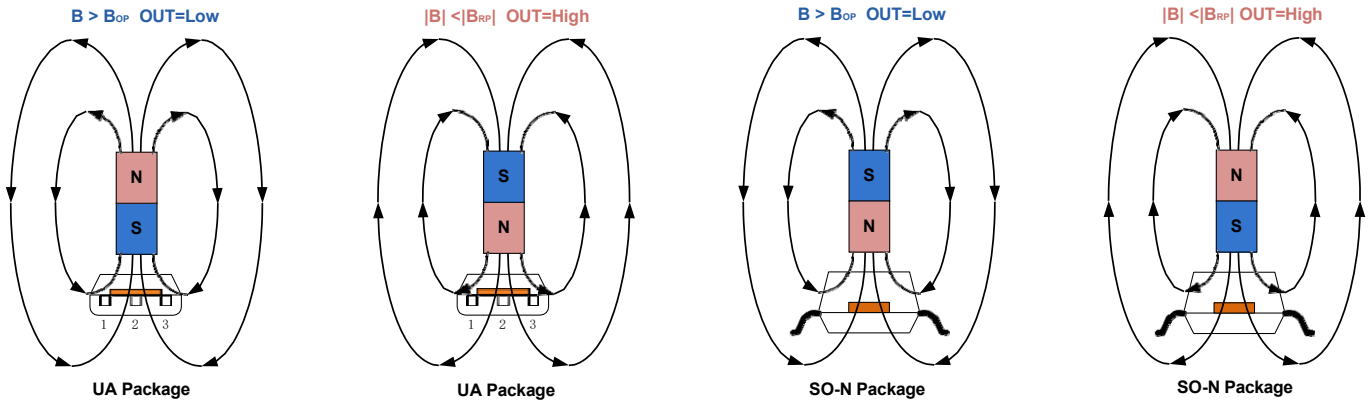
The SC2402 device is a chopper-stabilized Hall sensor with a digital latched output for magnetic sensing applications. The device can be powered with a supply voltage between 2.5 and 24V. The device does not operate when -0.5 to 2.2V is applied to the V_{DD} terminal (with respect to the GND terminal). In addition, the device can withstand voltages up to 40V for transient durations.

The output of SC2402 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 20mA and the output voltage is $V_{Q\ (sat)}$. 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.

An external output pull-up resistor is required on the OUT terminal. The OUT terminal can be pulled up to V_{DD} or to a different voltage supply. This allows for easier interfacing with controller circuits.

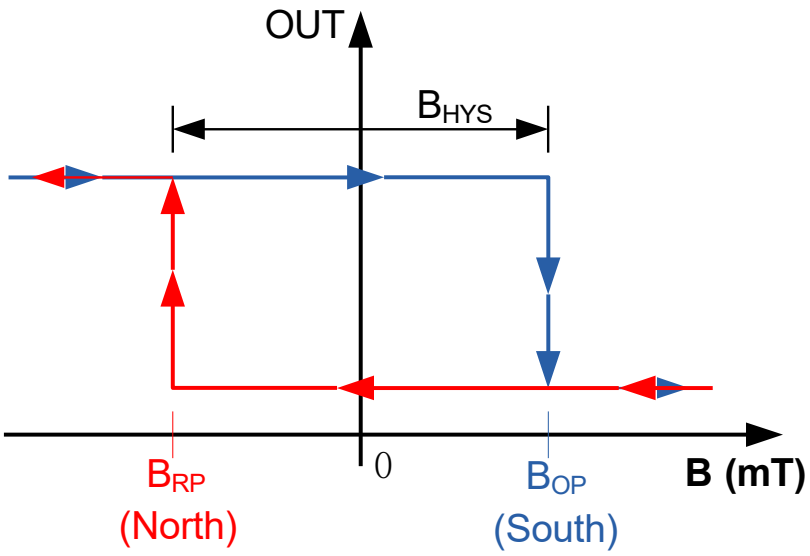
Field Direction Definition

A positive magnetic field is defined as a South pole near the marked side of the package.

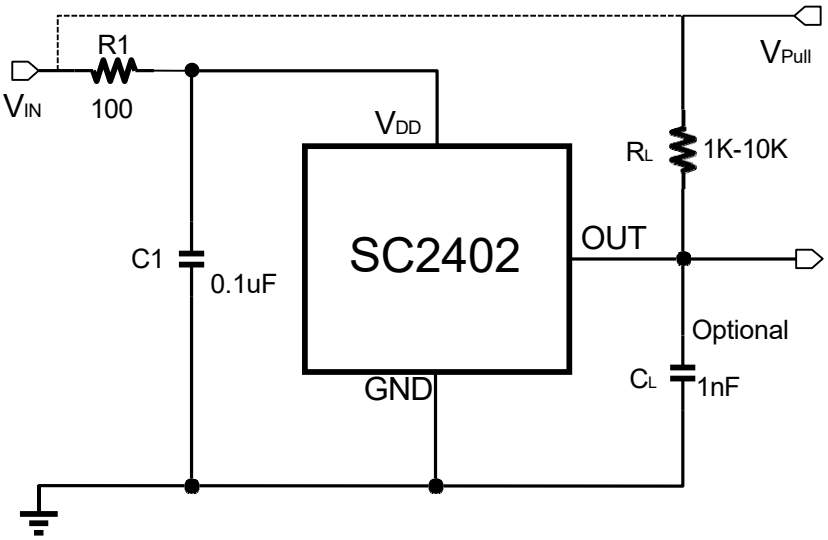


Transfer Function

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}. If the field strength is greater than B_{OP}, then the output is pulled low. If the field strength is less than B_{RP}, the output is released.



TYPICAL APPLICATION



The SC2402 contains an on-chip voltage regulator and can operate over a wide supply voltage range. In applications that operate the device from an unregulated power supply, transient protection must be added externally. For applications using a regulated line, EMI/RFI protection may still be required. It is recommended to shunt C1 capacitors to the ground near the chip V_{DD} power supply, with a typical value of 0. 1μF.At the same time in the external optional series resistor R1 their typical values for 100Ω.The output capacitor C_L is used as the output filter, typically 1nF.

Select a value for C_L based on the system bandwidth specifications as:

$$C_L = \frac{1}{2\pi \times R \times f\ (Hz)}$$

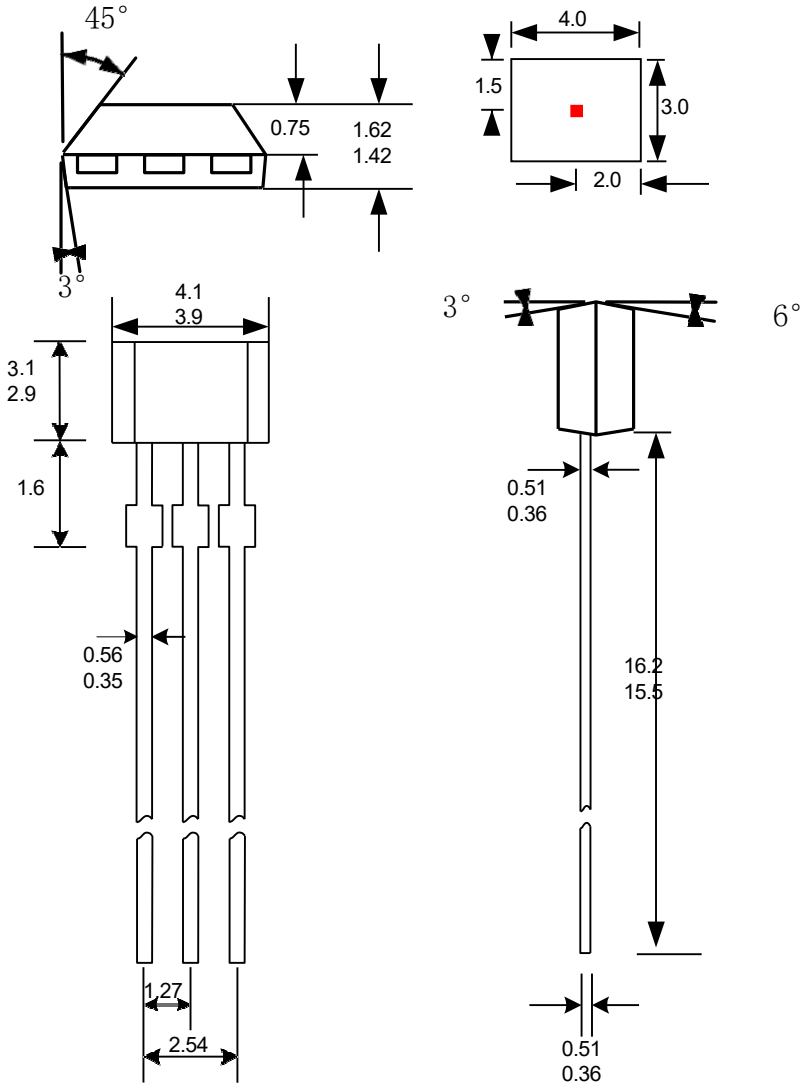
The output stage of the SC2402 device is a drain open-circuit NMOS tube, which provides a load capacity of 20mA.Adjust the pull-up resistor R_L to make it work properly. The R_L provides a high level for the leak-opening output. In general, less current is better, but faster transient response and bandwidth are required, with a smaller resistor R_L for faster switching.

V_{PULL} is not restricted to V_{DD}, and could be connected to other voltage reference. The allowable voltage range of this terminal is specified in the Absolute Maximum Ratings.

PACKAGE INFORMATION "UA"

3-Terminal
UA Package

Dimension:mm



Notes:

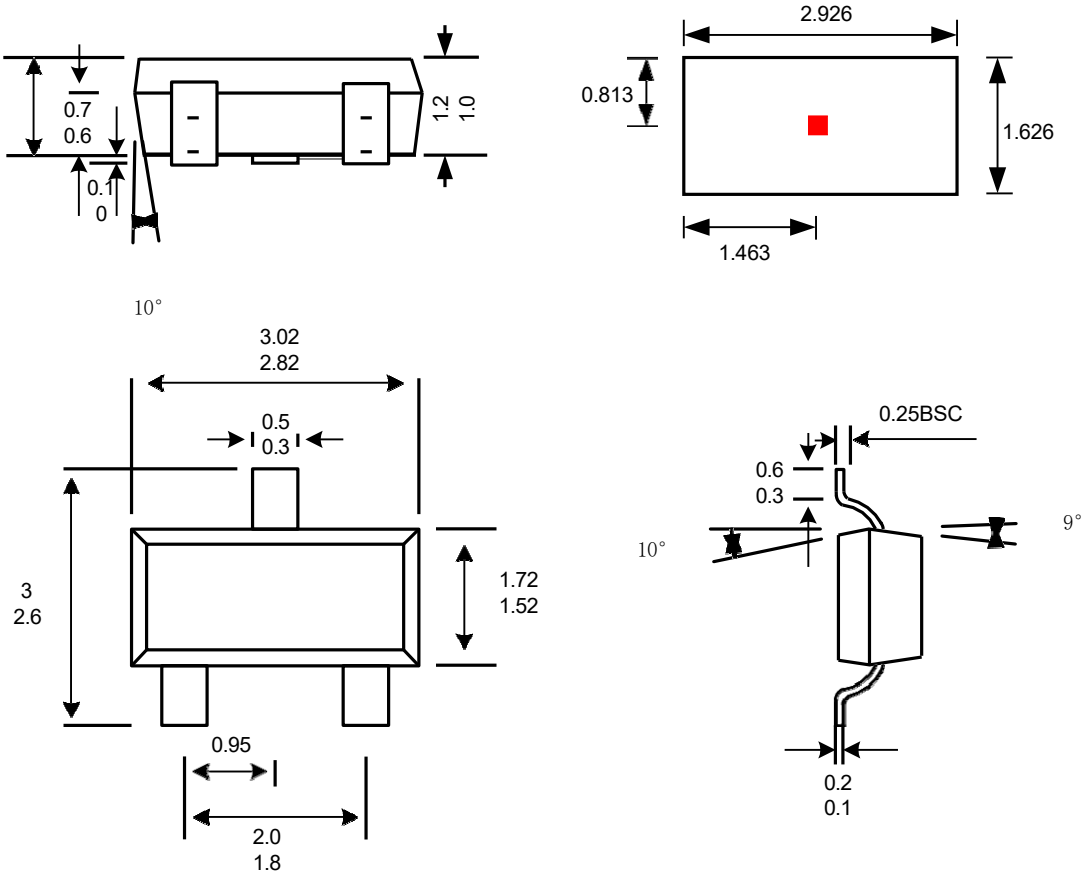
1. *Exact body and lead configuration at vendor's option within limits shown.*
2. *Height does not include mold gate flash.*

Where no tolerance is specified, dimension is nominal.

PACKAGE INFORMATION "SO"

3-Terminal
SO Package

Dimension:mm



Notes:

1. *Exact body and lead configuration at vendor's option within limits shown.*
2. *Height does not include mold gate flash.*

Where no tolerance is specified, dimension is nominal.

REVISON HISTORY

Revision	Date	Description
Rev0.1	2016-10-12	Preliminary datasheet
Rev2.3	2018-11-13	The final revision of old datasheet
RevA/1.0	2020-11-19	Unified datasheet format