Programmable Digital-Unipolar Hall Effect Sensor

1. Features

- Programmable Unipolar Hall sensor
- High chopping frequency
- Supports a wide voltage range
  - 2.5 to 24V
  - Operation on unregulated power supply
- Wide operating temperature range
- Factory-programmed at end-of-line for optimum
- Reverse battery protection (up to 28V)
- Over-voltage protection at all pins
- Robust EMC performance
- Solid-state reliability
- Automotive AEC-Q100 Qualified
- Small package
  - 3-pin TO-92S (UA)
  - 3-pin SOT23-3L (SO)

2. Applications

- Gear shift selectors
- Open/close sensor for LCD screens/doors/lids/trunks
- Clutch/brake position sensor
- Wiper home/end position sensor
- End-of-travel and index sensor

3. Description

The SC243X family, produced with Bi-CMOS technology, is a chopper-stabilized Hall Effect Sensor that offers a magnetic sensing solution with superior sensitivity stability over temperature and integrated protection features.
Superior high-temperature performance is made possible through dynamic offset cancellation, which reduces the residual offset voltage normally caused by device over molding, temperature dependencies, and thermal stress. Each device includes a voltage regulator, Hall-voltage generator, small-signal amplifier, chopper stabilization, Schmitt trigger, and an open-drain output to sink up to 20mA.
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 TO-92S(UA) package and a 3-pin SOT-23(SO) style package. Both are lead (Pb) free, with 100% matte tin lead frame plating.

Not To Scale

3 pin TO-92S(UA)

3 pin SOT23-3L(SO)

Fig.1 Package Outline

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4. Terminal Configuration

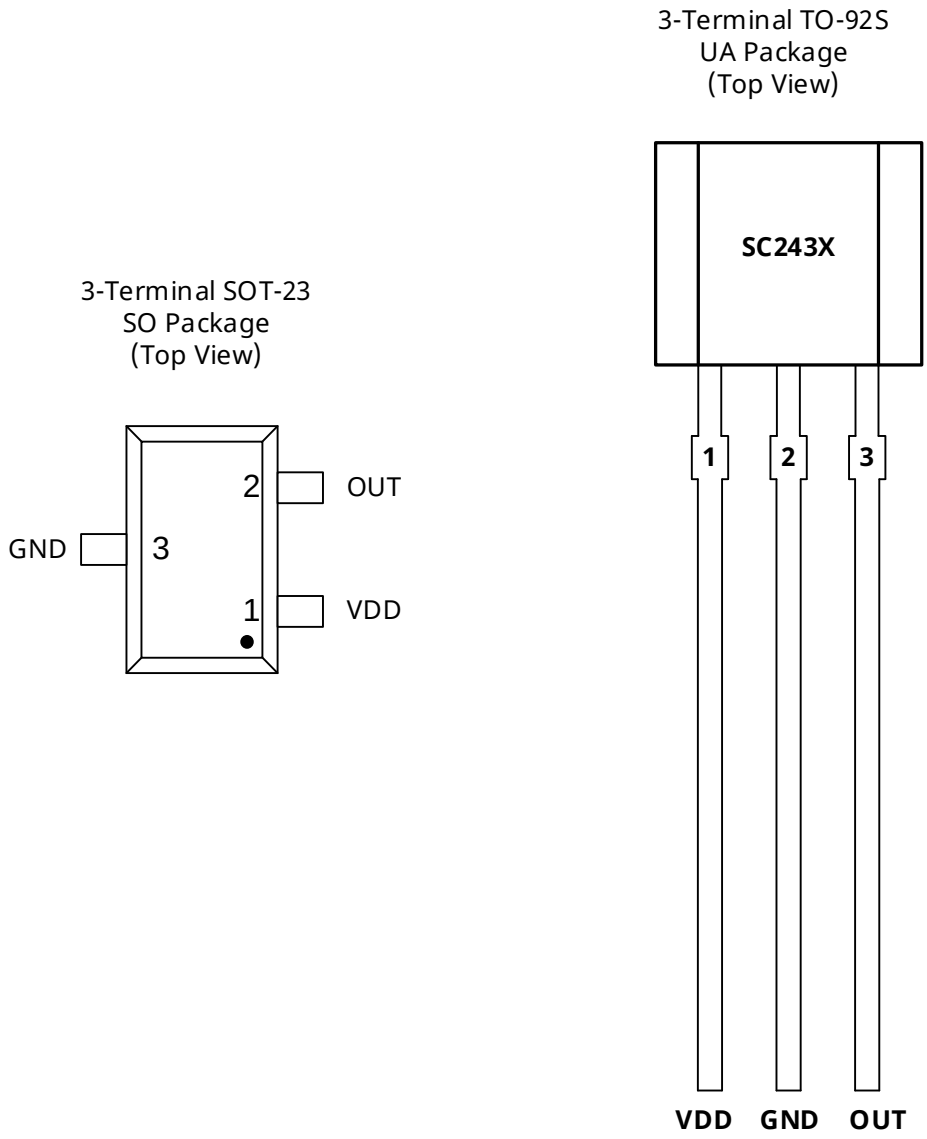


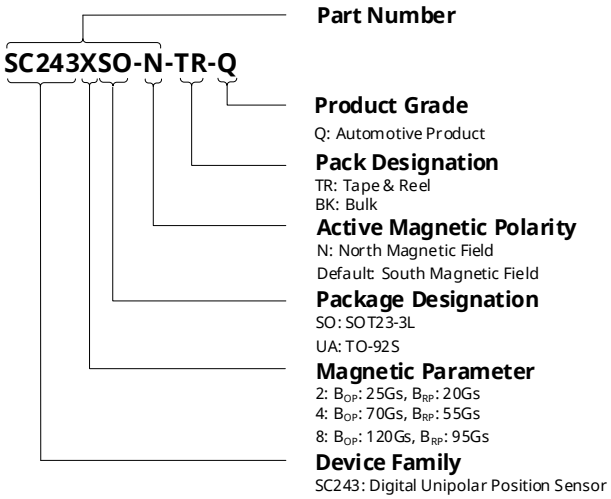
Fig. 2: Terminal Configuration

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

5. Ordering Information

Ordering Information	Mark	Option	B_{OP}(Gs)	B_{RP}(Gs)	Ambient, T_A(℃)	Package	Packing	Quantity
SC2432SO-TR	2432		25	20	-40~150	SOT23-3L	TR	3000/reel
SC2432SO-TR-Q	2432		25	20	-40~150	SOT23-3L	TR	3000/reel
SC2432SO-N-TR	2432	N	-25	-20	-40~150	SOT23-3L	TR	3000/reel
SC2432UA-BK	2432		25	20	-40~150	TO-92S	BK	1000/bag
SC2434SO-TR	2434		70	55	-40~150	SOT23-3L	TR	3000/reel
SC2434SO-N-TR	2434	N	-70	-55	-40~150	SOT23-3L	TR	3000/reel
SC2434UA-BK	2434		70	55	-40~150	TO-92S	BK	1000/bag
SC2438SO-TR	2438		120	95	-40~150	SOT23-3L	TR	3000/reel
SC2438SO-TR-Q	2438		120	95	-40~150	SOT23-3L	TR	3000/reel

5.1. Ordering Information Format



6. Absolute Maximum Ratings

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

Symbol	Parameter	Test Condition	Min.	Max.	Units
V_{DD}	Power supply voltage		-28	28	V
V_{OUT}	Output terminal voltage	For 5 Min. @1.2K pull-up resistor	-0.5	28	V
I_{SINK}	Output terminal current sink		0	30	mA
T_A	Operating ambient temperature		-40	150	℃
T_J	Maximum junction temperature		-55	165	℃
T_{STG}	Storage temperature		-65	175	℃

Note:

(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.

7. ESD Protection

Symbol	Parameter	Test Condition	Min.	Max.	Units
V_{ESD_HBM}	HBM	According to: standard AEC-Q100-002 HBM	-4	4	kV
V_{ESD_CDM}	CDM	According to: standard AEC-Q100-011 CDM	-1	1	kV

8. 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 (1)	℃/W
$R_{\theta JA}$	SO Package thermal resistance	Single-layer PCB, with copper limited to solder pads	228 (1)	℃/W

Note:

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

9. Operating Characteristics

9.1. Electrical Characteristics

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

Symbol	Parameter	Test Conditions	Min.	Typ.(2)	Max.	Units
V_{DD}	Operating voltage (1)	$T_J < T_{J(Max.)}$	2.5	5.0	24	V
V_{DDR}	Reverse supply voltage		-28	-	-	V
I_{DD}	Operating supply current	V_{DD}=2.5 to 24 V, T_A=25℃	-	1.6	2.5	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}=5.0V, I_O=10mA, T_A=25℃	-	20	-	Ω
		V_{DD}=5.0V, 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

Note:

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

(2) Typical values are defined at T_A = +25°C and V_{DD} = 5V

9.2. Magnetic Characteristics

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_{BW}	BW		20	-	-	kHz
SC2432 +2.5 /+2.0 mT(2)						
B_{OP}	Operating point	T_A=25℃	1.5	2.5	3.5	mT(1)
B_{RP}	Release point		1.0	2.0	3.0	mT
B_{HYS}	Hysteresis		-	0.5	-	mT
SC2434 +7.0 /+5.5 mT						
B_{OP}	Operating point	T_A=25℃	6.0	7.0	8.0	mT
B_{RP}	Release point		4.5	5.5	6.5	mT
B_{HYS}	Hysteresis		-	1.5	-	mT
SC2438 +12.0 /+9.5 mT						
B_{OP}	Operating point	T_A=25℃	10.0	12.0	14.0	mT
B_{RP}	Release point		7.5	9.5	11.5	mT
B_{HYS}	Hysteresis		-	2.5	-	mT

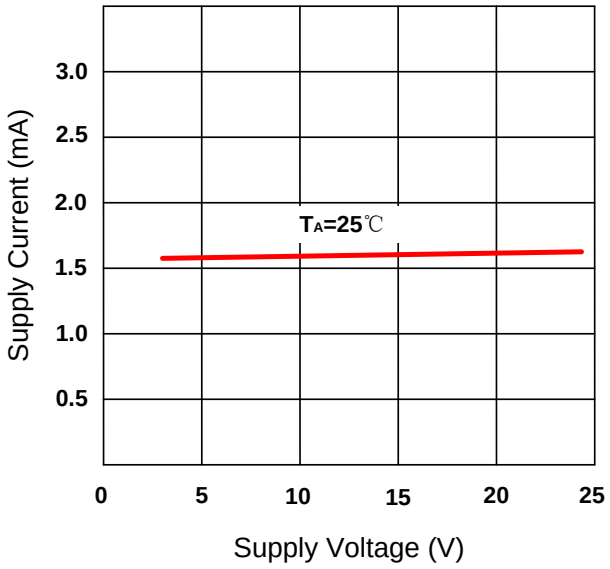
Note:

(1) 1mT=10Gs

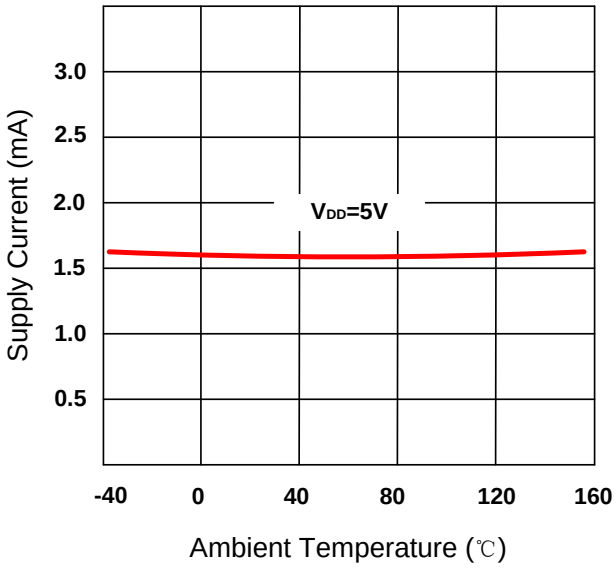
(2) Magnetic flux density, B, is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

10. Typical Characteristics

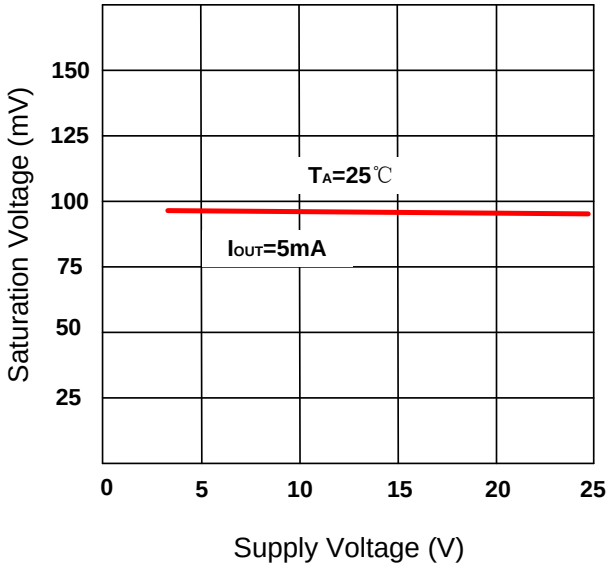
I_{DD} vs V_{DD}



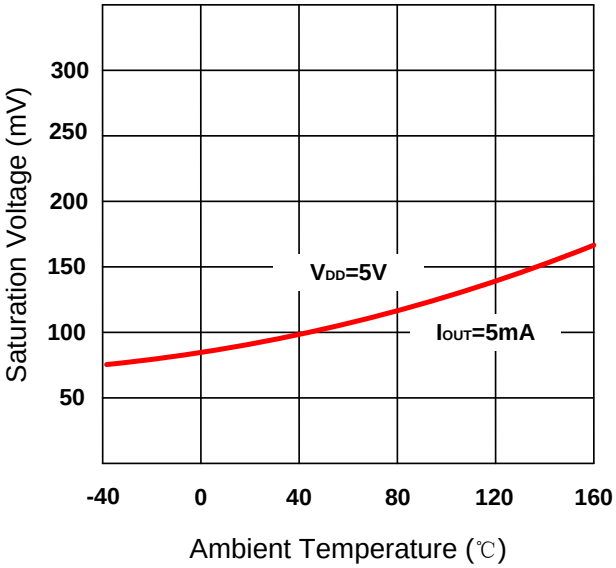
I_{DD} vs T_A



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



$V_{Q(sat)}$ vs T_A



11. Block Diagram

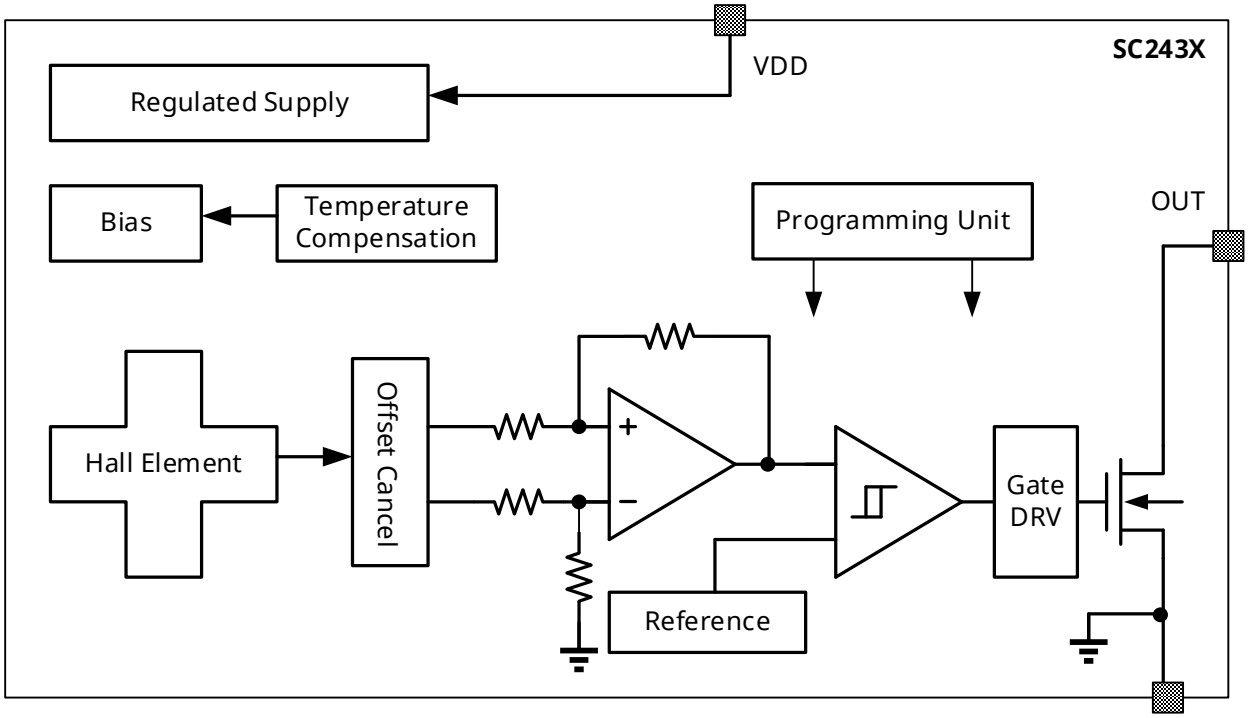


Fig. 3: Function Block Diagram

12. Function Description

The SC243X 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, and continuously survives continuous -28V reverse-battery conditions. The device does not operate when -28 to 2.2V is applied to the VDD terminal (with respect to the GND terminal). In addition, the device can withstand voltages up to 40V for transient durations.

The output of SC243X 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. It is convenient to interface with the controller.

12.1. Field Direction Definition

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

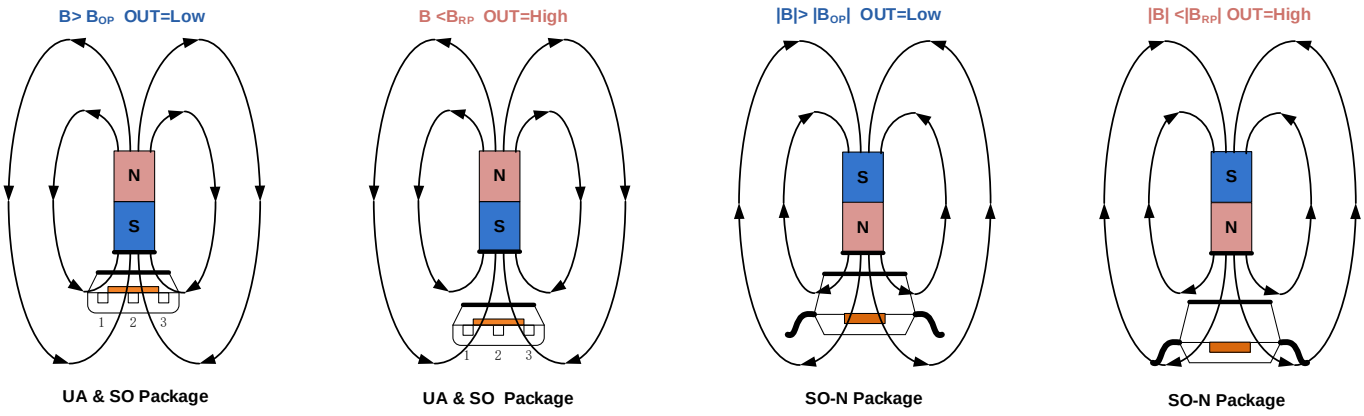


Fig. 4: Magnetic Field Direction Definition

12.2. 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.

B_{OP}—magnetic threshold for activation of the device output, turning in ON (low) state

B_{RP}—magnetic threshold for release of the device output, turning in OFF (high) state.

$B_{HYS} = B_{OP} - B_{RP}$

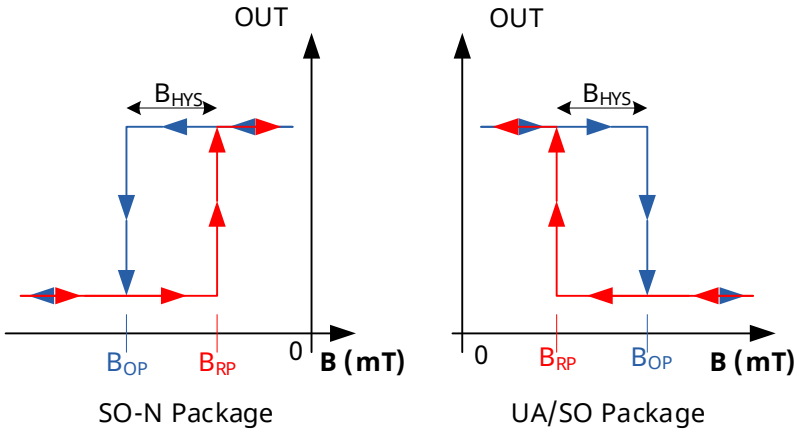


Fig. 5: Magnetic Transfer Function

13. Typical Application

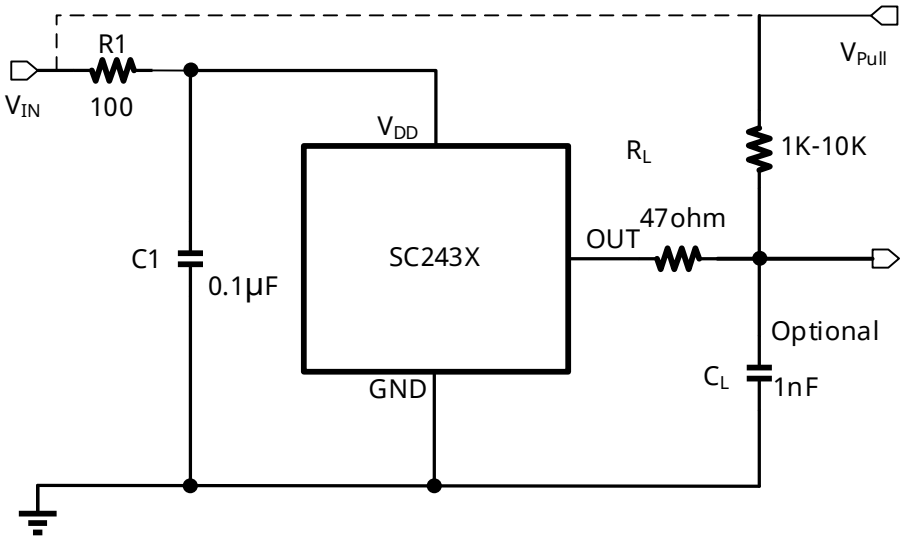


Fig. 6: Typical Application Circuit

The SC243X 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.

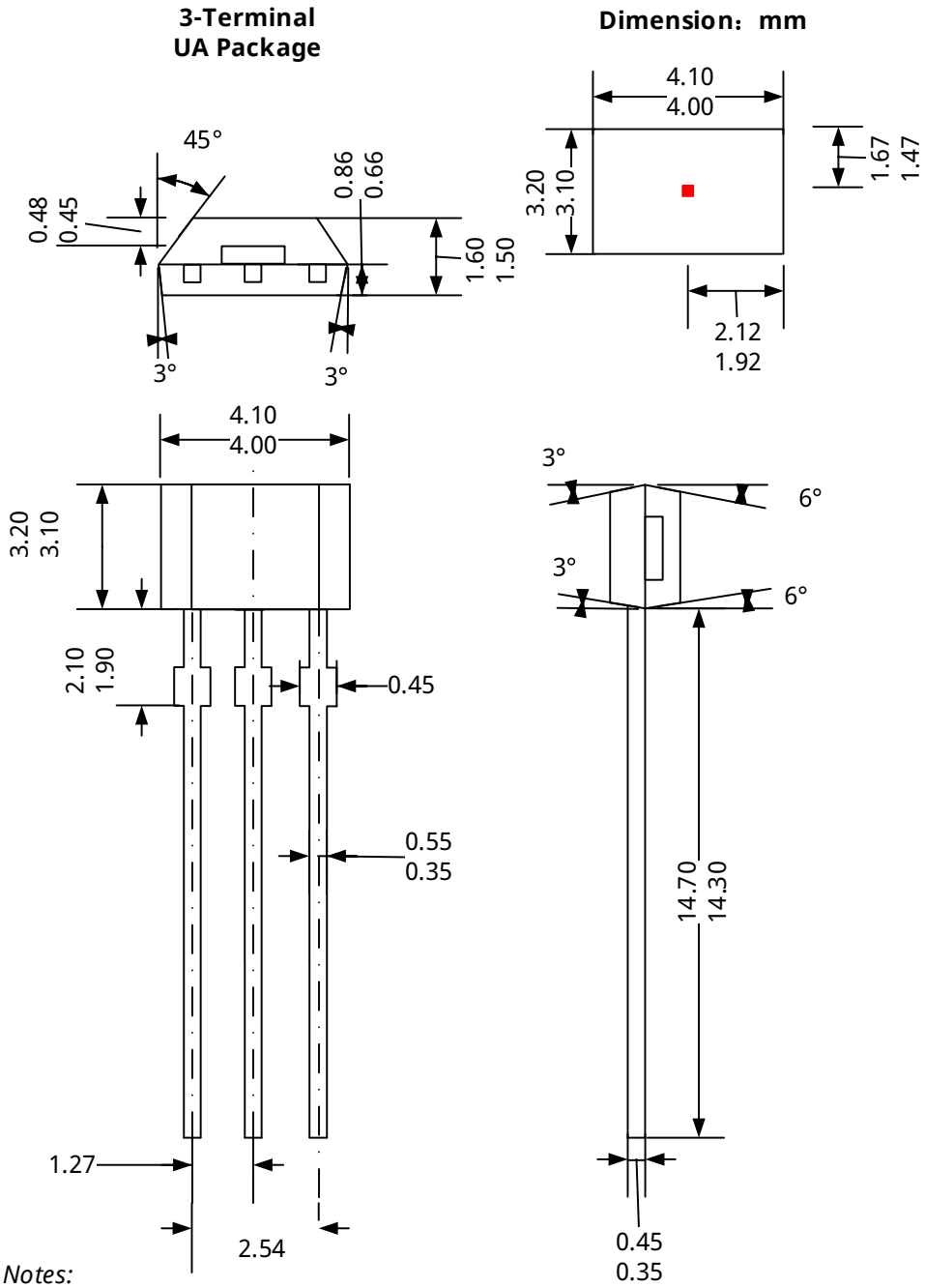
Select a value for C_L based on the system bandwidth specifications such as:

$$C_L < \frac{1}{2\pi \times R_L \times 2 \times f_{BW}(Hz)}$$

The output stage of the SC243X 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 power supply. The allowable voltage range of this terminal is specified in the Absolute Maximum Ratings.

14. Package Information "UA"



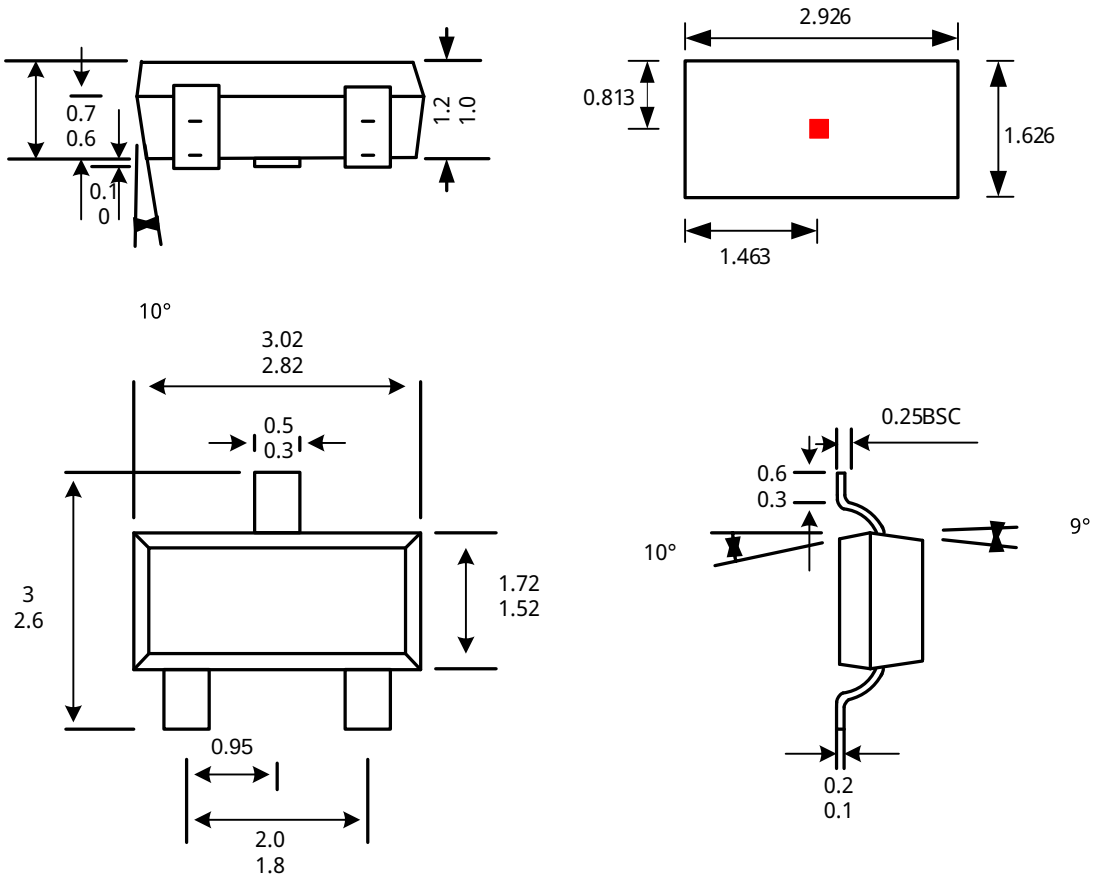
Notes:

1. *Exact body and lead configuration at vendor's option within limits shown.*
2. *Height does not include mold gate flash.*
3. *The plating thinckness is 7-15um*
4. *Fine dimension information reference POD-TO92SS1-241115-002*

15. 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.

16. Revision History

Revision	Date	Description
Rev1.0	2016-05-10	Preliminary datasheet
Rev1.1	2017-08-06	Add order information of SC2438SO
Rev2.3	2019-05-06	The final revision of old datasheet
Rev.A1.0	2021-01-04	Unified datasheet format
Rev.A1.1	2024-05-06	Update part number in order information
Rev.A1.2	2024-07-19	Correct SC2438 magnetic parameter
Rev.A1.3	2024-11-28	Update ordering information, update TO-92S package dimension