High Performance Unipolar Hall Effect Sensor

1. Features

- AEC-Q100 qualified
- Digital Unipolar Hall-Effect sensor
- High chopping frequency
- Superior temperature stability
- Supports a wide voltage range 2.5 to 24V
- Reverse battery protection (up to 28V)
- Over-voltage protection at all pins
- Robust EMC performance
- Small package: 3-pin SOT23-3L -(SO)

2. Applications

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

3. Description

The SC2455 family, produced with BiCMOS technology, is a chopper-stabilized Hall Effect Sensor that offers a magnetic sensing solution with superior performance 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 on a single silicon chip 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 SC2455 is available in SOT23-3L surface mount package. package is lead (Pb) free, with 100% matte tin lead frame plating.

Fig.1 Package Outline

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4. Terminal Configuration

SOT23-3L
SO Package
(Top View)

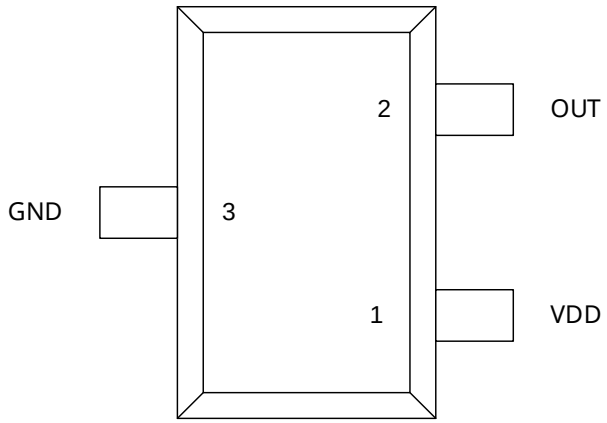


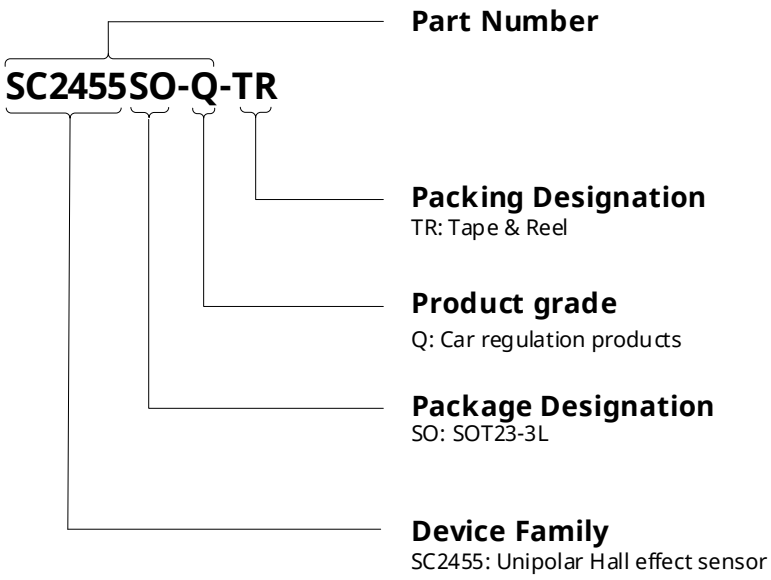
Fig. 2: Terminal Configuration

Terminal	Name	Type	Description
SO			
1	VDD	PWR	2.5V ~ 24V Power supply
3	GND	Ground	Ground terminal
2	OUT	Output	Open-drain output

5. Ordering Information

Order Information	Mark	Option	Ambient, T_A(℃)	Package	Packing	Quantity
SC2455SO-Q-TR	2455	Q	-40~150	SOT23-3L	TR	3000/reel

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	Human body model (HBM) testing according to AEC-Q100-002 standard	-4	4	kV
V_{ESD_CDM}	CDM	Charging Device Model (CDM) testing according to AEC-Q100-011 standard	-750	750	V

8. Thermal Characteristics

Symbol	Parameter	Test Conditions	Rating	Units
$R_{\theta JA}$	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.(1)	Max.	Units
V_{DD}	Operating voltage(2)	$T_J < T_{J(Max.)}$	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℃	0.8	1.6	2.0	mA
		V_{DD}=2.5 to 24 V, T_A=150℃	0.8	1.8	2.0	mA
t_{on}	Power-on time	V_{DD}≥5.0V	-	35	50	μs
I_{QL}	Off-state leakage current	Output Hi-Z	-	-	3	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=150℃		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) Typical values are defined at T_A = 25°C and V_{DD} = 5.0V

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

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
SC2455						
B_{OP}	Operating point	T_A=-40℃ to 125℃	23.5(1)	25.5	30.0	mT(2)
B_{RP}	Release point		18.0	20.0	24.5	mT
B_{HYS}	Hysteresis		-	5.5	-	mT

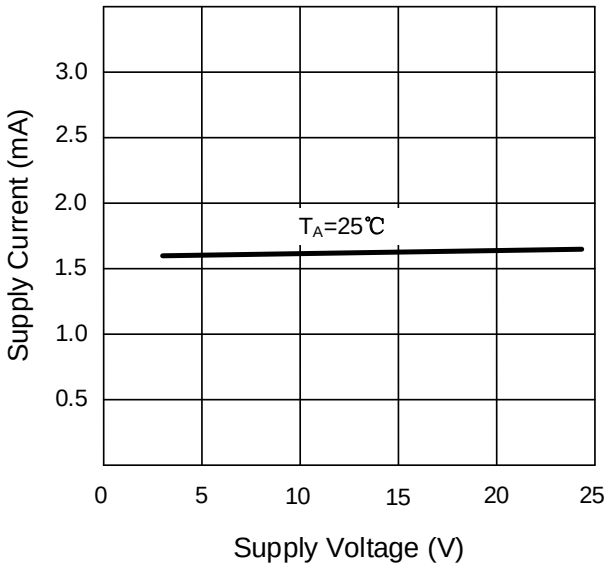
Note:

(1) 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,

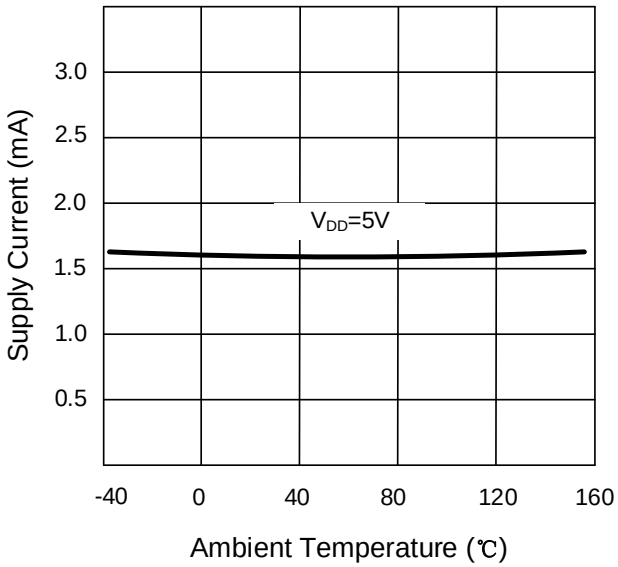
(2) 1mT=10Gs

10. Typical Characteristics

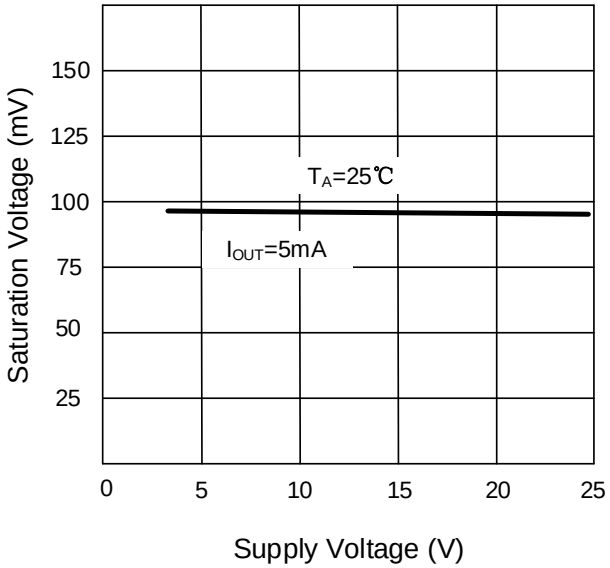
I_{DD} vs V_{DD}



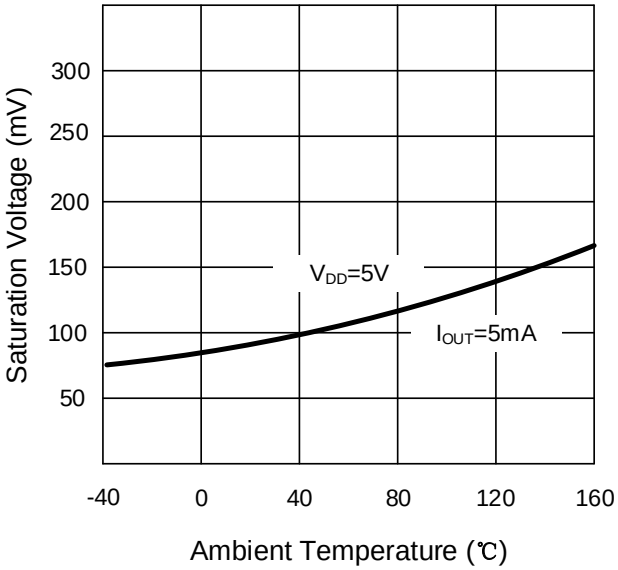
I_{DD} vs T_A



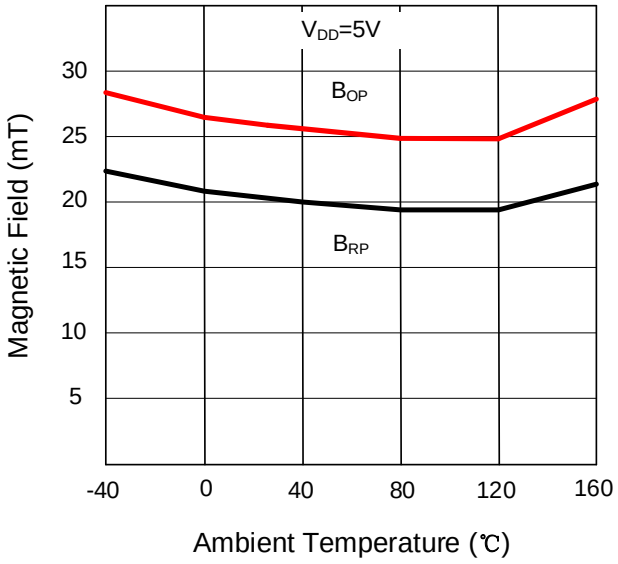
$V_{Q(sat)}$ vs V_{DD}



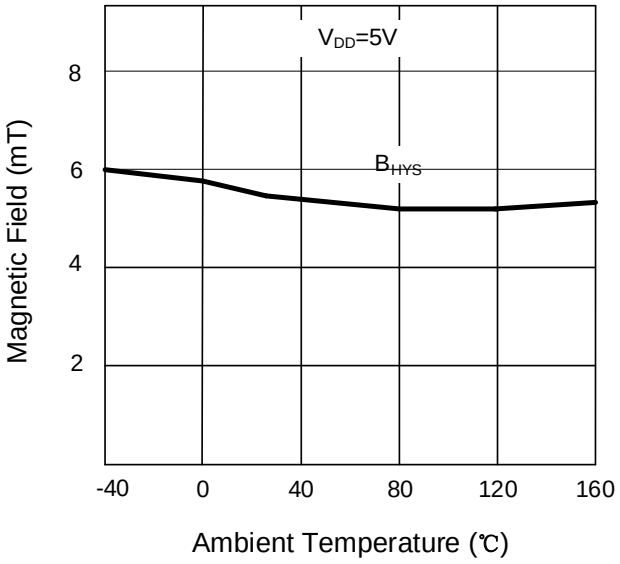
$V_{Q(sat)}$ vs T_A



B_{OP} and B_{RP} vs T_A



B_{HYS} vs T_A



11. Block Diagram

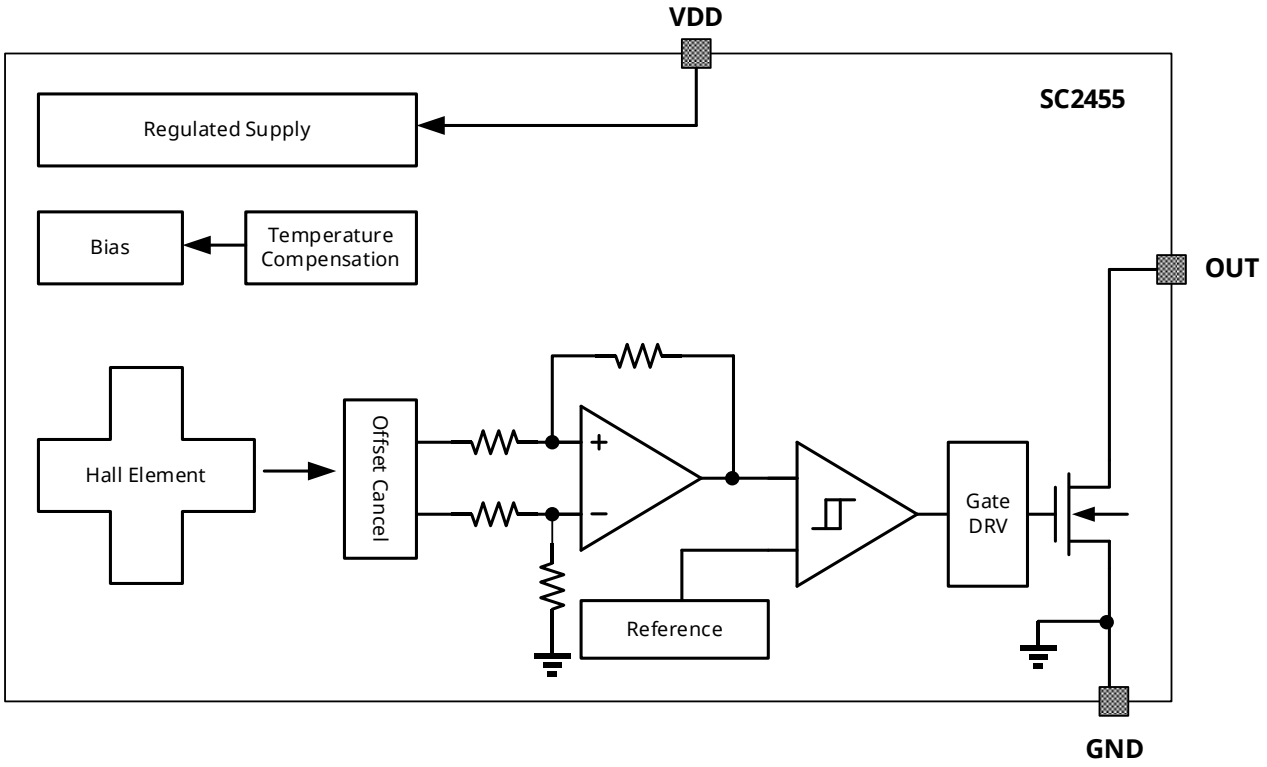


Fig. 3: Function Block Diagram

12. Function Description

The SC2455 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 output of SC2455 switches low (turns on) when a magnetic field 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 VQ (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 VDD or to a different voltage supply. This allows for easier interfacing with controller circuits

12.1. Field Direction Definition

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

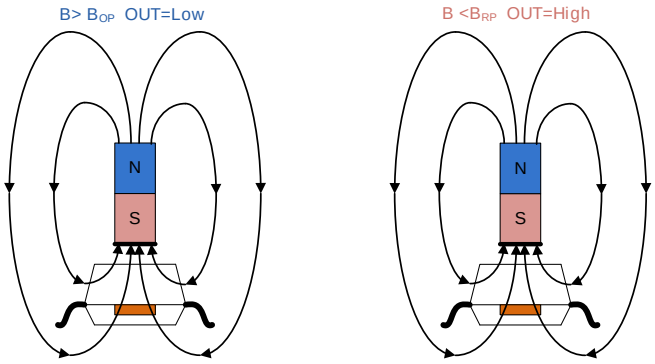


Fig. 4: Magnetic Field Direction Definition

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}

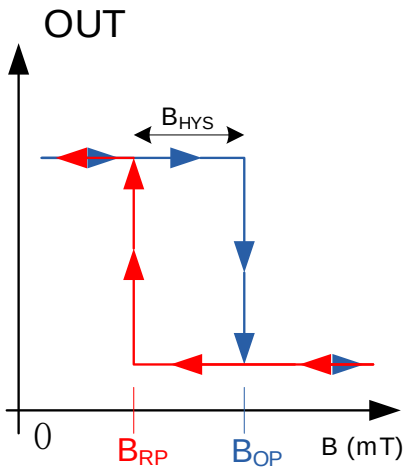


Fig. 5: Package Magnetic Transfer Function

13. Typical Application

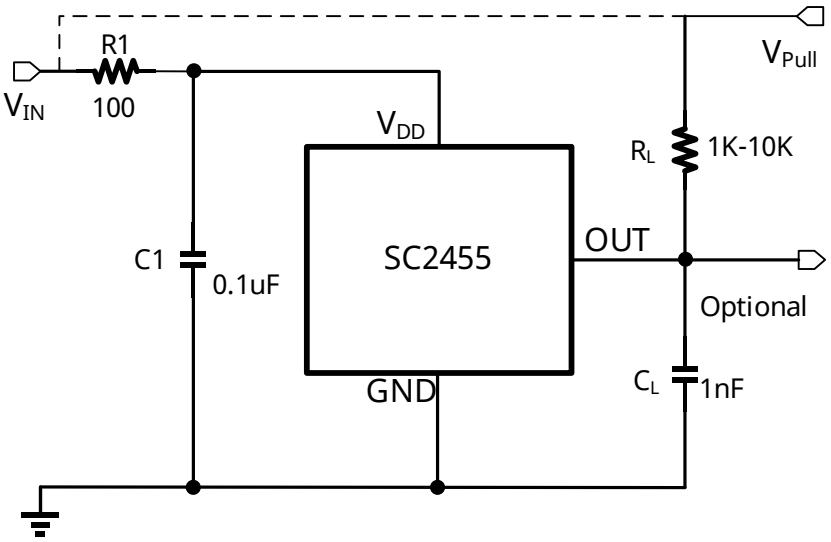


Fig. 6: Typical Application Circuit

The SC2455 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 that C1 capacitor be connected to the ground in parallel near the V_{DD} power end of the chip, with a typical value of 0.1uF. At the same time in the external optional series resistor R_1 and output capacitance C_L used for enhanced protection circuit, its typical values for 100Ω and 1nF.

The SC2455 device output stage uses an open-drain NMOS, and it is rated to sink up to 20mA of current. For proper operation, calculate the value of the pull-up resistor R_L is required. The size of R_L is a tradeoff between OUT rise time and the load capacity when OUT is pulled low. A lower current is generally better, however faster transitions and bandwidth require a smaller resistor for faster switching.

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

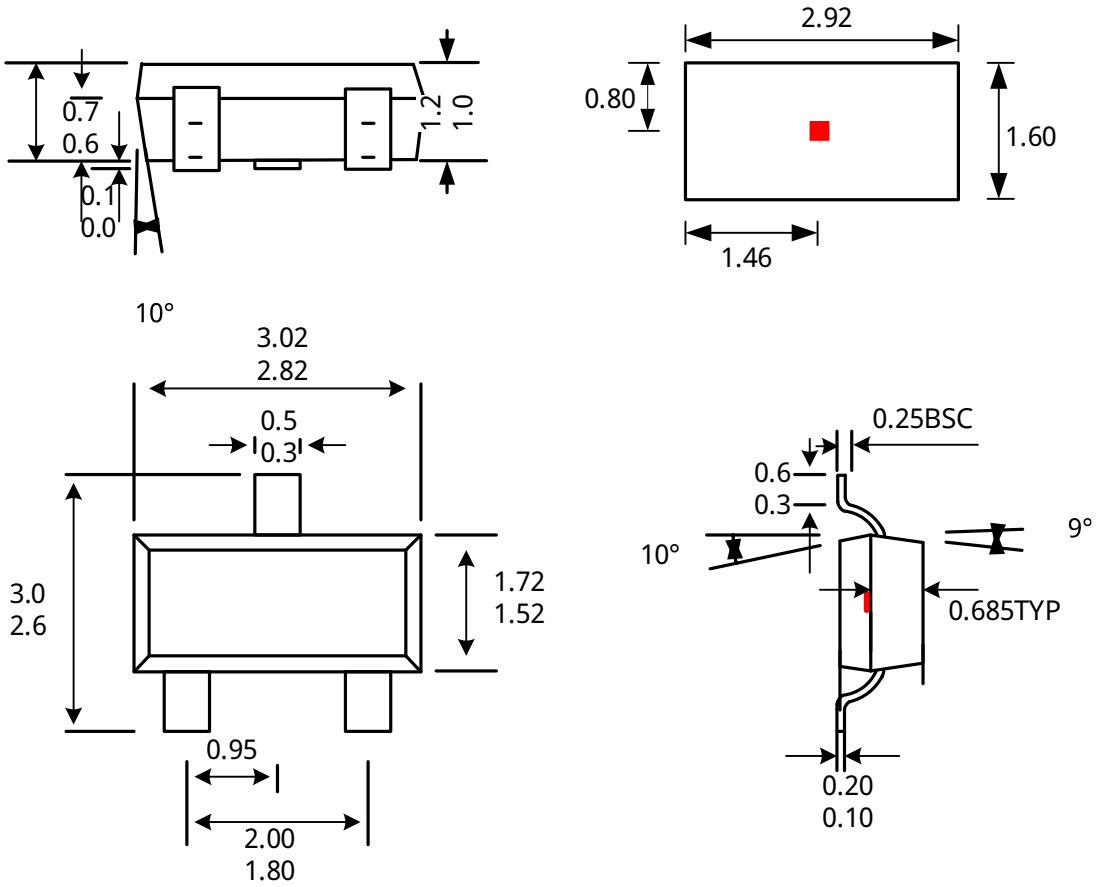
$$C_L < \frac{1}{2\pi \times R_L \times 2 \times f_{BW}(Hz)}$$

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.

14. 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.
3. The red mark is Hale element.

Where no tolerance is specified, dimension is nominal.

15. Revision History

Revision	Date	Description
Rev0.1	2023-03-3	Preliminary datasheet
RevA1.0	2023-04-11	Unified datasheet format
RevA1.1	2023-05-08	Update SC2455UA-N to SC2455UA
RevA1.2	2025-03-25	Remove UA encapsulation, update ordering information, and POD size