Two-Wire Unipolar Hall Effect Switches

1. Features

- AEC-Q100 qualified product
- ASIL-A Level
- High chopping frequency
- Support wide voltage range
  3.3 to 24V
- Operation from unregulated supply
- Wide operating temperature range
  -40℃ to 150℃
- Reverse-Voltage protection
- Output short-circuit protection
- High EMC immunity protection
- Package
  3-pin SOT23 (SE)
  3-pin TO-92S(UA)
  3-pin TO-92S(CUA)

2. Application

- Seat position detection
- Seat belt status
- Wiper motors
- Roof motor module

3. Description

The SC25891 is a Hall-effect unipolar switch designed in BCD process 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 wide operating voltage range and extended choice of temperature range make it suitable for use in automotive, industrial applications.

The device is available in a 3-pin SOT23 (SE) and TO-92S (UA) and TO-92S (CUA) package. Both are lead (Pb) free, with 100% matte tin lead frame plating.

Not to scale

Fig.1: TO-92S(Left)&SOT23(Right) Package Outline

CONTENTS

4. Terminal Configuration

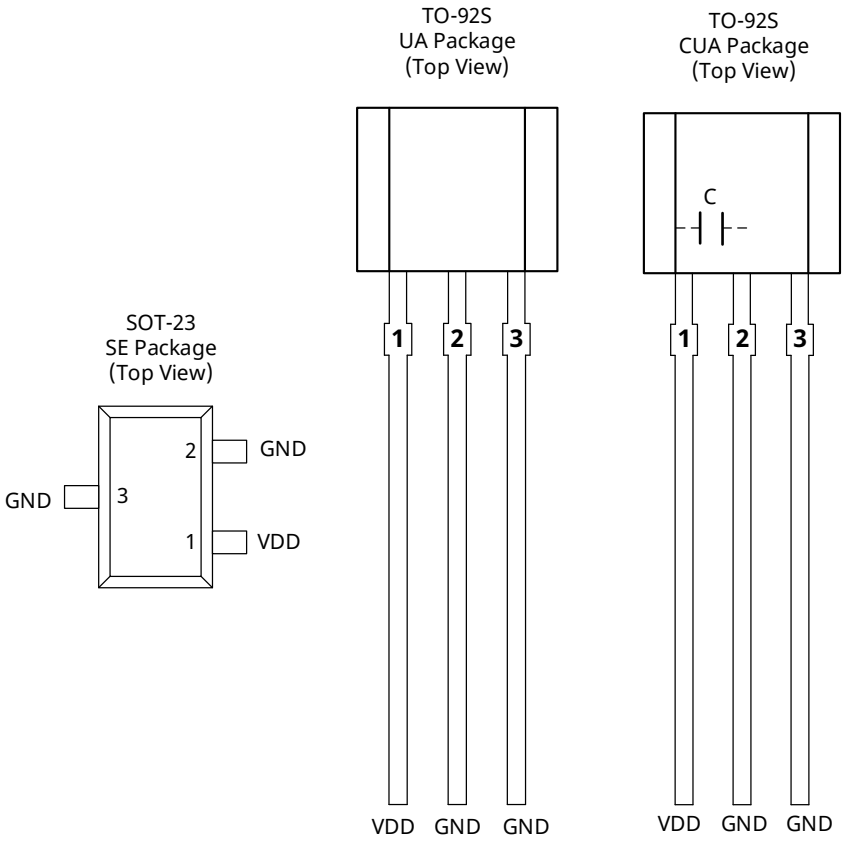


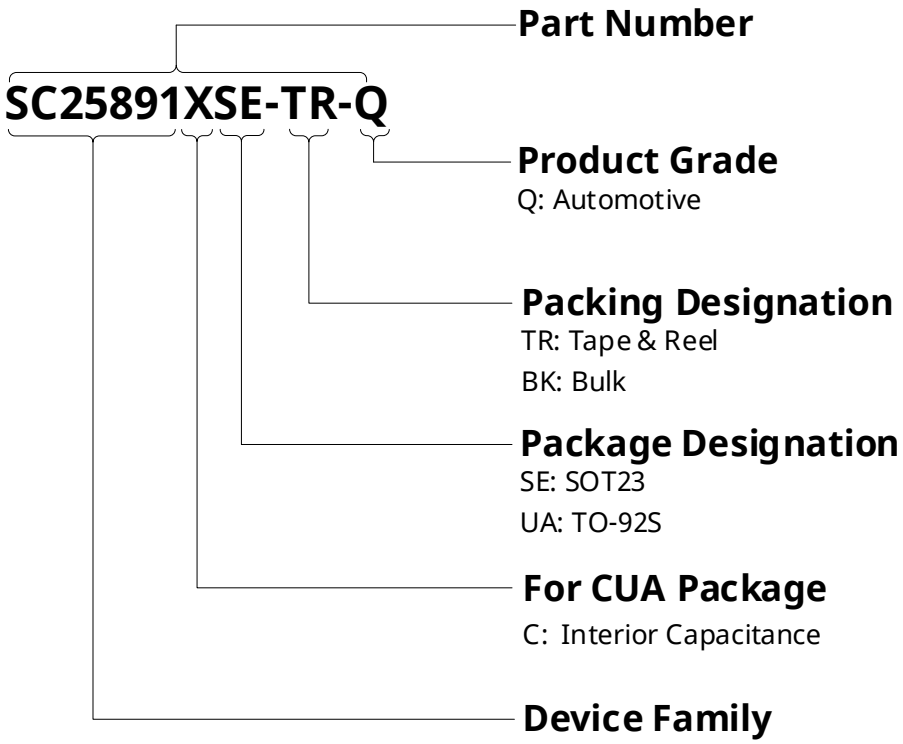
Fig.2: Pin Description

Terminal				Type	Description
Name	SE	UA	CUA		
VDD	1	1	1	PWR	3.3 to 24V power supply
GND	2	2	2	Ground	Ground
GND	3	3	3	Ground	Ground

5. Ordering Information

Ordering Information	Marking	Class	Ambient, T_A(℃)	Package	Packing	Quantity
SC25891SE-TR-Q	5891	Q	-40 to 150	SOT23	Tape & Reel	3000/Reel
SC25891UA-BK-Q	25891	Q	-40 to 150	TO-92S	Bulk	1000/Bulk
SC25891CUA-BK-Q	25891C	Q	-40 to 150	TO-92S	Bulk	1000/Bulk

Ordering Information Format



6. Absolute Maximum Ratings

V_{DD} = 3.3 to 24V, unless otherwise noted (1)

Symbol	Parameter	Test conditions	Min.	Max.	Units
V_{DD}	Power supply reverse Voltage	$T_J<T_{J(max)}$	-	32	V
I_{CC}	Supply current	-	-	50(2)	mA
$V_{DD\ REV}$	Reverse supply voltage	V_{DD}=0 to -40V, Step=1V	-26	-	V
$I_{CC\ REV}$	Reverse supply current	-	-20(3)	-	mA
T_A	Operating ambient temperature	-	-40	150	℃
T_J	Maximum junction temperature	-	-40	165	℃
T_{STG}	Storage Temperature	-	-65	175	℃
$R_{\theta JA}$	UA Package thermal resistance	Single-layer PCB, with copper limited to solder pads	-	200	℃/W
$R_{\theta JA}$	SE Package thermal resistance	Single-layer PCB, with copper limited to solder pads	-	300	℃/W

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.
(2) For maximum 500ms
(3) Through production device

7. ESD Protection

Symbol	Parameter	Test conditions	Min.	Max.	Units
V_{ESD_HBM}	HBM	Refer to AEC-Q100-002E HBM standard, R=1.5kΩ, C=100pF	-8	+8	kV
V_{ESD_CDM}	CDM	Refer to AEC-Q100-011C CDM standard	-2	+2	kV

8. Operating Characteristics

8.1. Electrical Characteristics

Within the operating temperature range, unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
Supply Characteristics						
V_{DD}	Operating voltage	$T_J<T_{J(max)}$	3.3	12	24	V
I_{Low}	Operating supply current	V_{DD}= 3.3 to 24V	5.0	6.0	6.9	mA
I_{High}	Operating supply current	V_{DD}= 3.3 to 24V	12	14	16	mA
$t_{(on)}$	Power-on time	V_{DD}= 12V, B＞B_{OP}	-	35	50	us
Output Characteristics						
t_d	Output delay time	V_{DD} =12V, R_{sense}=100Ω, C_{BYP}=100nF	-	-	25	us
Sr	Output Slew Rate	V_{DD} =12V, R_{sense}=100Ω, C_{BYP}=100nF	0.1	0.5	1.0	us
F_{sw}	Maximum switching frequency		10	-	-	KHz
FC	Chopping frequency	V_{DD} =12V	-	800	-	KHz

8.2. Magnetic Characteristics

V_{DD} = 3.3 to 24V, unless otherwise noted

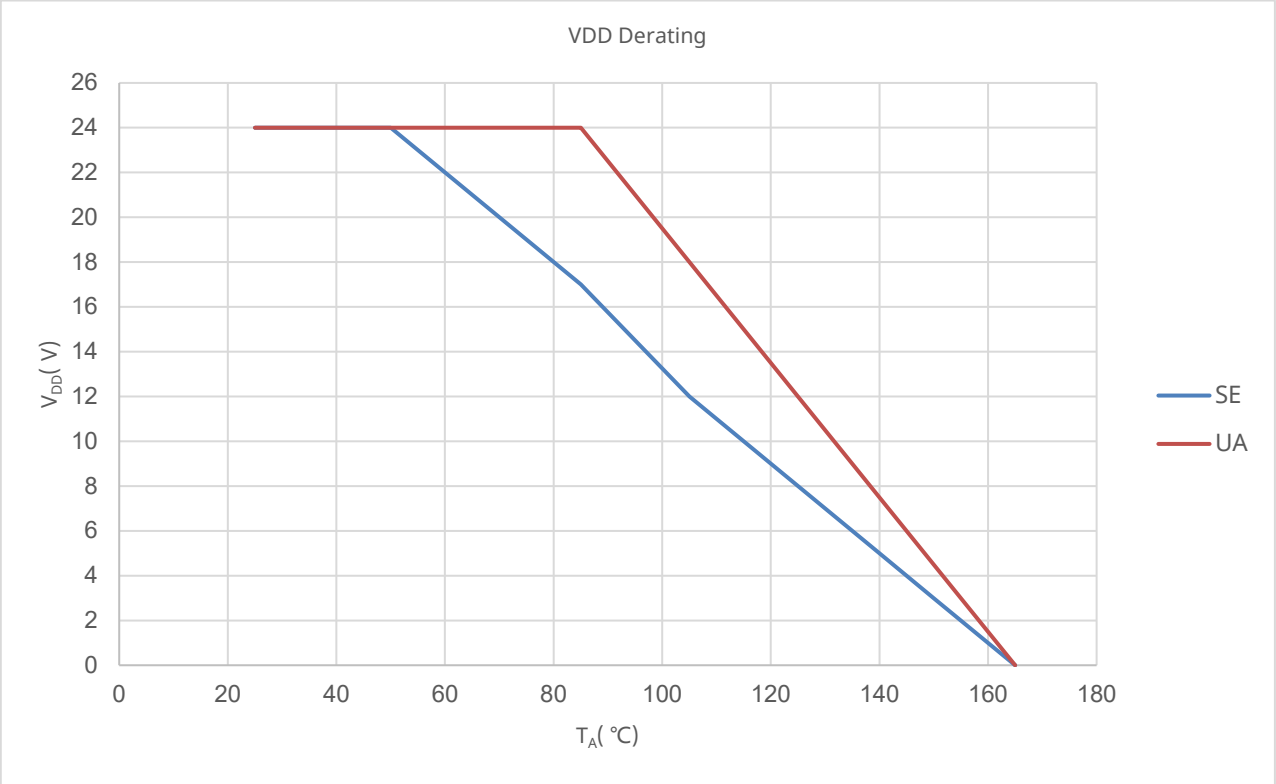
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
B_{OP}	Operated point	T_A=25℃	6.5	8.7	11.0	mT(1)
B_{RP}	Release point		5.2	7.3	9.8	mT
B_{HYS}	Hysteresis		-	1.4	-	mT

Note:

(1)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.

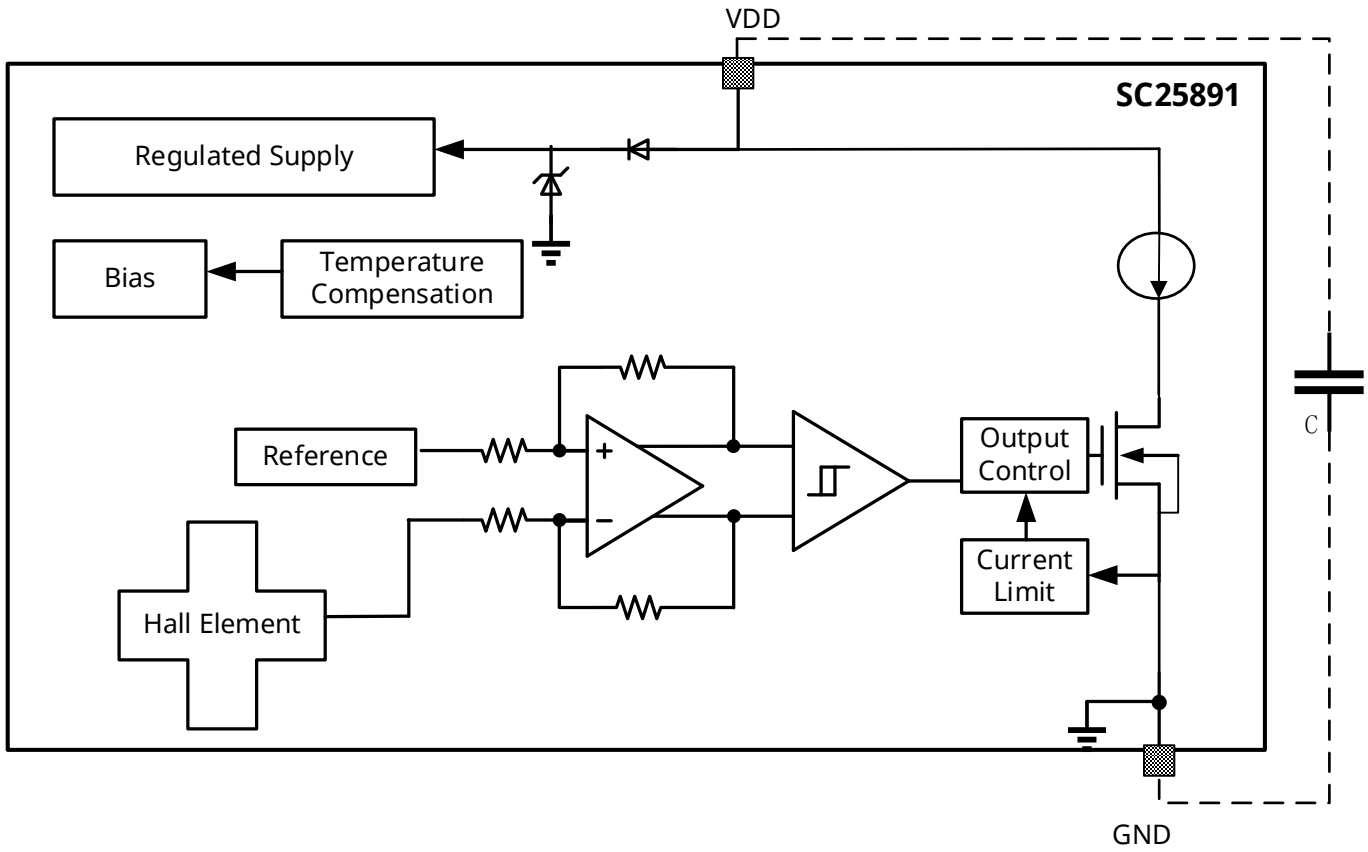
9. VDD-Derating



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

Fig.3: VDD-Derating

10. Block Diagram



Comments：Only TO-92 CUA contain C=100nF internally，others packages have not capacitor C

Fig.4: Block Diagram

11. Function Description

The SC25891 device is a chopper-stabilized Hall sensor with a digital output for magnetic sensing applications. The device can be powered with a supply voltage between 3.3 to 24V. The device does not operate when -26V to 3.3V is applied to the VDD terminal (with respect to the GND terminal). In addition, the device can withstand voltages up to 32V for transient durations.

The output of SC25891 switches IDD I_Low, when a magnetic field (South polarity) perpendicular to the Hall element exceeds the operating point threshold, B_{OP}. When the magnetic field is reduced below the release point, B_{RP}, the device IDD is I_High. The difference in the magnetic operation 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.

11.1. Field Direction Definition

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

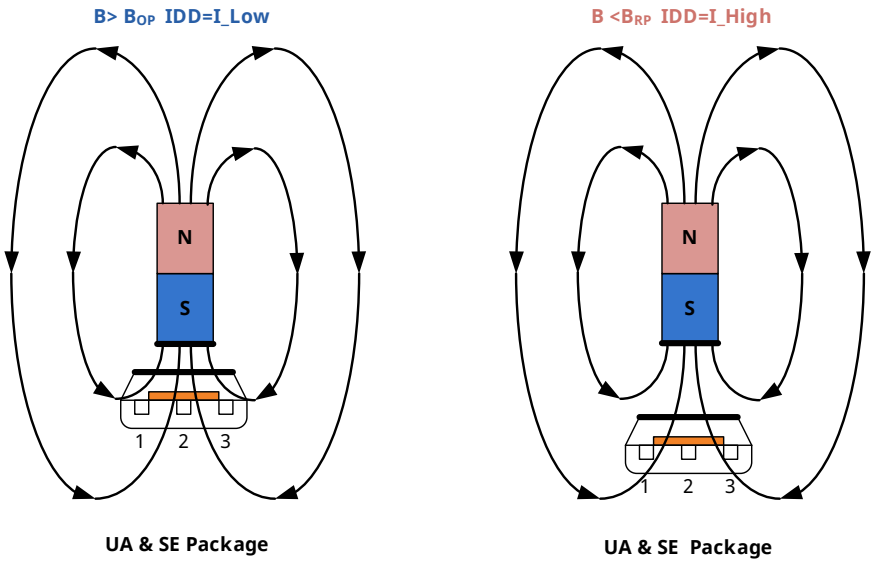


Fig.5: Magnetic Field Direction Definition

11.2. Transfer Function

Powering-on the device in the hysteresis region, less than BOP and higher than B_{RP}, allows an indeterminate output state. The correct state is attained after the first excursion beyond BOP or B_{RP}. If the field strength is greater than B_{OP}, then the IDD is I_Low. If the field strength is less than BRP, the IDD is I_High.

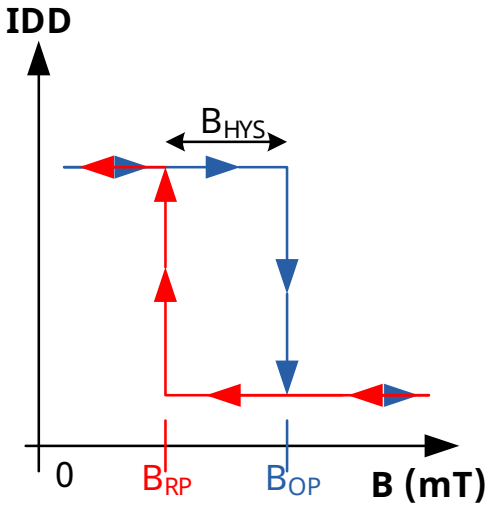


Fig.6: Transfer Function Diagram

12. Typical Application

It is strongly recommended that an external bypass capacitor, C_{BYP}, be connected (in close proximity to the Hall sensor) between the supply and ground of the device to guarantee correct performance under harsh environmental conditions and to reduce noise from internal circuitry (UA &SE Package). As is shown in Figure Below, a 0.01 μF capacitor is typical. Use of a larger bypass capacitor may result in a slower output slew rate and should be evaluated according to the requirements set forth by the application. Additionally, an optional output load capacitor may be added in parallel with the sense resistor for increased signal filtering and EMC immunity.

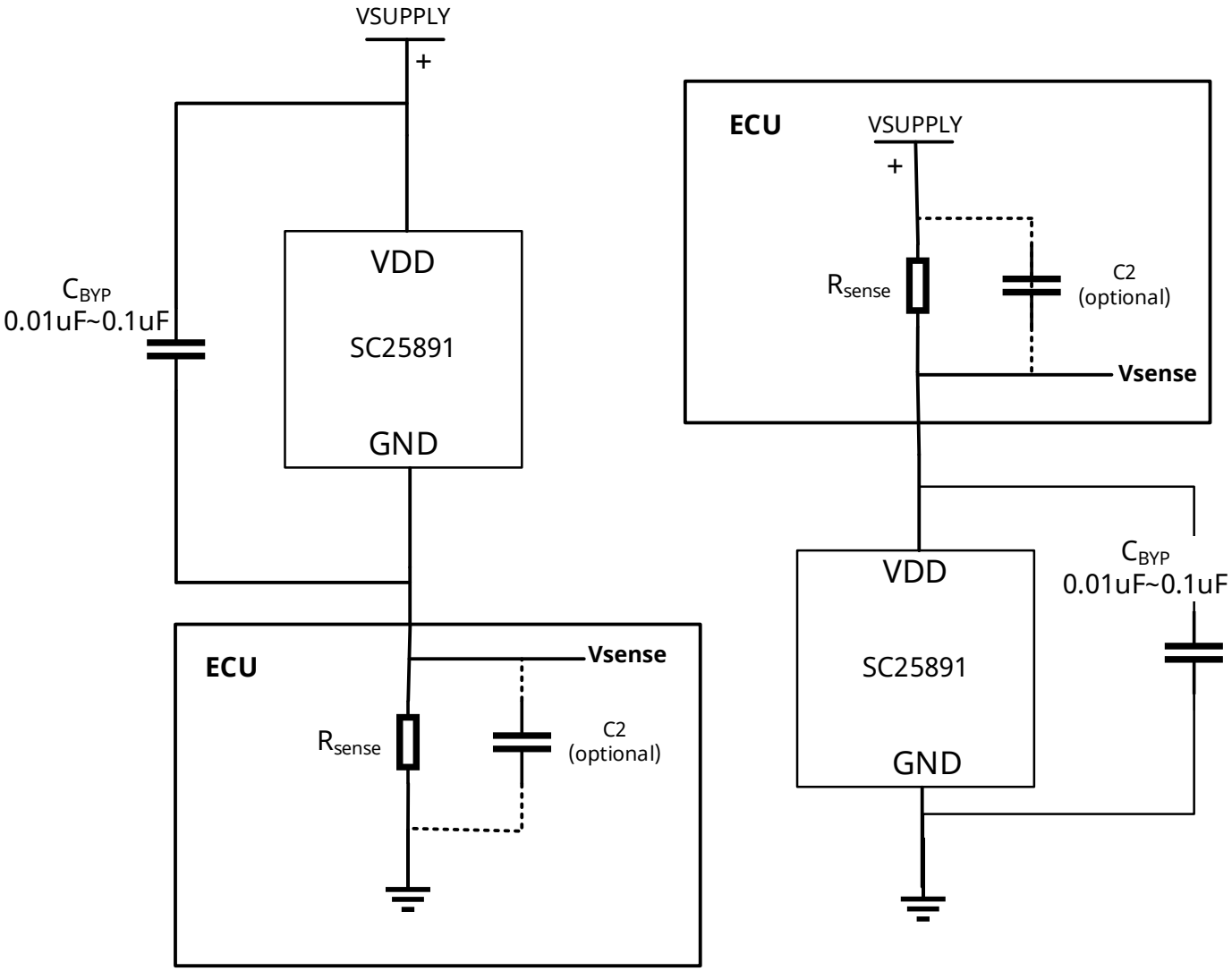


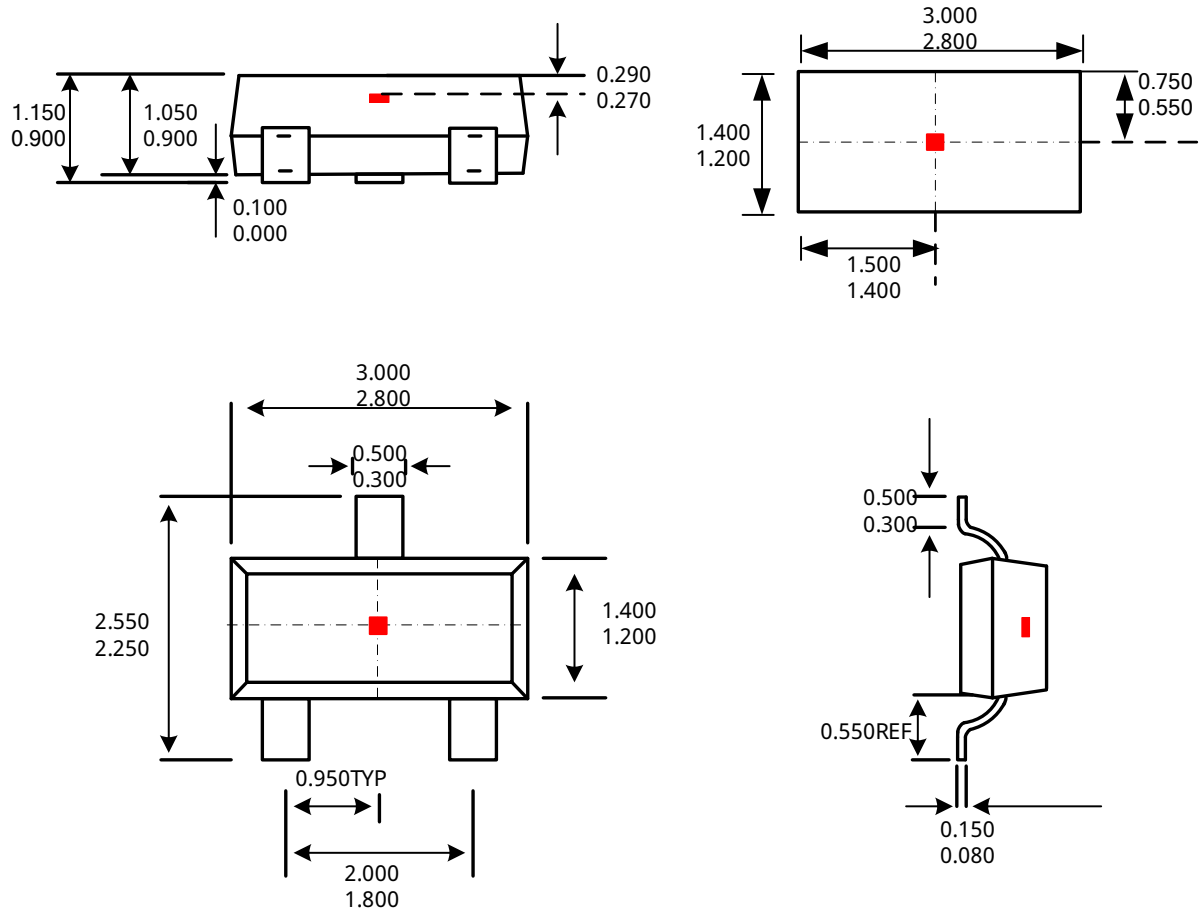
Fig.7: Typical Application

13. Package Information

13.1. Package Information “SE”

3-PIN
SE Package

Unit:mm

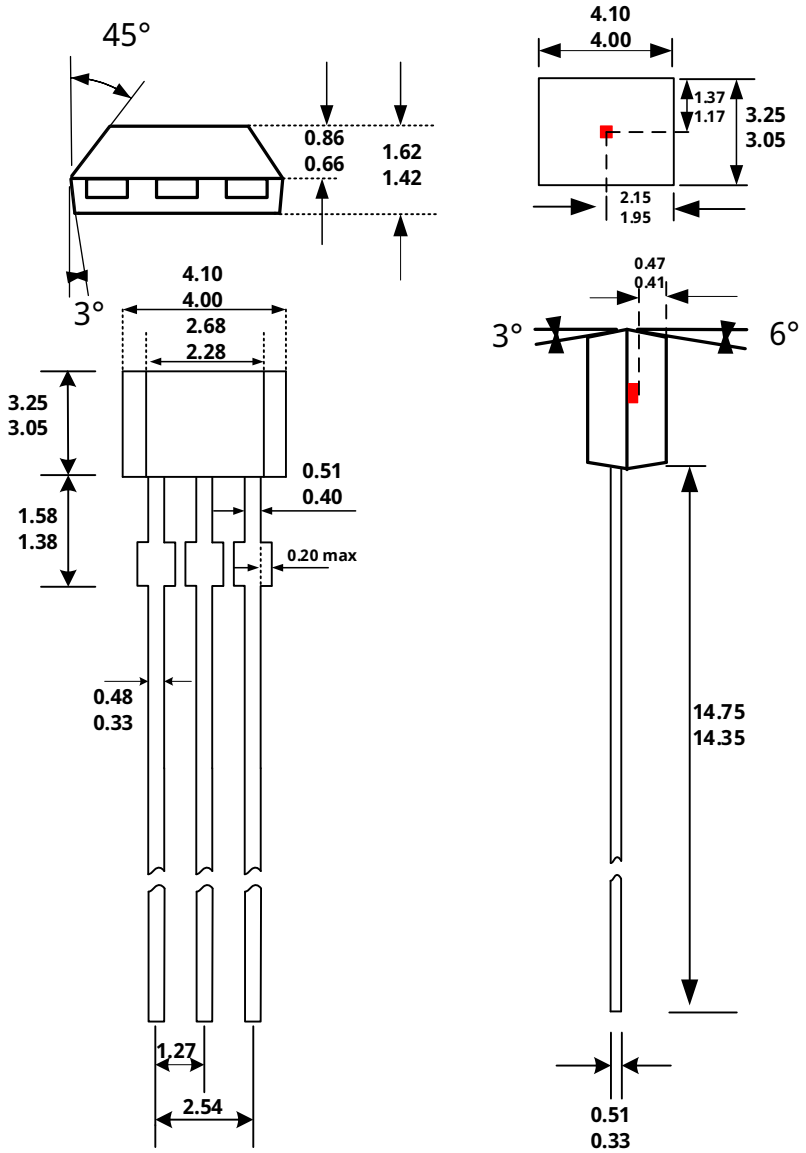


Notes:
1.Exact body and lead configuration at vendor’s option within limits shown.
2.Height does not include mold gate flash.
3.Red mark is Hall element
Where no tolerance is specified, dimension is nominal.

13.2. Package Information "UA"

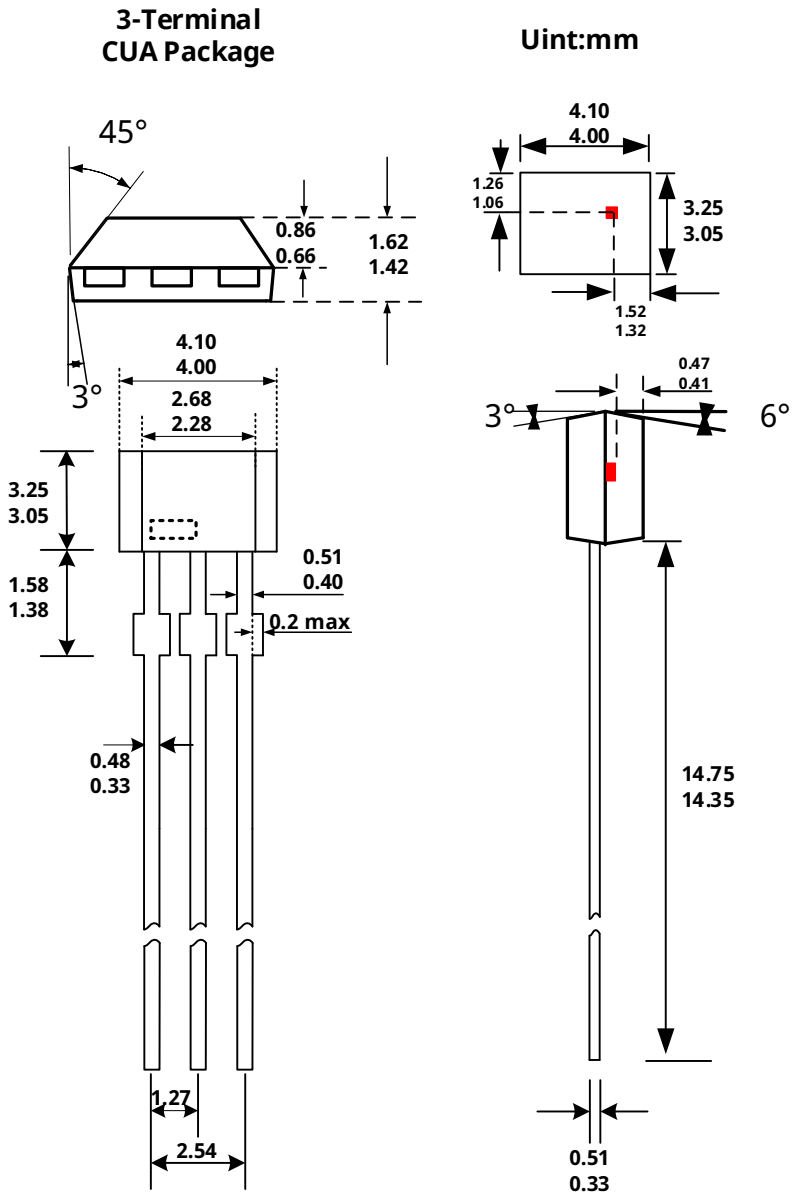
3-Terminal
UA Package

Uint: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.

13.3. Package Information "CUA"



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.

14. Revision History

Revision	Date	Description
Rev 0.1	2022-9-08	Preliminary datasheet
Rev 0.2	2022-12-5	Preliminary datasheet update
Rev 0.3	2023-01-06	Publish datasheet update
Rev E1.0	2023-04-10	Unified datasheet format
Rev E1.1	2023-06-27	Update VCC de-rating curve
Rev E1.2	2023-07-03	Add TO-92S Package
Rev E1.3	2023-11-24	Add CUA TO-92S Package
Rev A1.0	2023-11-28	Update POD data and formal version release
Rev A1.1	2025-02-08	Update POD data and formal version release