High-Precision, High-Bandwidth, Programmable Linear Hall Sensor

1. Features

- AEC-Q100 qualified
- Programmable High-Speed linear hall sensor IC
  - Quiescent output voltage
  - Sensitivity (0.6-14mV/Gs)
  - Quiescent voltage and sensitivity Temperature coefficients
- Response time as low as 3.7μs
- Bandwidth 120kHz
- Low noise
- Supply Under-Voltage lockout (UVLO), Output Short-Circuit protection
- Operating voltage range 4.5-5.5V
- Operating temperature range -40-150°C
- TO-94 package

2. Applications

- Brushless DC Motor (BLDC) current sensing
- Over-Current detection
- AC/DC converters
- Position detection

Not to scale

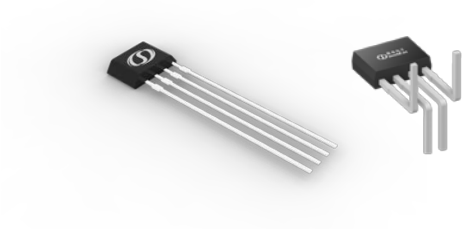

Fig.1 Package Outline

3. Description

The SC4643 is a programmable linear Hall sensor IC. It integrates an internal magnetic field sensing element, a three-stage variable gain low-noise amplifier, an output stage, a temperature sensor, quiescent output voltage compensation, sensitivity compensation, and an EEPROM control module. It senses the magnetic field perpendicular to the chip surface and converts it into a proportional output voltage (related to sensitivity), very suitable for current detection applications.

The Quiescent Output Voltage (output value at zero magnetic field) defaults to half the supply voltage. Based on application requirements, the quiescent voltage can be calibrated online via the supply and output pins. The sensitivity of the SC4643 is adjustable from 0.6-14 mV/Gs, adapt to the detection of currents of different ranges

The SC4643 integrates an internal temperature sensor module, allowing users to program the temperature coefficient to compensate for sensitivity variation over temperature. For compensating the magnet's temperature coefficient, enhances sensor accuracy.

The typical operating voltage is 5.0V, with an absolute maximum voltage rating of 15V. The operating temperature range supports -40°C to 150°C, meet the demanding requirements of automotive electronic environments.

The SC4643 is offered in TO-94 PKG with matte tin plating and halogen-free green mold compound, complying with environmental regulations.

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4. Terminal Configuration

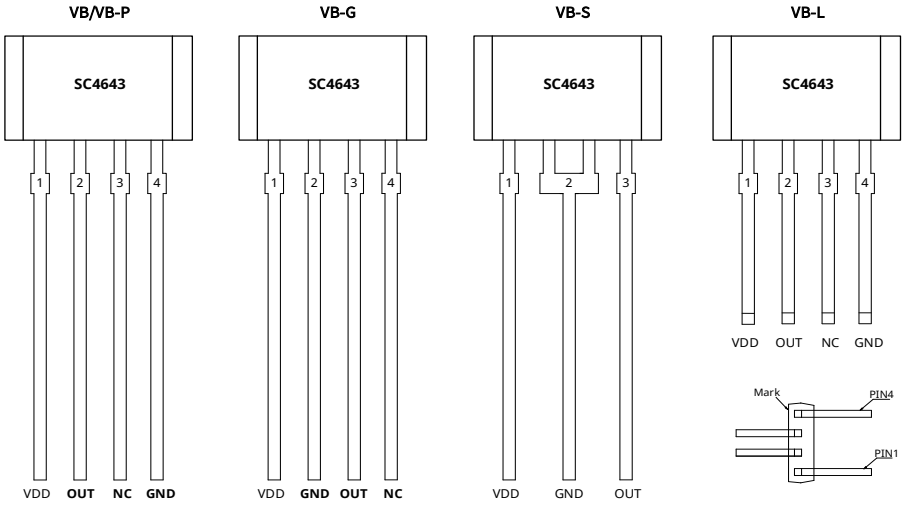


Fig.2 Pin Description

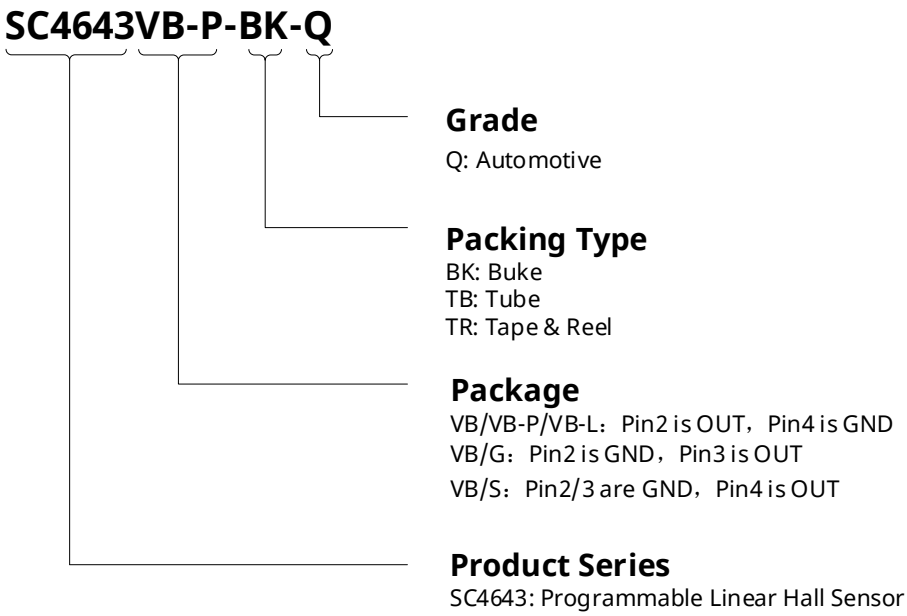
Name	Pin No.			Type	Description
	VB/VB-P/L	VB-G	VB-S		
VDD	1	1	1	Power	4.5V~5.5V power supply
OUT	2	3	3	Output	Output pin
NC	3	4	-	-	Recommended to connect to GND
GND	4	2	2	Ground	Ground

5. Ordering Information

Order Information	Sens(mV/Gs)	Operating Temp.(℃)	PKG	Packing	Quantity
SC4643VB-BK-Q(1)	0.6-14	-40-150	TO-94	Bulk	500 pcs/bag
SC4643VB-TR-Q	0.6-14	-40-150	TO-94	Tape & Reel	2000 pcs/reel
SC4643VB-P-BK-Q	0.6-14	-40-150	TO-94	Bulk	500 pcs/bag
SC4643VB-P-TR-Q	0.6-14	-40-150	TO-94	Tape & Reel	2000 pcs/reel
SC4643VB-G-BK-Q	0.6-14	-40-150	TO-94	Bulk	500 pcs/bag
SC4643VB-G-TR-Q	0.6-14	-40-150	TO-94	Tape & Reel	2000 pcs/reel
SC4643VB-S-BK-Q	0.6-14	-40-150	TO-94	Bulk	500 pcs/bag
SC4643VB-L-TB-Q	0.6-14	-40-150	TO-94	Tube	100 pcs/tube
SC4643VB-L-TR-Q	0.6-14	-40-150	TO-94	Tape & Reel	500 pcs/reel

Note: For special pin bending requirements, please contact the sales department.

Order information format description



6. Absolute Maximum Ratings

Symbol	Parameter	Comment	Min	Max	Unit
V_{DD}	Positive power supply voltage		-	15	V
V_{DDR}	Reverse power supply voltage		-15	-	V
V_{OUT}	Positive output voltage		-	15	V
V_{OUTR}	Reverse output voltage		-0.5	-	V
$I_{OUT(source)}$	Output source current		-	3	mA
$I_{OUT(sink)}$	Output sink current		-	10	mA
N	EEPROM erase/write cycles		-	100	cycle
T_A	Operating ambient temperature		-40	150	℃
T_{STG}	Storage temperature		-55	160	℃

Note：
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 conditions	Min.	Max.	Units
V_{ESD_HBM}	HBM	Refer to AECQ100-002 standard	-4	+4	kV
V_{ESD_CDM}	CDM	Refer to AECQ100-011 standard	-750	+750	V

8. Thermal Characteristics

Symbol	Parameter	Test conditions	Value(1)	Units
$R_{\theta JA}$	TO-94	Single-layer PCBS, JEDEC 1s0p are defined in JESD 51-3	177	℃/W

Note：

(1) The maximum operating voltage must meet the requirements of power consumption and junction temperature, refer to thermal characteristics

9. Operating Characteristics

(V_{DD}= 5V, T_A=25°C, C_{BY}=0.1μF, unless otherwise specified)

Valid over full temperature range unless noted in Test Conditions

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Power Supply Parameters						
V_{DD}	Supply voltage		4.5	5	5.5	V
I_{DD}	Supply current		10	13	16.5	mA
t_{PO}	Power-On time	C_{BYPASS}=Open, C_L=1nF, Sens= 2mV/G, B=400G	-	78	-	μs
V_{UVLOH}	Under-Voltage lockout threshold (Hysteresis)	V_{DD} rising	-	4	-	V
V_{UVLOL}		V_{DD} falling	-	3.6	-	V
V_{PORH}	Power-On reset threshold	V_{DD} rising	-	2.6	-	V
V_{PORL}		V_{DD} falling	-	2.3	-	V
V_Z	Zener diode breakdown voltage	I_{DD} = 30mA	15	-	-	V
Output Parameters						
$t_{RESPONSE}$	Response time	B_{step}=400G, C_L=1nF, Sens=2 mV/G	3	3.7	-	μs
V_N	Output noise	C_L=1nF, Sens=2 mV/G, B_{Wf}=B_{Wi}	-	10	-	mV_{p-p}
			-	1	-	mV_{RMS}
t_R	Rise time	B_{step}=400G, C_L=1nF, Sens=2 mV/G	-	3.6	-	μs
$V_{CLP(H)}$	Clamp voltage	$R_{L(DOWN)}$=10K to GND	4.5	4.7	4.85	V
$V_{CLP(L)}$		$R_{L(UP)}$=10K to VDD	0.15	0.3	0.45	V
$V_{SAT(H)}$	Saturation voltage	$R_{L(DOWN)}$=10K to GND	4.7	-	-	V
$V_{SAT(L)}$		$R_{L(UP)}$=10K to VDD	-	-	0.3	V
$R_{L(UP)}$	Output load resistance	V_{OUT} to VDD	4.7	-	-	kΩ
$R_{L(DOWN)}$		V_{OUT} to GND	4.7	-	-	kΩ
C_L	Output load capacitance	Sens=2 mV/G, C_L=1nF	-	1	10	nF
SR	Output slew rate	Sens=2 mV/G, C_L=1nF	-	400	-	V/ms
Quiescent Output Voltage $V_{OUT(Q)}$						
$V_{OUT(Q)init}$	Factory default V_{OUT}		2.4	2.5	2.6	V
$V_{OUT(Q)PR}$	$V_{OUT(Q)}$ programmable range		2.3	-	2.7	V
Q_{VO}	Programming resolution		-	9	-	bit
$Step_{VOUT(Q)}$	Programming step size		0.6	1.2	1.8	mV
Sens						
$Sens_{init}$	Factory default sensitivity	$SENS_{\_COARSE}$ =00	-	1	-	mV/Gs
		$SENS_{\_COARSE}$ =01	-	2	-	mV/Gs
		$SENS_{\_COARSE}$ =10	-	4.5	-	mV/Gs
		$SENS_{\_COARSE}$ =11	-	10	-	mV/Gs
$Sens_{PR}$	Sensitivity programmable range	$SENS_{\_COARSE}$ =00	0.6	-	1.6	mV/Gs
		$SENS_{\_COARSE}$ =01	1	-	3	mV/Gs
		$SENS_{\_COARSE}$ =10	2	-	7	mV/Gs
		$SENS_{\_COARSE}$ =11	4.5	-	14	mV/Gs
$SENS_{\_COARSE}$	Coarse sensitivity adjust bits		-	2	-	bit
$SENS_{\_FINE}$	Fine sensitivity adjust bits		-	9	-	bit
Sensitivity Temperature Drift						
TC_{SENS}	Sens temperature coefficient	T_A =-40℃ ~ 150℃, calculated relative to 25 °	-	0	-	%/℃
$\triangle Sens_{TC}$	Sensitivity variation over temperature	T_A =25℃ ~ 150 ℃	-2.5	-	2.5	%
		T_A =-40℃ ~ 25 ℃	-2.5	-	2.5	%
$R_{SENSETC}$	Sens temperature coefficient resolution		-	6	-	bit
$Step_{SENSTC}$	Avg. TC programming step size		-	-	0.3	%
Quiescent Voltage Temperature Drift						
TC_{QVO}	Temperature coefficient	T_A=-40℃ ~ 150℃, calculated relative to 25 ℃	-	0	-	mV/℃
$\Delta VOUT_{(Q)TC}$	Static output voltage range	T_A=25℃ ~ 150 ℃	-10	-	10	mV
		T_A=-40℃ ~ 25 ℃	-10	-	10	mV
	Temp. compensation resolution		-	30	-	bit
$Step_{QVOTC}$	Avg. TC Programming step size		-	1.2	-	mV

EEPROM Lock						
EELOCK	EEPROM lock bit		-	1	-	bit
Other Parameters						
Lin_{ERR}	Linearity error		-1	±0.2	1	%
Sym_{ERR}	Symmetry error		-1	±0.2	1	%
Rat_{ERRVQ}	VOUT(Q) error vs. supply voltage	Through supply voltage range	-1	0	1	%
$Rat_{ERRSens}$	Sens error vs supply voltage	Through supply voltage range	-1.5	±0.5	1.5	%
$\Delta Sens_{PKG}$	Package Effect on sensitivity	After temperature cycling	-1.25	0	1.25	%
BW	Band Width		-	120	-	kHz
f_C	Chopping frequency		-	500	-	kHz

10. Block Diagram

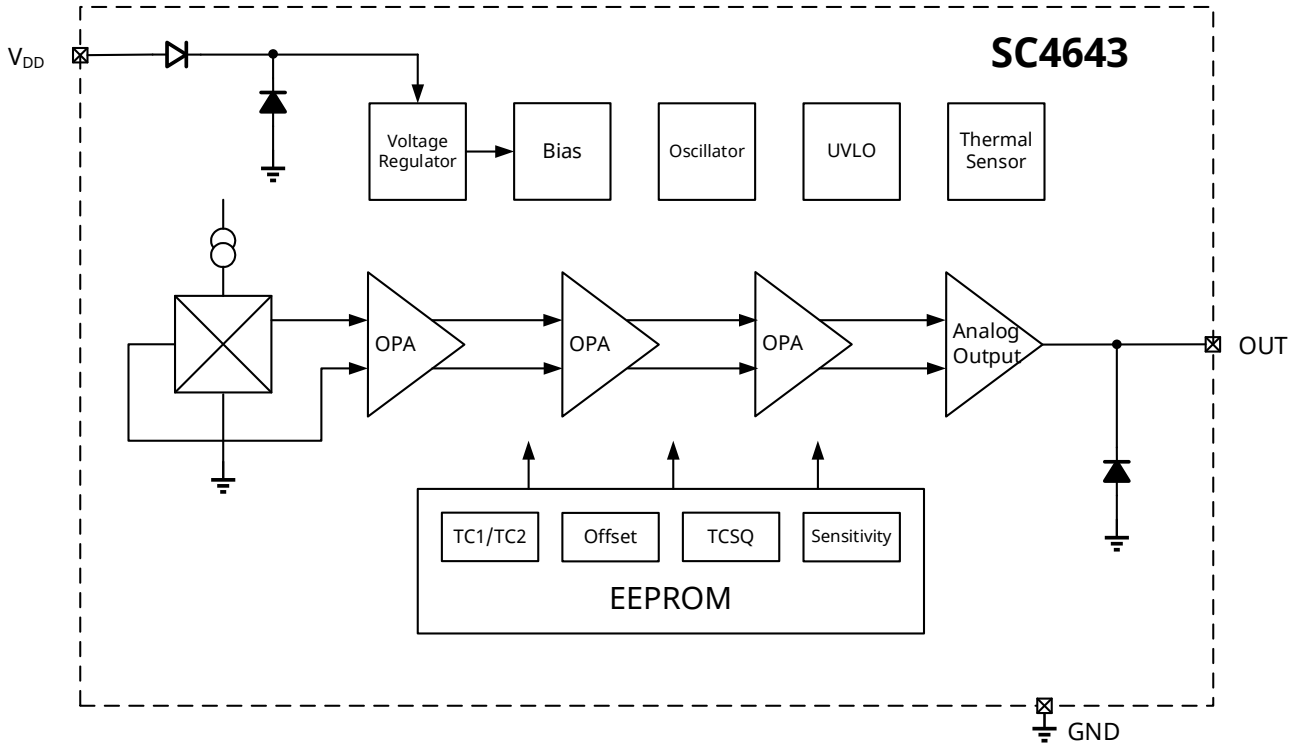


Fig.3 Block Diagram

11. Function Description

Quiescent Output Voltage (V_{OUTQ}): The Quiescent Output Voltage is the output voltage of the chip when no magnetic field is present (B=0Gs). Theoretically, the SC4643 output voltage equals VDD/2 under zero field conditions. However, due to offset voltages within the internal circuitry, sensitivity, package stress, and other factors, there is a deviation between the actual $V_{OUT(Q)}$ and this theoretical value. During production, $V_{OUT(Q)}$ is programmed to be within ±5mV of the theoretical value. $V_{OUT(Q)}$ has a temperature coefficient; it varies with temperature (more noticeably at higher sensitivities). The SC4643 incorporates an internal temperature sensor, enabling programming to compensate for the $V_{OUT(Q)}$ temperature coefficient.

Sensitivity(S)

$Sens = [VOUT(B1) - VOUT(B2)]/(B1 - B2)$

When a South (S) pole magnetic field perpendicular to the chip's printed side approaches, the output voltage increases proportionally until it reaches the supply voltage. Conversely, when a North (N) pole magnetic field perpendicular to the chip's printed side approaches, the output voltage decreases proportionally until it reaches the ground level. Sensitivity is defined as the ratio of the change in output voltage to the change in magnetic field strength, typically expressed in mV/Gs or mV/mT.

The chip's sensitivity is programmable online according to actual needs, within a range of 0.6 to 14 mV/Gs. Programming also allows adjustment of the sensitivity temperature coefficient (TC) to compensate for the inherent TC of the chip itself and the TC of different magnets or magnetic cores.

Power-On Time (t_{PO}): The Power-On Time is defined as: Under a specific magnetic field, the time between the input supply voltage reaching the minimum operating voltage value (4.5V) and the chip's output voltage reaching 90% of its target value.

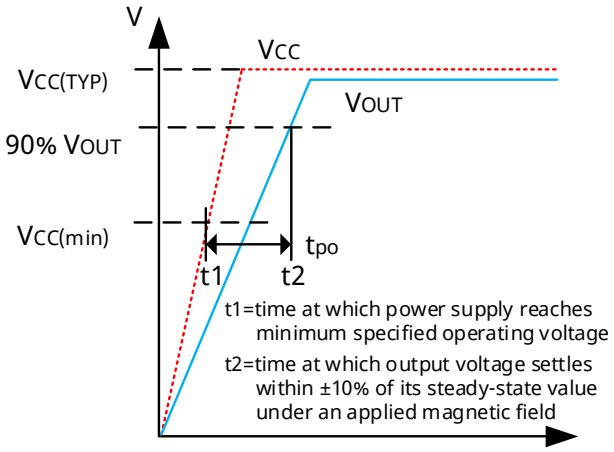


Fig.4 Power-On Time Definition

Response Time ($t_{RESPONSE}$): The time between the magnetic field reaching 80% of its target value and the chip's output reaching 80% of its target voltage. Response time depends on the chip's sensitivity (related to the measured current) and the output load capacitance.

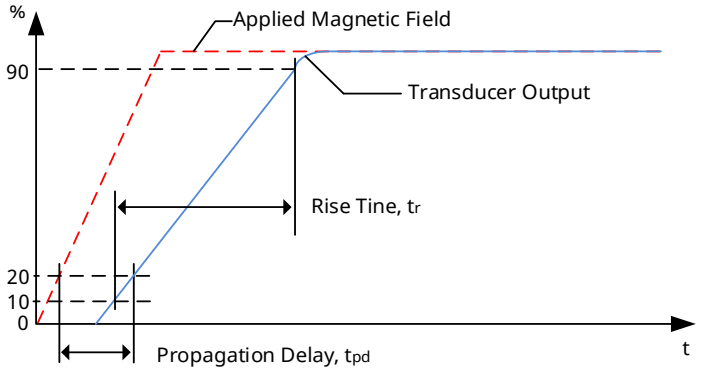


Fig.5 Propagation Delay and Rise Time Definition

12. Typical Application Circuit

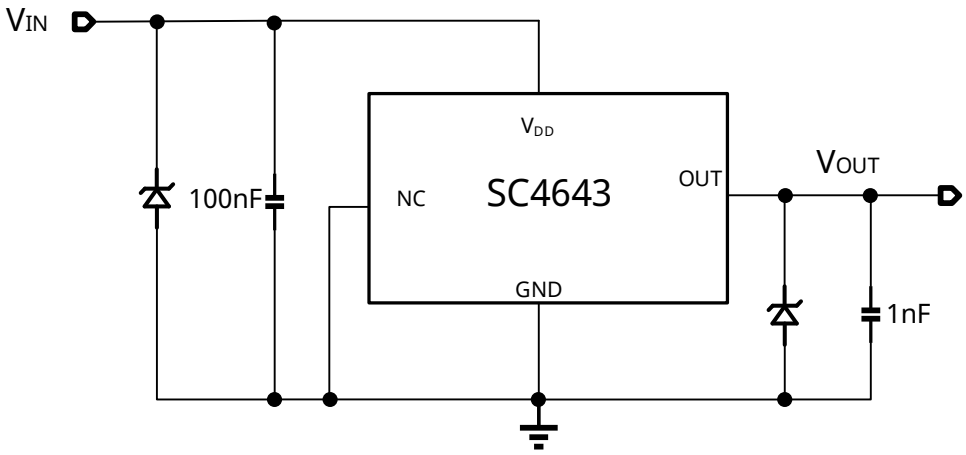


Fig.6 TO94 Typical Application Schematic

13. Transfer Function

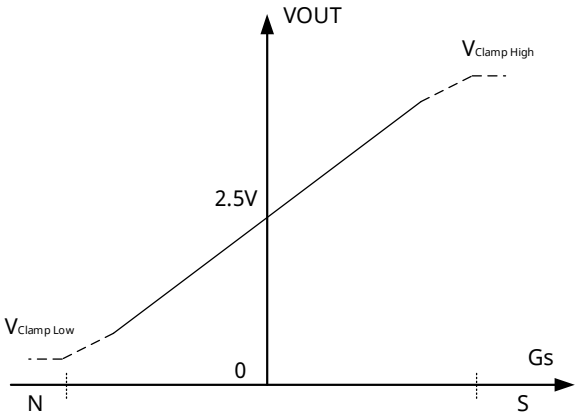
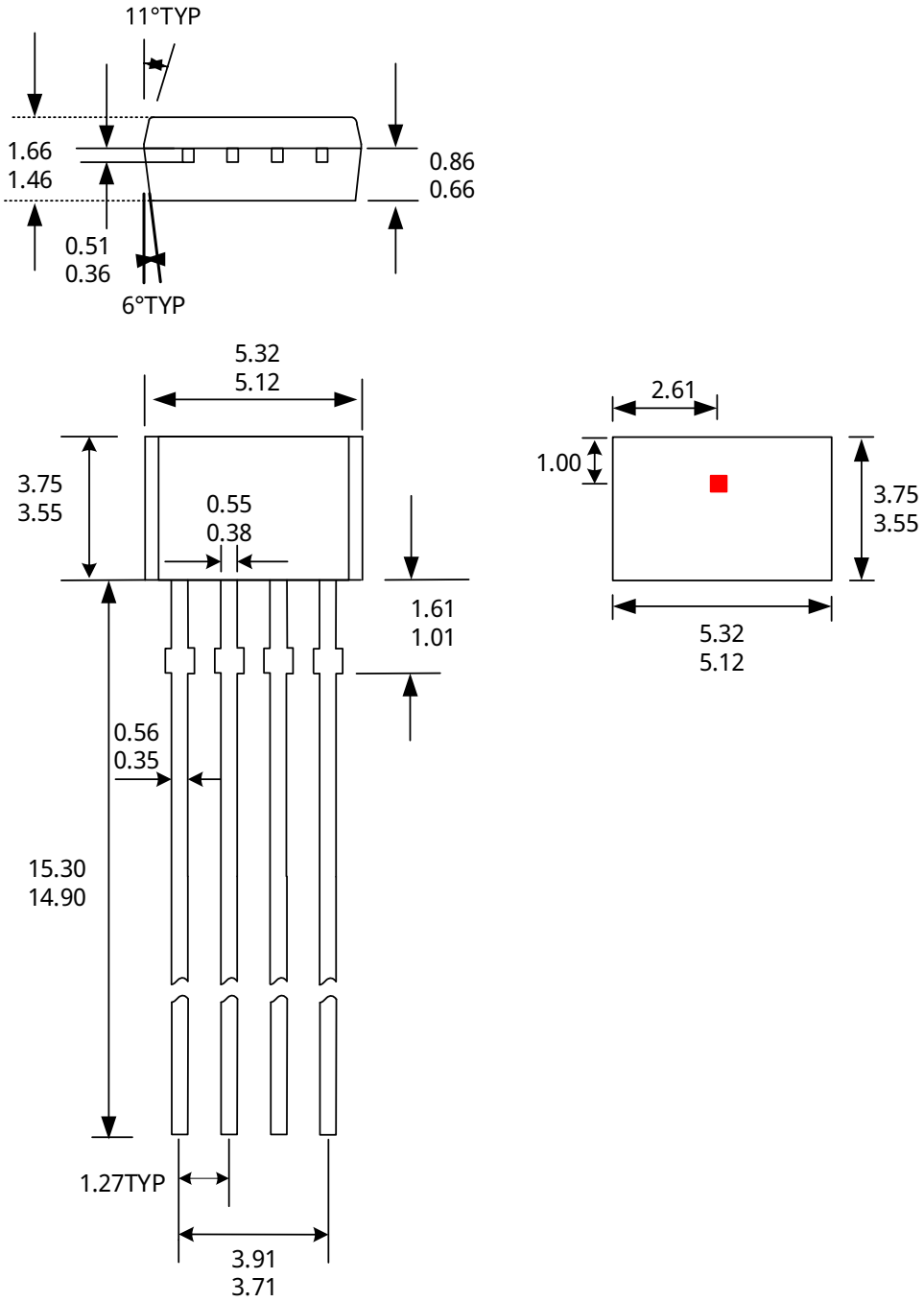


Fig.8 Transfer Function

14. Package Information TO-94(VB/VB-P/VB-G)

VB/VB-P/VB-G PKG

Unit: mm



Notes:

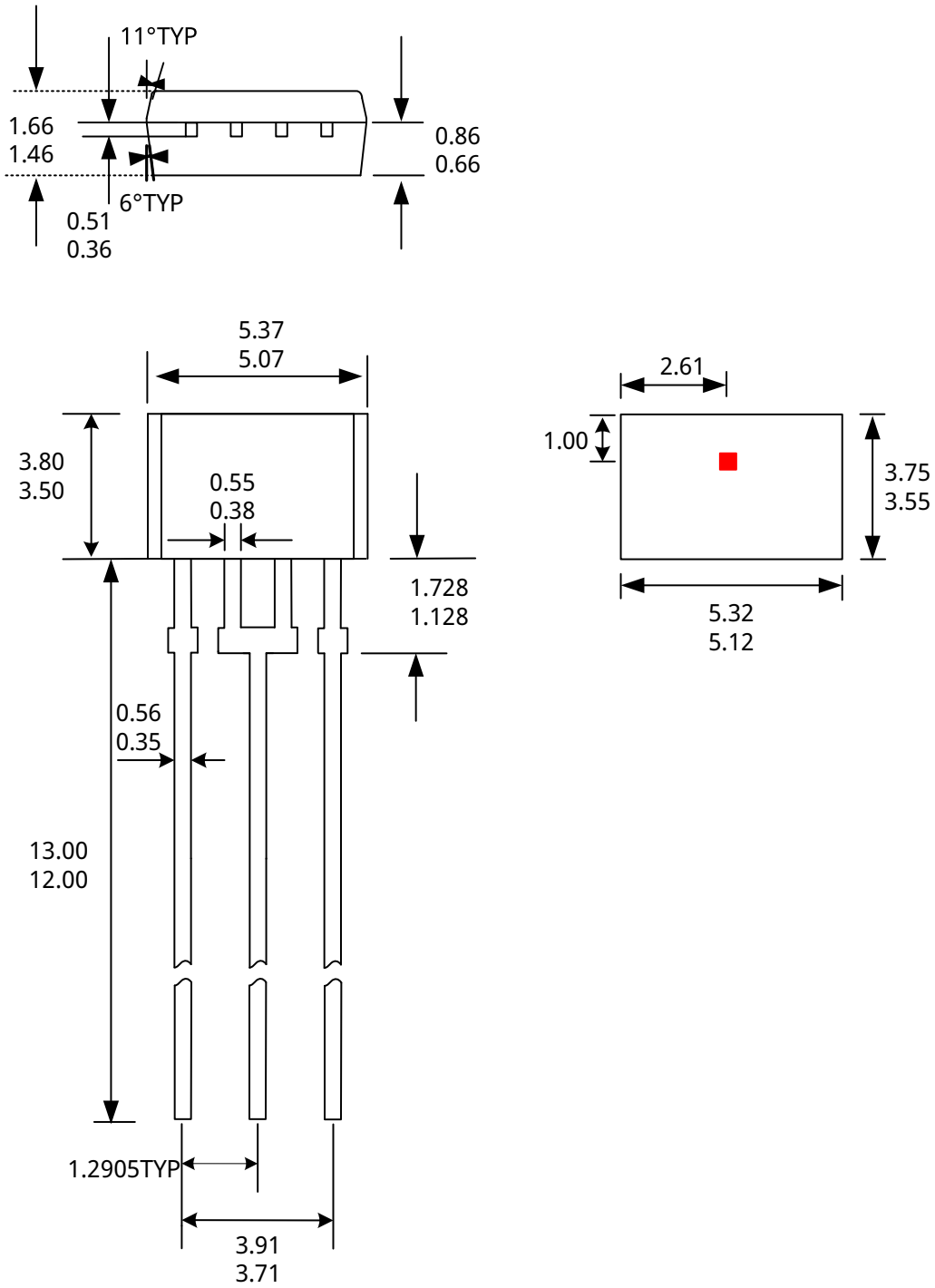
1. *Exact body and lead configuration at vendor's option within limits shown.*
2. *Height does not include mold gate flash.*

Where no tolerance is specified, dimension is nominal.

15. Package Information TO-94(VB-S)

VB-S PKG

Unit: mm



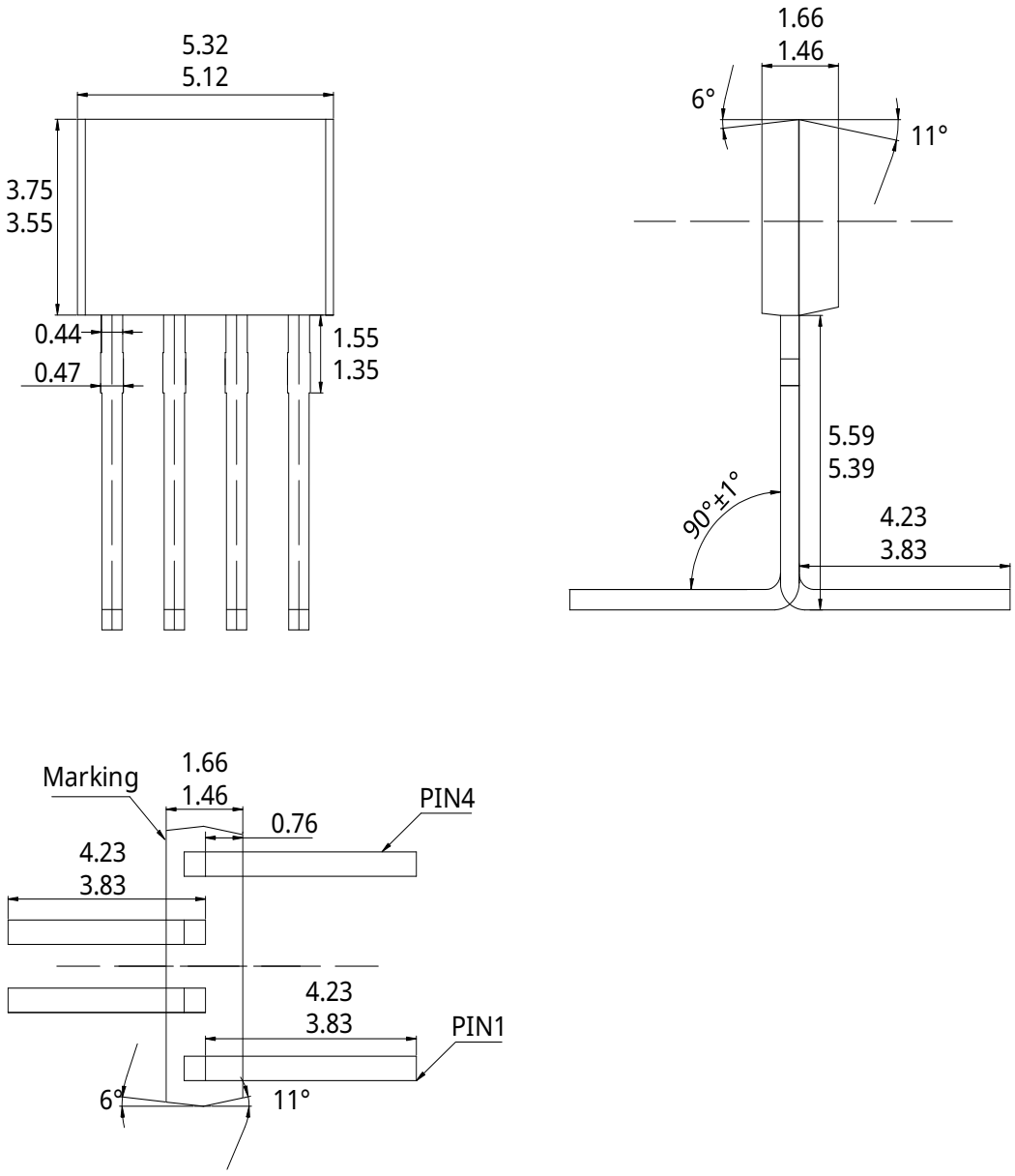
Notes:

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. Package Information TO94(VB-L)

VB-L PKG

Unit: 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.*

17. Revision History

Revision	Date	Description
Rev.E0.1	2018-06-15	Initial release
Rev.E0.2	2019-05-06	Enhanced product features
Rev.E0.3	2019-04-06	Final version number for old specification
Rev.A1.0	2020-11-19	Unified specification format
Rev.A1.1	2022-03-16	Modified package dimensions
Rev.A1.2	2022-06-20	Modified $V_{OUT(Q)PR}$, added Power-On timing diagram
Rev.A1.3	2023-04-10	Updated specification format, added AEC-Q100 certification, improved package drawings, enhanced functional description, removed Power-On timing diagram
Rev.A1.4	2023-09-20	Added product model SC4643VB-P
Rev.A1.5	2024-07-03	Added product models SC4643C & SC4643S, typical applications & packages
Rev.A1.6	2024-08-21	Added product model SC4643VB-G
Rev.A1.7	2025-02-20	Removed product model SC4643C, updated specification format
Rev.A1.8	2025-05-30	Added product model SC4643VB-L-TB-Q
Rev.A1.9	2025-07-30	Deleted TO-92U package outline

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