

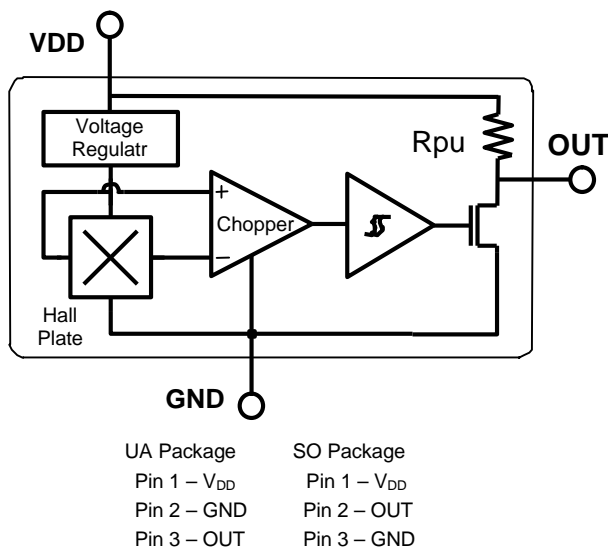
1 Features and Benefits

- Wide operating voltage range from 3.5V to 24V
- High magnetic sensitivity – Multi-purpose
- CMOS technology
- Chopper-stabilized amplifier stage
 - Superior temperature stability
 - Extremely low switchpoint dr
 - Insensitive to physical stress
- Low current consumption
- Output driver with internal pull-up resistor
- Tiny SOT23 3L and flat TO-92 3L
both RoHS Compliant packages

2 Application Examples

- Automotive, Consumer and Industrial
- Solid-state switch
- Brushless DC motor commutation
- Speed detection
- Linear position detection
- Angular position detection
- Proximity detection

3 Functional Block Diagram



4 General Discriptions

The HAL732 is a bipolar Hall effect sensor IC fabricated from mixed signal CMOS technology. The device integrates a voltage regulator, Hall sensor with dynamic offset cancellation system, Schmitt trigger and an output driver with internal pull-up resistor, all in a single package.

It incorporates advanced chopper stabilization techniques to provide accurate and stable magnetic switch points. There are many applications for this HED – Hall Electronic Device - in addition to those listed above. The design, specifications and performance have been optimized for commutation applications in 5V and 12V brushless DC motors

Thanks to its wide operating voltage range and extended choice of temperature range, it is quite suitable for use in automotive, industrial and consumer applications.

The device is delivered in a Small Outline Transistor (SOT) for surface mount process and in a Plastic Single In Line (TO-92 flat) for through-hole mount. Both 3-lead packages are RoHS compliant.

5 Ordering Information

Part No.	Temperature Code	Package Code
HAL732	E (-40℃ to 85℃)	SO (SOT-3L)
HAL732	E (-40℃ to 85℃)	UA (TO-92)
HAL732	L (-40℃ to 150℃)	SO (SOT-3L)
HAL732	L (-40℃ to 150℃)	UA (TO-92)

Table 1: Ordering Information

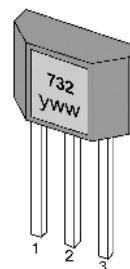
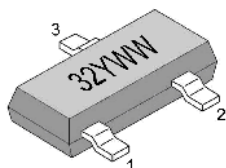
6 Glossary of Terms

MilliTesla (mT),	Gauss	Units of magnetic flux density: 1mT = 10 Gauss
RoHS	Restriction of Hazardous Substances	
SOT	Small Outline Transistor (SOT package)	– also referred with the package code “SO”
ESD	Electro-Static Discharge	
BLDC	Brush-Less Direct-Current	
Operating Point (B _{OP})	Magnetic flux density applied on the branded side of the package which turns the output driver ON (V _{OUT} = V _{DSon})	
Release Point (B _{RP})	Magnetic flux density applied on the branded side of the package which turns the output driver OFF (V _{OUT} = high)	

7 Pin Definitions and Descriptions

SE Pin	UA Pin	Name	Type	Function
1	1	VDD	Supply	Supply Voltage pin
2	3	OUT	Output	Open Drain Output pin
3	2	GND	Ground	Ground pin

Table 3: Pin definitions and descriptions



8 Detailed General Description

HAL732 exhibits latch magnetic switching characteristics. Therefore, it requires both south and north poles to operate properly.

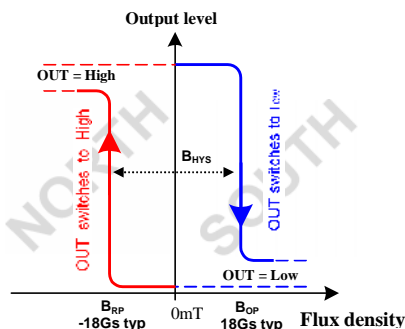
The OUT pin of these devices switches low (turns on) when a magnetic field perpendicular to the Hall sensor exceeds the operate point threshold, B_{OP} . After turn-on, the output voltage is V_{DSon} . Note that the device latches, that is, a south pole of sufficient strength towards the branded surface of the device turns the device on. The device remains on if the south pole is removed ($B = 0$). This latching property defines the device as a magnetic memory.

When the magnetic field is reduced below the release point, B_{RP} , the OUT pin turns off (goes high). The difference in the magnetic operate and release points is the hysteresis, B_{HYS} , of the device. This built-in hysteresis prevents output oscillation near the switching point, and allows clean switching of the output even in the presence of external mechanical vibration and electrical noise.

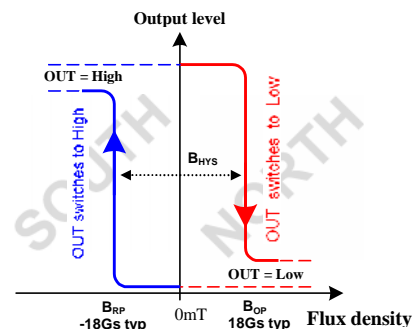
The device behaves as a latch with symmetric operating and release switching points ($B_{OP} = |B_{RP}|$). This means magnetic fields with equivalent strength and opposite direction drive the output high and low.

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} .

The SOT-23 device is reversed from the UA package. The SOT-23 output transistor will be latched on in the presence of a sufficiently strong North pole magnetic field applied to the marked face.



UA package - Latch characteristic



SO package - Latch characteristic

9 Unique Features

Based on mixed signal CMOS technology, HAL732 is a Hall-effect device with high magnetic sensitivity. This multi-purpose latch meets most of the application requirements.

The chopper-stabilized amplifier uses switched capacitor technique to suppress the offset generally observed with Hall sensors and amplifiers. The CMOS technology makes this advanced technique possible and contributes to smaller chip size and lower current consumption than bipolar technology. The small chip size is also an important factor to minimize the effect of physical stress. This combination results in more stable magnetic characteristics and enables faster and more precise design.

The wide operating voltage from 3.5V to 24V, low current consumption and large choice of operating

temperature range according to “L”, and “E” specification make this device suitable for automotive, industrial and consumer applications.

10 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Voltage	VDD	28	V
Supply Current	IDD	50	mA
Output Voltage	VOUT	28	V
Output Current	IOUT	50	mA
Storage Temperature Range	TS	-50 to 150	°C
Maximum Junction Temperature	TJ	165	°C

Table 2: Absolute maximum ratings

Operating Temperature Range	Symbol	Value	Units
Temperature Suffix “E”	TA	-40 to 85	°C
Temperature Suffix “L”	TA	-40 to 150	°C

Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

11 General Electrical Specifications

DC Operating Parameters $T_A = 25^\circ\text{C}$, $V_{DD} = 3.5\text{V to }24\text{V}$ (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Voltage	VDD	Operating	3.5		24	V
Supply Current	IDD	$B < B_{RP}$			5	mA
Output Saturation Voltage	VDSon	$IOUT = 20\text{mA}$, $B > B_{OP}$			0.5	V
Output Leakage Current	IOFF	$B < B_{RP}$ $VOUT = 24\text{V}$		1	10	μA
Output Rise Time	tr	$RL = 1\text{k}\Omega$, $CL = 20\text{pF}$		0.25		μs
Output Fall Time	tf	$RL = 1\text{k}\Omega$, $CL = 20\text{pF}$		0.25		μs
Internal pull-up resistor	Rpu	---	9	12	15	$\text{k}\Omega$
Maximum Switching Frequency	FSW	---		10		KHz
Package Thermal Resistance	RTH	Single layer (1S) Jedec board		301		°C/W

Table 4: Electrical specifications

Note:The output of HAL732 will be switched after the supply voltage is over 2.2V, but the magnetic characteristics won't be normal until the supply is over 3.5V.

12 Magnetic Specifications

DC Operating Parameters $V_{DD} = 5V$

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Point	B_{OP}	E spec., $T_A = 85^{\circ}C$	10	18	30	G
Release Point	B_{RP}		-30	-18	-10	G
Hysteresis	B_{HYS}		30	36	45	G
Operating Point	B_{OP}	L spec., $T_A = 150^{\circ}C$	5	18	40	G
Release Point	B_{RP}		-40	-18	-5	G
Hysteresis	B_{HYS}		20	36	50	G

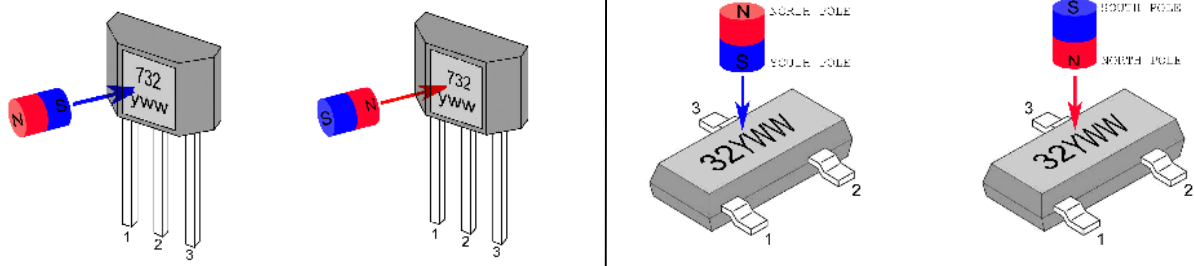
Table 5: Magnetic specifications

13 Output Behaviour versus Magnetic Pole

DC Operating Parameters $T_A = -40^{\circ}C$ to $150^{\circ}C$, $V_{DD} = 3.5V$ to $24V$ (unless otherwise specified)

Parameter	Test Conditions (SO)	OUT (SO)	Test Conditions (UA)	OUT (UA)
South pole	$B < B_{RP}$	High	$B > B_{OP}$	Low
North pole	$B > B_{OP}$	Low	$B < B_{RP}$	High

Table 6: Output behaviour versus magnetic pole



14 Application Information

It is strongly recommended that an external bypass capacitor be connected (in close proximity to the Hall sensor) between the supply (V_{DD} Pin) and ground (GND Pin) of the device to reduce both external noise and noise generated by the chopper stabilization technique. As is shown in the two figures in next page, a $0.1\mu F$ capacitor is typical.

For reverse voltage protection, it is recommended to connect a resistor or a diode in series with the V_{DD} pin. When using a resistor, three points are important:

- the resistor has to limit the reverse current to 50mA maximum ($V_{CC} / R1 \leq 50mA$)
- the resulting device supply voltage V_{DD} has to be higher than V_{DD} min ($V_{DD} = V_{CC} - R1 \cdot I_{DD}$)

- the resistor has to withstand the power dissipated in reverse voltage condition ($P_D = V_{CC}^2/R1$)

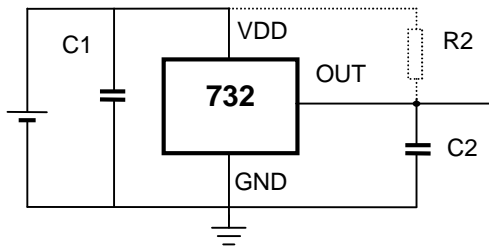
When using a diode, a reverse current cannot flow and the voltage drop is almost constant (0.7V).

Therefore, a 100 Ω /0.25W resistor for 5V application and a diode for higher supply voltage are recommended. Both solutions provide the required reverse voltage protection.

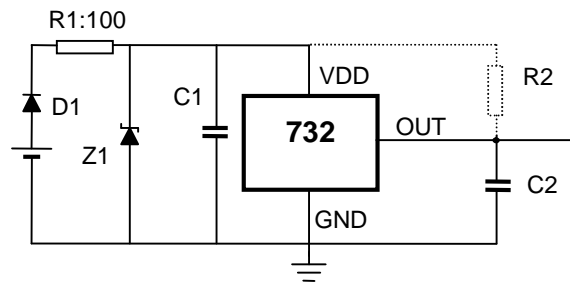
When a weak power supply is used or when the device is intended to be used in noisy environment, it is recommended that figure 13.3 from the Application Information section is used.

The low-pass filter formed by R1 and C1 and the zener diode Z1 bypass the disturbances or voltage spikes occurring on the device supply voltage VDD. The diode D1 provides additional reverse voltage protection.

Typical Three-Wire Application Circuit



Automotive and Severe Environment Protection Circuit



HAL732 have been optimized for commutation applications in 5V and 12V brushless DC motors. The follow figure is the typical application circuit for 3 phase brushless DC motors.

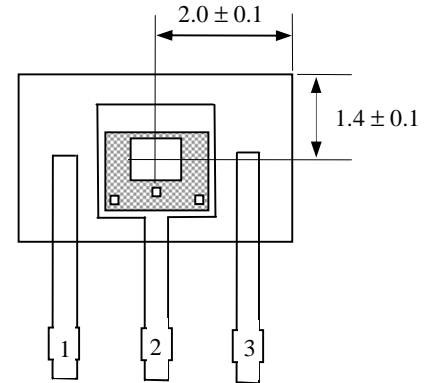
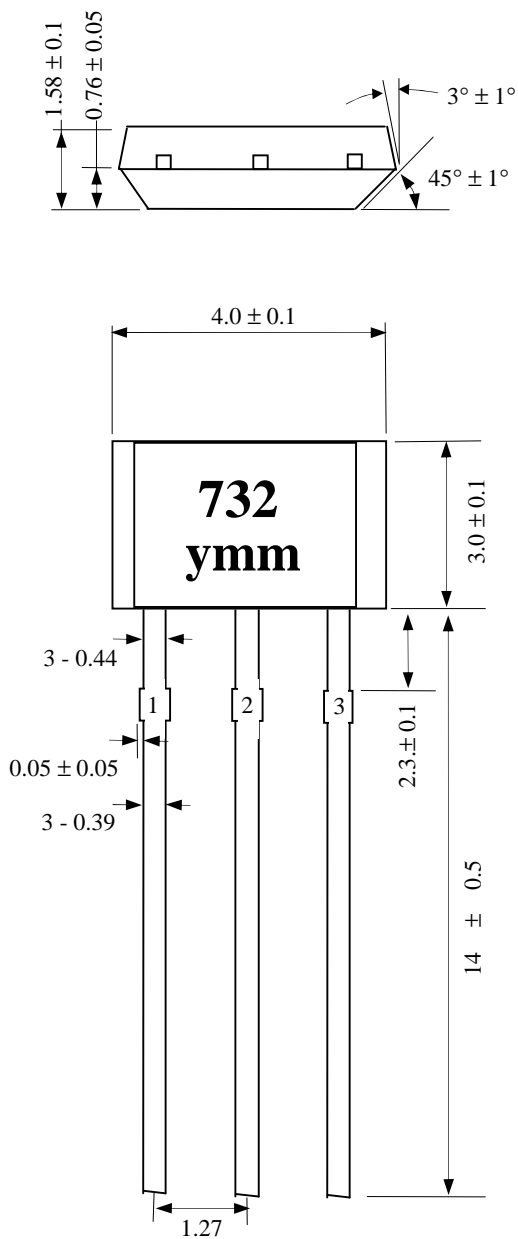
15 ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).

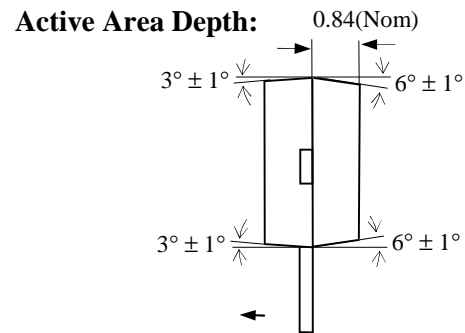
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

16 Package Information

16.1 UA Package (TO-92 flat)



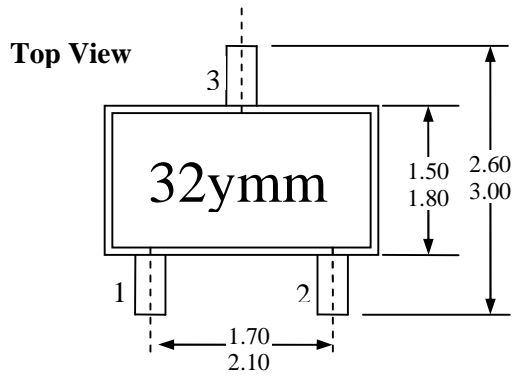
Hall plate Location



Notes:

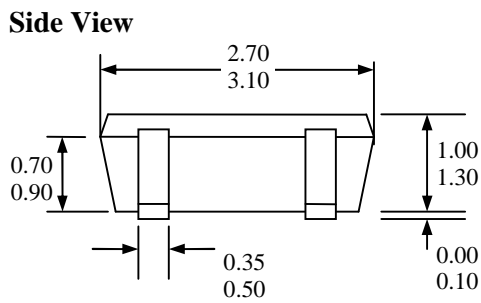
- 1). Controlling dimension : mm ;
- 2). Lesds must be free of flash and plating voids ;
- 3). Do not bend leads within 1 mm of lead to package interface ;
- 4). PINOUT: Pin 1 VDD
Pin 2 GND
Pin 3 Output

16.2 SO Package (SOT-3L)

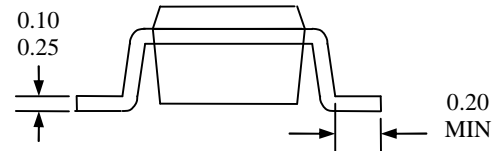


Notes:

- 1). PINOUT: Pin 1 VDD
Pin 2 Output
Pin 3 GND
- 2). All dimensions are in millimeters ;



End View



Hall plate location

