Data Sheet

Hall effect devices

Hall effect ic switch (RS stock no. 307-446)

A miniature semi-conductor proximity switch utilising the Hall effect to give 'bounce-free' switching when influenced by a magnetic field. A magnet is supplied which allows switching at distances of typically 2 mm. This may be increased if the Hall effect ic is mounted against a ferromagnetic surface. The device is magnetically unidirectional requiring the marked south pole of the magnet to face away from the magnetic centre indicated by the dimple, or alternatively the magnet may be positioned on the other side of the ic but in this instance the marked face of magnet should be towards the ic. Ideal for use in logic circuits where 'bounce free' switching is necessary.

The device will typically operate up to a 100 kHz repetition rate.

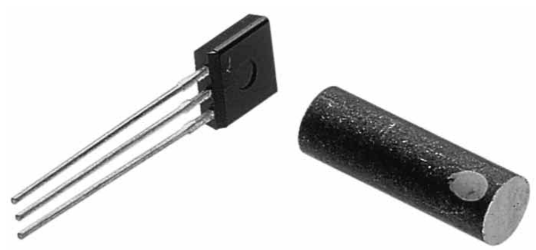
The circuit output can be interfaced directly with bipolar or MOS logic circuits.

Absolute maximum ratings

Power supply, V_{CC} ____ 25V
Magnetic flux density, B ____ Unlimited
Output 'OFF' voltage, $V_{OUT(OFF)}$ ____ 25V
Output 'ON' current, I_{SINK} ____ 50mA
Storage temperature range, T_S ____ -65°C to +150°C
Operating temperature range, T_A ____ 0°C to +70°C

Features

- Operates from 4.5V to 24Vdc power source
- Supplied complete with permanent magnet
- High reliability - eliminates contact wear, contact bounce; no moving parts
- Small size
- Constant amplitude output
- Output compatible with all logic families.

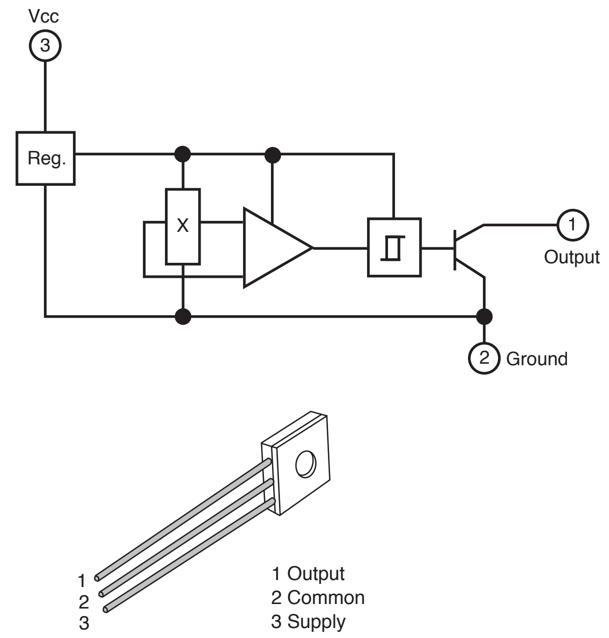


Electrical characteristics V_{CC} = 4.5V to 24Vdc, T_A = 25°C

Characteristic	Symbol	Test conditions	Limits			
			Min.	Typ.	Max.	Units
Magnetic flux density						
'Operate point'	B_{OP}		-	220	350	Gauss
'Release point'	B_{RP}		50	165	-	Gauss
Hysteresis	B_H		20	55	-	Gauss
Output saturation voltage	V_{SAT}	B⩾350 Gauss, I_{SINK} = 15 mA	-	85	400	mV
Output leakage current	I_{OFF}	B⩾50 Gauss, V_{OUT} = 24 V	-	0.1	20	μA
Supply current	I_{CC}	V_{CC} = 4.5 V, output open	-	5	9	mA
		V_{CC} = 24 V, output open	-	6	14	mA
Output rise time	t_r	V_{CC} = 12V, R_L = 820Ω, C_L = 20pF	-	15	-	ns
Output fall time	t_f	V_{CC} = 12 V, R_L = 820Ω, C_L = 20pF	-	100	-	ns

Note: 10 Gauss = 1 milliTesla (1mT).

Figure 1 **Functional block diagram**

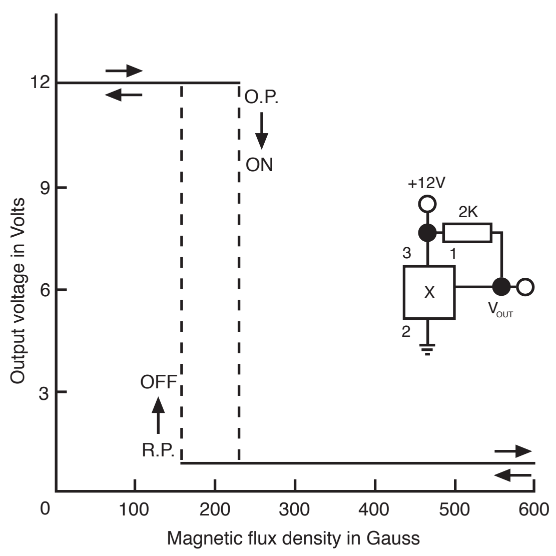


Operation

The output transistor is normally 'off' when the magnetic field perpendicular to the surface of the chip is below the threshold or 'operate point'. When the field exceeds the 'operate point', the output transistor switches 'on' and is capable of sinking 20mA of current.

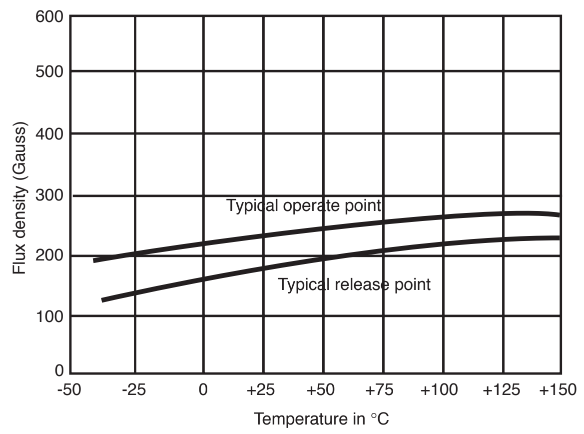
The output transistor switches 'off' when the magnetic field is reduced below the 'release point' which is less than the 'operate point'. This is illustrated graphically in the transfer characteristics curve (Figure 2). The hysteresis characteristic provides for unambiguous or non-oscillatory switching.

Figure 2 **Transfer characteristics showing hysteresis**



Switching point variations with temperature should be considered in applications covering a wide temperature range (Figure 3).

Figure 3 **Switching point variation with temperature**



Typical applications

Figure 4

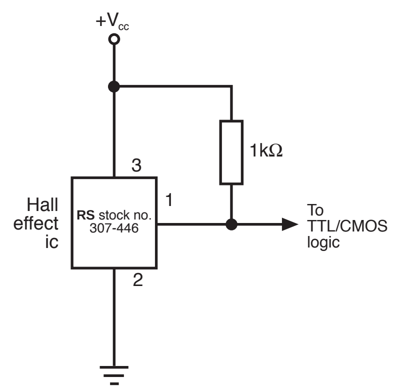
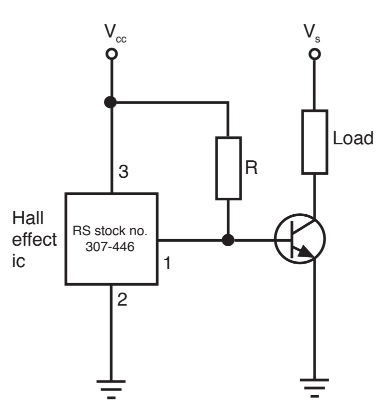


Figure 5



Hall effect vane switch
RS stock nos. 309-492 and 178-5689

Hall Effect sensor and magnet housed in PCB or leadwire packages detect the presence of a ferrous metal vane passing through the gap between sensor and magnet to produce a 'Bounce Fee' switched output. The devices which operate from 5Vdc,

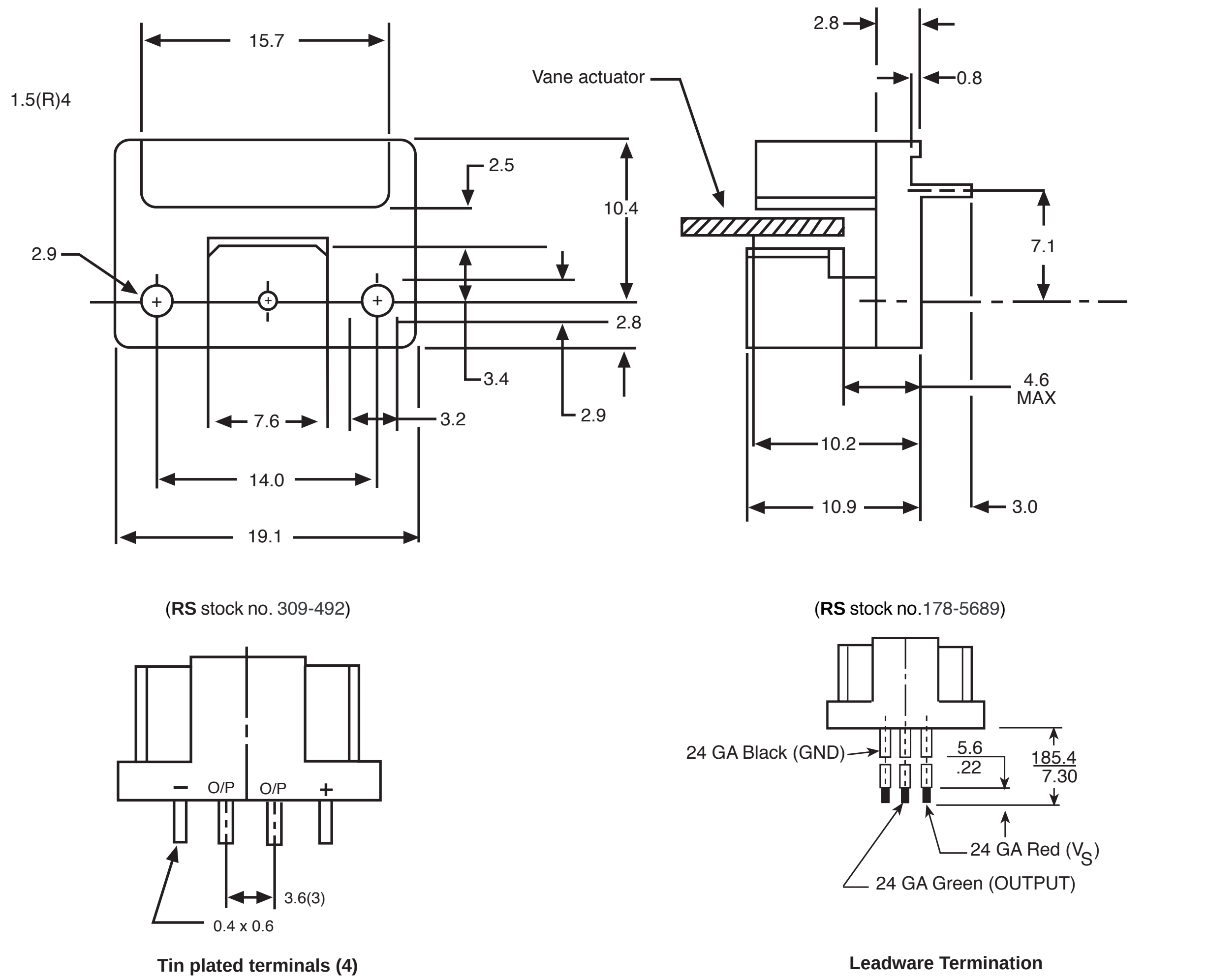
(**RS** stock no. 309-492) and 6-24Vdc (**RS** stock no.

178-5689) feature two independent TTL compatible outputs capable of sinking up to 4mA each or 8mA combined (**RS** stock no. 309-492) and 20mA (**RS** stock no. 178-5689).

Electrical specification

	PC Board (**RS** stock no. 309-492)	Leadwire (**RS** stock no. 178-5689)
Supply voltage:	4.5 - 5.5	6 - 24
Supply currrent:	7mA (max.)	13mA (max.)
Output voltage: (each output)	0.4V (sinking 4mA)	0.4V (sinking 4mA)
Output leakage current:	10μA (max.)	10μA (max.)
Switching time: rise	2.0μs (max.)	2.0μs(max.)
fall	1.0μs (max.)	1.0μs (max.)
Operating temperature	-40°C to +85°C	-40°C to +85°C

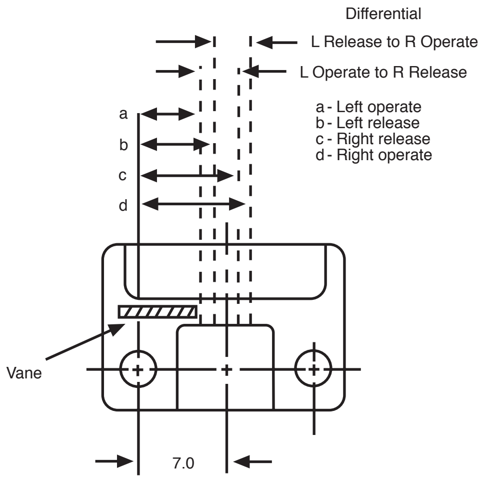
Figure 6 **Dimensions**



Actuation details

With no vane in gap, output is operated (conducting).
With vane in gap, output is released (non-conducting).

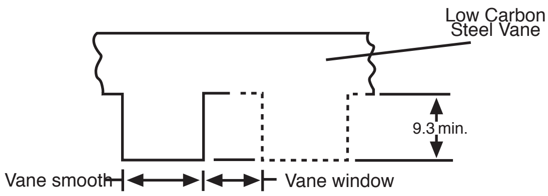
Figure 7 **Actuation details**



From left to right				
Left		Right		
a	b	d	c	Diff.
5.36	6.07	8.61	7.90	0.71

Vane dimensions

Thickness	Min. window	Min. tooth
1.0	10.2	10.2
1.6	10.2	6.3



Typical applications

Figure 8 **Basic circuit**

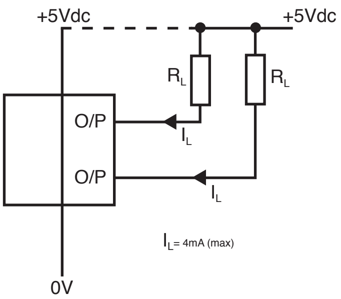


Figure 9 **Driving TTL**

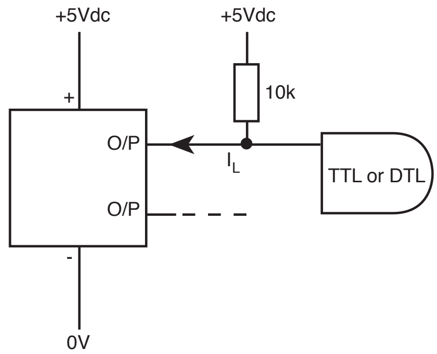


Figure 10 **Increased output**

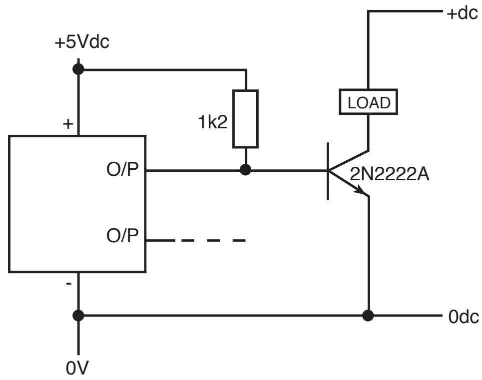
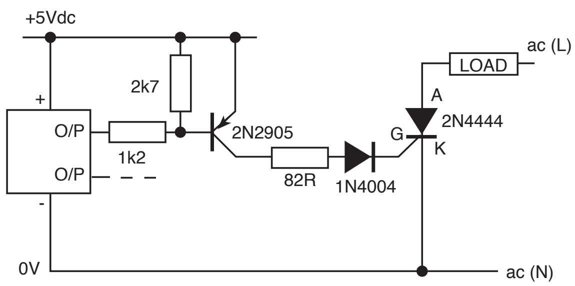


Figure 11 **Thyristor drive**



Linear Hall effect ic (RS stock no. 304-267)

A miniature linear output Hall effect sensor in a moulded 4-pin dil plastic package. This device features a differential output stage. One output increases linearly in voltage whilst the other decreases for a linear increase in magnetic flux density over a ±40mT range.

Typical applications for this versatile ic include magnetic field investigation in the vicinity of transformers and cables, current sensors with high isolation, linear feedback elements in analogue control systems, etc. The sensor is immune from damage by high values of flux density.

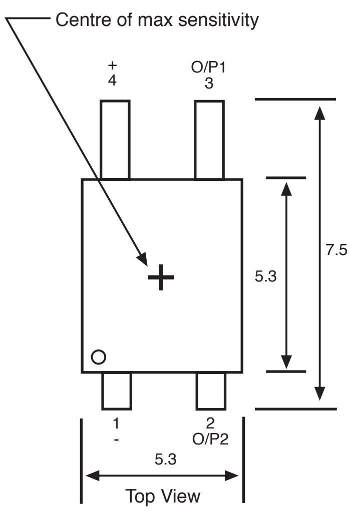
Absolute maximum ratings

Supply voltage ____ +12Vdc
Output current ____ 20mA
Operating frequency ____ 100kHz
Operating temperature ____ 40°C to +100°C
Storage temperature ____ -55°C to +150°C

Electrical characteristics

Supply voltage (Vdc)	Supply current (mA)	Output type	Output voltage	Sensitivity
4 to 10	3.5 typ.	Differential outputs, linear	1.75 to 2.25V at 5V & 0 Gauss	(-400 to +400 Gauss 0.75 to 1.06m V/Gauss

Figure 12 **Dimensions**



Typical linear output characteristics

The linear Hall effect ic features differential outputs. One output increases, whilst the other output decreases with an increase in Gauss.

Figure 13 **Typical output characteristics as a function of supply voltage**

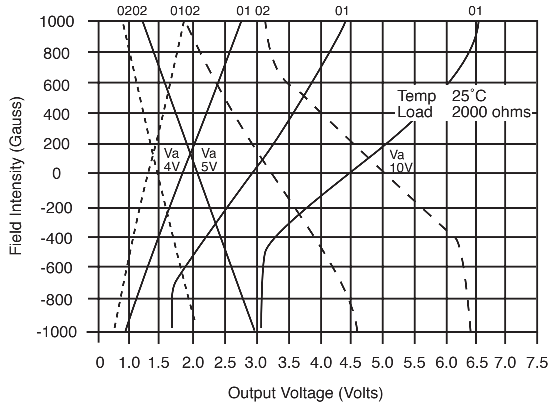
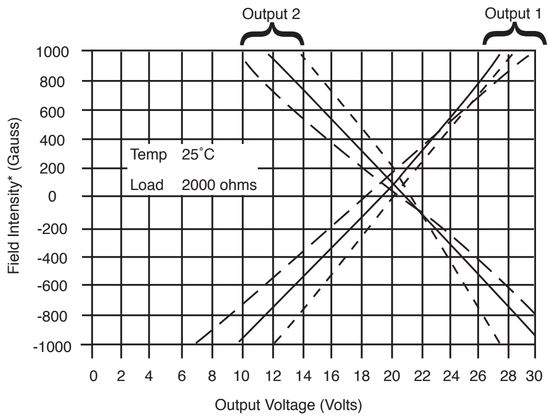


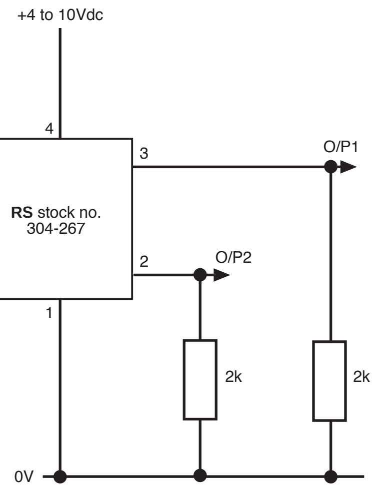
Figure 14 **Typical output characteristics as a function of temperature**



*Positive Gauss represents the south pole of the magnet facing the sensing area. Negative Gauss represents the north pole of the magnet facing the sensing area.

Typical application

Figure 15



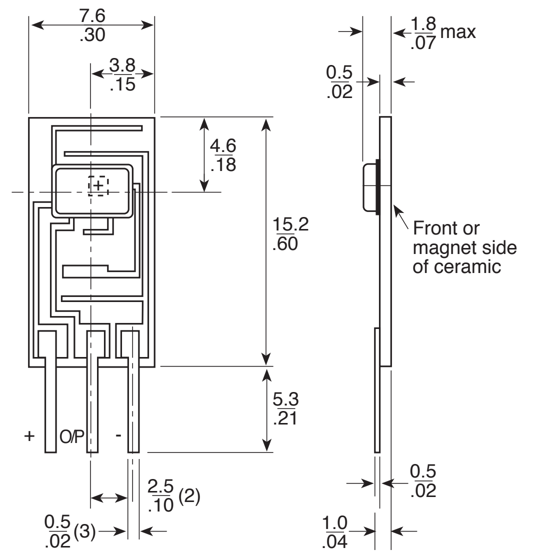
LOHET linear Hall effect devices

These analogue devices are designed to produce an output voltage proportional to the intensity of the magnetic field to which it is exposed.

LOHET I (**RS** stock no. 650-532)

The LOHET I Hall effect analogue position sensor is affected by the magnetic field of either permanent magnets or electro-magnets. The device is constructed on a thin ceramic substrate and has three in-line PCB terminals on standard 0.1in mounting centres. The device features laser trimmed thick film resistors to minimise variations in sensitivity and also to compensate for temperature variations. The transducer operates from a dc supply of between 8-16V (the performance data below relates to a supply of 12Vdc). The transducer, which has a ratiometric current sourcing output, has a maximum response time of 3μs. The output voltage from the device will increase linearly with the magnetic field until a +400 Gauss level is reached, at which point the nominal output voltage will be 9.0V. The output voltage at 0 Gauss is 6V ± 0.6V. At -400 Gauss, the nominal output voltage will be 3.0V.

Mounting dimensions



Specifications (performance details at 12Vdc)

Supply voltage	8 to 16Vdc
Maximum supply current	19mA
Output (current sourcing)	Ratiometric
Maximum response time	3μs
Magnetic characteristics	
Span (-400 to +400 Gauss)	6V
Null (offset at 0 Gauss)	6±0.6V
Sensitivity	7.5±0.2mV/gauss
Linearity	+1.5% span

Temperature errors	
Maximum null shift	
-40°C to +150°C	±5%
-25°C to + 85°C	±3%
0°C to + 50°C	±2%
Sensitivity	
-40°C to 0°C	-0.034%/°C
0°C to + 150°C	-0.077%/°C

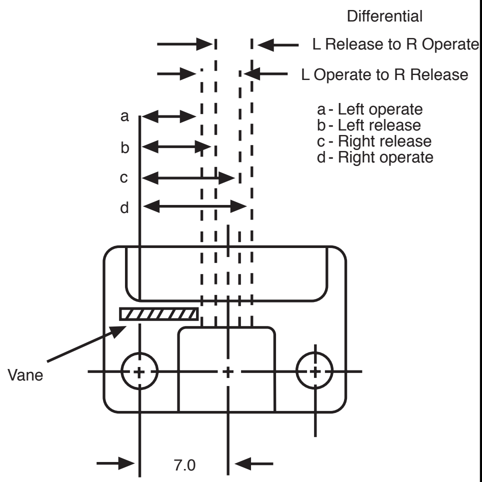
Features

- Three pin in-line PCB terminals
- Standard 0.1 in pin spacing
- Thin ceramic package
- Laser trimmed thick film resistors minimise variations in sensitivity and compensate for temperature variations
- Tight specification on output as a function of magnetic induction.

LOHET II (RS stock nos. 650-548, 244-3128, 178-5673, 189-5499, 244-3134 & 244-3140)

The LOHET II high performance Hall effect analogue position sensor is affected by the magnetic field of either permanent magnets or electro-magnets. The output voltage varies in proportion to the strength of the magnetic field. The transducer is constructed on a thin ceramic substrate and the actual chip is protected by a ceramic cap. The device has three in-line PCB terminals on standard 0.1in mounting centres, and utilises a new Hall effect integrated circuit which provides increased temperature stability and performance with a temperature drift almost ten times better than the LOHET I. The laser trimmed thick film resistors on the ceramic substrate, and the thin film resistors on the integrated circuit reduced null and gain shifts against temperature and provide consistent sensitivity from one device to another. The transducer operates from an 8Vdc supply, and the linear output can be either current sinking or current sourcing. The output from the transducer, which is a ratiometric device, varies from 25% to 75% of the supply voltage as the magnetic flux varies from -400 to +400 Gauss. The output voltage from the device will increase linearly with the magnetic field until a +400 Gauss level is reached, at which point the typical output voltage will be 6V. The output voltage at 0 Gauss is typically 4.0V.

Mounting dimensions



From left to right				
Left		Right		
a	b	d	c	Diff.
5.36	6.07	8.61	7.90	0.71

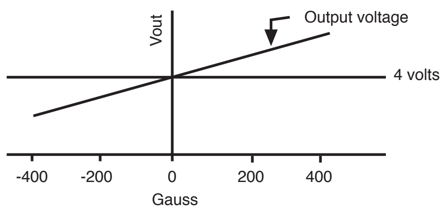
Specification

RS stock no	650-548	244-3128	178-5673	189-5499	244-3134	244-3140
Main feature	Gen. Purpose	Low drift	High sensitivity	Noise shielded††	Noise shielded††	Noise shielded††
Supply voltage (VDC)*	6.6 to 12.6	6.6 to 12.6	6.6 to 12.6	6.6 to 12.6	6.6 to 12.6	6.6 to 12.6
Supply current (mA) **	12 typ. 30 max.	12 typ. 30 max.	12 typ. 30 max.	12 typ. 30 max.	12 typ. 30 max.	12 typ. 30 max.
Output current (mA) Sinking or sourcing	1 max.	1 max.	1 max.	1 max.	1 max.	1 max.
Response time (µ sec.)	3 typ.	3 typ.	3 typ.	3 typ.	3 typ.	3 typ.
Magnetic Characteristics ** Span *	.625Vs	.625Vs	.625Vs	.625Vs	.625Vs	.625Vs
Range (Gauss) *	-500 to +500	-500 to +500	-100 to +100	-500 to +500	-1000 to +1000	-2500 to +2500
Sensitivity (mV/gauss @ 25°C)	5.0±.1	5.0±.1	25.0±.5	5.0±.1	25.0±.05	1.00±.02
Linearity† (% span)	-0.8 typ -1.5 max	-0.8 typ -1.5 max	-0.8 typ. -1.5 max	-0.8 typ. -1.5 max	-0.8typ. -1.5 max	-0.8 typ. -1.5 max
Vout (0 gauss @ 25°C) ***	4.00 ±.04V	4.00 ±.04V	4.00 ±.04V	4.00 ±.04V	4.00 ±.04V	4.00 ±.04V
Temperature error (all %s reference 25°C value)* Null (%/°C)	±.02	±.01	±.10	±.02	±.0125	±.007
Gain (%/°C)	±.02	±.02	+.02 -.055	±.02	±.02	±.02

Features

- Single, current sinking or current sourcing, linear output
- Improved temperature stability
- Three pin in-line PCB terminals Standard 0.1in mounting centres
- Laser trimmed thin film and thick film resistors minimise variations in sensitivity and compensate for temperature variations
- Flux range of -400 to +400 Gauss.

Figure 16 **Transfer characteristics**



Current transducers

These current transducers monitor either alternating or direct current and produce an analogue output signal proportional to the current flow. As the linear signal duplicates the waveform of the current being sensed, it is ideal for use as a feedback element to control a motor or regulate the amount of work being done by a machine. These transducers utilise a through hole design, ensuring that there will be no dc insertion loss in the conductor. In addition, the through-hole design simplifies installation by eliminating the need for direct connection, thus minimising energy dissipation and providing output isolation at no extra cost. These transducers cannot be damaged by over current. All the above transducers incorporate the LOHET I linear output Hall effect device centred in the gap of the flux collector and assembled in a PCB mountable housing available in bottom mount or side mount configurations.

When sensing zero current, the output voltage of the transducer will be equal to half the supply voltage. It will sense current flow in either direction, in one direction the output voltage will increase from its offset value whilst current flow in the opposite direction will cause the output voltage to decrease from its offset value. The output voltage range is from 25% to 75% of the supply voltage, and can be calculated using the following formula (up to the rated maximum current of the transducer).

where:

N = No. of turns of the current carrying conductor passing through the centre of the flux collector

I = Magnitude of current in the current carrying conductor (in Amperes)

Ig = The gap cut in the flux collector (in inches)

V_{CC} = Supply voltage

B = Gauss

$$B = \frac{0.485 \times NI \times K}{Ig}$$

K = Correction factor for the position of sensor in flux concentrator gap

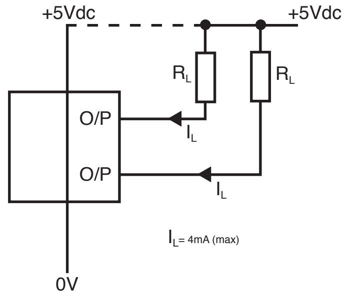
V_{out} is dependent on supply voltage

V_s	V_{out} (mV/Gauss)
16V	10mV
12V	7.5mV
8V	5.0mV
6V	3.75mV

Specifications: Bottom and side mount with LOHET I sensors

RS stock no.	Core gap	Supply current	Sensed current	Mounting style
650-554	0.075 in	19mA	57A	Top mounting
650-560	0.125 in	19mA	100A	Top mounting
650-576	0.075 in	15mA	57A	Side mounting
For all other specifications see LOHET I				

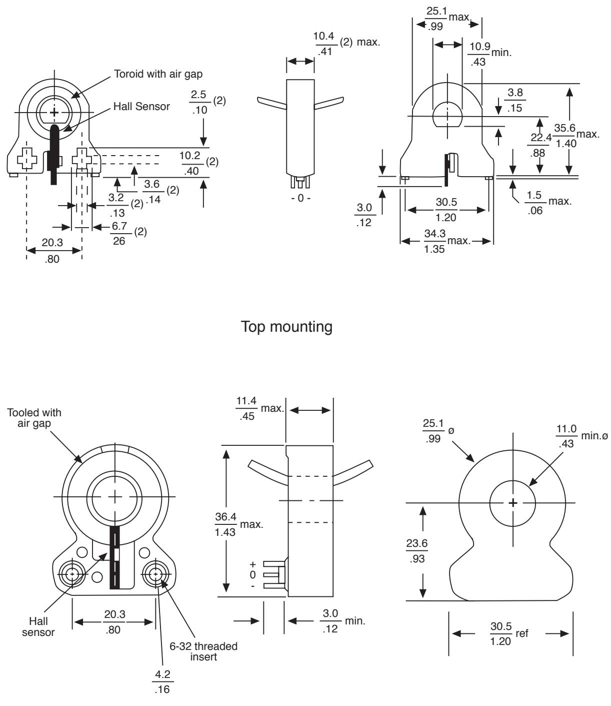
Lohet Sensor Position



Applications

- Variable speed motor controls
- Automotive diagnostics (eg. battery drain detector)
- Earth fault detectors
- Motor overload protection
- Current monitoring of electric welders
- Ring transfer relay in telephone systems
- Protection of power semiconductors
- Control system diagnostics.

Dimensions



Specifications: Bottom and side mount with LOHET II sensors

Catalogue Listing	MTG DIM Fig	Supply Volt DC	Supply Current (mA MN)	Sensor Current (AMPS PEAK)	Offset Volts ±10%	Sensitivity MV/NI at 12 VDC NOM	Sensitivity ±TOL	Offset Shift %/°C	Response Time (μSec)
181-2129	1	6-12	20	72	Vcc/2	32.7	±3.0	±.02	3
181-2135	2	6-12	20	150	Vcc/2	16.2	±1.1	±.02	3

Applying linear output Hall effect transducers

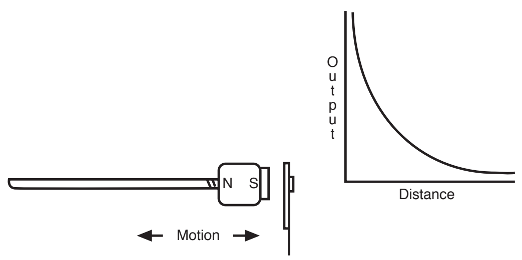
Magnetics

The LOHET I is magnetically actuated. Figures 16 to Figure 19 represent a few of the ways a magnetic system can be presented to the LOHET I for position measurement. The method of actuation will be determined based upon cost, performance, accuracy and other requirements for a given application. The LOHET I is used in these examples to provide sensor output information.

Head-on sensing

A simple method of position sensing is shown in Figure 16. One pole of a magnet is moved directly to or away from the LOHET I. This is a unipolar head-on position sensor. When the magnet is farthest away from the sensor, the magnetic field at the sensing face is near zero Gauss. In this condition, the sensor's nominal output voltage will be six volts with a 12 volt supply. As the south pole of the magnet approaches the sensor, the magnetic field at the sensing surface becomes more and more positive. The output voltage will increase linearly with the magnetic field until a +400 Gauss level or nominal output of 9 volts is reached. The output as a function of distance is non-linear, but over a small range may be considered linear.

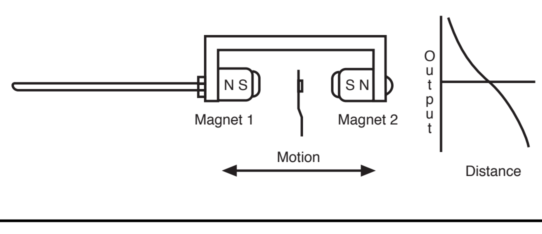
Figure 17 **Unipolar head-on position sensor**



Bipolar head-on sensing

Bipolar head-on sensing is shown in Figure 18. When the magnets are moved to the extreme left, the LOHET I is subjected to a strong negative magnetic field by magnet 2, forcing the output of the sensor to a nominal 3.0 volts. As magnet 1 moves towards the sensor, the magnetic field becomes less negative, until the fields of magnet 1 and magnet 2 cancel each other, at the midpoint between the two. The sensor output will be a nominal 6.0 volts. As magnet 1 continues toward the sensor, the field will become more and more positive until the sensor output reaches 9.0 volts. This approach offers high accuracy and good resolution as the full span of the LOHET I is utilised. The output from this sensor is linear over a range centred above the null point.

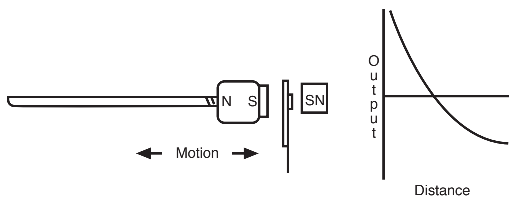
Figure 18 **Bipolar head-on position sensor**



Biased head-on sensing

Biased head-on sensing, a modified form of bipolar sensing, is shown in Figure 19. When the moveable magnet is fully retracted, the LOHET I is subjected to a negative magnetic field by the fixed bias magnet. As the moveable magnet approaches the sensor, the fields of the two magnets combine. When the moveable magnet is close enough to LOHET I, the sensor will 'see' a strong positive field. This approach features mechanical simplicity, and utilises the fall span of the LOHET I.

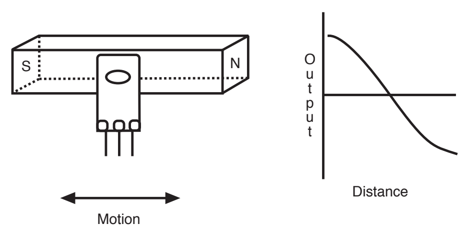
Figure 19 **Biased head-on position sensor**



Slide-by sensing

Slide-by actuation is shown in Figure 20. A tightly controlled gap is maintained between the magnet and the LOHET I. As the magnet moves back and forth at that fixed gap, the field seen by the sensor becomes negative as it approaches the north pole, and positive as it approaches the south pole. This type of position sensor features mechanical simplicity and, when used with a long enough magnet, can detect position over a long magnet travel. The output characteristic of a bipolar slide-by configuration is the most linear of all systems illustrated, especially when used with a pole piece at each pole face. However, tight control must be maintained over both vertical position and gap to take advantage of this system's characteristics.

Figure 20 **Slide-by position sensor**

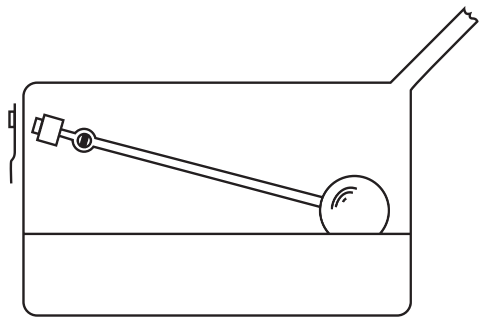


Sensor applications

Liquid level measurement

Determining the height of a float is one method of measuring the level of liquid in a tank. Figure 21 illustrates an arrangement of a LOHET I and a float in a tank made of non-ferrous material (aluminium). As the liquid level goes down, the magnet moves closer to the sensor, causing an increase in output voltage. This system allows liquid level measurement without any electrical connections inside the tank.

Figure 21 **LOHET I float height detector**



Interfacing the LOHET with comparators and op amps

Introduction

This section covers some common comparator and op amp circuits and their interface with LOHET ic manufacturers' specification sheets should be consulted when choosing the best op amp or comparator for your application.

Resistor tolerances and temperature coefficients influence overall accuracy. The load resistor (RL) however, is not critical. A ±10% carbon resistor is satisfactory. The load resistor on the LOHET output ensures that the load is the same as that used during LOHET manufacture.

Comparators

Figures 22, 23, 24 and 25 show typical comparator circuits. A single supply LM339 (or equivalent) is used to make a digital switch with adjustable operate point. Hysteresis is provided by resistor RH. In Figures 22 and 23, hysteresis is essentially zero, but can be made large enough to provide a latching circuit. By-pass capacitors may be required in some applications, but are not shown on these circuits. The LM339 can provide up to four different switch points per LOHET. If linear use and digital operation with one LOHET are required, an LM124 (or equivalent) op amp may be substituted.

Figure 22 **Non-inverting**

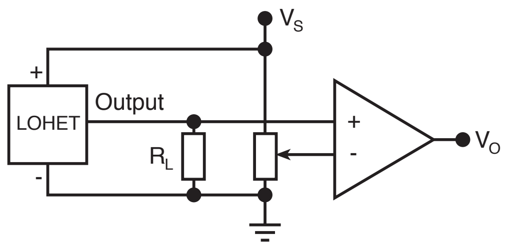


Figure 23 **Inverting**

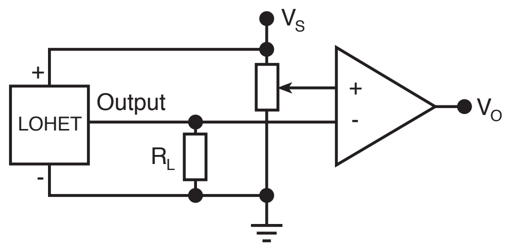


Figure 24 **Non-inverting with hysteresis**

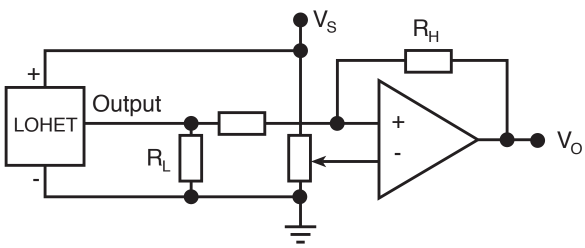
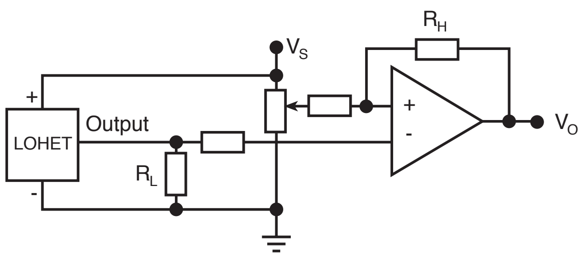


Figure 25 **Inverting with hysteresis**



Op amps

Figures 26, 27 and 28 show the LOHET interfaced with common single supply op amp circuits. Op amp characteristics limit the output voltage (VO) equations at high and low ends.

The circuit in Figure 26 can be used with adjustable gain and adjustable offset, although the adjustments will not be completely independent. One method is to adjust the gain to the desired value with V1 at approximately one-half VS. Then, adjust V1 to give the exact offset at VO required for the application.

The basic op amp circuits or circuit combinations will fulfil most LOHET use requirements, ac coupling is not shown, but can be used to ground reference ac levels out of the LOHET.

Figure 26 **Inverting**

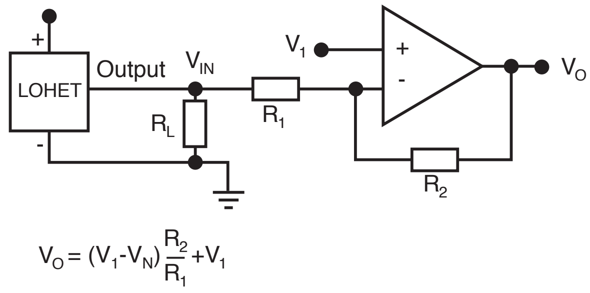


Figure 27 **Non-inverting**

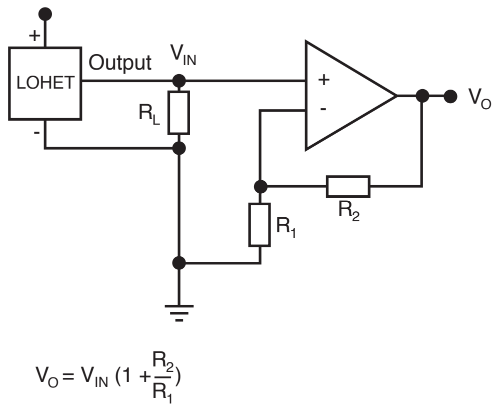
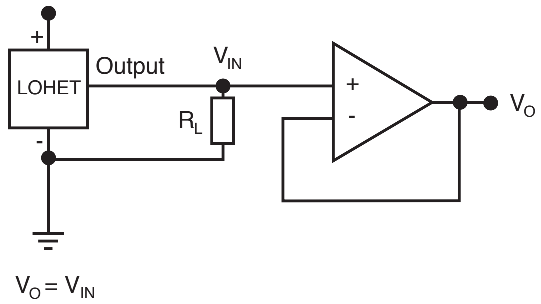


Figure 28 **Voltage-follower**



RS Components, PO Box 99, Corby, Northants, NN17 9RS
An Electrocomponents Company
Telephone: 01536 201234