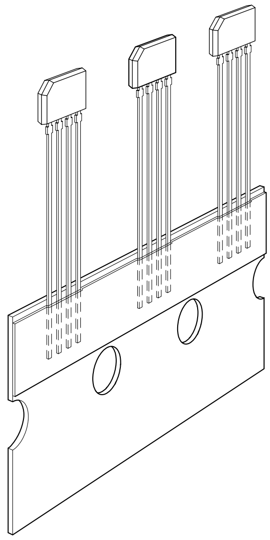
Linear Output Hall Effect IC **TLE 4990**

Data Sheet

Features

- Very linear and ratiometric rail-to-rail output signal
- Low drift of output signal over temperature and lifetime
- Digital "on chip" trimming of
  - zero field voltage
  - magnetic sensitivity
  - clamping option and
  - temperature coefficient
- Working over temperatures from -40 °C up to 150 °C
- Single supply voltage
- Slim package
- Reverse polarity protection
- Output short circuit protection
- On board diagnostics (wire breakage)


P-SSO-4-1

Target Applications

- Linear and angular position sensing in automotive applications like pedal position, suspension control, valve position, throttle position, and steering angle
- High current sensing for battery management, motor control, and electronic fuse

Type	Ordering Code	Package
TLE 4990	Q62705-K417	P-SSO-4-1

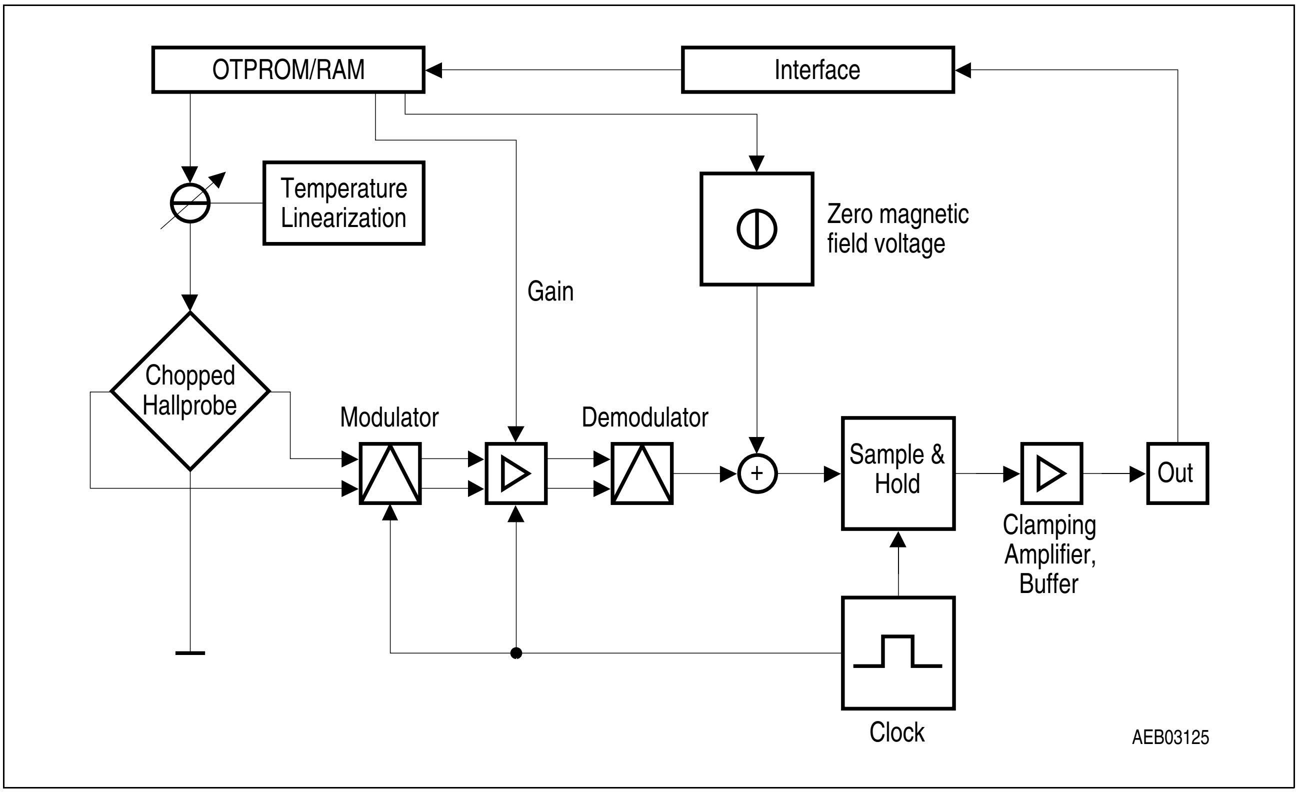


Figure 1 Block Diagram

The linear Hall IC TLE 4990 has been designed specifically to meet the demands of highly accurate rotation and position detection, as well as for current measurement applications. The sensor provides a ratiometric analog output voltage which is ideally suited for A/D conversion with the supply voltages as a reference. The IC is produced in BiCMOS technology with high voltage capability and also providing reverse polarity protection.

The temperature compensation of the sensitivity is programmable to provide excellent accuracy. Stability is achieved by the dynamic offset cancellation technique to eliminate any spurious mechanical or temperature effects.

The transfer function of the linear Hall IC TLE 4990 can be adopted randomly to the application needs in terms of offset (quiescent) voltage, sensitivity and clamping.

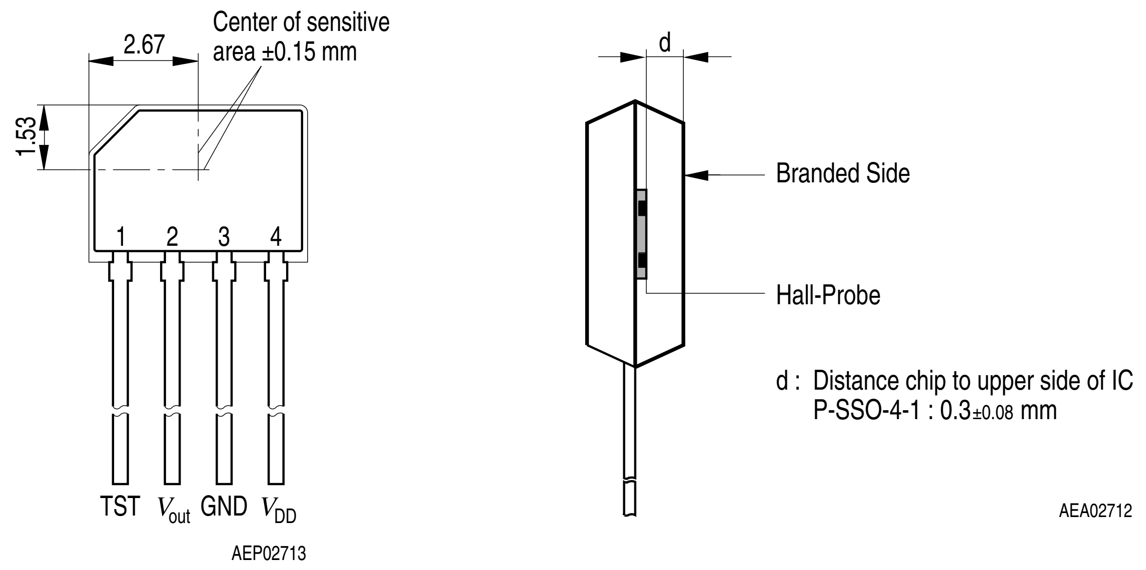


Figure 2 Pin Configuration and Hall Cell Location

Pin Definitions and Functions

Pin No.	Symbol	Function
1	TST	Test pin for internal use
2	V_{out}	Output voltage
3	GND	Ground
4	V_{DD}	Supply voltage

Principle of Operation

- A magnetic flux is measured by a Hall-Effect cell.
- The output signal from the Hall-Effect cell is amplified and a zero field voltage is added.
- The output voltage is proportional to the supply voltage (ratiometric).
- The output voltage range can be limited (clamped).

The sensor TLE 4990 provides a ratiometrically increasing output voltage when actuated by an increasing external magnetic field. Refer to **Figure 3** for details on magnetic field direction. The magnetic field range and the output voltage with no magnetic field present, can be adjusted by customers to their specific needs to achieve optimal accuracy. A programming tool is available.

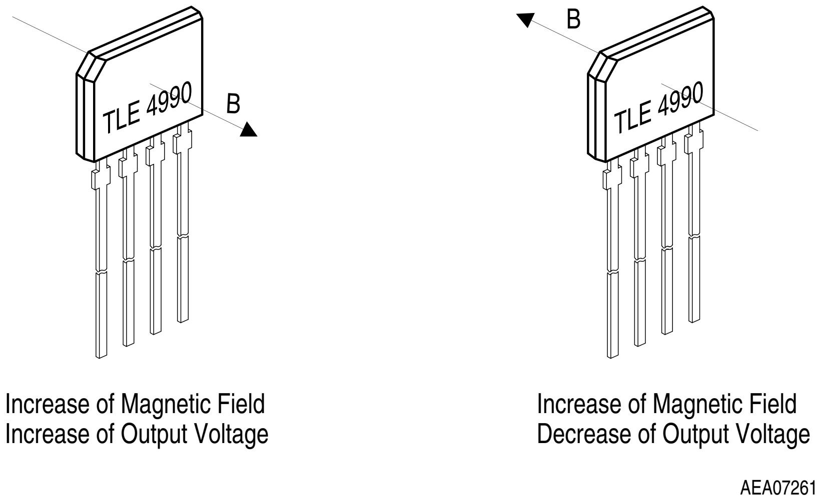


Figure 3 Magnetic Field Direction Definition

Zero-field Output Voltage (V_{zero})

The output voltage with no magnetic field present is called the zero field voltage V_{zero}. It is programmable within the range of 3% to 18% of V_{DD} (for Bipolar bit = 0) and 42% to 59% of V_{DD} (for Bipolar bit = 1) by 10 ODAC bits with a resolution of 1.0 mV to 1.2 mV.

Magnetic Sensitivity (S)

The magnetic sensitivity is set in two steps: First the "coarse gain" is selected out of 8 values (3 PRE bits). Then the "fine gain" is adjusted by another 10 GDAC bits.

The resulting range of sensitivity extends from 15 mV/mT to 180 mV/mT at the nominal supply voltage of 5 V. Note that as the sensitivity is ratiometric, it will also depend linearly on the supply voltage.

Magnetic Sensitivity and Full Scale Range (at nominal supply V_{DD} = 5 V)

PRE	Nominal Sensitivity (mV/mT)	Magnetic Full Scale Range (mT)
0	11.49 ... 16.49	285 ... 409
1	16.17 ... 23.20	203 ... 291
2	22.75 ... 32.65	144 ... 207
3	32.00 ... 45.96	102 ... 147
4	45.04 ... 64.63	72.7 ... 104
5	63.38 ... 90.92	51.7 ... 74.2
6	89.16 ... 127.9	36.8 ... 52.7
7	125.5 ... 180.0	26.1 ... 37.5

Temperature Gain Compensation

The temperature characteristic of the circuitry and the magnet which actuates the IC are compensated. This is performed through temperature gain compensation (4 bits). The typical increase of sensitivity is set to +350 ppm/K to compensate the temperature characteristic of SmCo permanent magnets.

The calibration of the temperature gain compensation is performed during production for each device individually, and is stored permanently in its OTPROM.

Clamping Option

It is possible to reduce the output voltage swing from its original 3% ... 97% V_{DD} to a limited swing of 10% ... 90% V_{DD} by setting the clamping bit. This enables to detect a broken wire, in which case the output voltage is tied to ≤ 6% or ≥ 94% of V_{DD}.

Absolute Maximum Ratings

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	V_{DD}	3	24	V	for $T_a \leq 80$ °C max. 10 min.
Reverse supply voltage protection	–	– 18	0	V	for $T_a \leq 80$ °C max. 10 min.
Output short circuit protection	–	0.3	16	V	for $T_a \leq 80$ °C max. 5 min.
Junction temperature	T_j	– 40	160	°C	–
ESD protection (according HBM)	–	–	2.0	kV	–
Max. magnetic field	–	–	unlimited	T	–

Operating Range

Parameter	Symbol	Limit Values			Unit	Remarks
		min.	typ.	max.		
Supply voltage	V_{DD}	4.5	5	5.5	V	–
Supply current	I_{DD}	3.5	–	5.5	mA	without current through load $I_{OUT} = 0$[1)]
Output current	I_{OUT}	-1.2	–	+1.2	mA	–
Output resistance	R_{OUT}	–	3	6	Ω	[1)]
Output voltage swing	–	3	–	97	$\%V_{DD}$	$R_{LOAD} \geq 4.7$ kΩ
Zero field output voltage	V_{zero}	3 42	– –	18 59	$\%V_{DD}$	Bipolar-Bit = 0 Bipolar-Bit = 1
Ratiometricity	*Rat*	99.9	100	100.1	%	[2)]
Linearity	*Lin*	99.9	100	100.1	%	[3)]
Resolution	B_n	20	–	60	μT_{RMS}	[4)]
Output voltage noise	$V_{OUT,n}$	–	1.2	–	mV_{RMS}	[5)]
Zero field voltage drift over lifetime	$\Delta V_{zero,L}$	-10	–	+10	mV	–
Zero field voltage drift from $T = 25$ °C to +150 °C	$\Delta V_{zero,T(+)}$	-30	–	0	mV	–

Operating Range (cont'd)

Parameter	Symbol	Limit Values			Unit	Remarks
		min.	typ.	max.		
Zero field voltage drift from T = -40 °C to 25 °C	$\Delta V_{zero,T(-)}$	-30	–	0	mV	–
Zero field voltage drift from T = -40 °C to 150 °C	$\Delta V_{zero,T}$	-40	–	0	mV	–
Range of sensitivity	S	15	–	180	mV/ mT	@ V_{DD} = 5 V, programmable [6]
Temperature coefficient of sensitivity	α	+200	+350	+500	ppm/ °C	[7]
Sensitivity drift over lifetime	ΔS_L	-0.9	–	+0.9	%	T_a = 25 °C
Upper limit of output voltage clamping limit	$V_{cl,high}$	88	90	92	$\%V_{DD}$	$R_{LOAD} \geq 4.7$ kΩ
Lower limit of output voltage clamping limit	$V_{cl,low}$	8	10	12	$\%V_{DD}$	$R_{LOAD} \geq 4.7$ kΩ
Power on time	t_{Pon}	0.3	0.6	0.75	ms	[8]
Maximum operating frequency	f_{op}	1100	1600	2300	Hz	-3 dB corner frequency
Max. phase shift error at 100 Hz sine input	–	2	4	8	Degree	–
Output voltage limit GND - line broken	–	94	–	100	$\%V_{DD}$	$R_{LOAD} \geq 7$ kΩ
Output voltage limit V_{DD} - line broken	–	0	–	6	$\%V_{DD}$	$R_{LOAD} \geq 7$ kΩ

1) Is valid for V_{out} in the range from 10% V_{DD} to 90% V_{DD}.

2) Definition: *Rat* = (V_{OUT}(V_{DD})/V_{DD}) / (V_{OUT} (V_{DD} = 5 V)/5 V) · 100% for V_{out} in the range from 10% V_{DD} to 90% V_{DD}.

3) $B_{10\%}$ is the magnetic field, at which $V_{OUT} = 0.1 \cdot V_{DD}$. $B_{90\%}$ is the magnetic field, at which $V_{OUT} = 0.9 \cdot V_{DD}$. $V_{OUT,id} = 0.1 + 0.8 \cdot (B - B_{10\%}) / (B_{90\%} - B_{10\%})$.
Lin = (V_{OUT} / $V_{OUT,id}$ - 1) · 100% for all V_{OUT} between 10% V_{DD} and 90% V_{DD}.

4) Equivalent to magnetic input noise at 25 °C. The equivalent magnetic input noise depends on the selected sensitivity. At highest sensitivity it is typically 25 μT_{RMS}, at lowest sensitivity it is typically 50 μT_{RMS} at 25 °C.

5) No external filtering, at a sensitivity of 30 mV/mT (digital switching noise included) at 25 °C.

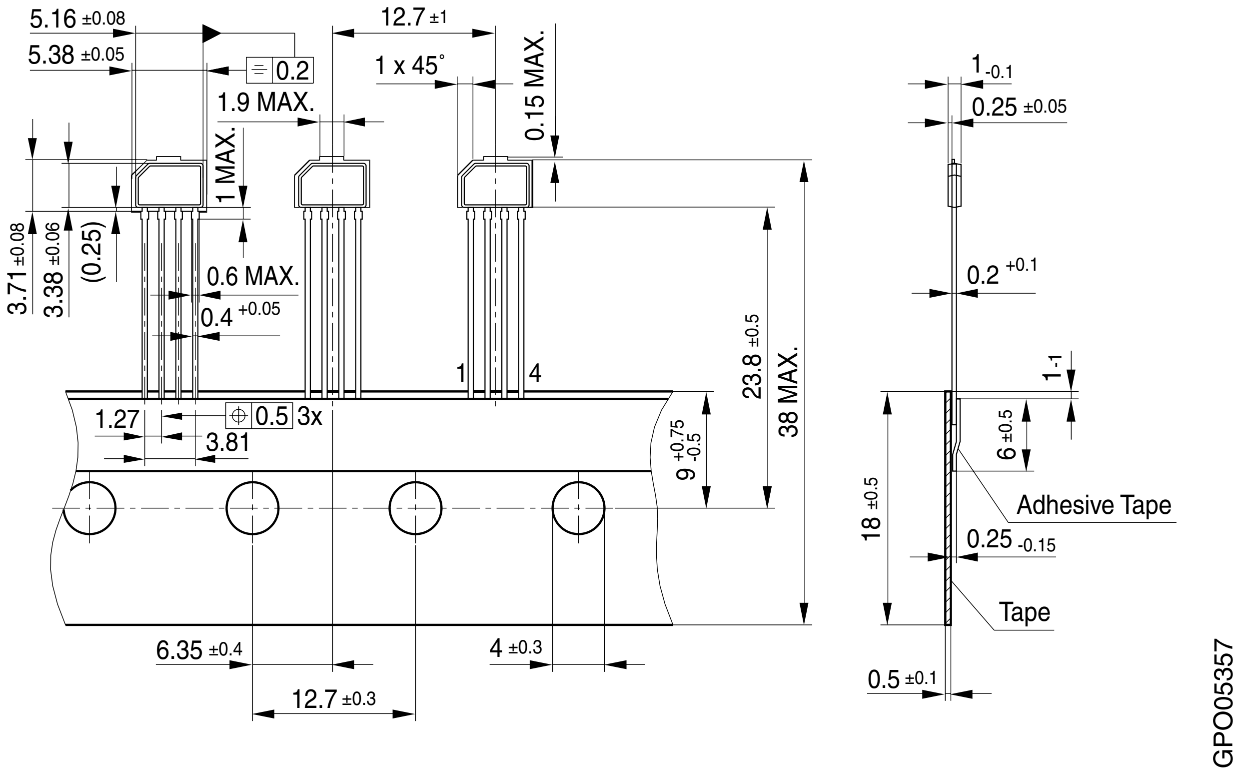
6) In the lowest programmable sensitivity range a sensitivity less or equal to min(S) is guaranteed. In the highest programmable sensitivity range a sensitivity of greater or equal to max(S) is guaranteed. The ratio of max(S) / min(S) ≥ 15.

7) The temperature coefficient of the magnetic sensitivity is the slope of a linear least-square fit through the real curve.

8) The output voltage has reached 99% of its final value within t_{Pon} after power on.

Package Outline

P-SSO-4-1
(Plastic Single Small Outline Package)



Sorts of Packing
Package outlines for tubes, trays etc. are contained in our Data Book "Package Information".

Dimensions in mm

TLE 4990 **Revision History:**		**Current Version: 2001-09-19**
Previous Version:		
Page (in previous Version)	Page (in current Version)	Subjects (major changes since last revision)

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