

Dynamic Differential Hall Effect Sensor IC

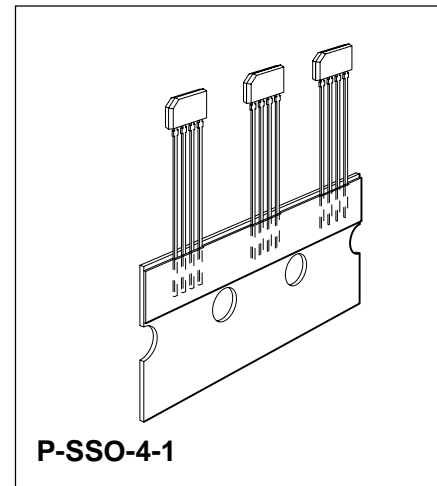
TLE 4921-2

Preliminary Data

Bipolar IC

Features

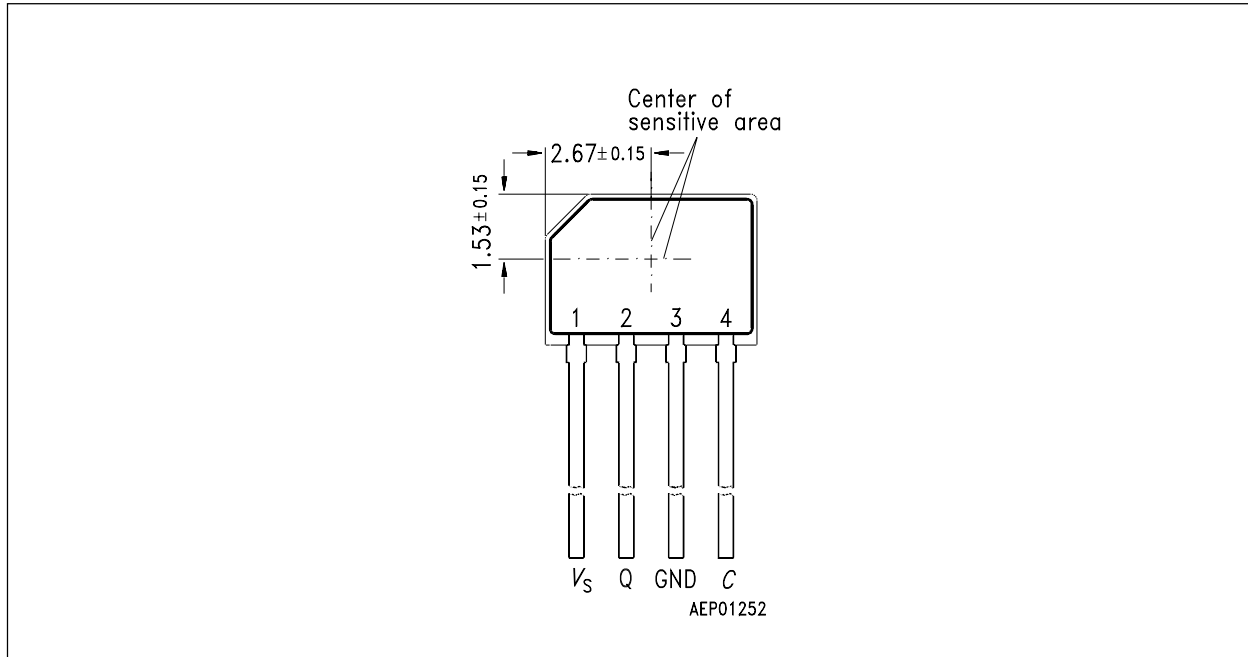
- AC coupled
- Digital output signal
- Two-wire and three-wire configuration possible
- Large temperature range
- Large distance, low frequency cut-off
- Protection against overvoltage
- Protection against reversed polarity
- Output protection against electrical disturbances



Type	Ordering Code	Package
▼ TLE 4921-2U	Q67006-A9055	P-SSO-4-1
▼ New type		

The differential Hall Effect sensor TLE 4921-2U is particularly suitable for rotational speed detection and timing applications of ferromagnetic toothed wheels such as anti-lock braking systems, transmissions, crankshafts, etc. The integrated circuit (based on Hall effect) provides a digital signal output with frequency proportional to the speed of rotation. Unlike other rotational sensors differential Hall ICs are not influenced by radial vibration within the effective airgap of the sensor and require no external signal processing.

Pin Configuration (top view)



Pin Definitions and Functions

Pin No.	Symbol	Function
1	V_S	Supply voltage
2	Q	Output
3	GND	Ground
4	C	Capacitor

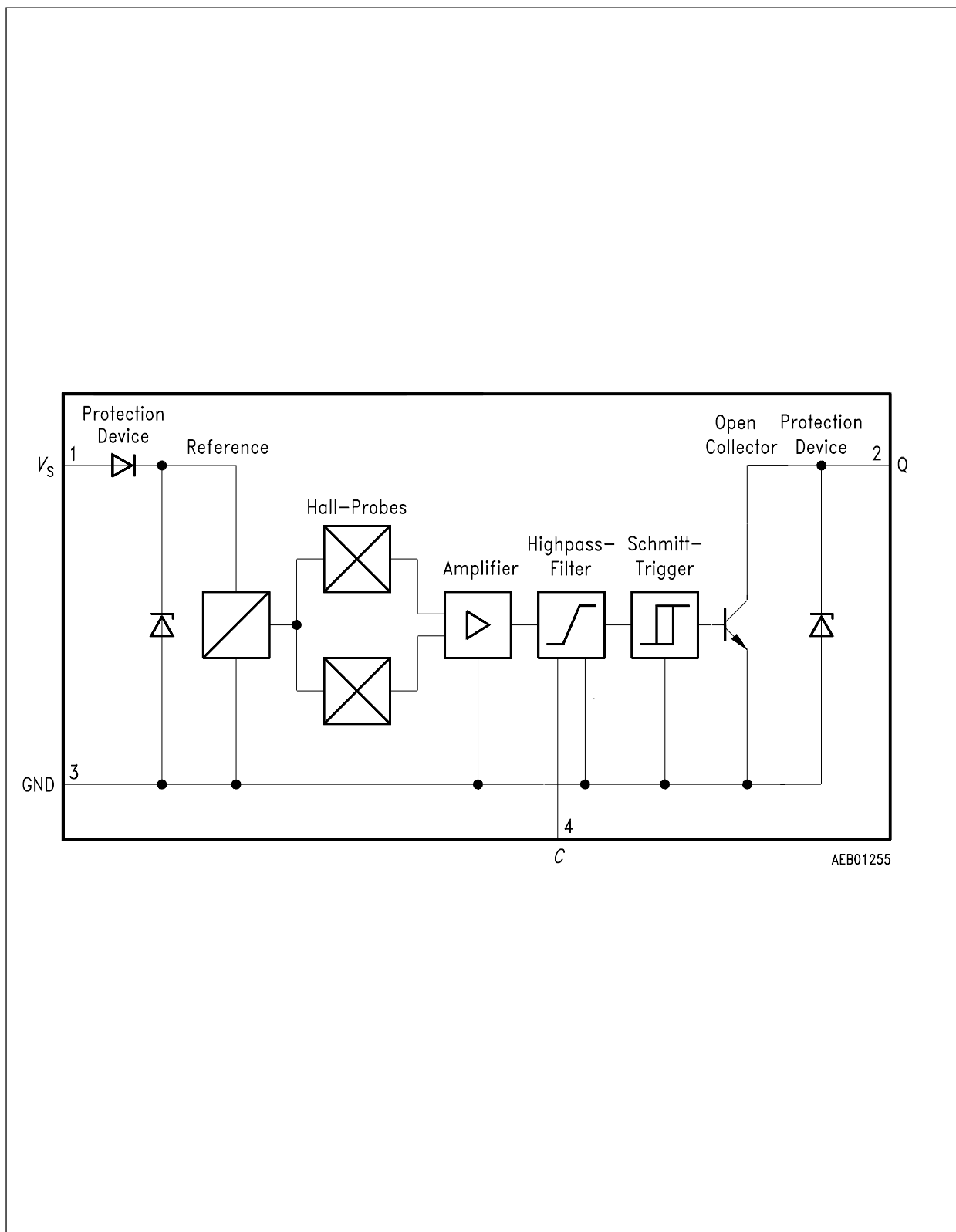


Figure 1
Block Diagram 1

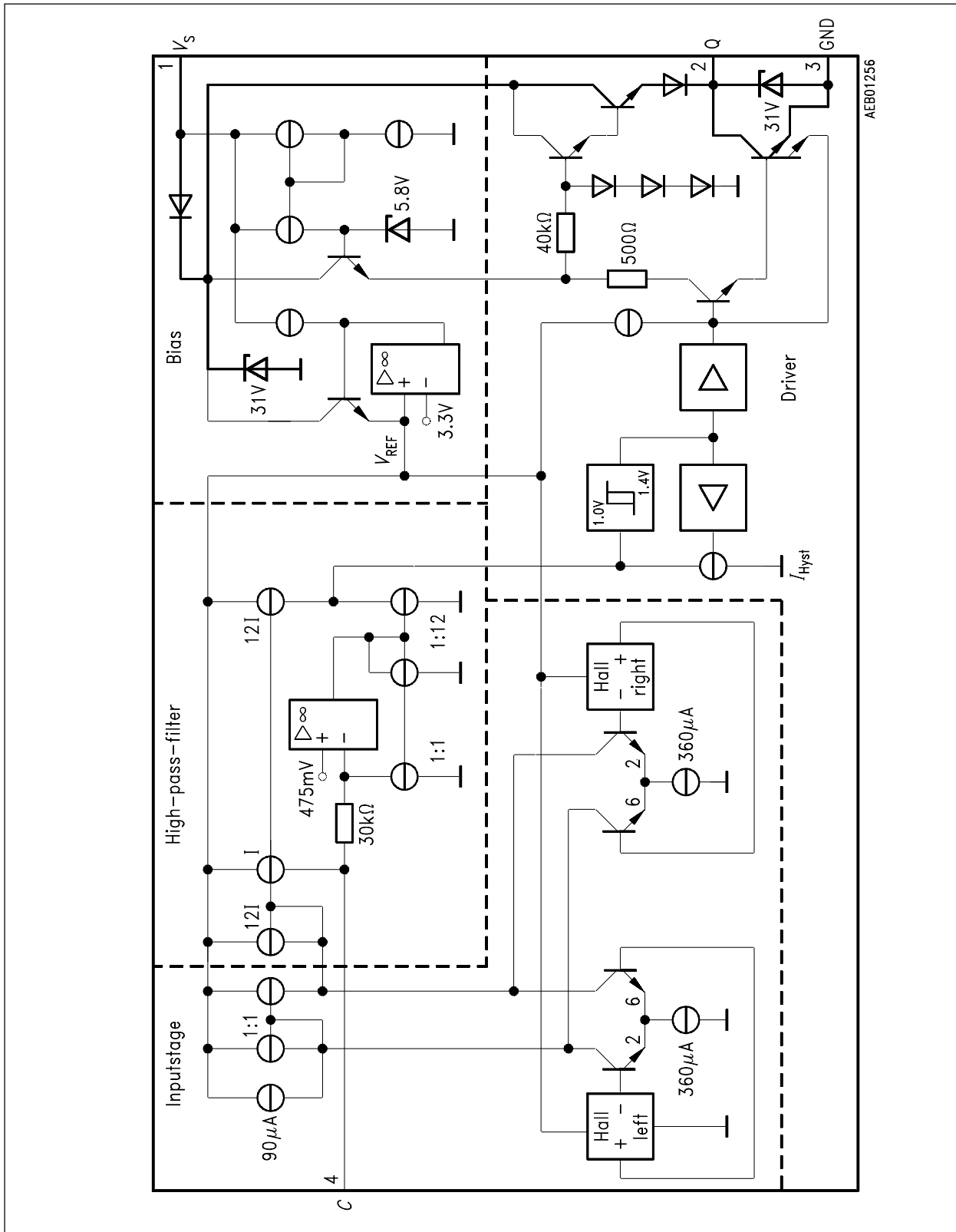


Figure 2
Block Diagram 2

Functional Description

The Differential Hall Sensor IC detects the motion of, and static position of, ferromagnetic and permanent magnet structures by measuring the differential flux density of the magnetic field. To detect ferromagnetic objects the magnetic field must be provided by a back biasing permanent magnet (southpole of the magnet attached to the back, unmarked, side of the IC package).

Using an external capacitor the generated Hall-voltage signal is slowly adjusted via an active high pass filter with low frequency cutoff. This causes the output to switch into a biased mode after a time constant is elapsed. The time constant is determined by the external capacitor. Filtering avoids aging and temperature influence from Schmitt-trigger input and eliminates device and magnetic offset.

The TLE 4921-2U can be exploited to detect toothed wheel rotation in a rough environment. Jolts against the toothed wheel and ripple have no influence on the output signal. Furthermore the TLE 4921-2U can be operated in a two-wire - as well as in a three-wire-configuration.

The output is logic compatible by high/low levels regarding on and off.

Circuit Description (see Figure 1 and 2)

The TLE 4921-2U is comprised of a supply voltage reference, a pair of Hall probes spaced at 2.5 mm, differential amplifier, Schmitt trigger, and open collector output.

Protection is provided at the input/supply (pin 1) for overvoltage and reverse polarity and against overstress such as load dump, etc., in accordance with ISO-TR 7637 and DIN 40839. The output (pin 2) is protected against voltage peaks and electrical disturbances.

Absolute Maximum Ratings

$T_j = -40$ to 150 °C

Parameter	Symbol	Limit Values		Units	Remarks
		min.	max.		
Supply voltage	V_S	- 40	30	V	
Output voltage	V_Q	- 0.7	30	V	
Output current	I_Q		50	mA	
Output revers current	$-I_Q$		50	mA	
Capacitor voltage	V_C	- 0.3	3	V	
Junction temperature	T_j		150	°C	
Junction temperature	T_j		170	°C	1000 h
Junction temperature	T_j		210	°C	40 h
Storage temperature	T_s	- 40	150	°C	
Thermal resistance PSSO-4-1	$R_{th JA}$		190	K/W	
Current through input-protection device	I_{SZ}		200	mA	$t < 2$ ms ; $v = 0.1$
Current through output-protection device	I_{QZ}	- 200	200	mA	$t < 2$ ms ; $v = 0.1$

Electro Magnetic Compatibility

ref. DIN 40839 part 1; test circuit 1

Testpulse 1	V_{LD}	- 100		V	$t_d = 2$ ms
Testpulse 2	V_{LD}		100	V	$t_d = 0.05$ ms
Testpulse 3a	V_{LD}	- 150		V	$t_d = 0.1$ μs
Testpulse 3b	V_{LD}		100	V	$t_d = 0.1$ μs
Testpulse 4	V_{LD}	- 7		V	$t_d \leq 20$ s
Testpulse 5	V_{LD}		120	V	$t_d = 400$ ms; $R_p = 450$ Ω

Operating Range

Supply voltage	V_S	4.5	24	V	
Junction temperature	T_j	- 40	150	°C	
Junction temperature	T_j	- 40	170	°C	thresholds may exceed the limits
Pre-induction	B_0	0	200	mT	Southpole at the backside of IC

AC/DC Characteristics

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Supply voltage	V_S					$4.5 \text{ V} \leq V_S \leq 24 \text{ V}$	
Junction temperature	T_j					$-40 \text{ }^\circ\text{C} \leq T_j \leq 150 \text{ }^\circ\text{C}$	
Supply current	I_S	3.5	8.5	14	mA	$V_Q = \text{high}$ $I_Q = 0 \text{ mA}$	1
		4.0	9	14.5	mA	$V_Q = \text{low}$ $I_Q = 40 \text{ mA}$	1
Output saturation voltage	V_{QSat}		0.25	0.6	V	$I_Q = 40 \text{ mA}$	1
Output leakage current	I_{QL}			10	μA	$V_Q = 24 \text{ V}$	1
Switching frequency	f	5		20000	Hz	$C = 470 \text{ nF}$ $\Delta B = 5 \text{ mT}$	2
Switching flux density	ΔB_{OP}	-2	0	1	mT	$f = 100 \text{ Hz};$ $B_O = 150 \text{ mT}$ $C = 470 \text{ nF};$ $\Delta B_{\text{max}} = 1.75 \text{ mT}$	2
Hysteresis	ΔB_{Hy}	0.5	1.5	2.5	mT	$f = 100 \text{ Hz};$ $B_O = 150 \text{ mT}$ $C = 470 \text{ nF};$ $\Delta B_{\text{max}} = 1.75 \text{ mT}$	2
Overvoltage protection at supply voltage at output	V_{SZ}	27		35	V	$I_S = 16 \text{ mA}$	2
	V_{QZ}	27		35	V	$I_S = 16 \text{ mA}$	2

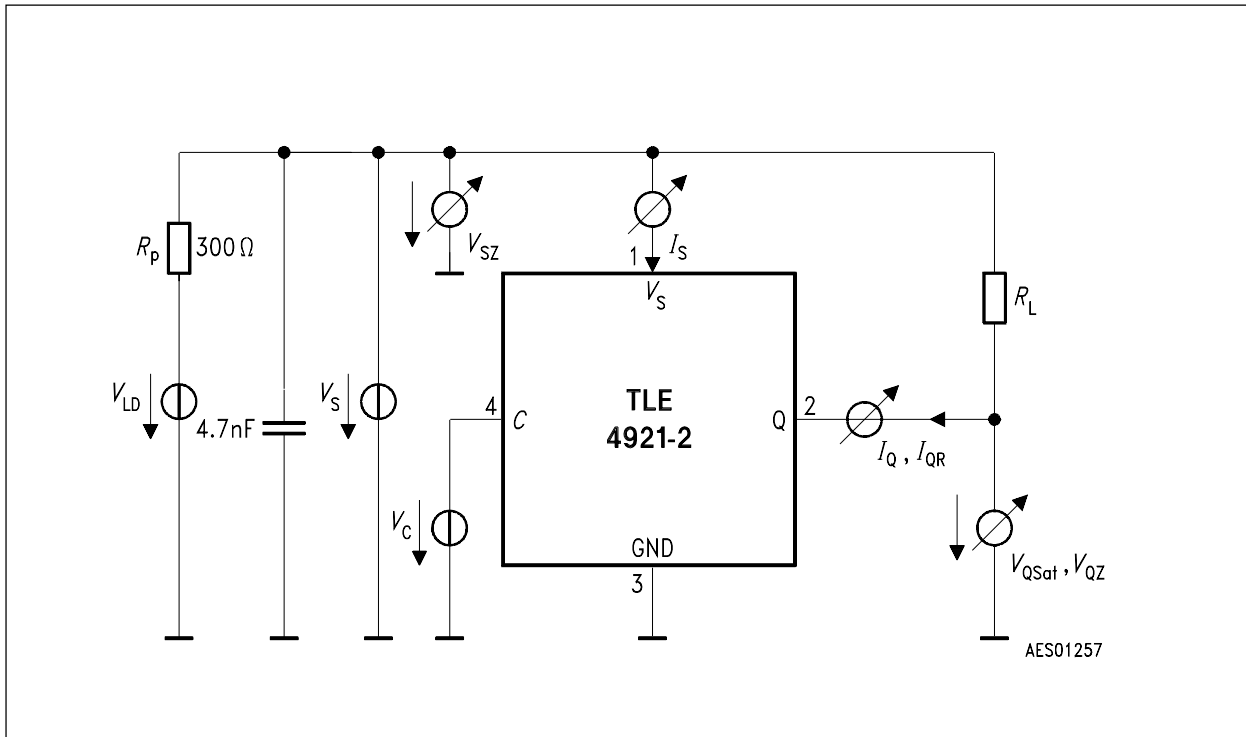


Figure 3
Test Circuit 1

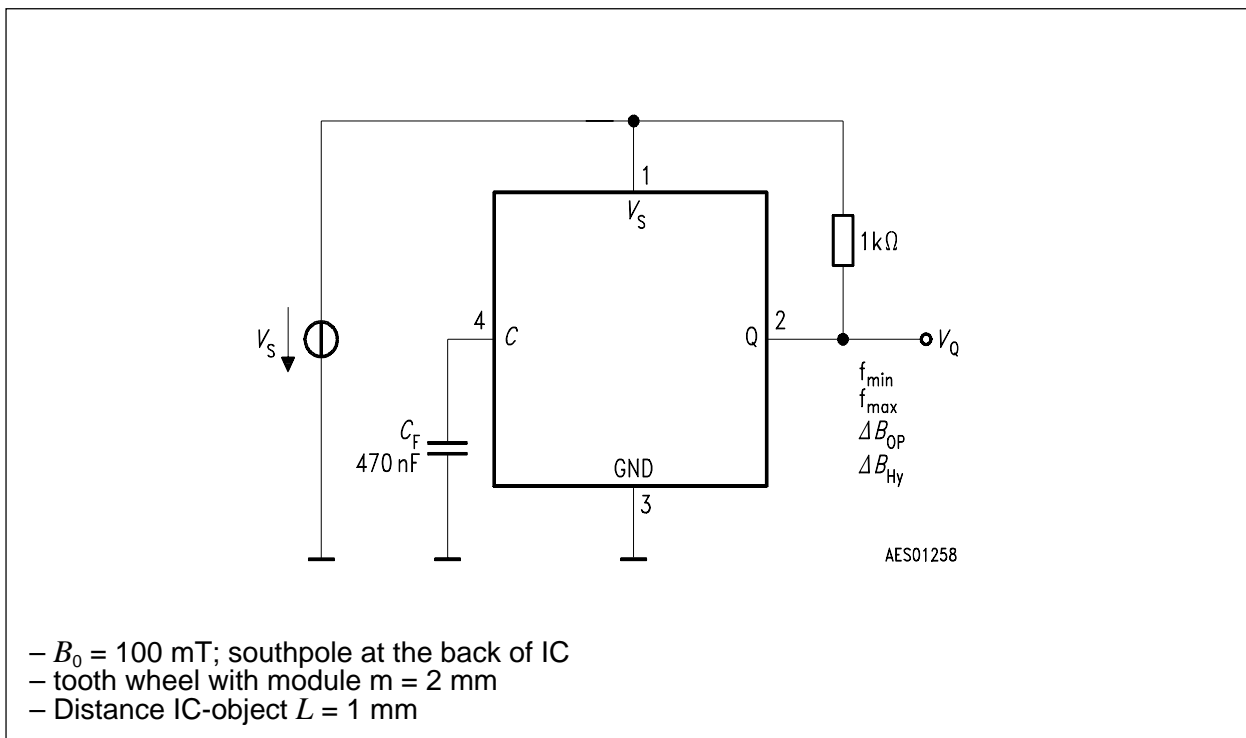


Figure 4
Test Circuit 2

Application Notes

Two possible applications are shown in **figure 7 and 8** (Toothed and Magnet Wheel).

The differences between two-wire and three-wire application is shown in **figure 9**.

Gear Tooth Sensing

In the case of ferromagnetic toothed wheel application the IC has to be biased by the southpole of a permanent magnet (e.g. SEC₀₅ (Vacuumschmelze VX145) with the dimensions 8 mm x 5 mm x 3 mm) which should cover both hall-probes.

The maximum air gap depends on

- the magnetic field strength (magnet used),
- the tooth wheel that is used (dimensions, material, etc.),
- the ambient temperature,
- the connected capacitor

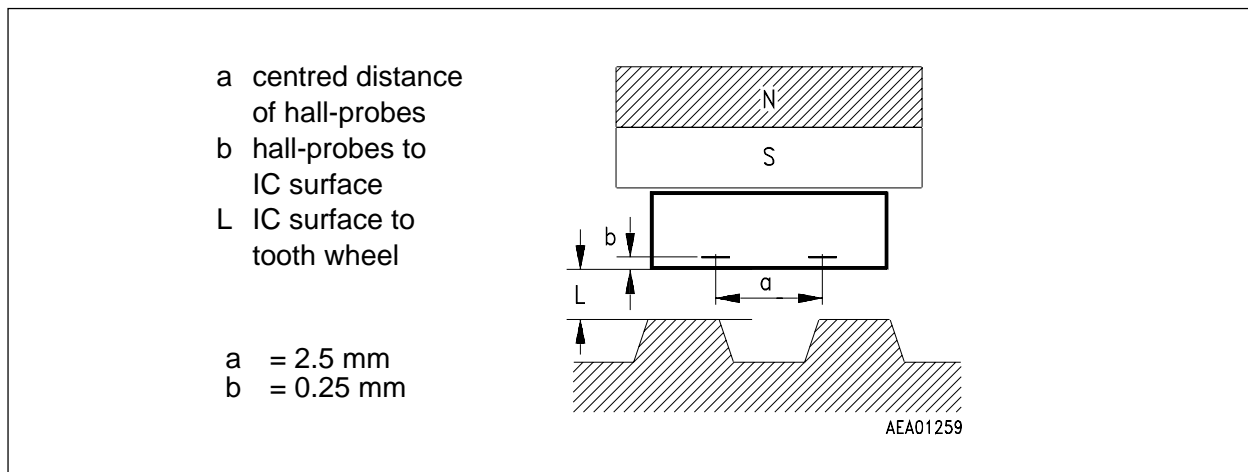


Figure 5
Sensor Spacing

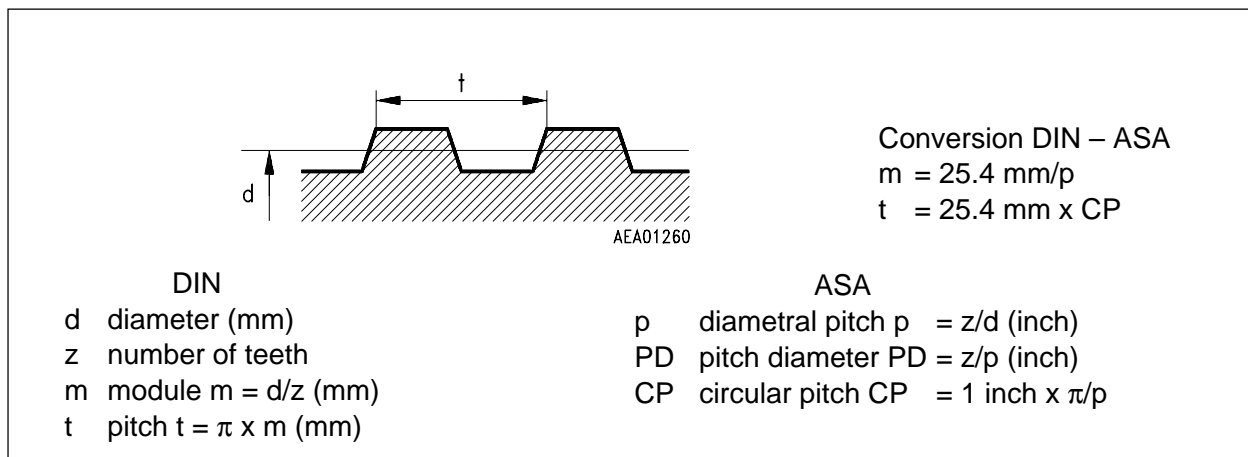


Figure 6
Tooth Wheel Dimensions

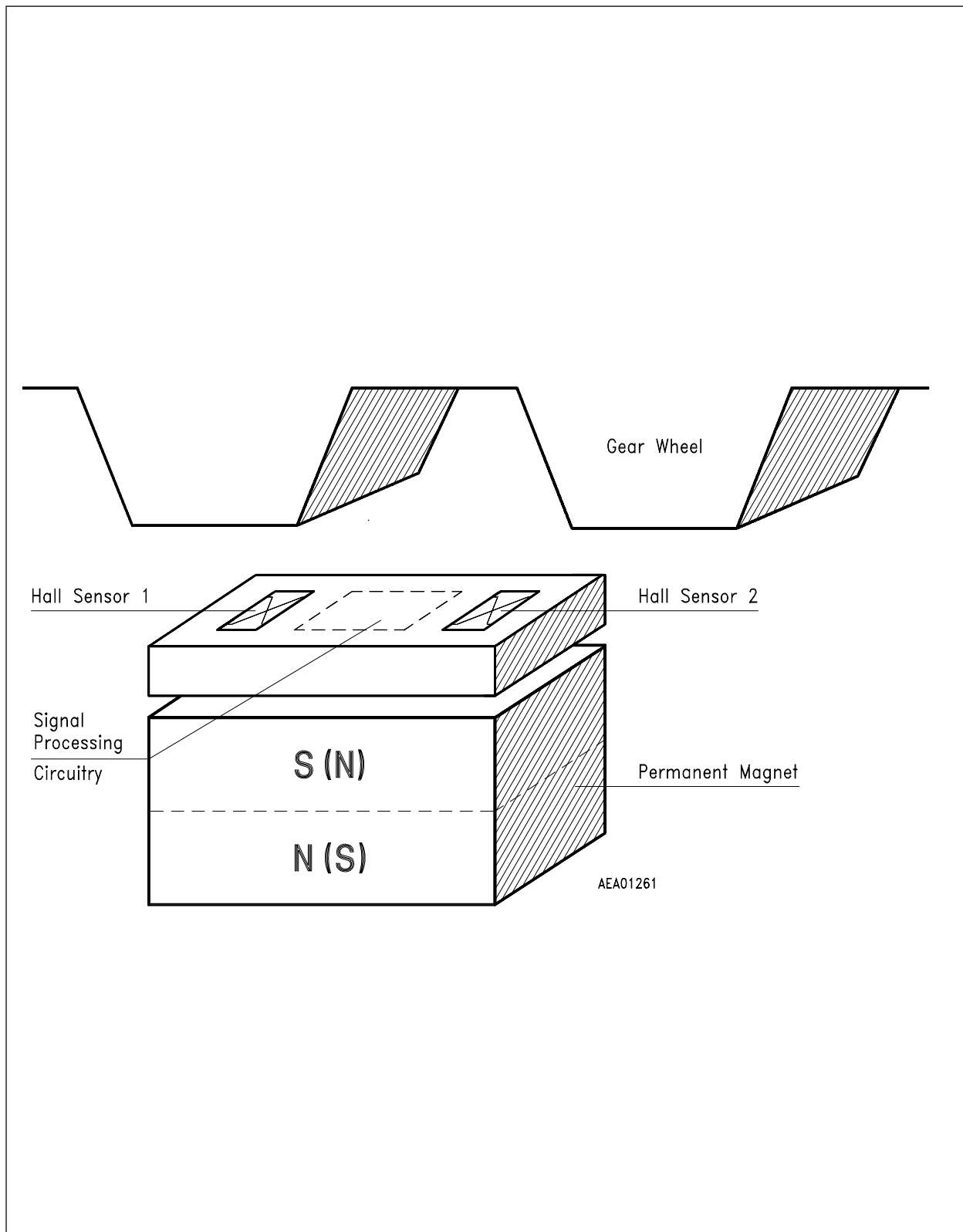


Figure 7
TLE 4921-2U, with Ferromagnetic Toothed Wheel

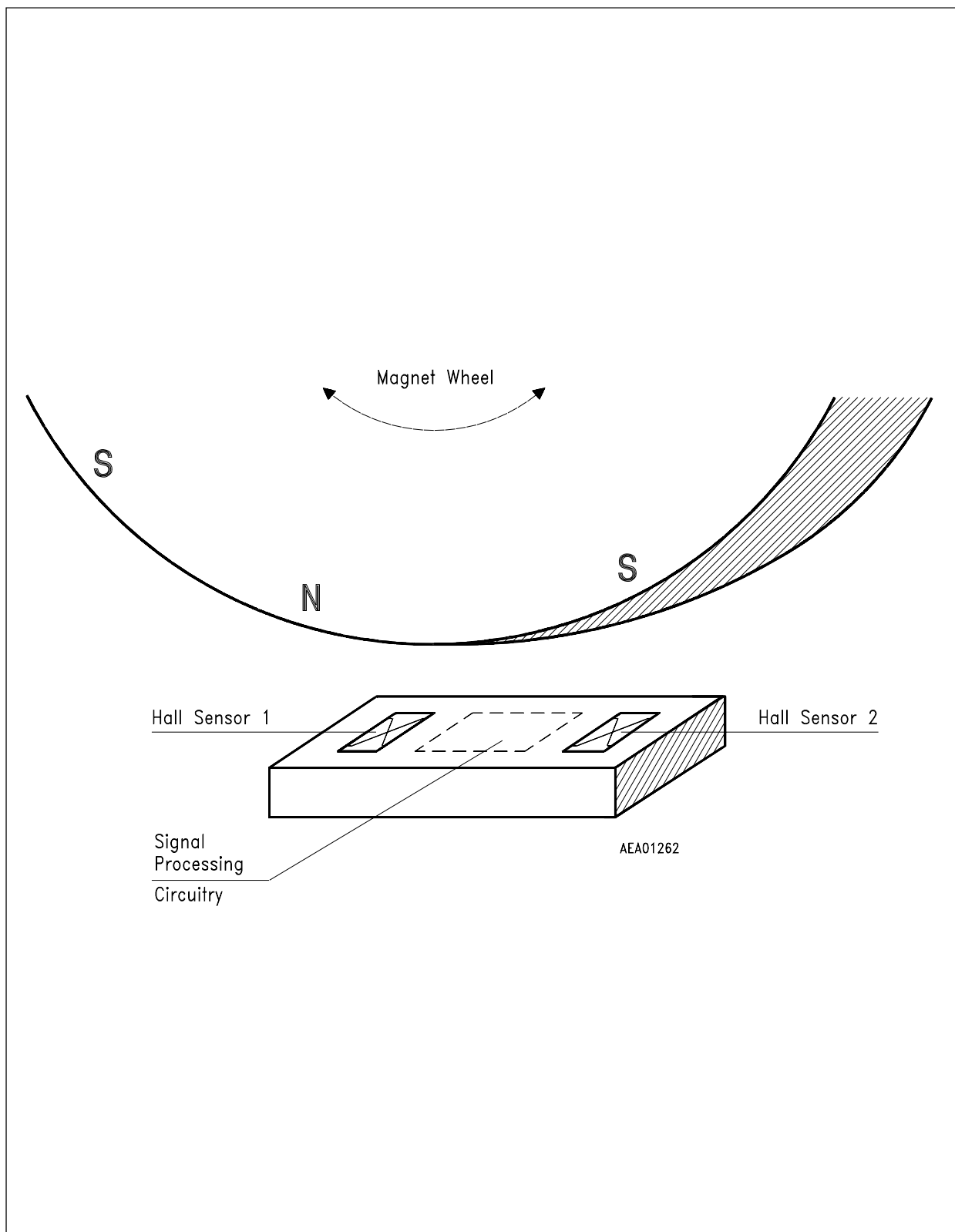


Figure 8
TLE 4921-2U, with Magnet Wheel

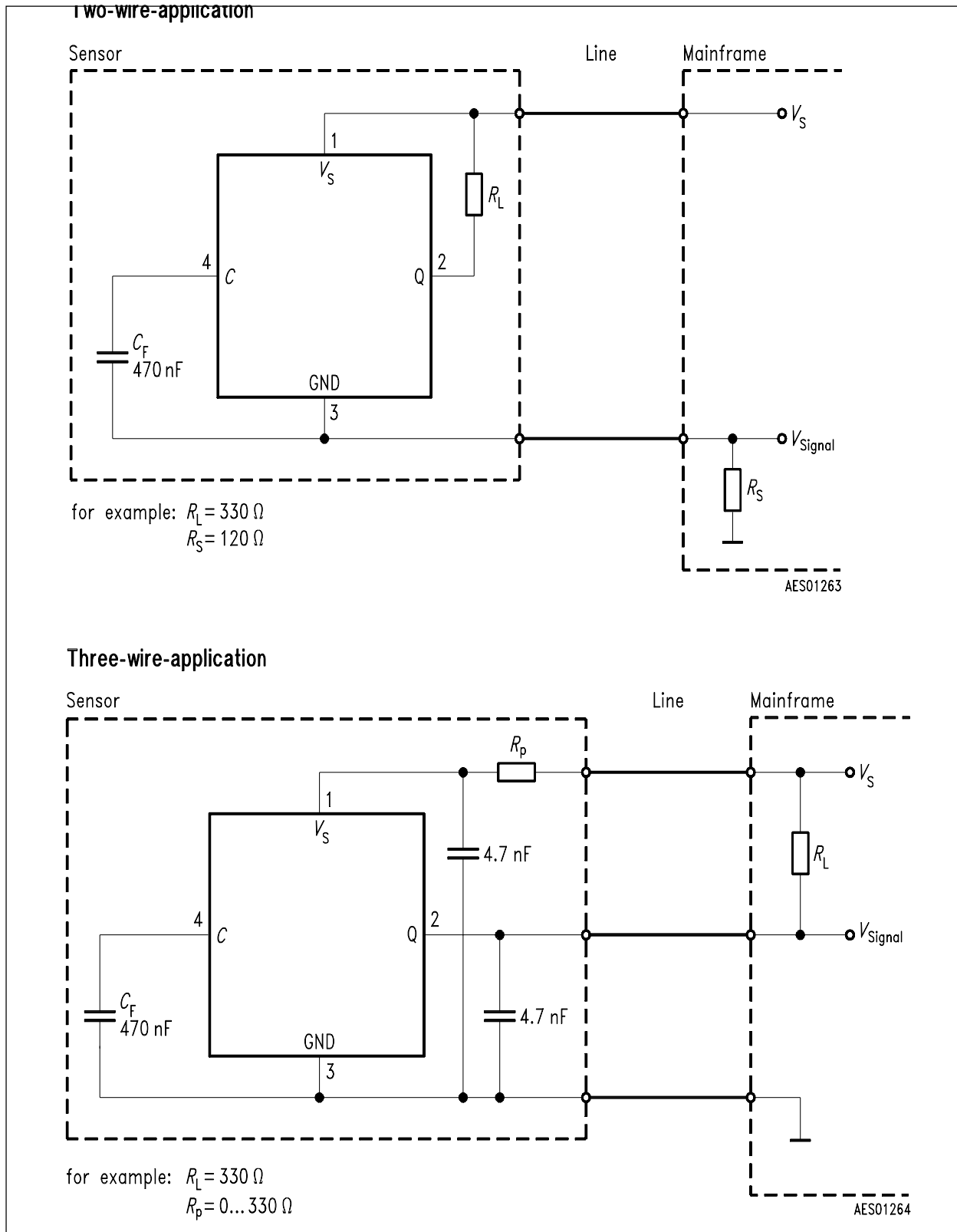


Figure 9
Application Circuits

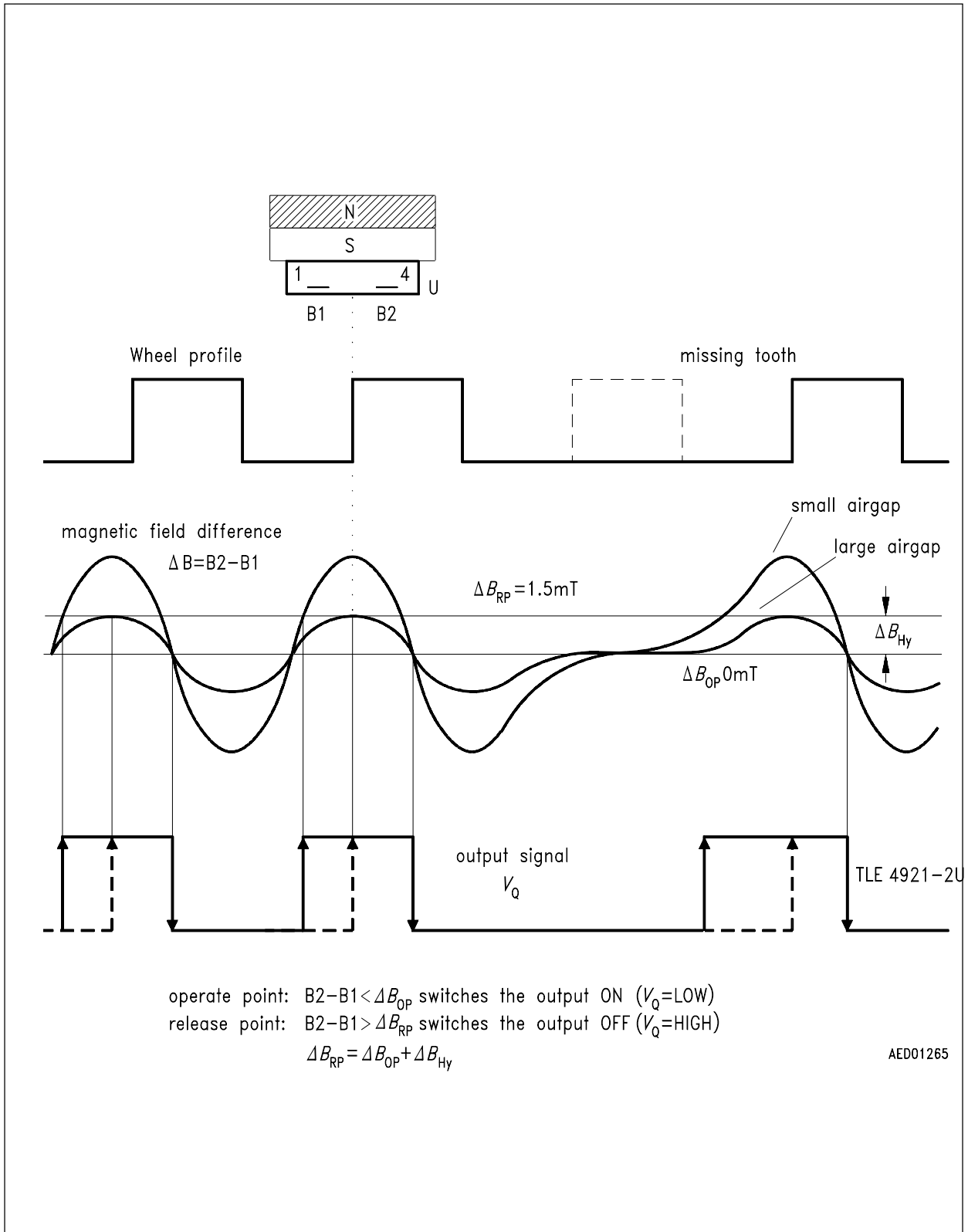
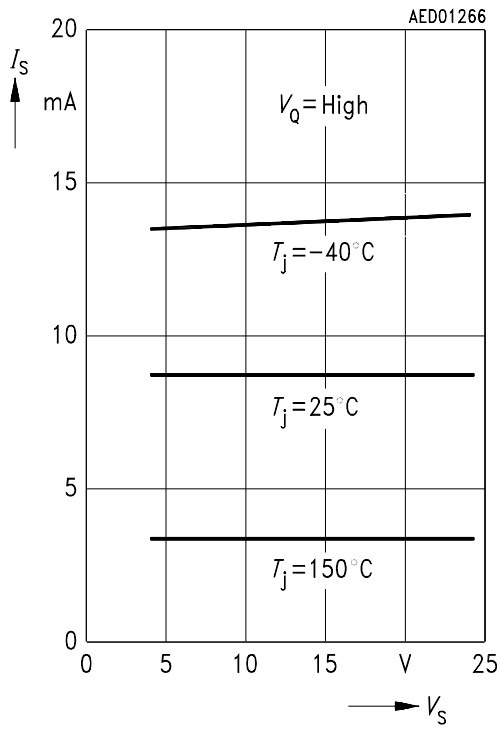
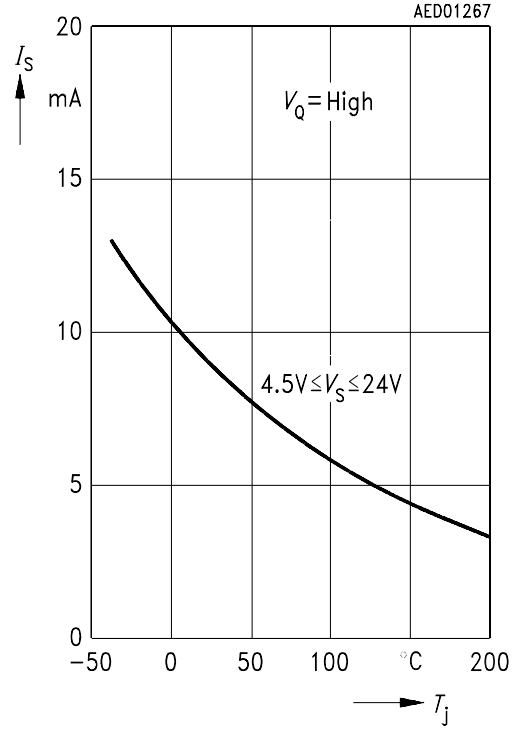


Figure 10
System Operation

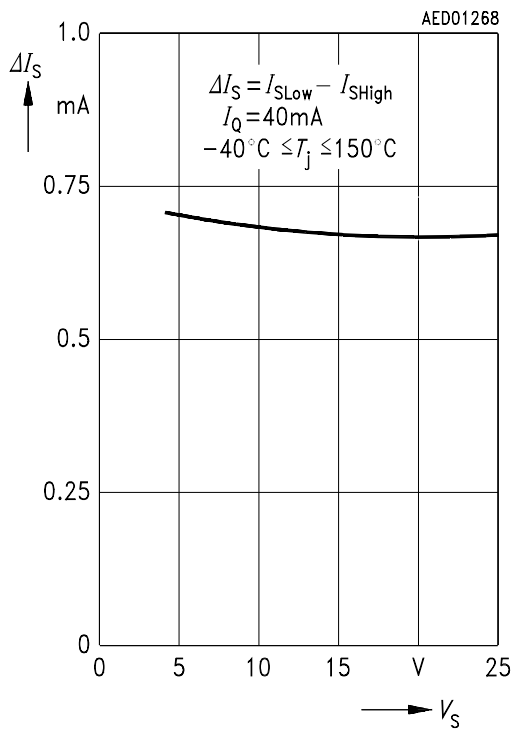
Quiescent Current versus Supply Voltage



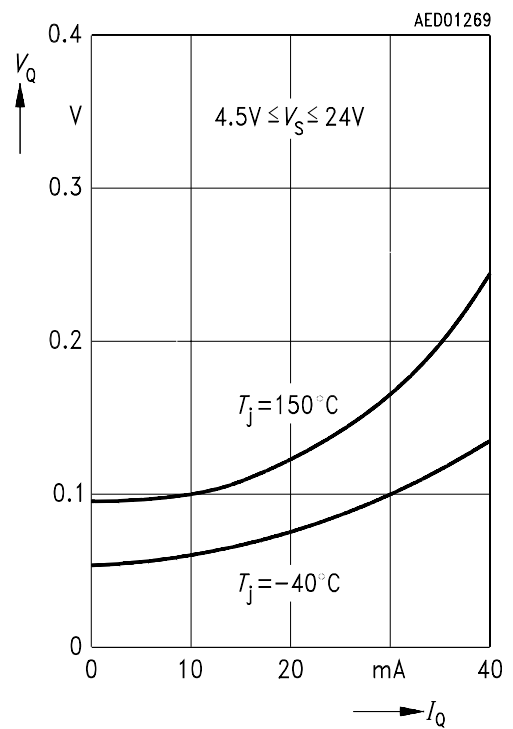
Quiescent Current versus Junction Temperature



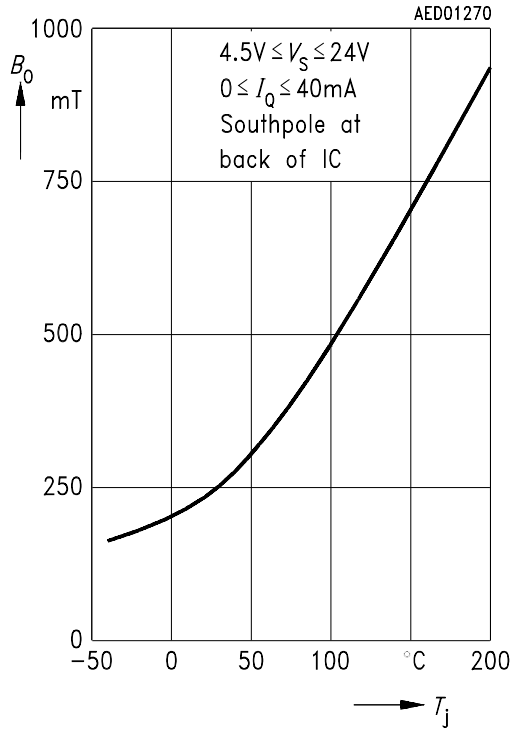
Quiescent Current Difference versus Supply Voltage



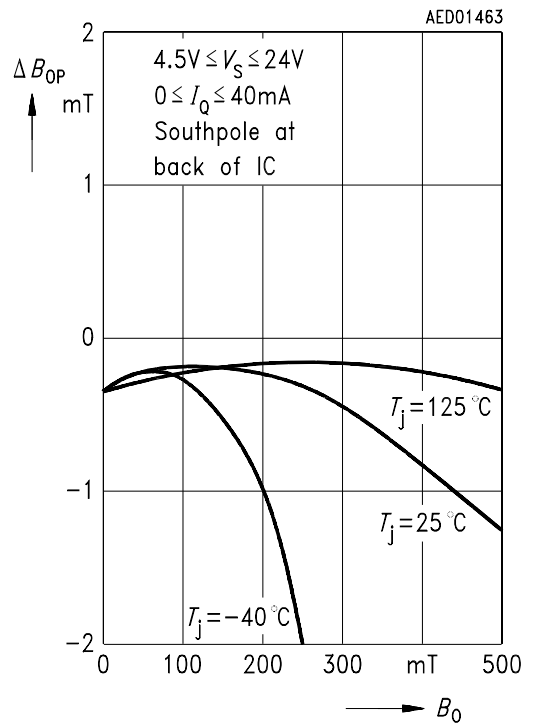
Saturation Voltage versus Output Current



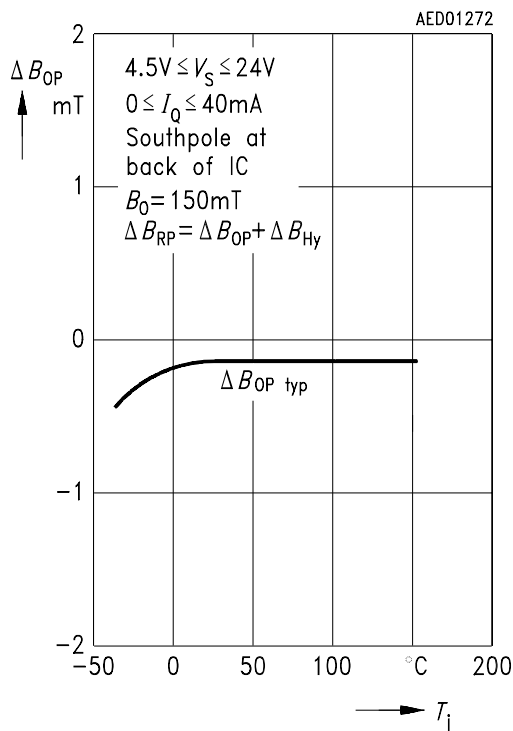
Maximum Preinduction versus Junction Temperature



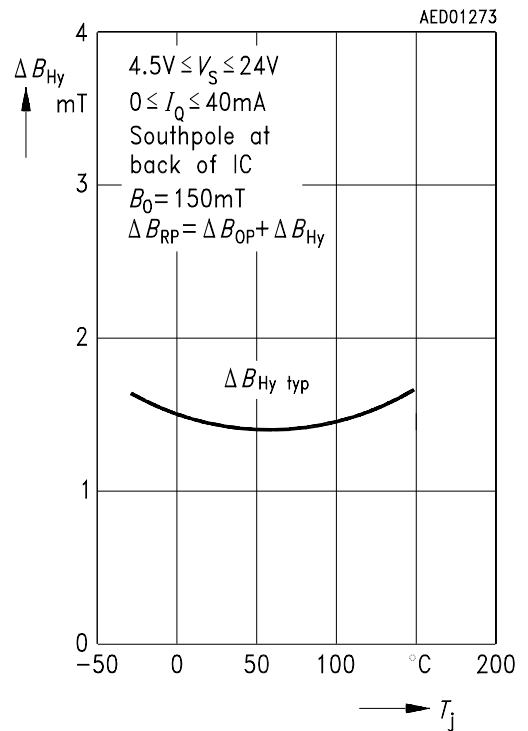
Switching Induction versus Preinduction



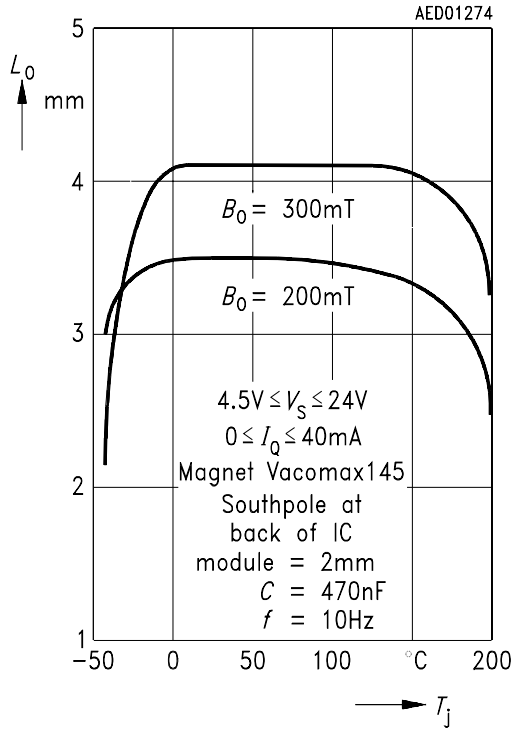
Switching Induction versus Temperature



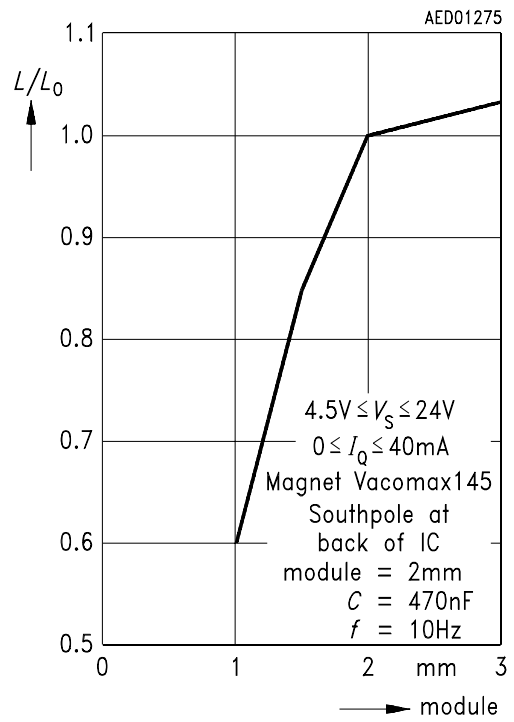
Hysteresis Induction Versus Junction Temperature



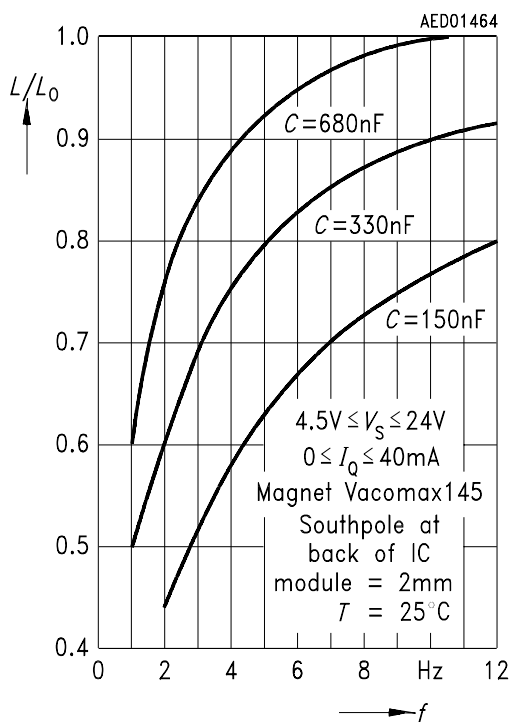
Distance IC-tooth Wheel versus Junction Temperature



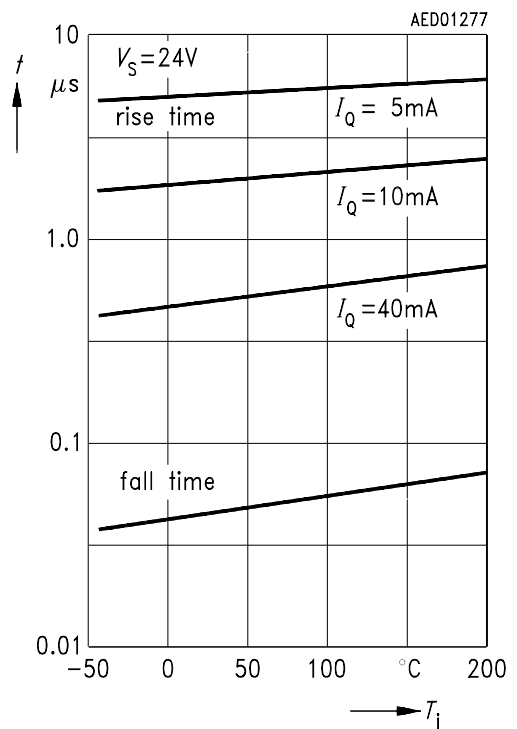
Relative Distance versus Module



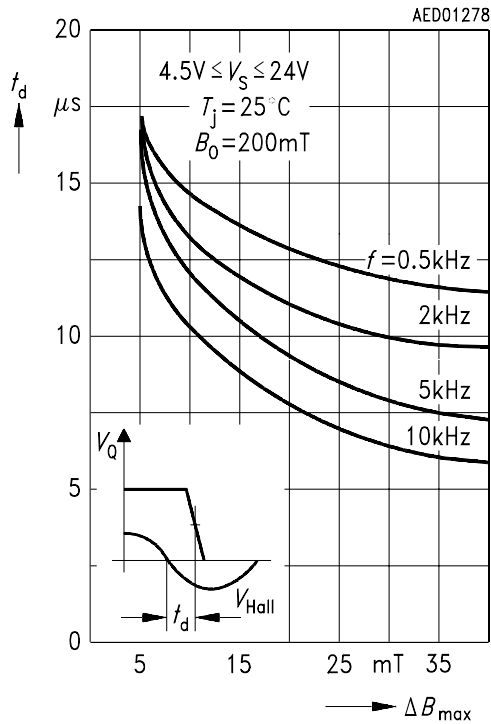
Relative Distance versus Switching Frequency



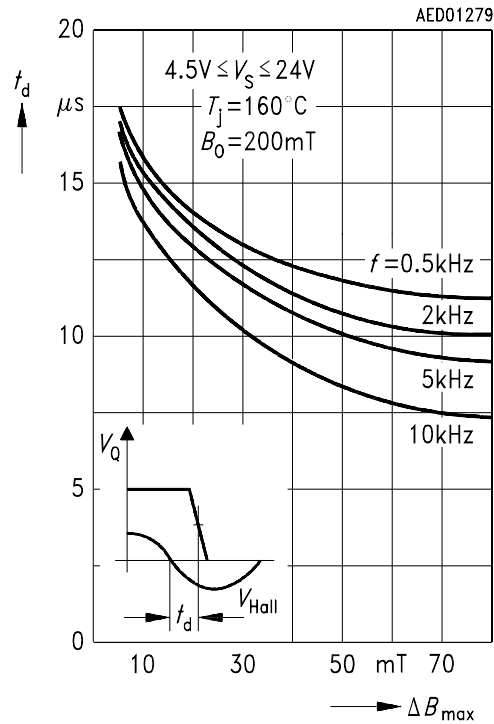
Fall- and Rise-Time versus Junction Temperature



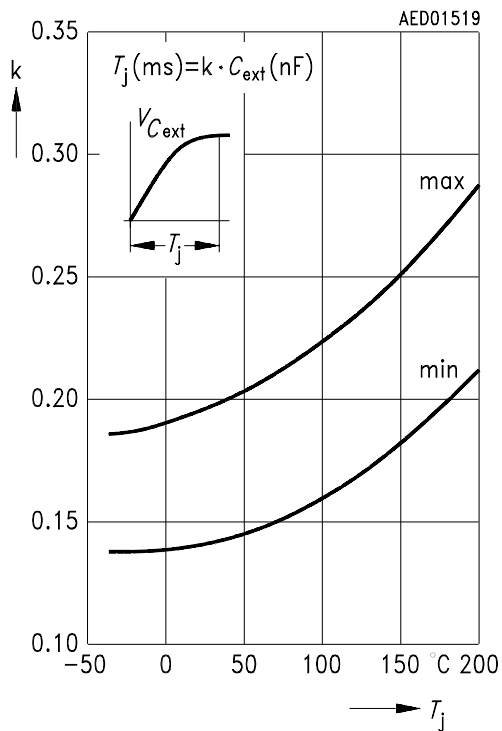
Delay Time between Zero-Axis Crossing of ΔB and Falling Edge of V_Q at $T_j = 25^\circ\text{C}$



Delay Time between Zero-Axis Crossing of ΔB and Falling Edge of V_Q at $T_j = 160^\circ\text{C}$



Delay time T_j versus Junction Temperature for V_S Switching from 0 V to 4.5 V



Influence of Filter and Delay Time for Different ΔB_{max} values

