

Differential Hall Effect Sensor ICs

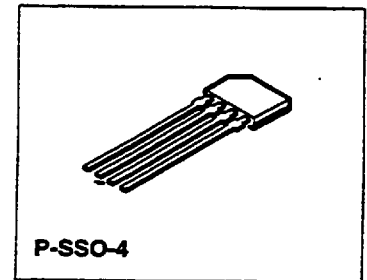
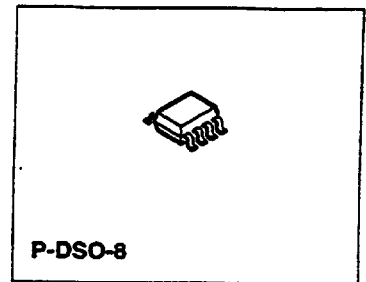
TLE 4921-2 G/U

Bipolar-IC

Preliminary Data

Features

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



The differential Hall Effect sensor TLE 4921-2 G/U 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.

Type	Ordering Code	Package
TLE 4921-2G	Q67000-A9141	P-DSO-8 (SMD)
TLE 4921-2U	Q67006-A9055	P-SSO-4

The information in this data sheet describes the type of component and shall not be considered as assured characteristics. Terms of delivery and rights to change design reserved.

Liability for patent rights of third parties for components perse, not for circuitries / applications.

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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 4921-2 G/U 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 4921-2 G/U 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 4921-2 G/U is comprised of a supply voltage reference, a pair of Hall probes spaced at 2.5mm, 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.

Block Diagram 1

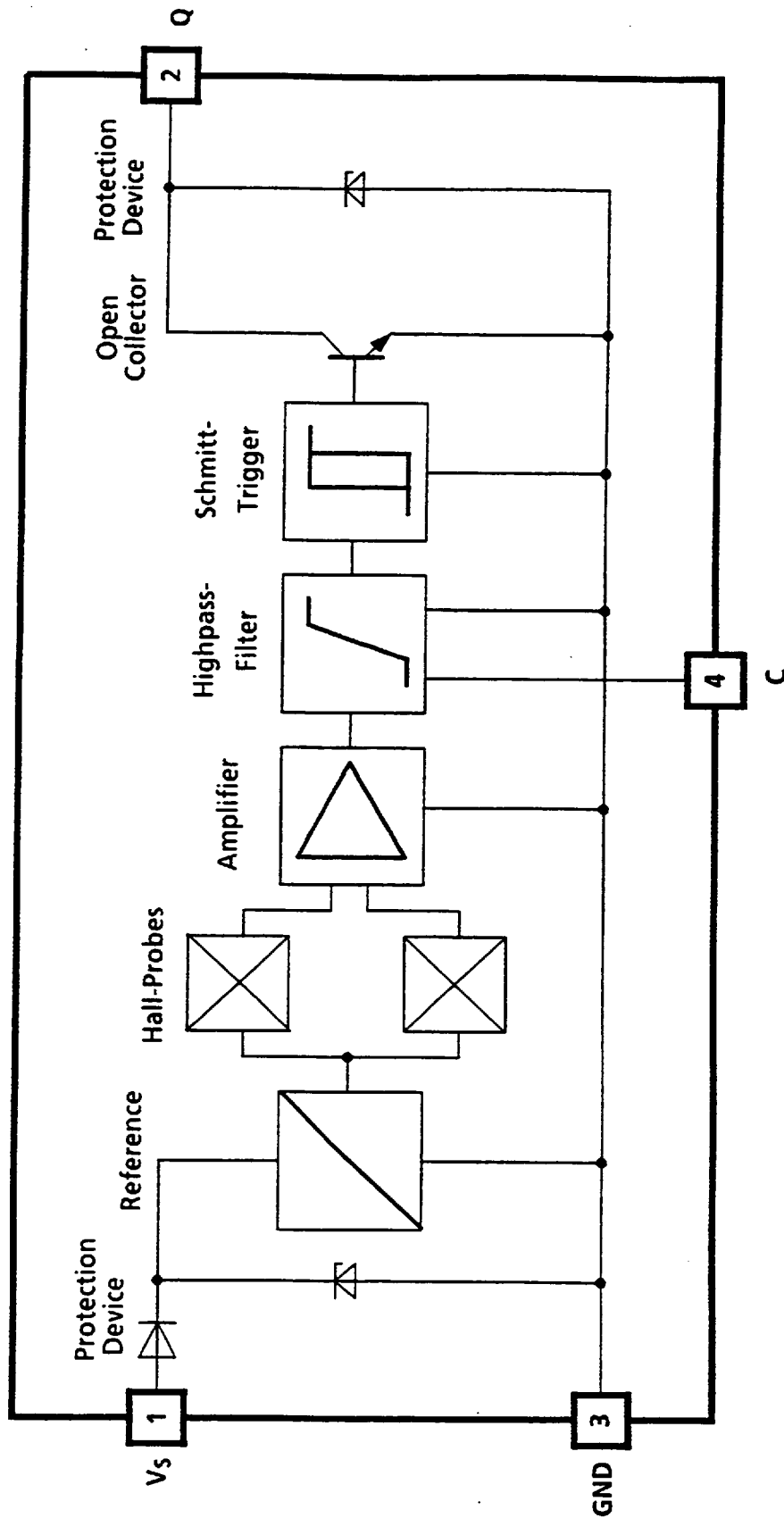


Figure 1

Block Diagram 2

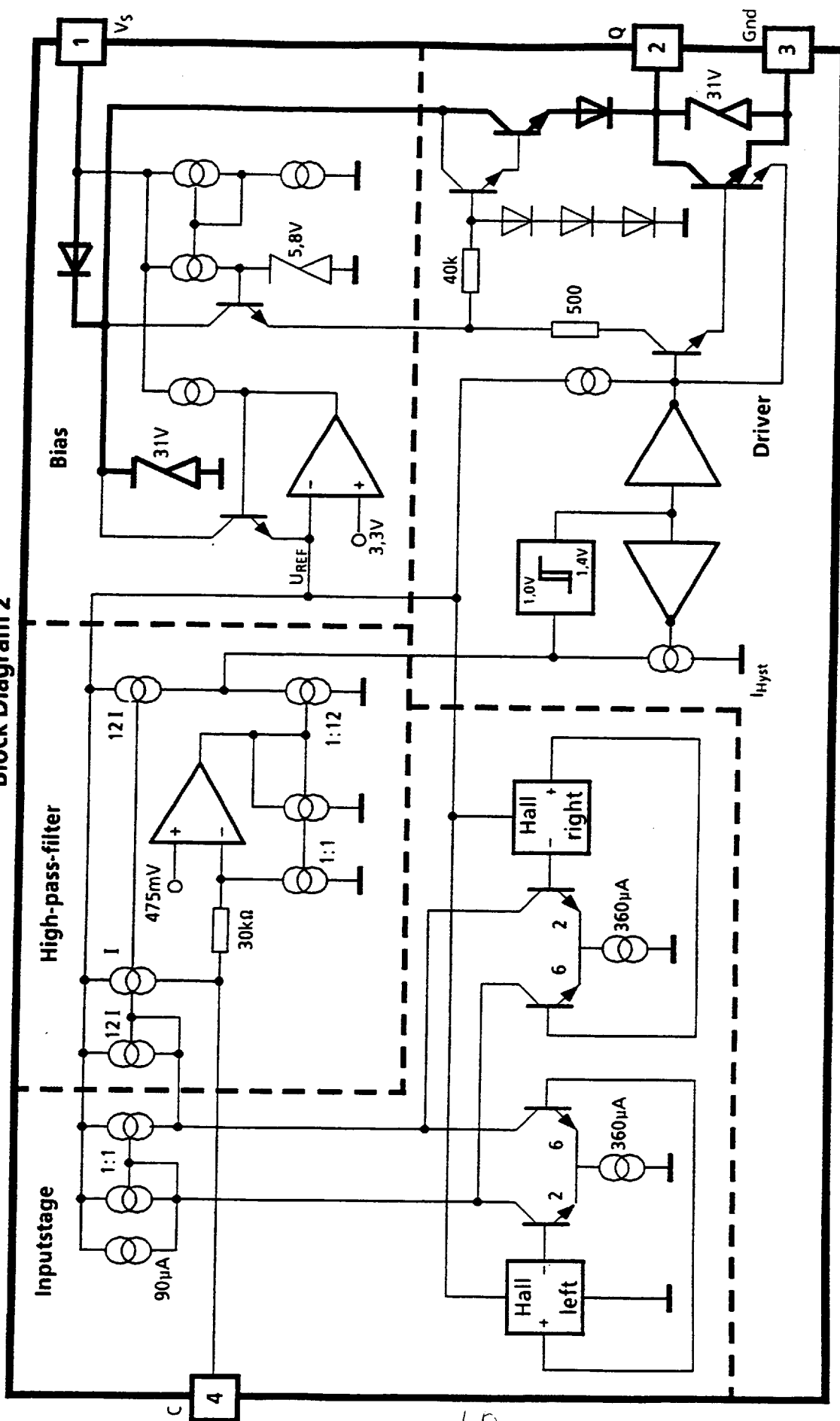
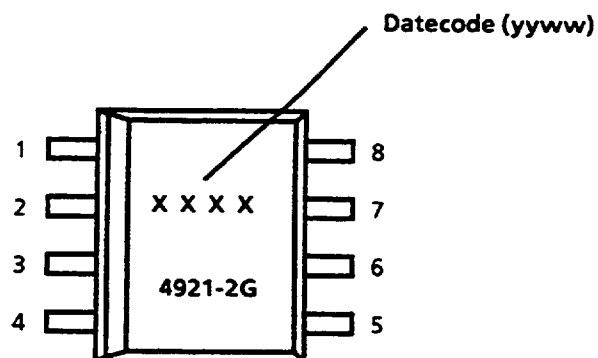


Figure 2

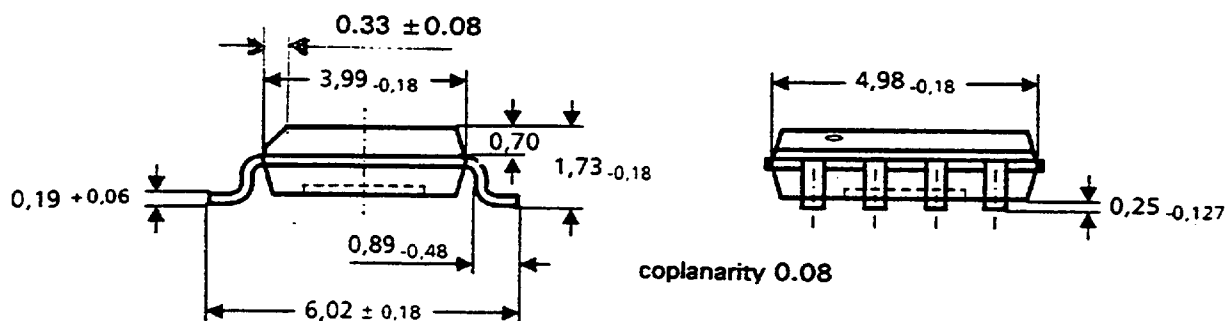
Pin Assignment



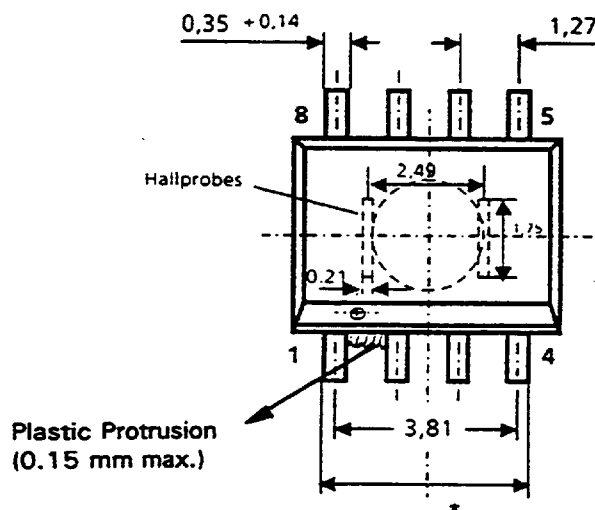
PIN	DESCRIPTION
1	Supply voltage (V _S)
2	Output (Q)
3	GND (Gnd)
4	Capacitor (C)
5	not connected
6	not connected
7	not connected
8	not connected

Package Outline

Plastic-Package P-DSO-8, Suffix "G"
(Dual-in-Line-Package, Small-Outline)
20 A 8 DIN 41870 T16 (SMD)

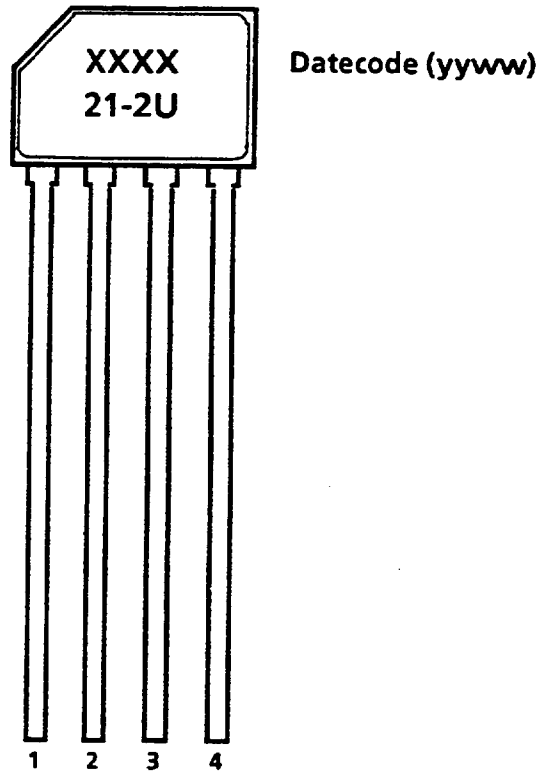


* center of sensitive area
is toleranced $\pm 0,10$ mm
to the center of pin outline



Note: Package width $3.99 - 0.18$ does not
include plastic protrusion

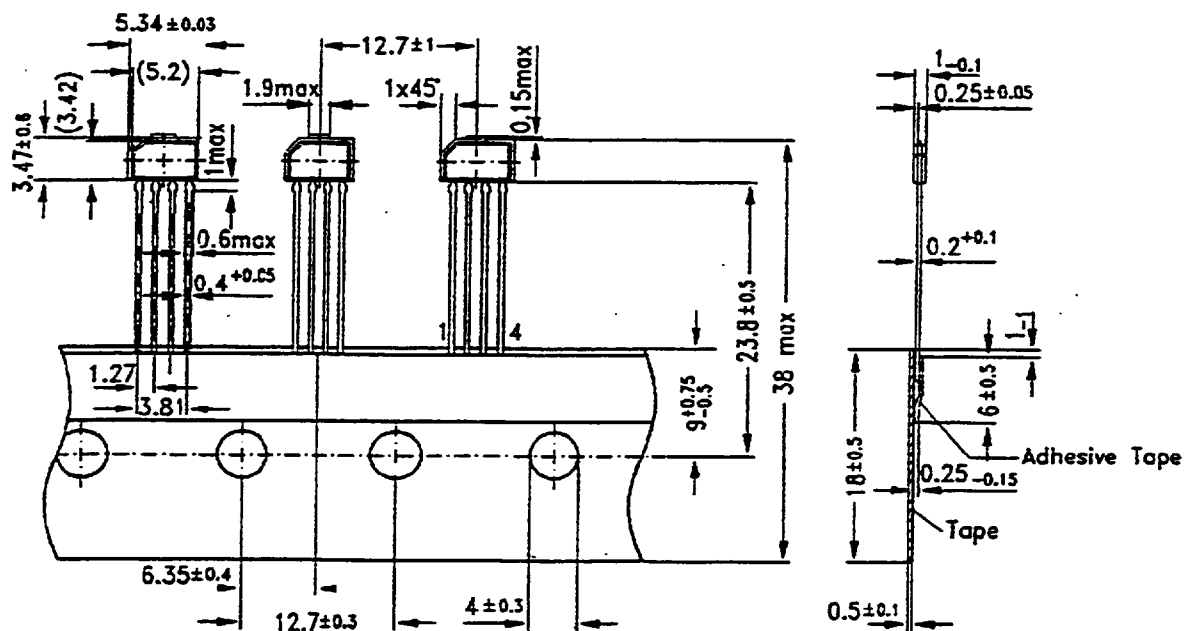
Pin Assignment



PIN	DESCRIPTION	TLE 4921-2U
1	Supply voltage	(V _S)
2	Output	(Q)
3	GND	(Gnd)
4	Capacitor	(C)

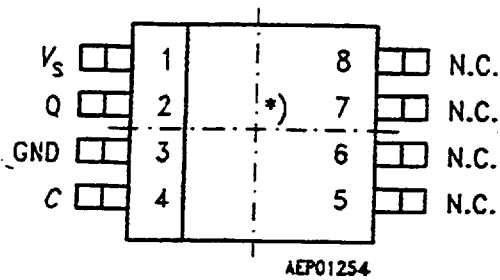
Package Outline/Packing

Plastic Package, P-SSO-4, Suffix "U"
(Single-in-Line-Package, Small-Outline, Tape and Reel)



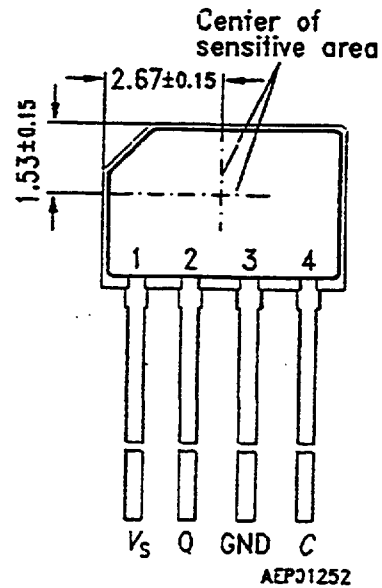
Sensor Position

TLE 4921-2G



*) Center of sensitive area
is toleranced ± 0.10 mm
to the center of pin outline

TLE 4921-2U



Preliminary Data**Absolute Maximum Ratings**

The maximal ratings may not be exceeded under any circumstances, not even momentarily and individually, as permanent damage to the IC will result.

Max. Ratings for junction temperature T_j - 40 °C to 150 °C	Symbol	Min.	Max.	Units	Remarks Testcondition:
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	U_C	-0.3	3	V	
Junction temperature	T_j		150	°C	
Junction temperature	T_j		170	°C	1000h
Junction temperature	T_j		210	°C	40h
Storage temperature	T_s	-40	150	°C	
Thermal resistance	R_{thJA} R_{thJA}		125 190	K/W K/W	P-DSO-8 P-SSO-4
Current through input-protection device	I_{SZ}		200	mA	$t < 2ms$; $v = 0.1$
Current through output-protection device	I_{QZ}	-200	200	mA	$t < 2ms$; $v = 0.1$
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	$t_d = 0.1 \mu s$
Testpulse 3b	V_{LD}		100	V	$t_d = 0.1 \mu s$
Testpulse 4	V_{LD}	-7		V	$t_d \leq 20 s$
Testpulse 5	V_{LD}		120	V	$t_d = 400 ms$, $R_p = 450 \Omega$

Operational Range

Within the operational range the IC operates as described in the circuit description. The AC/DC characteristic limits are not guaranteed.

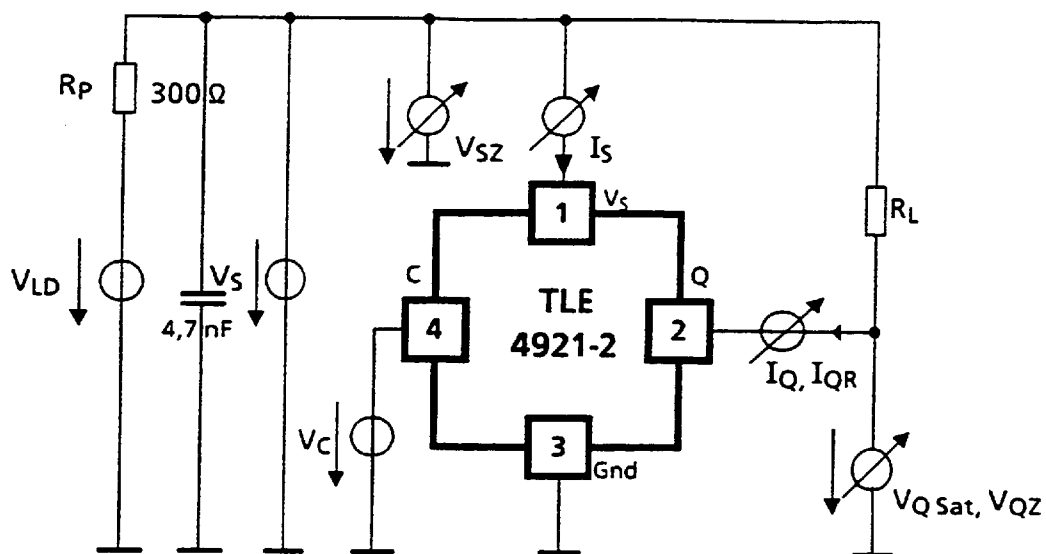
Parameter	Sypmbol	Min.	Max.	Units	Remarks
Supply voltage	V _S	4,5	24	V	
Junction temperature	T _J	-40	150	°C	
Junction temperature	T _J	-40	170	°C	1000h
Junction temperature	T _J	-40	210	°C	40h
Pre-Induction	B _O	0	200	mT	Southpole at the backside of IC

AC/DC Characteristics

AC/DC characteristics involve the spread of values guaranteed within the specified supply voltage and junction temperature range. Typical characteristics are the median of the production.

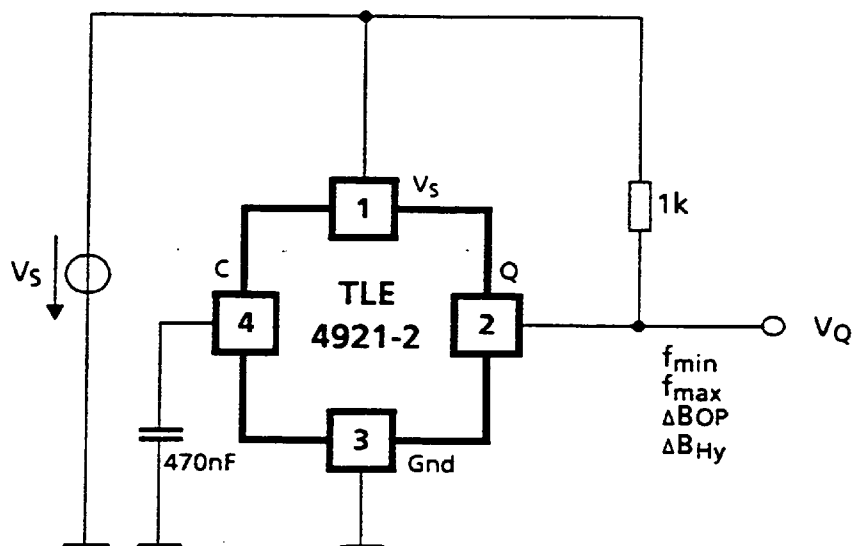
Parameter Units	Symbol	Test Conditions	Test Circuit	Min.	Typ	Max.	
Supply voltage Junction temperature		$4,5V \leq V_S \leq 24V$ $-40^\circ C \leq T_J \leq 150^\circ C$ $B_0 = 0 \text{ mT}$					
Supply current	I_S	$V_Q = \text{High}, I_Q = 0 \text{ mA}$	1	3.5	8.5	14	mA
	I_S	$V_Q = \text{Low}, I_Q = 40 \text{ mA}$	1	4.0	9	14.5	mA
Output saturation voltage	V_{QSat}	$I_Q = 40 \text{ mA}$	1		0,25	0.6	V
Output leakage current	I_{QL}	$V_Q = 24V$	1			10	μA
Switching frequency	f	$C = 470 \text{ nF}, \Delta B = 5 \text{ mT}$	2	5		20000	Hz
Switching flux density	ΔB_{OP}	$f = 100 \text{ Hz}, C = 470 \text{ nF}$	2	-1	0	1	mT
Hysteresis	ΔB_{Hy}	$f = 100 \text{ Hz}, C = 470 \text{ nF}$	2	0,5	1.5	2,5	mT
Overvoltage protection							
- at supply voltage	V_{SZ}	$I_S = 16 \text{ mA}$	2	27		35	V
- at output	V_{QZ}	$I_S = 16 \text{ mA}$	2	27		35	V

Test Circuit 1



Test Circuit 2

- $B_0 = 100\text{mT}$; southpole at the back of IC
- tooth wheel with module $m = 2\text{mm}$
- Distance IC-object $L = 1\text{mm}$



Application Notes

Two possible applications are shown in figure 3 and 4 (Toothed and Magnet Wheel).

The differences between two-wire and three-wire application is shown in figure 5.

Gear tooth sensing

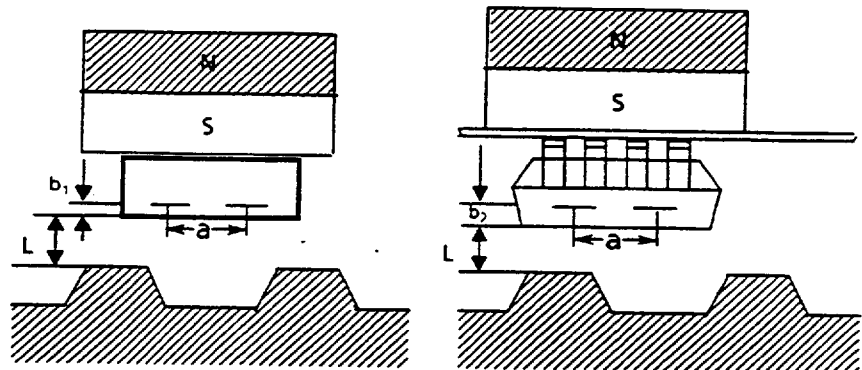
In the case of ferromagnetic toothed wheel application the IC has to be biased by the southpole of a permanent magnet (e.g. SECo₅ (Vacuumschmelze VX145) with the dimensions 8 mm x 5 mm x 3 mm) which should cover both hallprobes.

The maximum air gap depends on

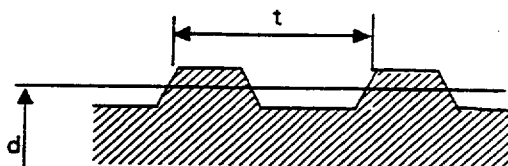
- the magnetic field strength (magnet used),
- the tooth wheel that is used (dimensions, material, etc),
- the ambient temperature
- the connected capacitor

Sensor spacing

- a centred distance of hall-probes $a = 2.5\text{mm}$
 b hall-probes to IC surface $b_1 = 0.25\text{mm}$
 $b_2 = 0.5\text{mm}$
 L IC surface to tooth wheel



Tooth wheel dimensions



Conversion DIN - ASA

$m = 25.4 \text{ mm/p}$

$t = 25.4 \text{ mm} \times \text{CP}$

DIN

- d diameter (mm)
 z number of teeth
 m module $m = d/z$ (mm)
 t pitch $t = \pi \times m$ (mm)

ASA

- p diametral pitch $p = z/d$ (inch)
 PD pitch diameter $PD = z/p$ (inch)
 CP circular pitch $CP = 1 \text{ inch} \times \pi / p$

TLE 4921-2 U, with Ferromagnetic Toothed Wheel

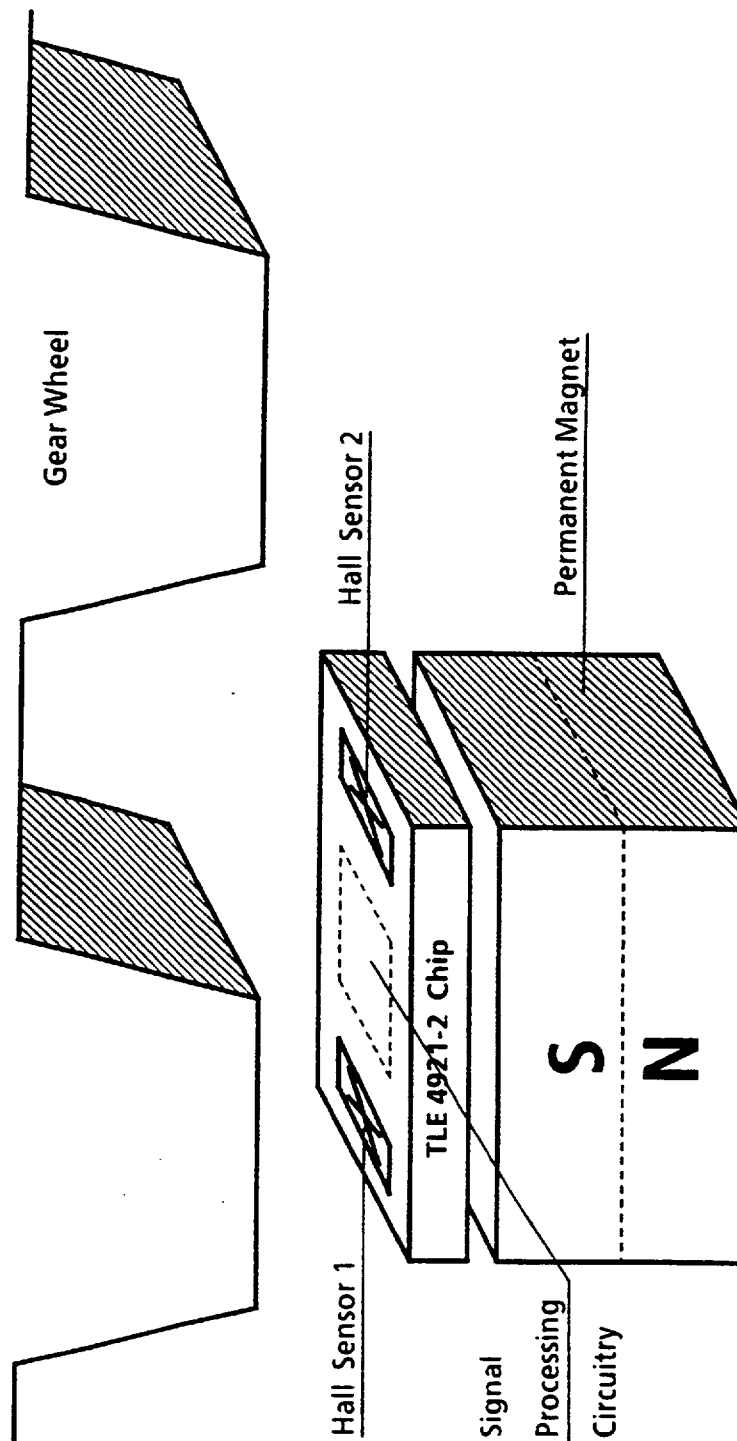


Figure 3

TLE 4921-2 G/U, with Magnet Wheel

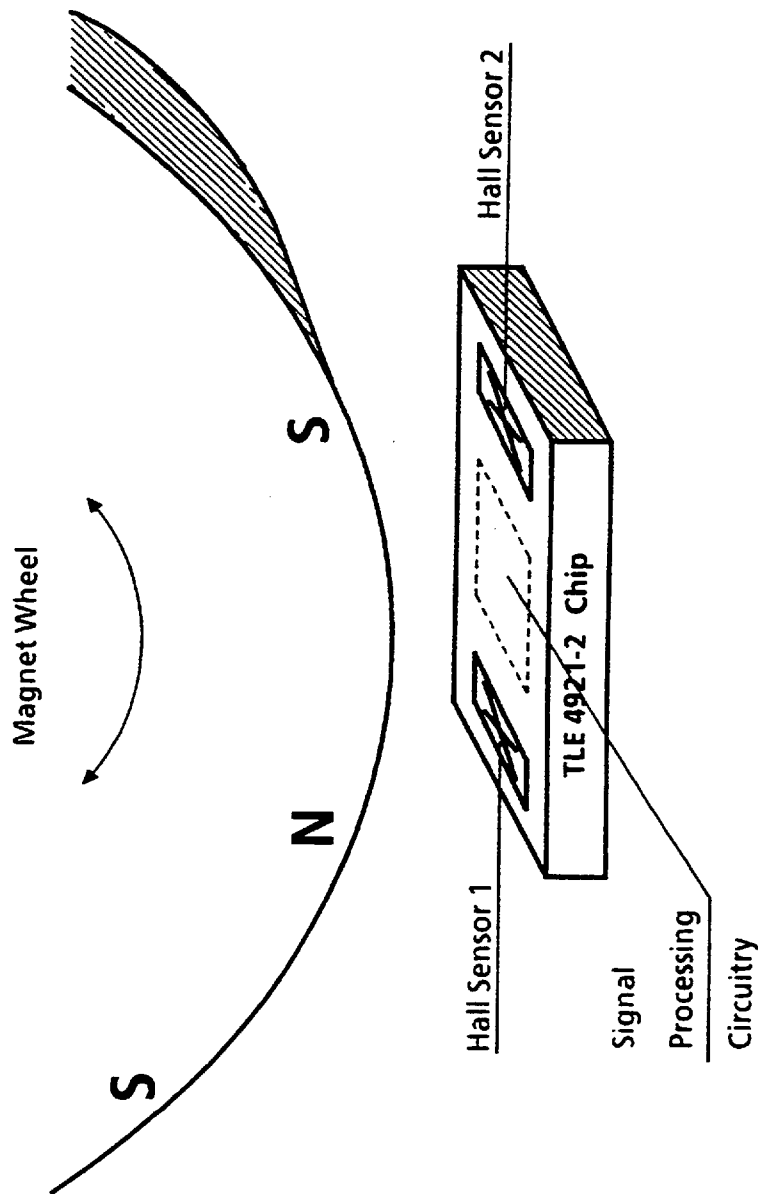
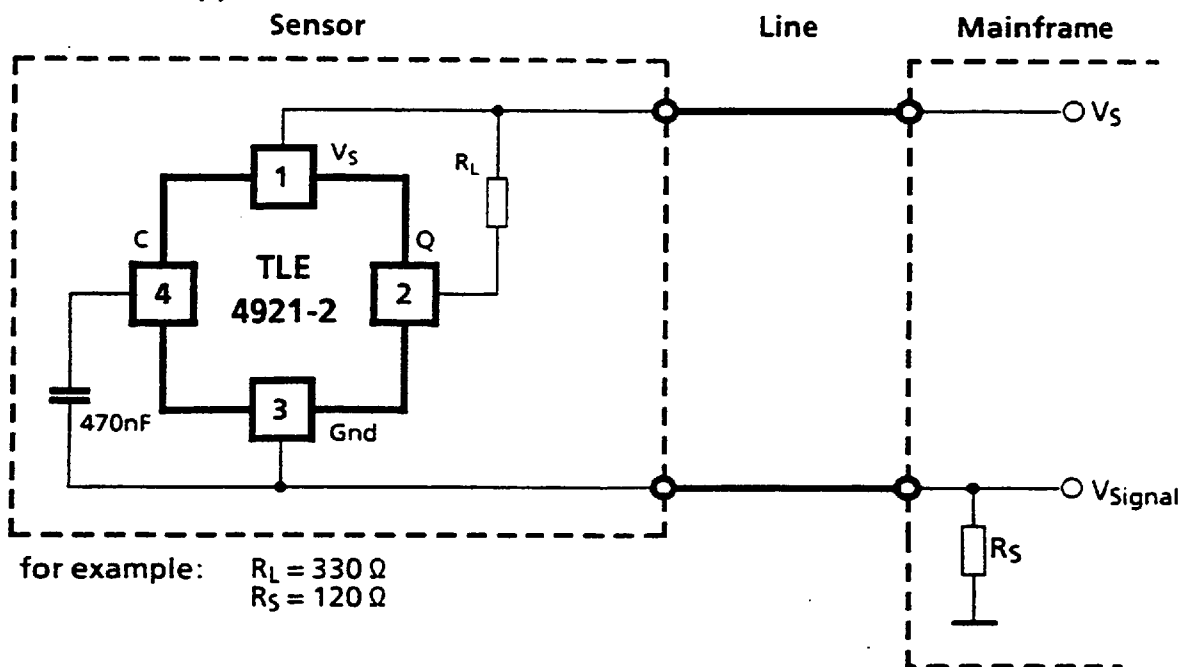


Figure 4

Two-wire-application:



Three-wire-application:

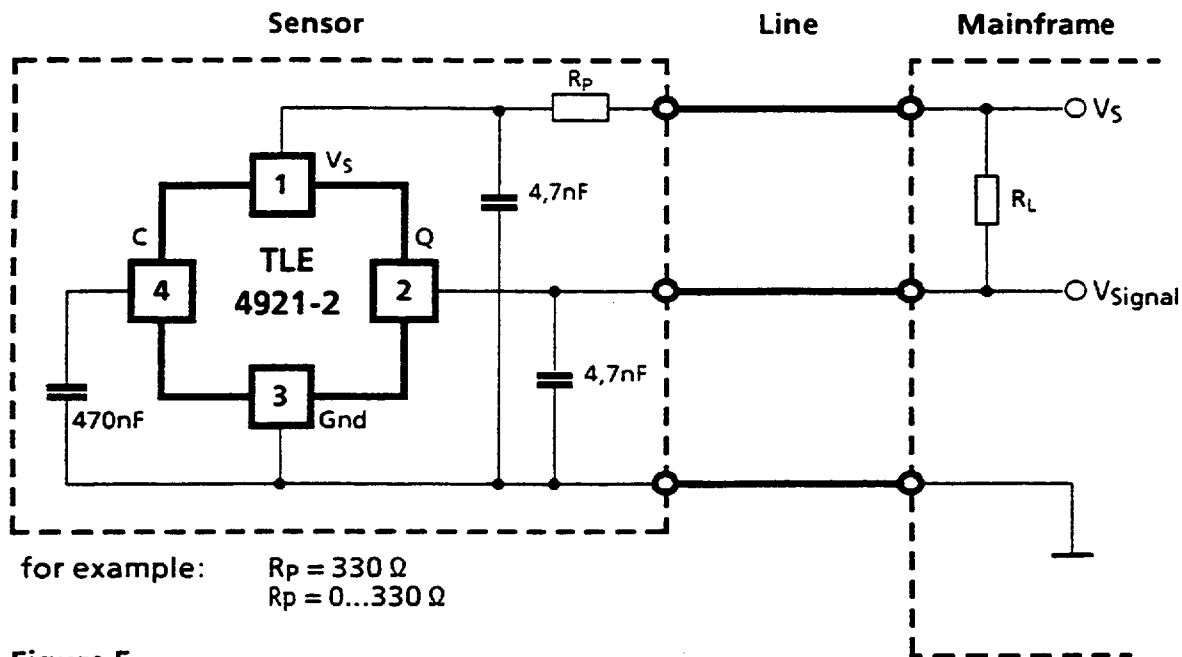
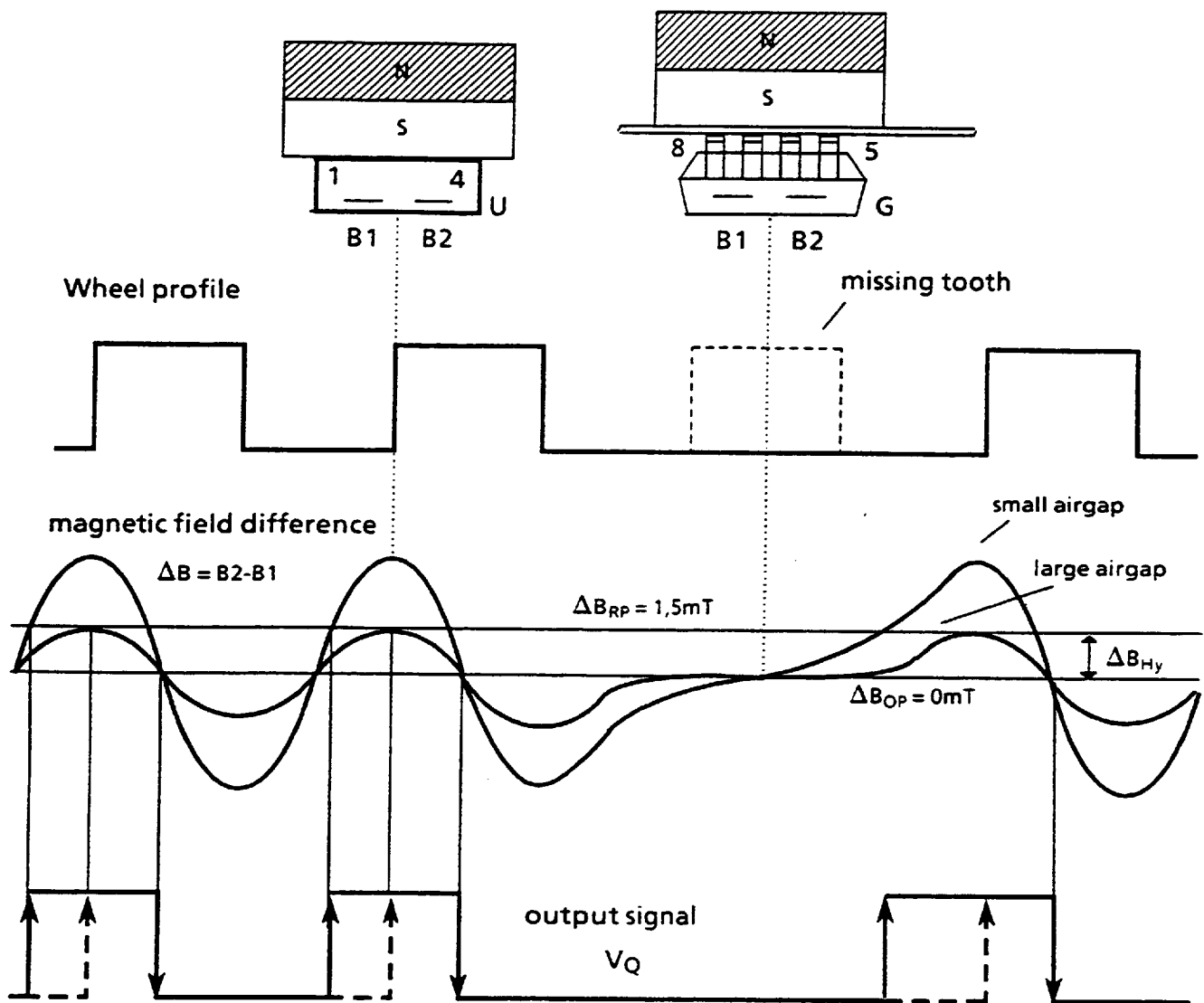


Figure 5

System Operation

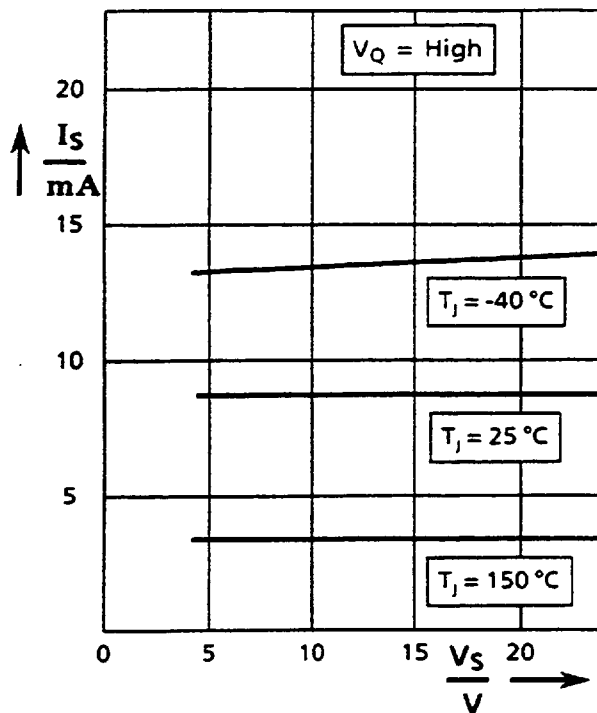


operate point: $B2 - B1 < \Delta B_{OP}$ switches the output ON ($V_Q = \text{LOW}$)
 release point: $B2 - B1 > \Delta B_{RP}$ switches the output OFF ($V_Q = \text{HIGH}$)
 $\Delta B_{RP} = \Delta B_{OP} + \Delta B_{Hy}$

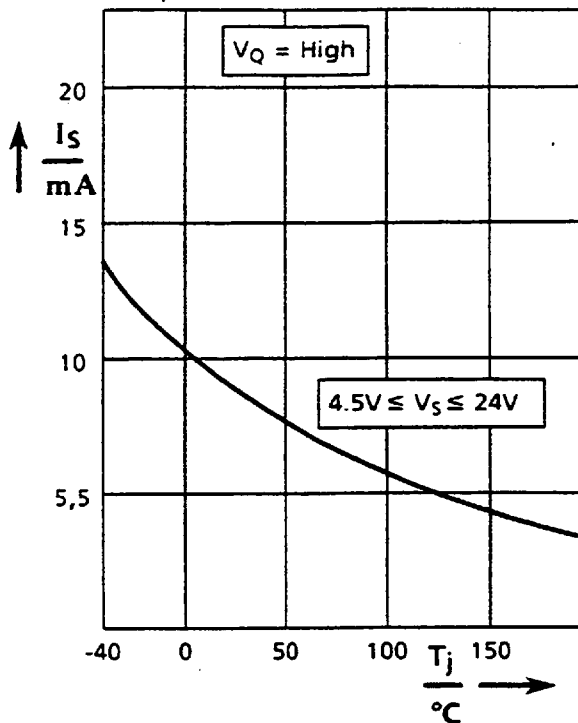
Diagrams

Preliminary Data

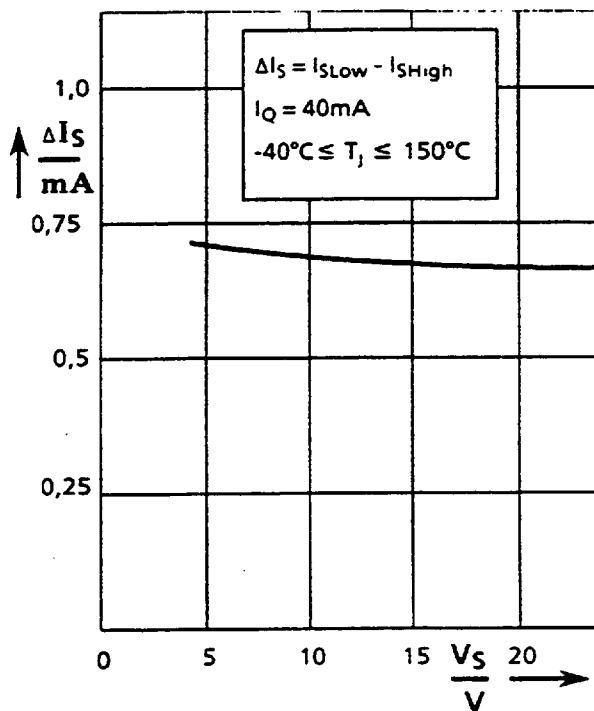
Quiescent current vs. supply voltage



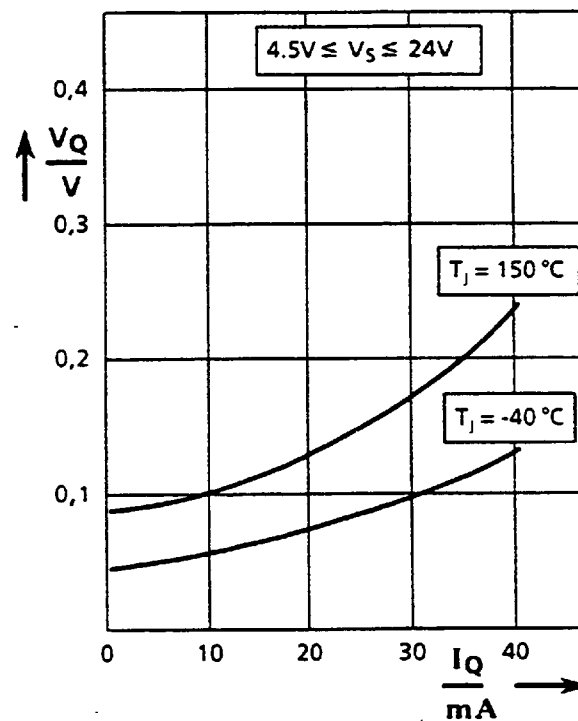
Quiescent current vs. junction temperature



Quiescent current difference vs. supply voltage



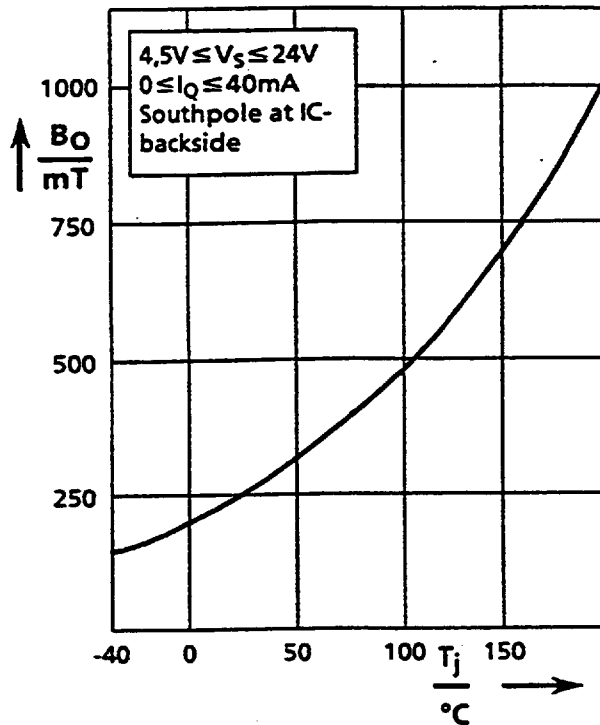
Saturation voltage vs. output current



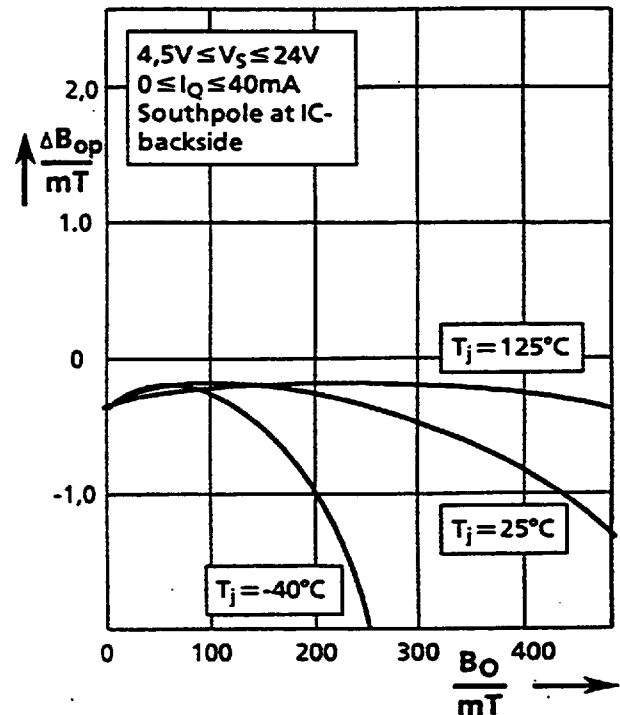
Diagrams

Preliminary Data

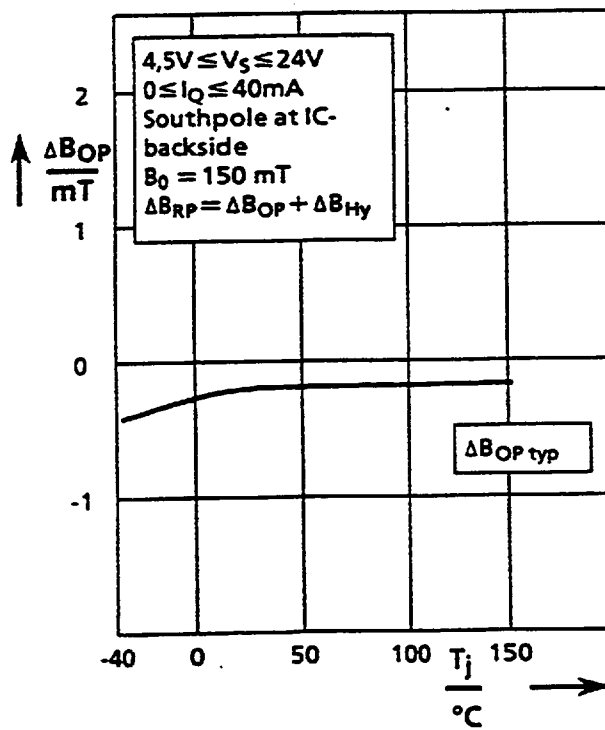
maximum preinduction vs. junction temperature



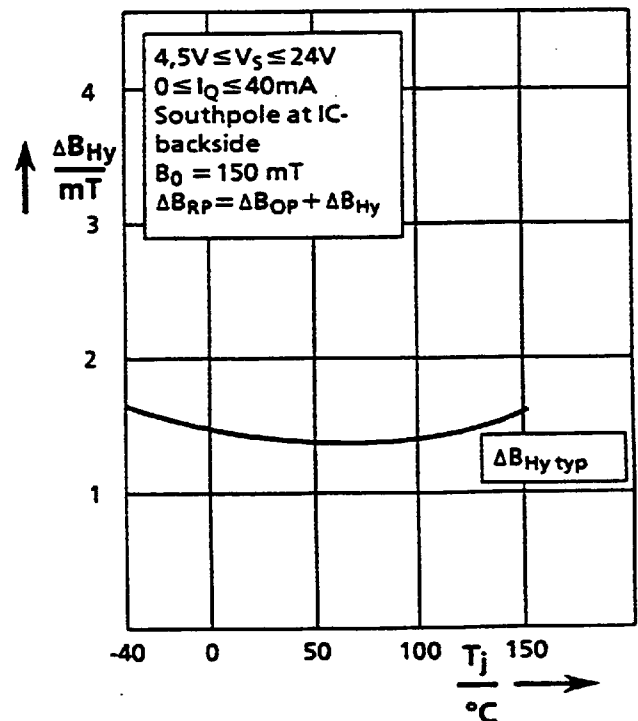
switching induction vs. preinduction



Switching induction vs. temperature



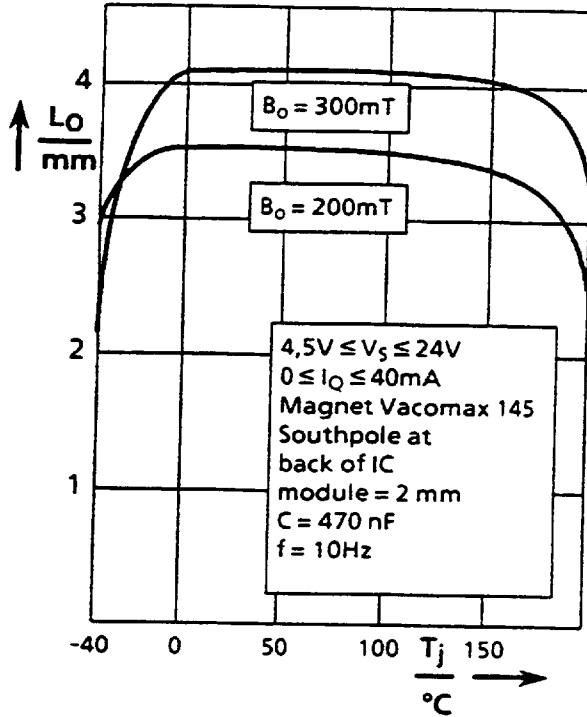
Hysteresis induction vs. junction temperature



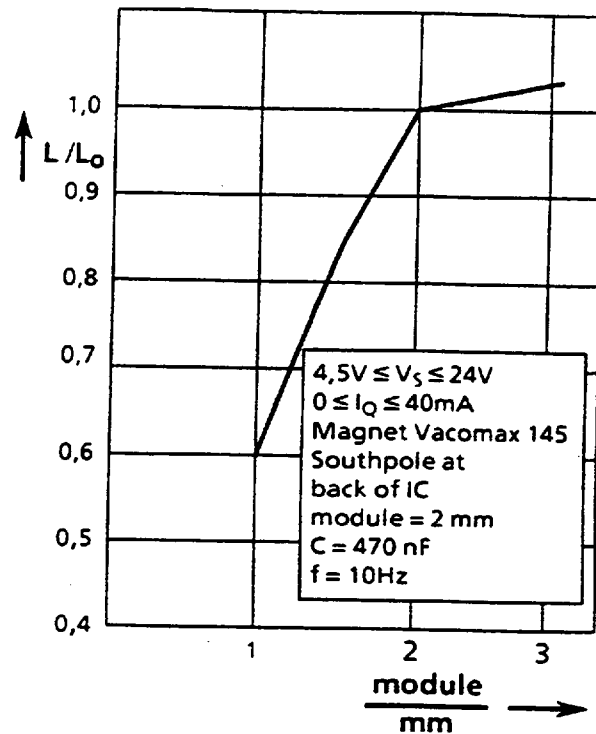
Diagrams

Preliminary Data

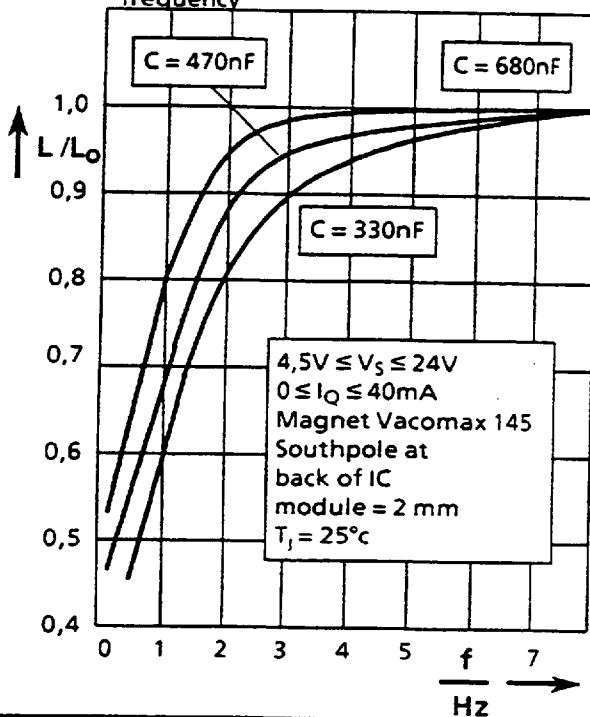
Distance IC-tooth wheel vs. junction temperature



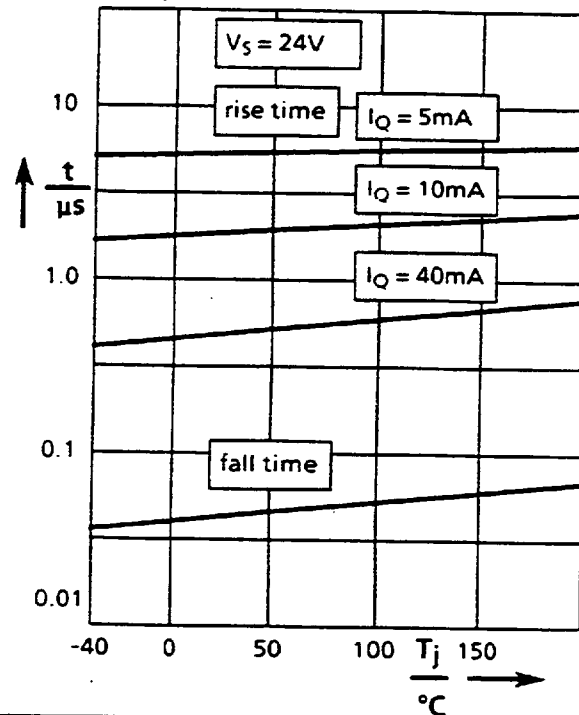
Relative distance vs. module



Relative distance vs. switching frequency



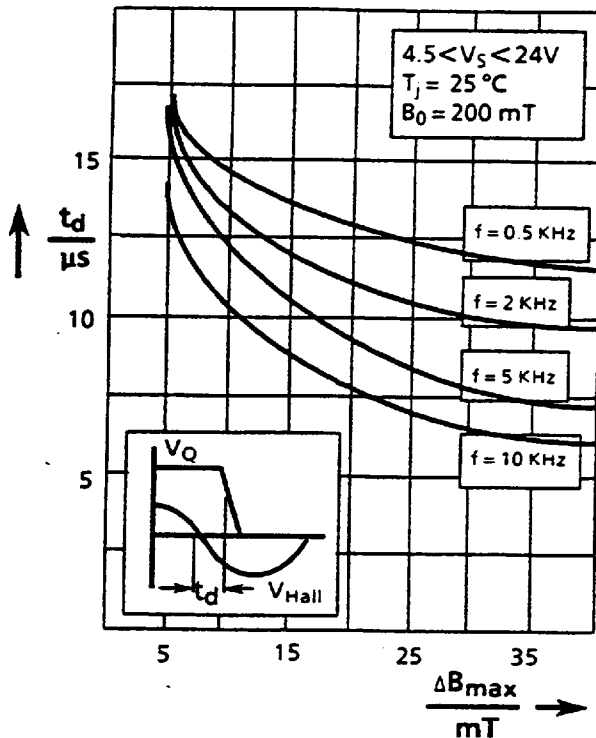
Fall- and rise- time vs. junction temperature



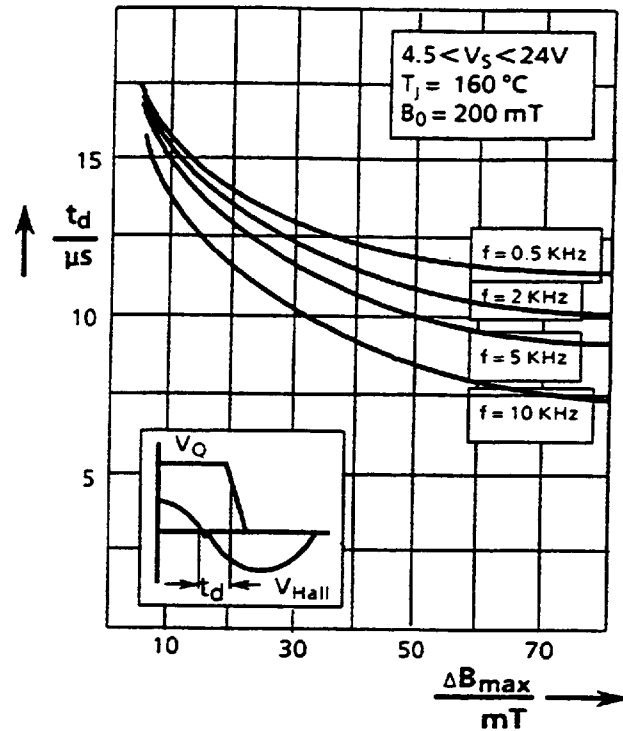
Diagrams

Preliminary Data

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_l vs. junction temperature for V_S switching from 0V to 4.5V.

