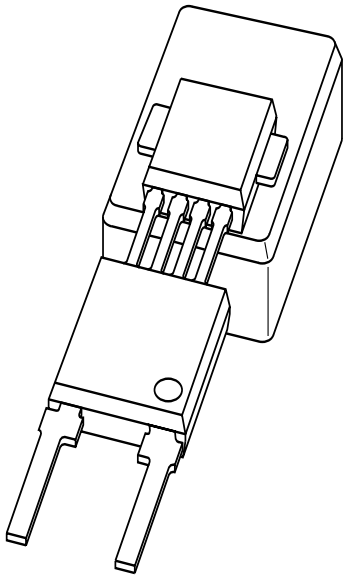
DATA SHEET



KMI20/1
Rotational speed sensor for extended air gap application

Objective specification

2000 Sep 04

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Rotational speed sensor for extended air gap application

KMI20/1

FEATURES

- Digital current output signal
- Digital offset compensation
- Extended air gap
- Zero speed capability
- Wide temperature range
- High tolerance to vibration
- EMC resistant
- Tolerant to positioning.

DESCRIPTION

The KMI20/1 is a sensitive rotational speed sensor for the application with ferrous gear wheels(1). The sensor consists of a magnetoresistive sensor element, a driver IC in BIMOS technology, a digital signal conditioning IC in a highly integrated CMOS technology and a magnetized ferrite magnet. The frequency of the digital current output signal is proportional to the rotational speed of a gear wheel.

CAUTION
Do not press two or more products together against their magnetic forces.

(1) The sensor contains customized integrated circuits. Usage in hydraulic brake systems and in systems with active brake control is forbidden. For all other applications, higher temperature versions of up to 150 °C are available on request.

PINNING

PIN	DESCRIPTION
1	V_{CC}
2	V–

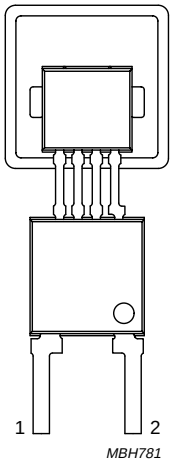


Fig.1 Simplified outline (SOT453B).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage between leads 1 and 2	0	12	18	V
$I_{CC\ (low)}$	current output signal low	5.6	7	8.4	mA
$I_{CC\ (high)}$	current output signal high	11.2	14	16.8	mA
d	sensing distance	0 to 4	0 to 4.5	–	mm
f_t	operating tooth frequency	0	–	2500	Hz
T_{amb}	ambient operating temperature	–40	–	+85	°C

LIMITING VALUES

In accordance with Absolute Maximum Rating System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	DC supply voltage	T_{amb} = –40 to +85 °C; R_L = 115 Ω	0	18	V
T_{stg}	storage temperature		–65	+150	°C
T_{amb}	operating ambient temperature		–40	+85	°C
T_{sld}	soldering temperature	t < 10 s	–	+260	°C
	output short-circuit duration	V_{CC} to GND (see Fig.7)	continuous		
	wrong polarity	T_{amb} = –40 to +65 °C; R_L = 115 Ω; note 1	continuous		

Note

1. With R_L = 115 Ω the device is continuously protected against wrong polarity of the DC supply voltage (V_{CC}) to GND (see Fig 7).

CHARACTERISTICS

T_{amb} = 25 °C; V_{CC} = 12 V; d = 2.1 mm; f_t = 2 kHz; test circuit: see Fig.7; R_L = 115 Ω; central sensor positioning: see Fig.9; gear wheel: module 2 mm; material 95MnPb28k; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{CC\ (low)}$	current output low	–40 to +85 °C; see Figs 7 and 9	5.6	7	8.4	mA
$I_{CC\ (high)}$	current output high	–40 to +85 °C; see Figs 7 and 9	11.2	14	16.8	mA
t_r	output signal rise time	C_L = 100 pF; see Fig.11; 10% to 90% value	–	0.5	–	µs
t_f	output signal fall time	C_L = 100 pF; see Fig.11; 90% to 10% value	–	0.5	–	µs
f_t	operating tooth frequency	for both rotational directions	0	–	2500	Hz
$d_{in\ 0\ Hz}$	sensing distance in initial mode for signals 0 Hz < f_t < 1 Hz	see Fig.9	0 to 2.5	0 to 2.9	–	mm
$d_{in\ 1\ Hz}$	sensing distance in initial mode for signals >1 Hz	see Fig.9	0 to 3.5	0 to 3.9	–	mm
d_{act}	sensing distance in active mode	see Fig.9	0 to 4.0	0 to 4.5	–	mm
$\delta_{in\ 0\ Hz}$	duty cycle in initial mode for signals >0 Hz	see Fig.5	20	50	80	%
$\delta_{in\ 1\ Hz}$	duty cycle in initial mode for signals >1 Hz	see Fig.5	20	50	80	%
δ_{act}	duty cycle in active mode	see Fig.5	40	50	60	%

FUNCTIONAL DESCRIPTION

The KMI20/1 is sensitive to the motion of ferrous gear wheels. The functional principle is shown in Fig.3. Due to the effect of flux bending, the different directions of magnetic field lines in the magnetoresistive sensor element will cause an electrical signal. Because of the chosen sensor orientation and the direction of ferrite magnetization the KMI20/1 is sensitive to movement in the 'y' direction in front of the sensor only (see Fig.2).

The KMI20/1 contains a magnetoresistive sensor element and two ICs: a Position Detector IC (PDIC) and a Line Driver IC (LDIC). The sensor signal is fed into the PDIC. The PDIC converts the signal to the digital domain, applies digital compensation and after additional processing converts it back to analogue. The LDIC contains two current sources (one constant, one switchable) and a voltage control unit (see Fig.4).

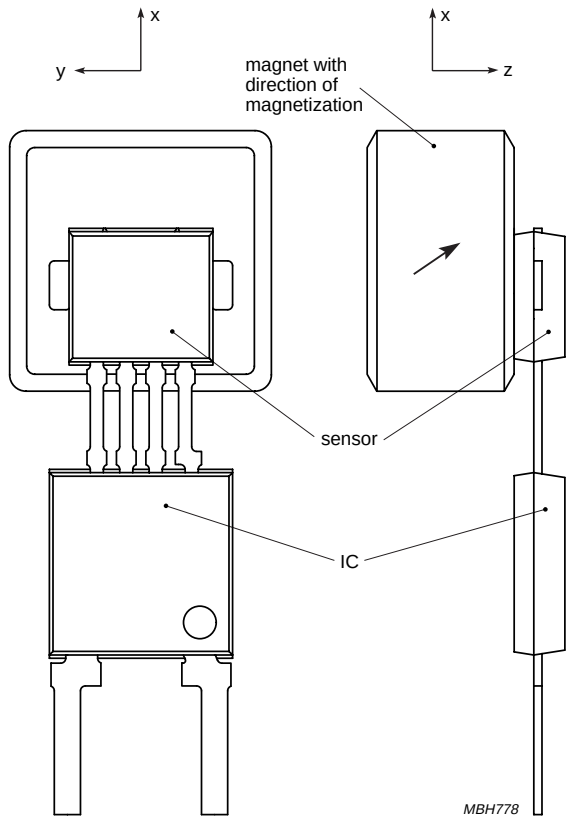


Fig.2 Component detail of the KMI20/1.

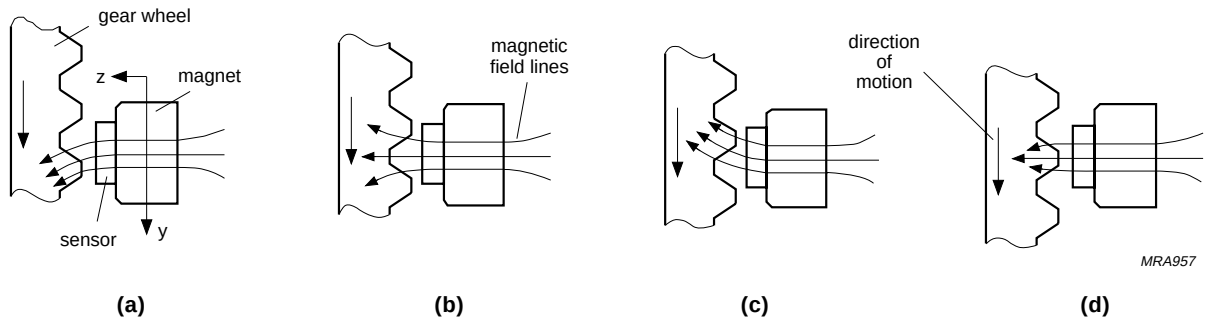


Fig.3 Functional principle.

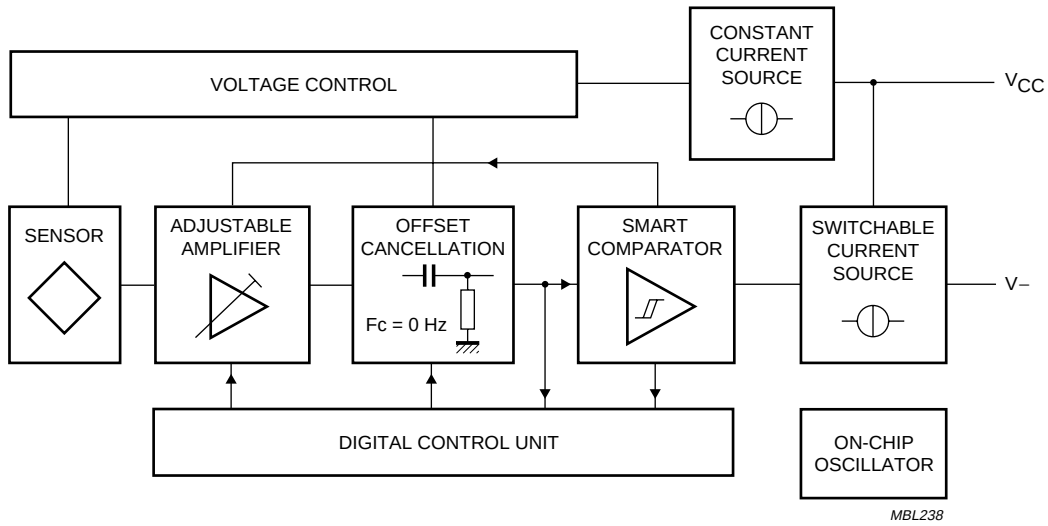


Fig.4 Block diagram.

Figure 5 shows the digital compensation function in algorithmic format. After power on the sensor system is running in INITIAL MODE 0 Hz. The sensor signal is preamplified but not offset compensated. The output signal represents the specified sensing distances (see Chapter “Characteristics”) for every tooth of the wheel, totally speed independent. When $d_{in\ 0\ Hz} < d < d_{in\ 1\ Hz}$ the system must first detect the sensor signal amplitudes to compensate for the sensor offset (INITIAL MODE 1 Hz). An output signal is produced (first compensation run finished) at the latest after 11 wheel teeth, with a frequency above 1 Hz.

After detecting the teeth in initial mode the PDIC changes to ACTIVE MODE and the sensor signal is permanently offset compensated. The available sensing distance is increased to d_{act}. Quitting ACTIVE MODE is caused by power off or by the teeth frequency falling below 1 Hz. The system is locked into COMPENSATION MODE and continues to detect every wheel tooth down to zero speed.

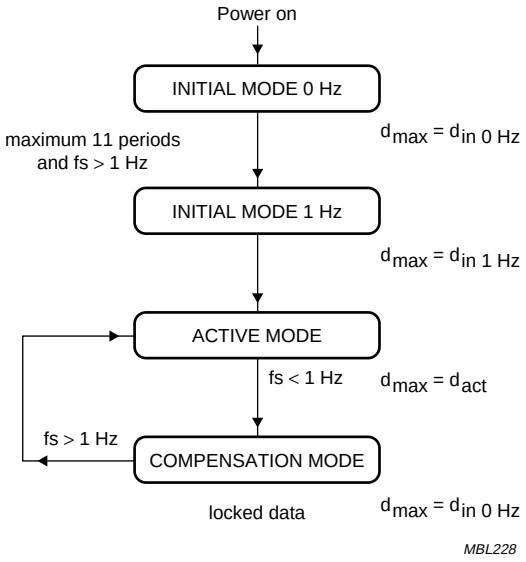


Fig.5 PDIC function algorithm.

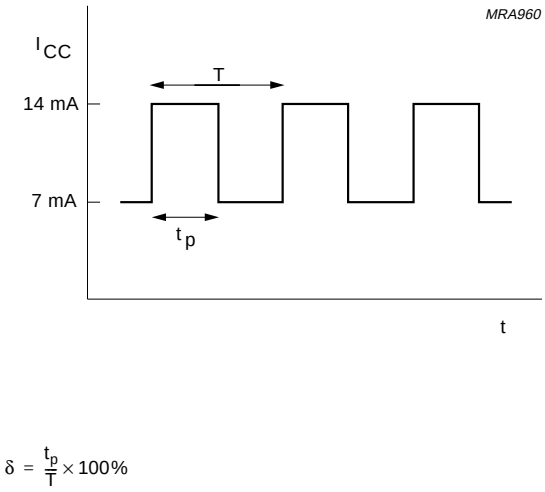


Fig.6 Output signal as a function of time.

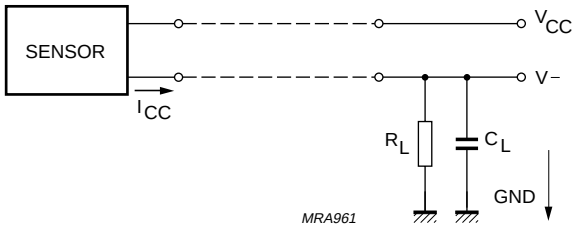


Fig.7 Test and application circuit.

Mounting conditions

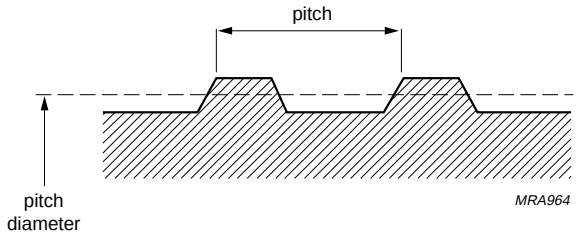
The recommended sensor position in front of a gear wheel is shown in Fig.9. Distance ‘d’ is measured between the sensor front and the tip of a gear wheel tooth. The KMI20/1 senses ferrous indicators like gear wheels in the ±y direction only (no rotational symmetry of the sensor); see Fig.2. The symmetrical reference axis of the sensor corresponds to the axis of the ferrite magnet.

Gear wheel dimensions

SYMBOL	DESCRIPTION	UNIT
German DIN		
z	number of teeth	–
d	diameter	mm
m	module m = d/z	mm
p	pitch p = π × m	mm
ASA; note 1		
PD	pitch diameter (d in inch)	inch
DP	diametric pitch DP = z/PD	$inch^{-1}$
CP	circular pitch CP = π/DP	inch

Note

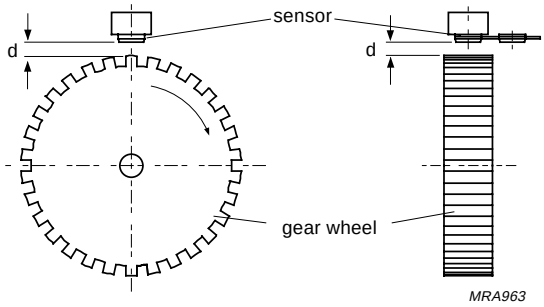
1. For conversion from ASA to DIN: m = 25.4 mm/DP; p = 25.4 mm × CP.



$$\text{module} = \frac{\text{pitch diameter}}{\text{number of teeth}}$$

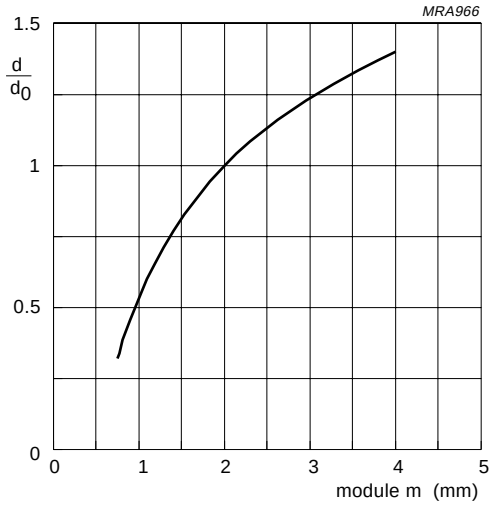
$$\text{pitch} = \text{module} \times \pi$$

Fig.8 Gear wheel dimensions.



Centre die position: see Chapter “Package outline”

Fig.9 Sensor positioning.



d_0 = measuring distance for a gear wheel with module m = 2 mm.

Fig.10 Normalized maximum sensing distance as a function of gear wheel module; typical values.

EMC

Figure 11 shows a recommended application circuit for automotive applications. It provides a protection interface to meet Electromagnetic Compatibility (EMC) standards and safeguard against voltage spikes. Table 1 lists the tests which are applicable to this circuit and the achieved class of functional status. Protection against 'load dump' (test pulses 5 according to *"DIN 40839"*) means a very high demand on the protection circuit and requires a suitable suppressor diode with sufficient energy absorption capability.

The board net often contains a central load dump protection that makes such a device in the protection circuit of the sensor module unneccesary.

Tests for ElectroStatic Discharge (ESD) were conducted in line with *"MIL Std. 883D, Method 3015.7"* to demonstrate the KMI20/1's handling capabilities. The test conditions were: C = 150 pF, R = 150 Ω and V = 4 kV.

Electromagnetic disturbances with fields up to 150 V/m and f = 1 GHz (ref. *"DIN 40839"*) have no influence on performance.

Table 1 EMC test results

EMC REF. DIN 40839	SYMBOL	MIN. (V)	MAX. (V)	REMARKS	CLASS
Test pulse 1	V_{LD}	−100	–	t_d = 2 ms	C
Test pulse 2	V_{LD}	–	100	t_d = 0.2 ms	A
Test pulse 3a	V_{LD}	−150	–	t_d = 0.1 µs	A
Test pulse 3b	V_{LD}	–	100	t_d = 0.1 µs	A
Test pulse 4	V_{LD}	−7	–	t_d = 130 ms	B
Test pulse 5	V_{LD}	–	120	t_d = 400 ms	B

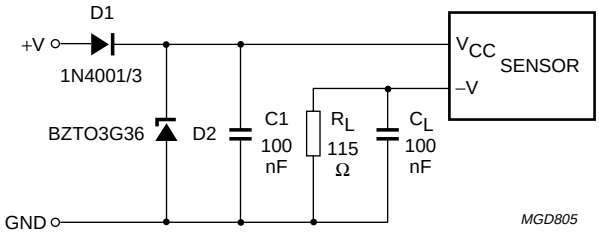
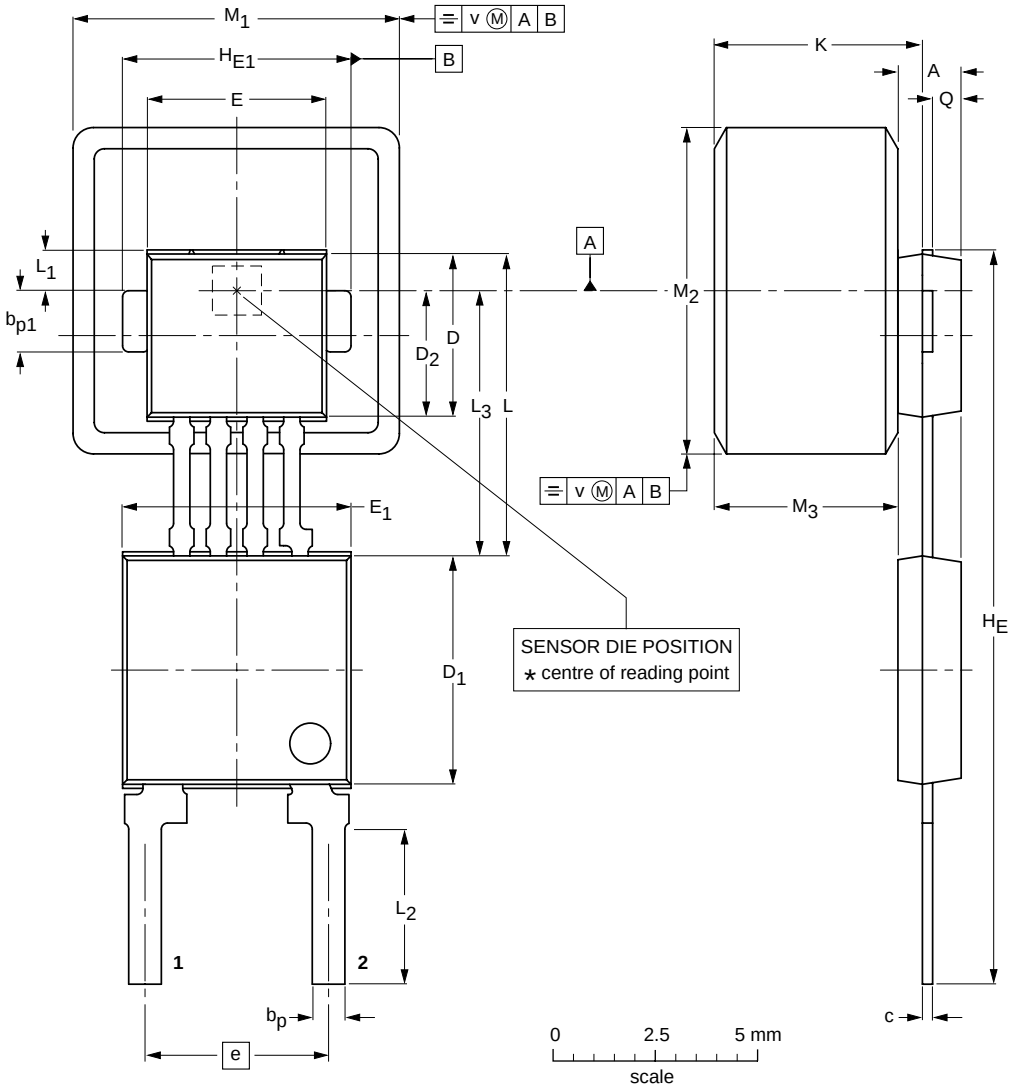


Fig.11 Test/application circuit for the KMI20/1.

PACKAGE OUTLINE

Plastic single-ended multi-chip package; magnetized ferrite magnet (8 x 8 x 4.5 mm); 4 interconnections; 2 in-line leads **SOT453B**



DIMENSIONS (mm are the original dimensions)

UNIT	$A^{(1)}$	b_p	b_{p1}	c	$D^{(2)}$	$D_1^{(2)}$	$D_2^{(2)}$	$E^{(2)}$	$E_1^{(2)}$	e	H_E	H_{E1}	K max.	L	L_1	L_2	L_3	M_1	M_2	$M_3^{(1)}$	Q	v
mm	1.7 1.4	0.8 0.7	1.57 1.47	0.3 0.24	4.1 3.9	5.7 5.5	3.15 2.95	4.5 4.3	5.7 5.5	4.6 4.4	18.2 17.8	5.6 5.5	5.37	7.55 7.25	1.2 0.9	3.9 3.5	6.55 6.35	8.15 7.85	8.15 7.85	4.7 4.3	0.75 0.65	0.25

Notes

1. Glue thickness not included.
2. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT453B						~~99-09-23~~ 00-08-31

DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS (1)
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

Note

1. Please consult the most recently issued data sheet before initiating or completing a design.

DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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