iC-MZI

2-WIRE DIFFERENTIAL HALL SWITCH

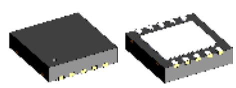
FEATURES

- ♦ Simple electric connection possible as two-wire device
- ♦ High magnetic sensitivity with input frequency up to 30 kHz
- ♦ User-defined current levels preset by external resistors
- ♦ Automatic duty-cycle correction and operation point settings
- ♦ Reverse polarity protected supply voltage
- ♦ Extended temperature range from -40 to +125 °C

APPLICATIONS

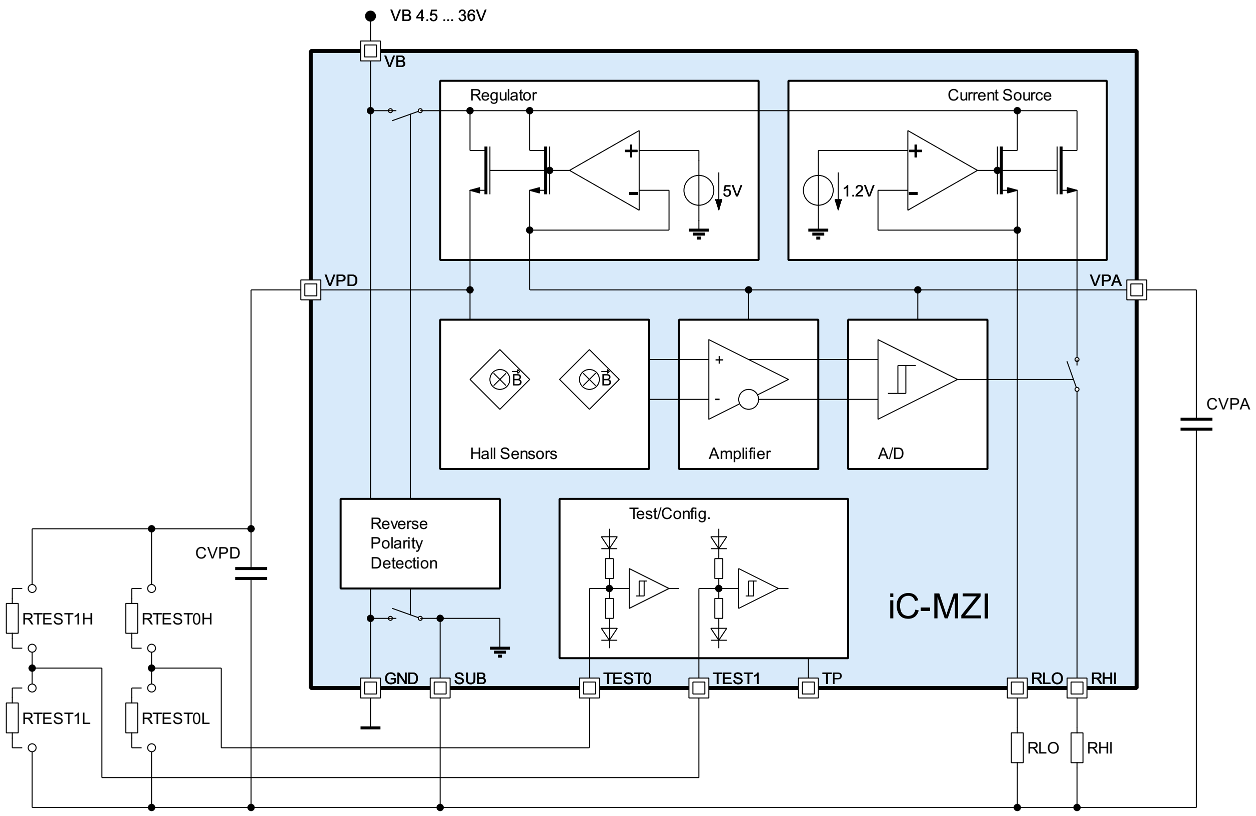
- ♦ Gear wheel sensing
- ♦ Magnetic position encoders
- ♦ Proximity switch

PACKAGES



DFN10
4 mm x 4 mm x 0.9 mm
RoHS compliant

BLOCK DIAGRAM

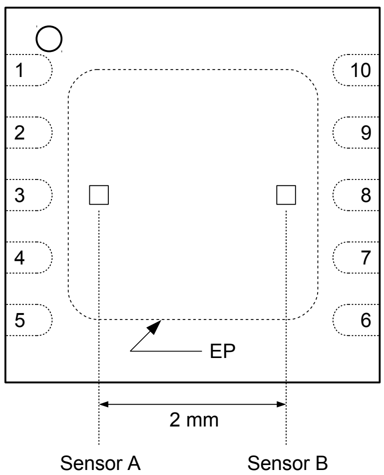


DESCRIPTION

The iC-MZI is a differential Hall switch intended for sensing a magnetic target or, with the aid of an additional back-bias magnet, a ferromagnetic gear. The two Hall sensors are spaced 2 mm apart. Depending on the detected magnetic field difference, the supply current of the iC-MZI will vary between two levels (high, low) which are preset by two external resistors RHI and RLO respectively. With solenly using the supply pins VB and GND, thus the iC-MZI acts as a simple two-wire, reverse polarity protected magnetic sensor switch.

PACKAGING INFORMATION

PIN CONFIGURATION DFN10 4x4



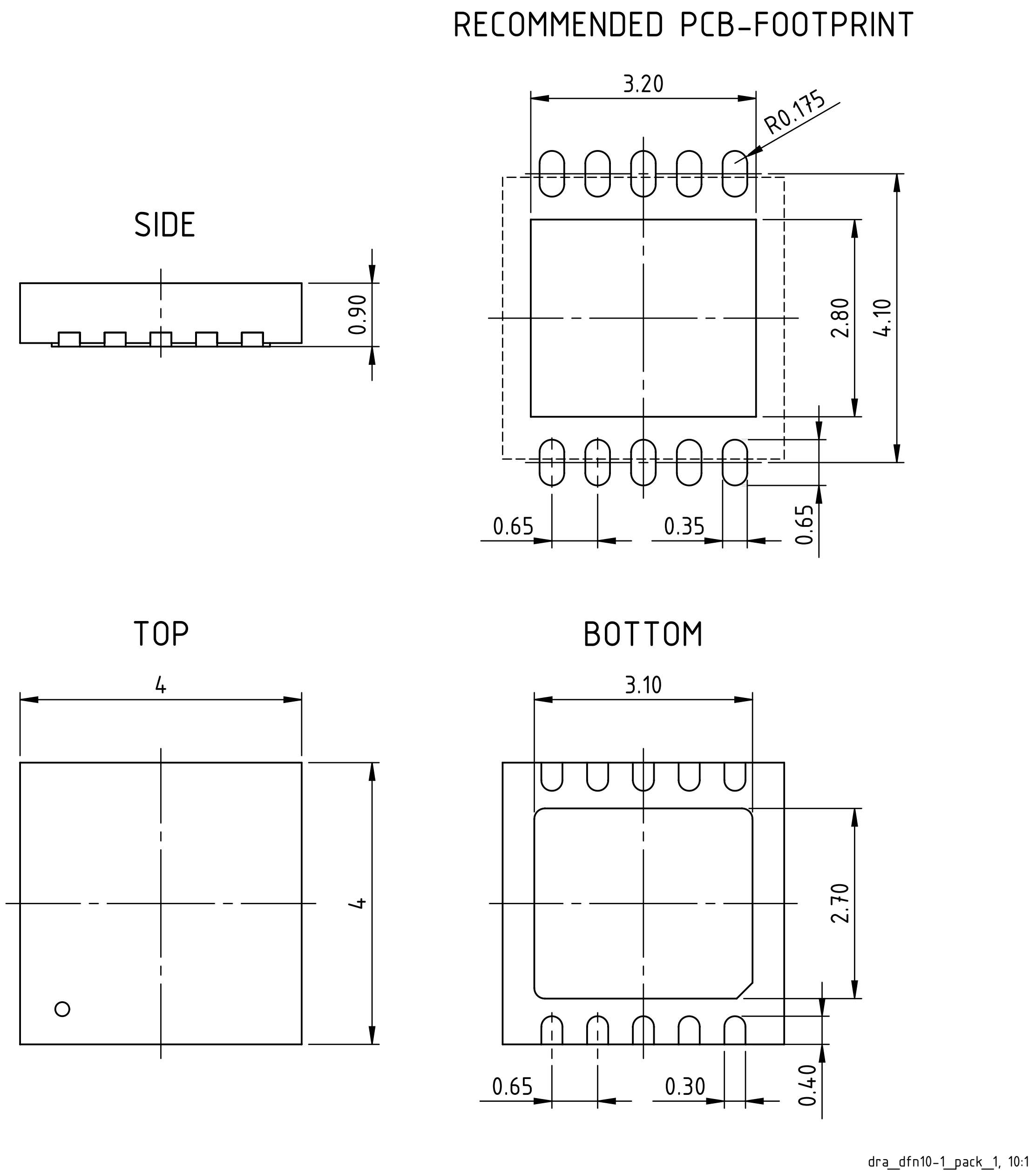
PIN FUNCTIONS

No.	Name	Function
1	VPD	Internal digital supply voltage
2	RLO	Low level current preset
3	TEST0	Test pin 0
4	RHI	High level current preset
5	GND	Supply Ground
6	VB	Supply voltage
7	TP	(iC-Haus use only - do not connect)
8	SUB	Substrate (internal Ground)
9	TEST1	Test pin 1
10	VPA	Internal analog supply voltage
	EP	Exposed Pad

Connect the *Exposed Pad* EP to SUB pin. Use a large ground plane to improve thermal performance. EP is not intended as an electrical connection point. The pin TP is for iC-Haus test purpose and has to be left unconnected. Orientation of the logo (iC MZI CODE ...) is subject to alteration.

PACKAGE DIMENSIONS DFN10 4 mm x 4 mm

All dimensions given in mm.



ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed.

Item No.	Symbol	Parameter	Conditions	Min.	Max.	Unit
G001	VB	Voltage at VB		-40	40	V
G002	I(VB)	Current in VB		-40	40	mA
G003	Vd()	Susceptibility to ESD at all pins	HBM 100 pF discharged through 1.5 kΩ		2	kV
G004	V()	Voltage at all pins (exept VB)	versus SUB	-0.3	5.5	V
G005	I()	Current in TEST0, TEST1		-4	4	mA
G006	I()	Current in RLO, RHI, VPA, VPD, SUB		-20	20	mA

THERMAL DATA

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating ambient temperature range		-40		+120	°C
T02	Tj	Junction Temperature		-40		+125	°C
T03	Ts	Storage Temperature		-55		+125	°C

All voltages are referenced to ground unless otherwise stated.
All currents flowing into the device pins are positive; all currents flowing out of the device pins are negative.

ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 4.5...36 V, Tj = -40...125 °C

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply data							
001	VB	Permissible supply voltage		4.5		36	V
002	I(VB)	Supply current in VB	device only, with I(RHI, RLO) = 0	2.1	3.2	3.8	mA
003	V()on	Turn-on threshold VB	versus SUB	4.0		4.4	V
004	V()off	Turn-off threshold VB	versus SUB	3.8		4.2	V
005	V()hys	Hysteresis VB		200		300	mV
006	V(VPA)	Internal analog supply	versus SUB	4.2	5.0	5.5	V
007	V(VPD)	Internal digital supply	versus SUB	4.2	5.0	5.5	V
008	V(SUB)	Substrat voltage	versus GND, I(GND) = 20 mA			200	mV
009	Vc()hi	Clamp voltage hi at pins RHI, RLO, TEST0, TEST1, TP	VCc()hi = V() − V(VPD), I() = 1 mA	0.3		1.6	V
010	Vc()lo	Clamp voltage lo an pins RHI, RLO, TEST0, TEST1, TP, VPA, VPD	Vc()lo = V() − V(SUB), I() = -1 mA versus SUB	-1.6		-0.3	V
011	Vc()hi	Clamp voltage hi an Pin VB	I() = 10 mA, versus GND, I(RHI, RLO) = 0	36			V
012	Vc()lo	Clamp voltage lo an Pin VB	I() = -10 mA, versus GND			-36	V
013	ton	Response time	From t(VB > V()on) until start of switching operation			200	µs
014	CVPA	Capacitance at VPA	versus SUB			10	nF
015	CVPD	Capacitance at VPD	versus SUB			10	nF
Magnetic data							
101	Hdc	Magnetic Field	DC value	-400		400	kA/m
102	Hth,hi	Magnetic switching threshold, high	TEST0, TEST1: open circuit	-2.6	1.2	5.4	kA/m
103	Hth,lo	Magnetic switching threshold, low	TEST0, TEST1: open circuit	-5.4	-1.2	2.6	kA/m
104	Hth,hys	Hysteresis		2.0	2.4	2.8	kA/m
105	|∆Hmin|	Differential field	switching	3			kA/m
106	fc	signal cut-off frequency	-3 dB roll off	25	30		kHz
107	fmag	Magnetic input frequency		0		30	kHz
108	Hth,max	duty cycle correction range, max. magnetic field				9	kA/m
109	Hth,min	duty cycle correction range, min. magnetic field		-9			kA/m
110	∆Hth	Step size of duty cycle correction		0.1	0.15	0.2	kA/m
Pins RLO, RHI							
201	V(RLO)	Voltage at RLO	I() ≤ -7 mA, versus SUB	1.1	1.22	1.3	V
202	V(RHI)	Voltage at RHI	I() ≤ -14 mA, versus SUB	0	1.22	1.3	V
203	I(RLO)	Current at RLO	versus SUB			7	mA
204	Isc(RLO)	Short-circuit current at RLO	versus SUB	10		25	mA
205	I(RHI)	Current at RHI	versus SUB			14	mA
206	Isc(RHI)	Short-circuit current at RHI	versus SUB	15		35	mA
207	Vt()hi	Input threshold voltage hi	in test mode, versus SUB	3			V
208	Vt()lo	Input threshold voltage lo	in test mode, versus SUB			2	V
Inputs TEST0, TEST1							
401	V()open	Open circuit voltage	pin not connected	2.0	2.5	2.9	V
402	I()pu	Pull-Up current	V() = 0 V	-40		-9	µA
403	I()pd	Pull-Down current	V() = V(VPD)	9		40	µA
404	Vt()hi,on	Input threshold voltage hi	Vt()hi = V(VPD) − V()	0.7		1.3	V
405	Vt()hi,off	Input threshold voltage hi	Vt()hi = V(VPD) − V()	1.0		1.6	V
406	Vt()lo,on	Input threshold voltage lo	versus SUB	0.7		1.2	V
407	Vt()lo,off	Input threshold voltage lo	versus SUB	0.9		1.5	V

Current level setting using external resistors

The voltages at pins RHI, RLO are regulated to 1.25 V typically. Therefore, attached resistors will cause additional current draw I = U/R depending on the resistor values. The quiescent current I(VB) of the iC-MZI (typ. 3.6 mA) has to be accounted for the total resulting current levels.

As an example, to set the supply current levels to I(VB,LO)= 7 mA and I(VB,HI) = 14 mA, the resulting preset currents must be I(LO) = I(VB,LO) - I(VB) = 7 mA − 3.6 mA = 3.4 mA and I(HI) = I(VB,HI) - I(VB,LO) = 7 mA, which leads to resistor values of R(RLO) = 1.25 V/3.4 mA = 370 Ω and R(RHI) = 1.25 V/7 mA = 180 Ω.

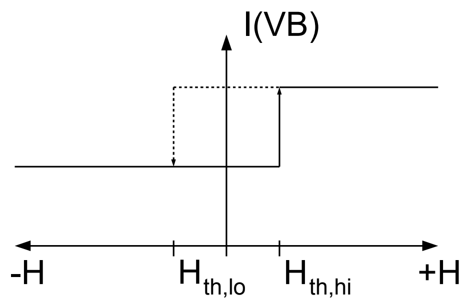


Figure 1: Current level switching vs. magnetic field difference

Switching thresholds and hysteresis

In a typical gear sensing application, the iC-MZI is back--biased with an external magnet and the resulting variations in the magnetic field due to the modulation by the gear teeth is monitored. As the Hall sensors are spaced apart, the two sensor signals will differ and can be evaluated, thus eliminating the DC bias signal. Figure 2 shows the magnetic input signals for the two Hall sensors (green and red), from which the differential signal (blue) is extracted and, after further amplification, is fed to a comparator to toggle the two current levels.

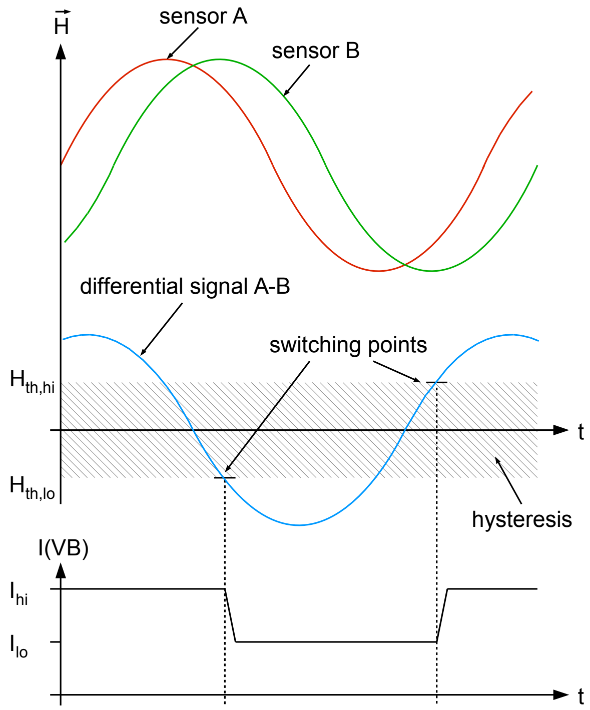


Figure 2: Signal transfer characteristics

Effects of signal noise

In case of a moving gear with constant rotating speed, also a fixed frequency switching output signal with 50% duty-cycle is expected. Noise in the internal signal path of the device or external interference of electric or magnetic origin may have undesirable effect on switching operation.

Fig 3 shows the transfer function S(ΔH) (blue) of the iC-MZI with respect to the differencial magnetic field ΔH. R The additional noise and interferences as shown in the light blue area will also contribute to the time of switching, resulting in deviation of the nominal expected transisition known as jitter. Therefore, this jitter will lead to non-constant output duty-cycle as shown in Fig. 4.

Also note that the switching level associated with a given hysteresis, which makes the duty-cycle sensitve to the magnitude of the differential magnetic field. As shown in Fig. 5, the magnetic signal should be large compared to the hysteresis to maintain a 50% duty cycle. A weakdifferetial signal results in large deviations in duty-cycle or even non-switching operating behaviour.

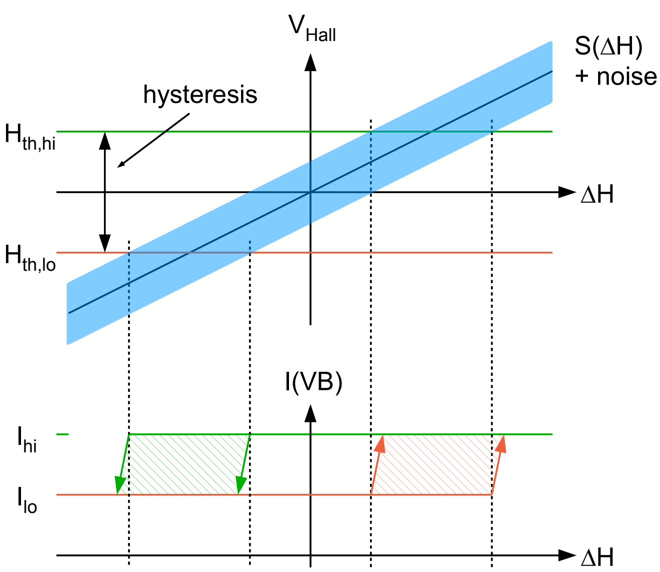


Figure 3: Switching behaviour vs. magnetic input signal

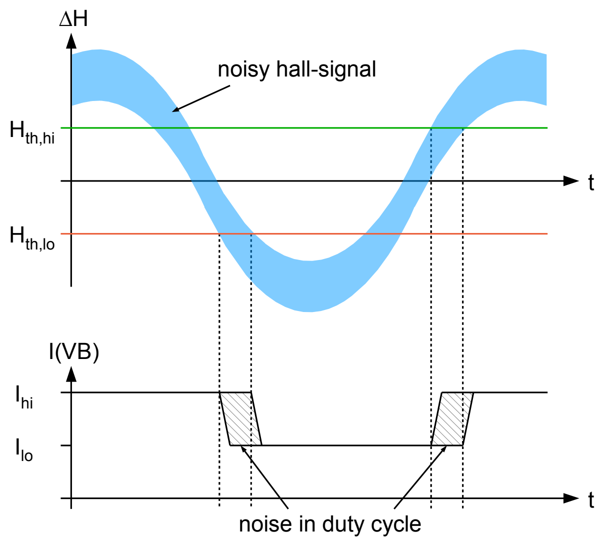


Figure 4: Effect of noise on output duty-cycle

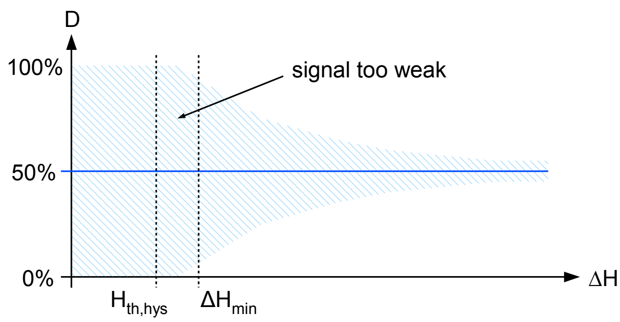


Figure 5: Duty-cycle as a function of ΔH

Offset and duty-cycle correction

The iC-MZI allows for a duty-cylce correction provided the input signal frequency is in the range of 20 Hz to 25 kHz. This is done by offsetting the switching threshold toward the mean value of the input signal (see center bar in Fig. 6).

Table 4 shows the configuration of the offset depending on the logic state at the two pins TEST0 und TEST1.

The value PRESEL defines the threshold value of the comparator at the time of power-on to compensate for a given magntic offset. With setting AUTO an automatic offset correction is initiated.

Nr.	TEST0	TEST1	Duty-Cycle Correction	PRESEL [kA/m]
0		Z		0
1	Z	L	OFF	-4,8
2		H		+4,8
3		Z		0
4	L	L	ON	-2,4
5		H		-4,8
6		Z		AUTO
7	H	L	ON	+2,4
8		H		+4,8

Table 4: Parameters for Duty-Cycle Correction

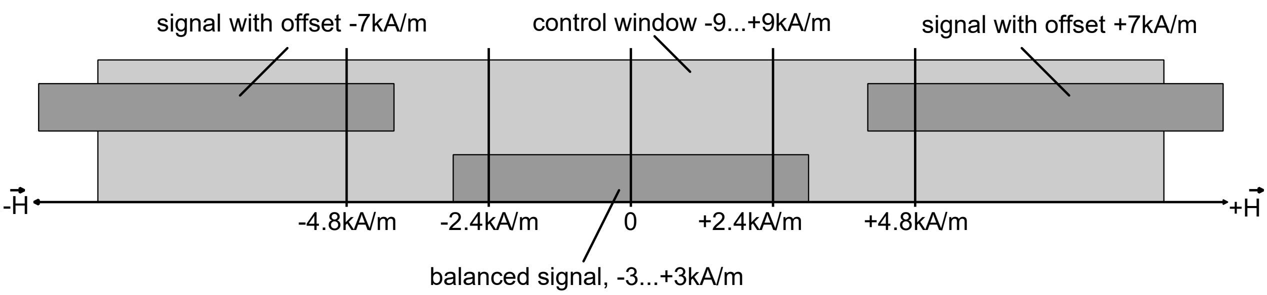


Figure 6: Adjustment range and starting values

Fig. 8 shows how the pins TEST0 and TEST1 can be configured using exterally connected resistors. The pin VPD should not be loaded with more than about 100 µA, therefore the resistors should be of no less value than about 25kΩ. Either a high or a low state at the input can be realized by connecting a resistor from the pin to VPD or SUB. Leaving the pin open results in the third logic state (mid-level, logic state Z). Fig. 7 shows how the internal signals TEST_LO and TEST_HI are related to the input voltage of the pin.

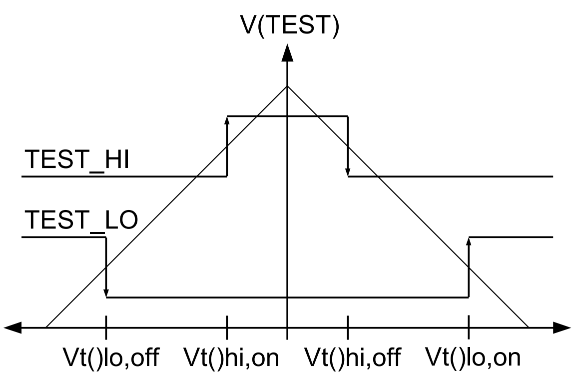


Figure 7: Three-level transfer function

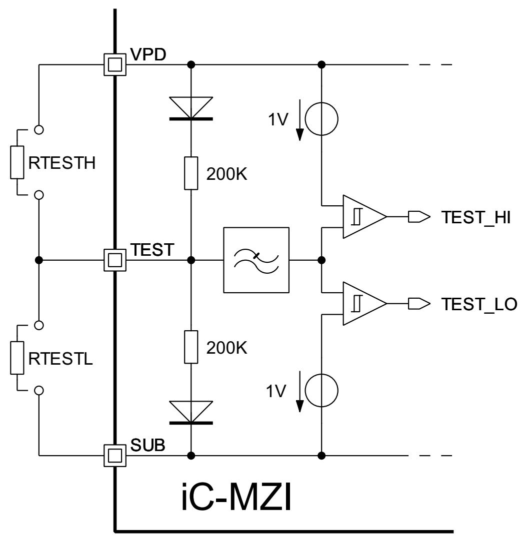


Figure 8: Schematic of the three-level inputs of TEST0 and TEST1 pins and optional preset circuitry

Reverse polarity protection

The iC-MZI is reverse polarity protected with respect to the VB and GND pins. In case of wrong polarity the internal circuitry will be disconnected from the supply pins VB and GND.

Substrate pin SUB

External compontents should be located as close as possible to the iC-MZI, with pin SUB as a common reference ground. During normal operation, the reverse polarity control connects SUB to the GND pin.

Application Example

Figure 9 shows a typical arrangement of the iC-MZI together with a control unit. The latter one sources the iC-MZI with the supply voltage and shunts the supply current to convert it back to sensor voltages to be further evaluated.

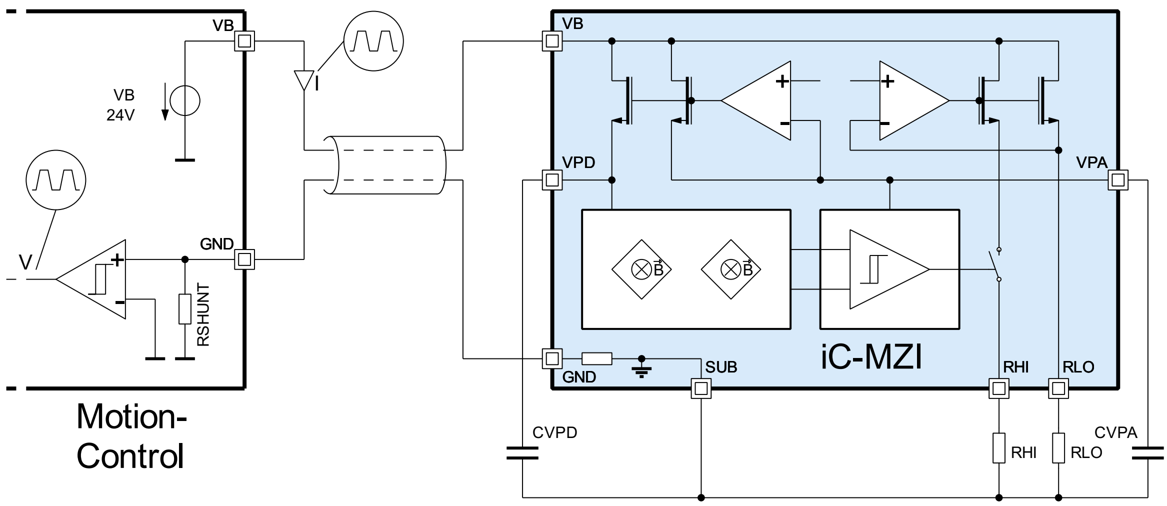


Figure 9: Sourcing and sensing the iC-MZI as a two-wire sensor

REVISION HISTORY

Rel.	Rel. Date*	Chapter	Modification	Page
A.1	2018-11-09		Preliminary Release	all

Rel.	Rel. Date*	Chapter	Modification	Page
A.2	2020-11-20	all	"preliminary" label removed	all
		FEATURES	Feature added for extended temperature range	1
		Switching thresholds and hysteresis	Caption of Fig. 2 changed to "Signal transfer characteristics"	6

* Release Date format: *YYYY-MM-DD*

ORDERING INFORMATION

Type	Package	Options	Order Designation
iC-MZI	10-pin DFN, 4 mm x 4 mm 0.9 mm thickness RoHS compliant		iC-MZI DFN10-4x4

Please send your purchase orders to our order handling team:

Fax: +49 (0) 61 35 - 92 92 - 692
E-Mail: dispo@ichaus.com

For technical support, information about prices and terms of delivery please contact:

iC-Haus GmbH
Am Kuemmerling 18
D-55294 Bodenheim
GERMANY

Tel.: +49 (0) 61 35 - 92 92 - 0
Fax: +49 (0) 61 35 - 92 92 - 192
Web: http://www.ichaus.com
E-Mail: sales@ichaus.com

Appointed local distributors: http://www.ichaus.com/sales_partners