iC-OW
INCREMENTAL OPTO ENCODER

target specification

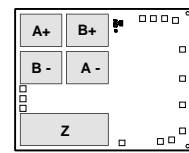## FEATURES

- ♦ Monolithically integrated photodiodes
- ♦ Excellent matching, high reliability
- ♦ Differential scanning for tracks A and B
- ♦ Adjustable threshold for index track Z
- ♦ Gated index Z with switch-off capability
- ♦ Adjustable LED current control compensates for temperature and system ageing effects
- ♦ 50mA LED driver integrated
- ♦ Control monitoring with alarm output
- ♦ Electronic test aids
- ♦ Track outputs TTL-compatible and short-circuit-proof
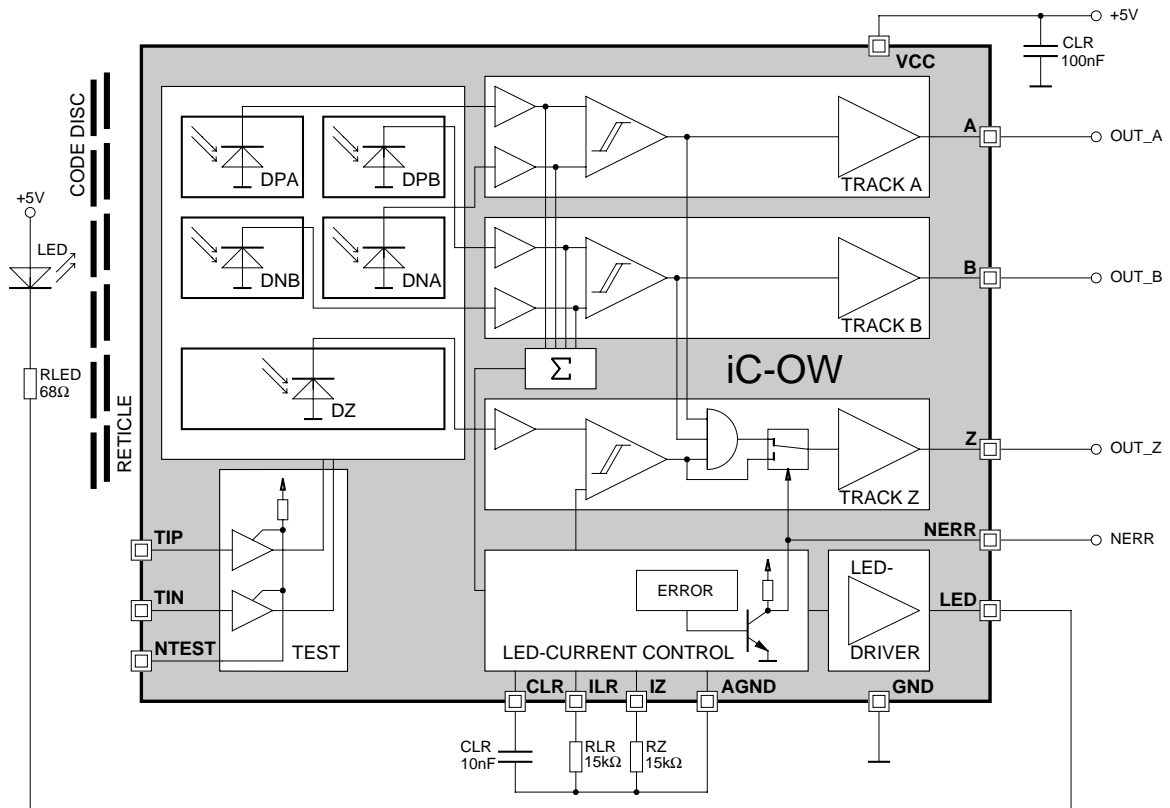- ♦ ESD protection

APPLICATIONS

- ♦ Optical position decoding for incremental encoders using the principle of differential scanning

CHIP

chip size 4.02mm x 3.24mm

BLOCK DIAGRAM

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DESCRIPTION

iC-OW is an evaluator iC for optical incremental linear and rotary motion sensors, such as glass scales or shaft encoders, for example. A photodiode array, amplifiers, comparators and TTL-compatible push-pull output drivers are integrated monolithically.
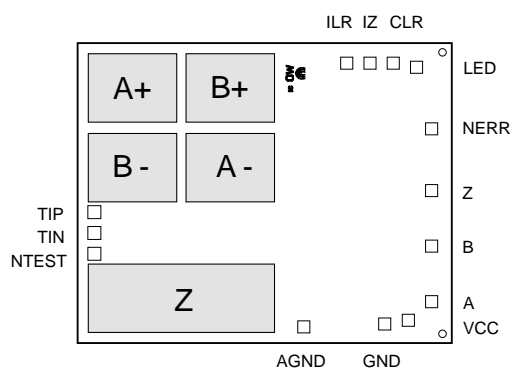
Two tracks, A and B, are evaluated differentially, with index track Z as constant light. The integrated LED current control with a driver stage enables a transmitter LED with a series resistor to be directly connected to the device and ensures a constant optical receive power. Two external resistors are used to set the comparator threshold of the relative index track and to determine the receive photocurrents.

The internal logical AND operation of index track Z to tracks A and B can be switched off for adjustment.

A monitoring circuit generates an error message when the LED current control range is violated. The error output, designed as an open collector, is low active and functions simultaneously as an input which can turn off the AND operation of the index track.

All pins are protected against destruction by ESD. The outputs are short-circuit-proof.

CHIP LAYOUT

PAD DESCRIPTION

Name	Function
VCC	+5V Supply Voltage
A	Track A Output
B	Track B Output
Z	Track Z Output
NERR	Error Output (low active) / AND Gate Disable Input
LED	LED Current Control Output
CLR	Capacitor for LED Current Control
IZ	Index Track Threshold Adjust
ILR	LED Current Control Setup
GND	Ground
AGND	Reference Ground for ILR, IZ, CLR circuitry
TIP	Positive Test Aid Input
TIN	Negative Test Aid Input
NTEST	Test Enable Input, low active

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iC-Haus

ABSOLUTE MAXIMUM RATINGS

Values beyond which damage may occur; device operation is not guaranteed.

Item	Symbol	Parameter	Conditions	Fig.	Min.	Max.	Unit
G001	VCC	Supply Voltage			0	6	V
G002	V(A,B,Z)	Voltage at Outputs A, B, Z			-0.3	VCC+0.3	V
G003	I(A,B,Z)	Current in Outputs A, B, Z	V(A,B,Z)< 0V or V(A,B,Z)> VCC		-4	4	mA
G004	I(ILR) I(IZ)	Current in ILR, IZ			-6	1	mA
G005	I(CLR)	Current in CLR			-1	1	mA
G006	I(LED)	Current in LED	V(LED)> VCC		-1	1	mA
G007	I(LED)	Current in LED	V(LED)$\leq$ VCC		-1	60	mA
G008	V(NERR)	Voltage at NERR			-0.3	VCC+0.3	V
G009	I(NERR)	Current in NERR	V(NERR)< 0 or V(NERR)> VCC		-4	4	mA
TG1	Tj	Operating Junction Temperature			-25	120	°C
TG2	Tj	Storage Temperature Range			-40	150	°C

THERMAL DATA

Operating Conditions: VCC= 5V ±10%

Item	Symbol	Parameter	Conditions	Fig.	Min.	Typ.	Max.	Unit
T1	Ta	Operating Ambient Temperature Range (extended range on request)			-25		125	°C

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

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ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC= 5V ±10%, RZ= RLR= 15kΩ, CLR= 10nF, λ= 850nm, Tj= -25..125°C, unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Total Device									
001	VCC	Permissible Supply Voltage				4.5		5.5	V
002	I(VCC)	Supply Current in VCC, Outputs A, B, Z hi	closed LED control loop, I(LED)≈ 3mA, NERR= hi, I(A,B,Z)= 0; I(DZ,DPx)= -400nA, I(DNx)= -40..0nA, (x= A,B)					10	mA
003	I(VCC)	Supply Current in VCC, Outputs A, B, Z lo	see 002; I(DZ,DPx)= -40..0nA I(DNx)= -400nA	27			5.5	12	mA mA
004	fo	Cut-off Frequency for Tracks A and B	sinusoidal waveform, I(DPx)= -20..-400nA, I(DNx)= -400..-20nA			500			kHz
005	fo	Cut-off Frequency for Index Track Z	rectangular waveform, I(DZ)= -20..-400nA			250			kHz
006	Δtp()	Propagation Delay Deviation track vs.track at A, B, Z						100	ns
Photodiodes									
007	Aph()	Radiant Sensitive Area	diodes DPA, DNA, DPA, DPB diode DZ				0.95 x 0.74 2.00 x 0.74		mm^2 mm^2
008	S(λ)max	Spectral Sensitivity					0.5		A/W
009	Sar(λ)	Spectral Application Range	Sar(λ)= 0.1 x S(λ)max			500		1050	A/W
Differential Photocurrent Amplifier, Tracks A and B									
101	I(DPx) I(DNx)	Permissible Sensor Current at DPA, DNA, DPB, DNB				-600		0	nA
102	CM(P/N)	Common Mode DPA vs. DNA, DPB vs. DNB				0.85	1	1.15	
Comparators, Tracks A and B									
201	Hys	Hysteresis referred to [I(DPx) + I(DNx)] / 2	I(DPx,DNx)= -400..0nA			15	20	25	%
Photocurrent Amplifier, Index Track Z									
401	I(DZ)	Permissible Sensor Current at DZ				-600		0	nA
Comparator, Index Track Z									
801	Hys	Hysteresis referred to I(DZ)	I(DZ)= -400..0nA			7	10	13	%
Push-Pull Outputs A, B, Z									
301	Vs()hi	Saturation Voltage hi	Vs()hi= VCC -V(); I()= -400µA	-25 27 70 125			0.9 0.8 0.75 0.7	1.1 1.0 0.9 0.9	V V V V
302	Vs()hi	Saturation Voltage hi	Vs()hi= VCC -V(); I()= -1.6mA	-25 27 70 125			1.2 1.1 1.05 1.05	1.5 1.4 1.3 1.3	V V V V
303	Vs()lo	Saturation Voltage lo	I()= 0.8mA I()= 1.6mA					0.4 0.5	V V
304	Isc()hi	Short-Circuit Current hi	V()= 0V..2.8V			-8		-1.7	mA
305	Isc()lo	Short-Circuit Current lo	V()= 1V..VCC			2		13	mA

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Operating Conditions: VCC= 5V ±10%, RZ= RLR= 15kΩ, CLR= 10nF, λ= 850nm, Tj= -25..125°C, unless otherwise noted

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Push-Pull Outputs A, B, Z (continued)									
306	Vc()hi	Clamp Voltage hi	Vc()hi= V()-VCC; I()= 4mA			0.4		1.5	V
307	Vc()lo	Clamp Voltage lo	I()=-4mA			-1.5		-0.4	V
LED Current Control: CLR, ILR, IZ, LED									
601	ISUM	Permissible Total Photocurrent	ISUM= I(DPA)+I(DNA) +I(DPB) +I(DNB)			-1500		-50	nA
602	I(LED)	Permissible Driver Current in LED				0.1		50	mA
603	Vs(LED)	Saturation Voltage lo at LED	I(LED)= 50mA, I(ILR)> 5µA, ISUM= 0	27		0.4	0.8	1.2	V V
604	Vref()	Reference Voltage at ILR, IZ	I(ILR,IZ)= -150..-5µA			1.15	1.22	1.28	V
606	Isc()	Short-Circuit Current in ILR, IZ	V(ILR)= 0, V(IZ)= 0			-5			mA
607	CR1()	Current Ratio I(ILR)/ISUM	closed LED control loop, ISUM= -800..-50nA			80	100	125	
608	CR2()	Current Ratio I(IZ)/I(DZ)	closed LED control loop, I(DZ)= -400..-10nA			320	400	500	
609	Vc()hi	Clamp Voltage hi at LED, CLR, ILR, IZ	VCC= 0V, I()= 1mA			0.4		1.0	V
610	Vc()lo	Clamp Voltage lo at LED, CLR, ILR, IZ	VCC= 0V, I()= -1mA			-1.0		-0.4	V
Error Output / AND Gate Disable Input NERR									
501	R()	Internal Pull-Up Resistor				20	30	45	kΩ
502	Vt()	AND Gate Turn-Off Threshold	Gate disabled if V(NERR)< 0.4V			0.4		1	V
701	Vs()lo	Saturation Voltage lo	I(NERR)= 1.6mA I(NERR)= 5mA					0.4 0.8	V V
702	Isc()lo	Short-Circuit Current lo	V(NERR)= 2V..VCC			5		30	mA
703	Vc()hi	Clamp Voltage hi	Vc()hi= V(NERR)-VCC; NERR=hi, I(NERR)= 4mA			0.4		1.5	V
704	Vc()lo	Clamp Voltage lo	NERR=lo, I(NERR)=-4mA			-1.5		-0.4	V
Test Aid Inputs TIP, TIN, NTEST									
A01	CR1()	Current Ratio I(TIP) / I(DPA,DPB,DZ) and I(TIN) / I(DNA,DNB)	NTEST= lo, I()= 5..200µA			300	400	550	
A02	CR2()	Current Ratio I(TIP,TIN) / I(CLR)	NTEST= lo, I()= 5..200µA			1.8	2	2.2	
A03	V()on	Test Aid Operation Voltage at TIP, TIN	NTEST= lo; I()= 5..200µA			1.2		2.6	V
A04	Ipd()	Pull-Down Current at TIP, TIN	V(NTEST) open, V(TIP,TIN)< 1V			50		500	µA
A05	Rpu()	Pull-Up Resistor at NTEST	V(NTEST)= 0..0.4V			80	210	550	kΩ
A06	V0()	Voltage at NTEST	I(NTEST)= 0			0.35	0.7	1.0	V
A07	Vt()	Threshold Voltage lo at NTEST						0.3	V

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APPLICATIONS INFORMATION

Figure 1 shows the schematic of the electronic system of an incremental rotary encoder. iC-Haus devices iC-OW and line driver iC-WE are used.

The rotary encoder requires the supply voltages VCC= +5V and VB= +5V to +30V (line driver) and supplies the conditioned signals of tracks A and B and index track Z at the outputs. It is possible to transmit these signals over lines of 100m in length directly connected to the device. The system's upper cut-off frequency is typically 300kHz for tracks A and B.

Internal monitoring functions are available for the chip temperature of the line driver, for the supply voltages and for the LED current control. The ERROR port provides an error message signal which can be logically linked to other, external error signals by a simple connection.

Fig. 1: incremental encoder application circuit

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ORDERING INFORMATION

Type	Package	Order designation
iC-OW	-	iC-OW chip

For information about prices, terms of delivery, options for other case types, etc., please contact:

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