iC-OG
8-BIT DIFFERENTIAL SCANNING OPTO ENCODER

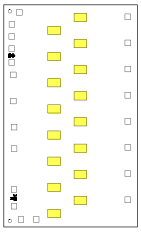
FEATURES

- Monolithic construction with integrated photodiodes ensures excellent matching and technical reliability
- Short track spacing of 600 µm
- Elimination of dark currents through differential scanning
- Photocurrent amplifier with high cut-off frequency
- Comparators with precise signal-related hysteresis
- Current-limited push-pull outputs
- Adjustable LED current control for constant received power
- Integrated power driver for the LED
- LED current monitor with error message output
- Integrated test aid
- Low power consumption from 5V supply voltage
- Available as a 20-pin BLCC or as chip
- Options: extended temperature range of -40..110 °C, customized packages, reticle assembly

APPLICATIONS

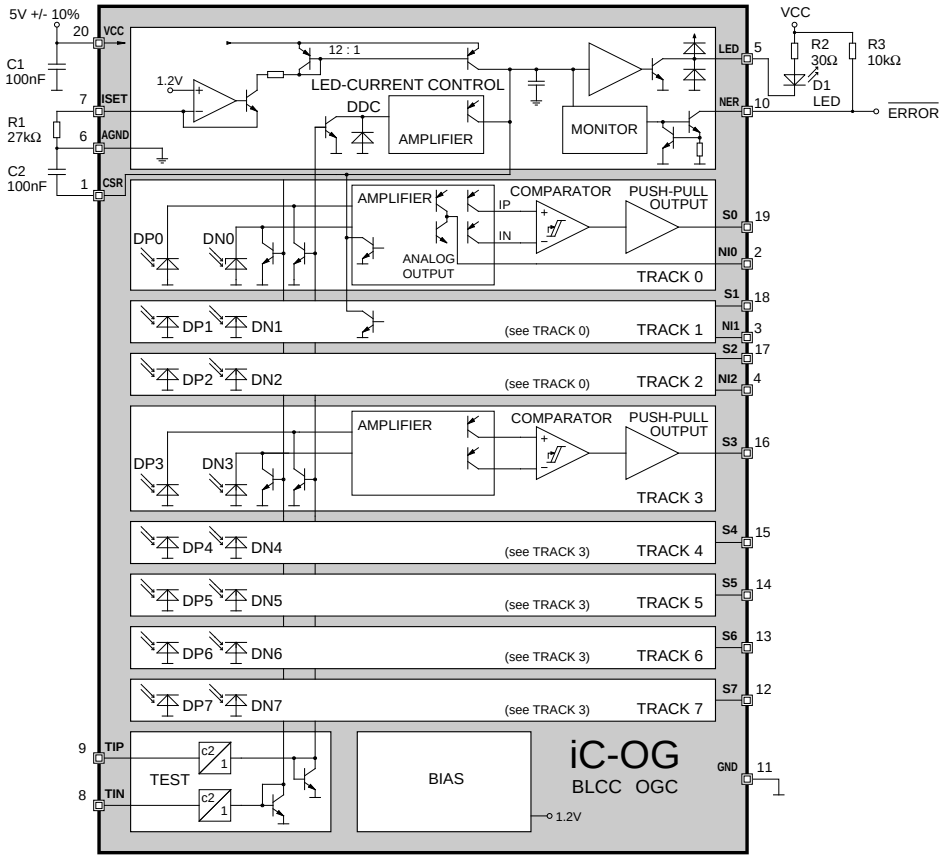
- Optical position decoding using the principle of differential scanning
- Incremental and absolute encoder with a resolution of up to 8 bits

CHIP



3.05mm × 5.1mm

BLOCK DIAGRAM



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DESCRIPTION

The iC-OG device is an optoelectronic detector IC for linear and angle measuring systems, such as glass scales or shaft encoders, for example. Photodiodes, amplifiers, comparators and TTL-compatible push-pull output drivers are integrated monolithically. Each of the 8 tracks is evaluated differentially; there are also analog outputs available from three of the special feature tracks.

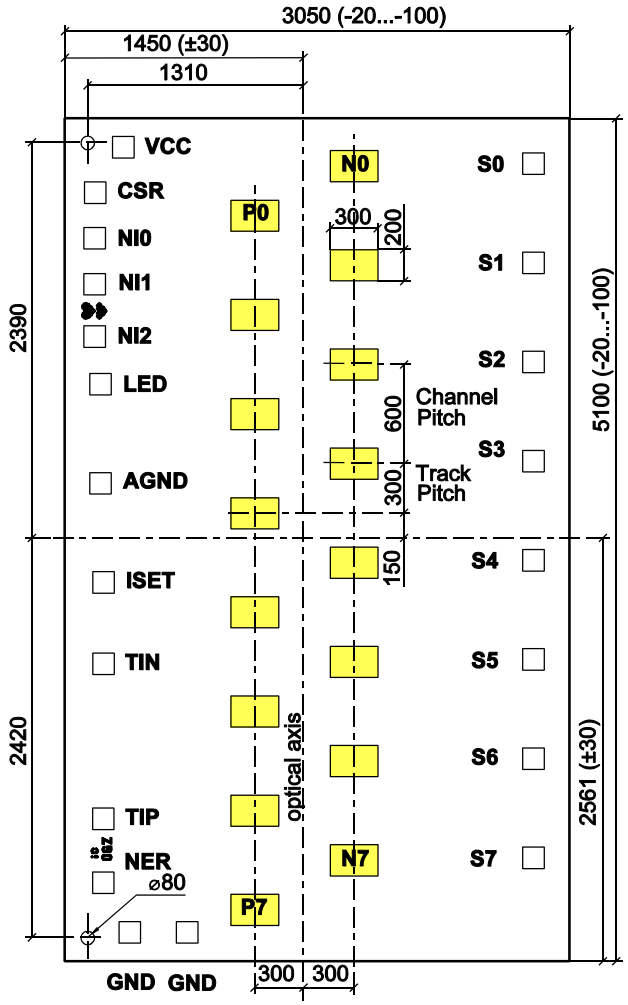
The integrated LED current control with a driver stage enables a transmit diode with series resistor to be directly connected and ensures a constant optical received power. The setpoint for the receive current is adjusted using an external resistor. Should the LED current control deviate from its working range, this is reported at the error message output.

Two test pins allow a full test of all functions to be carried out excluding the photodiodes.

All push-pull and analog outputs are protected against ESD and short-circuit damage. The error message output NER is also protected against short-circuiting and can be used in bus systems due to its open-collector output.

CHIP LAYOUT

Dimensions in µm; chip size 3.05 mm × 5.1 mm



PAD DESCRIPTION

Name	Function
CSR	External capacitor for LED control
NI0	Track 0 Analog Push-Pull Output
NI1	Track 1 Analog Push-Pull Output
NI2	Track 2 Analog Push-Pull Output
LED	LED Driver Output
AGND	Reference Ground for ISET and CSR circuitry
ISET	LED Current Control Setup
TIN	Negative Test Aid Input
TIP	Positive Test Aid Input
NER	Error Message Output, low active
GND	Ground
S7	Track 7 Push-Pull Output
..	..
S0	Track 0 Push-Pull Output
VCC	+5V Supply Voltage

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			-0.3	6	V
G301	V(S)	Voltage at Outputs S0..7			-0.3	VCC+0.3	V
G302	I(S)	Current in Outputs S0..7	V(S)< 0V or V(S)> VCC		-3	3	mA
G501	V(NI)	Voltage at Analog Outputs NI0..2			-0.3	VCC+0.3	V
G502	I(NI)	Current in Analog Outputs NI0..2			-3	3	mA
G601	I(TIP) I(TIN)	Current in TIP, TIN			-1	1	mA
G701	I(ISET)	Current in ISET			-1	0.1	mA
G702	I(AGND)	Current in AGND			-5	5	mA
G703	I(LED)	Current in LED	V(LED)< 0 or V(LED)> VCC		-3	3	mA
G704	I(LED)	Current in LED	0< V(LED) < VCC		0	150	mA
G705	V(CSR)	Voltage at CSR			-0.3	VCC+0.3	V
G706	I(CSR)	Current in CSR			-3	3	mA
GA01	V(NER)	Voltage at NER			-0.3	6	V
E001	Vd()	ESD Susceptibility	HBM, 100 pF discharged through 1.5 kΩ			2	kV
TG1	Tj	Junction Temperature			-40	125	°C
TG2	Ts	Storage Temperature	see package specification				

THERMAL DATA

Operating Conditions: VCC= 5V ±10%

Item	Symbol	Parameter	Conditions	Fig.	Min.	Typ.	Max.	Unit
T1	Ta	Operating Ambient Temperature Range	see package specification					

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.

ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC= 5V ±10%, Tj= -40..125 °C, unless otherwise noted.

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Total Device									
001	VCC	Permissible Supply Voltage Range				4.5		5.5	V
002	I(VCC)	Supply Current in VCC, Outputs S0..7 hi	LED control active: R(ISET/AGND)= 140kΩ, I(LED)≈ 8mA, NER=hi; I(DP0..7)= 30nA, I(DN0..7)= 3nA, I(S0..7)= 0;				10		mA
003	I(VCC)	Supply Current in VCC, Outputs S0..7 lo	LED control active: R(ISET/AGND)= 14kΩ, I(LED)≈ 80mA, NER=hi; I(DP0..7)= 3nA, I(DN0..7)= 30nA, I(S0..7)= 0;				10		mA
004	fo	Cut-off Frequency, tracks 0..7	sinusoidal waveform, I(DP0..7)= 3..30nA I(DN0..7)= 30..3nA			100			kHz
005	tp(D-A)	Propagation Delay	see No. 4					2.5	µs
006		Cut-off Frequency, tracks 0..7	sinusoidal waveform, I(DP0..7)= 6..60nA I(DN0..7)= 60..6nA			200			kHz
007		Propagation Delay	see No. 6					1.5	µs
Photodiodes and Amplifiers, tracks 0..7									
101	Aph(D)	Radiant Sensitive Area					0.2 × 0.3		mm²
102	S(λ)max	Spectral Sensitivity	λ= 850nm				0.5		A/W
103	λar	Range of Spectral Sensitivity	S(λar)= 0.1×S(λ)max			500		1050	nm
104	I(D)	Permissible Photocurrent						90	nA
105	CM()	Common Mode DPi to DNi				0.85	1	1.15	
Difference Comparators, tracks 0..7									
201	Hys	Hysteresis referred to [I(DPi) + I(DNi)] /2	I(DPi, DNi)= 3..90nA			8	11	17	%
Push-Pull Outputs S0..7									
301	Vs()hi	Saturation Voltage hi	Vs()hi= VCC-V(); I()= -40µA	27			0.69	0.95	V V
302	Vs()hi	Saturation Voltage hi	Vs()hi= VCC-V(); I()= -400µA	27			0.83	1.05	V V
303	Vs()lo	Saturation Voltage lo	I()= 1.6mA	27			0.22	0.4	V V
304	Isc()hi	Short-Circuit Current hi	V()= 0V..VCC-1.2V			-7	-4.6	-1.4	mA
305	Isc()lo	Short-Circuit Current lo	V()= 0.4V..VCC			1.8	7.3	13	mA
306	tr()	Slew-Rate hi	CL()= 30pF	27		24	61	130	V/µs V/µs
307	tf()	Slew-Rate lo	CL()= 30pF	27		40	115	380	V/µs V/µs
308	Vc()hi	Clamp Clamp Voltage hi	Vc()hi= V()-VCC; S()= hi, I()= 3mA			0.4		1.5	V
309	Vc()lo	Clamp Clamp Voltage lo	S()= lo, I()= -3mA			-1.5		-0.4	V

ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC= 5V ±10%, Tj= -40..125 °C, unless otherwise noted.

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Analog Outputs NI0..2									
501	CR()	Current Ratio I(NIi) / (I(DPi)-I(DNi))	V(NIi)= 0.3V..VCC-1.2V, I(DPi)= 3..90nA, I(DNi)= 90..3nA	27		550	720	1250	
502	I0()	Leakage Current	V(NI)= 0.3V..VCC-1.2V, I(DPi,DNi)= 0			-1.5		1.5	µA
503	fo()	Cut-off Frequency	V(NIi)= constant, sinussoidal waveform, I(DPi)= 3..30nA, I(DNi)= 30..3nA			100			kHz
504	fo()	Cut-off Frequency	V(NIi)= constant, sinussoidal waveform, I(DPi)= 6..60nA, I(DNi)= 60..6nA			200			kHz
505	fo()	Cut-off Frequency	R(VCC/NIi)= 50kΩ, R(NIi/GND)= 50kΩ, CL()= 30pF			50	80		kHz
506	Vc()hi	Clamp Voltage hi	Vc()hi= V()-VCC; I()= 3mA			0.4		1.5	V
507	Vc()lo	Clamp Voltage lo	I()= -3mA			-1.5		-0.4	V
Test Aid TIP, TIN									
601	CR()	Current Ratio I(TIP) / I(DPi,DDC) and I(TIN) / I(DNi)	Test aid active, I()= 2..200µA			750	1100	1600	
602	It()	Pull-Down Current (Test Aid Turn-on Threshold)	V()= 0.4V	-40 27 85 125		2.5	14 19 25 28	125	µA µA µA µA µA
603	V()on	Turn-on Voltage	Test aid active, I(TIP)= 2..200µA and I(TIN)= 100µA, or I(TIP)= 100µA and I(TIN)= 2..200µA	-40 27 85 125		1.9 1.6 1.2 1.1	2.4 2.1 1.8 1.6	2.7 2.4 2.1 1.9	V V V V
LED Current Control ISET, AGND, LED, CSR									
701	ISUM	Permissible Sum Current of photodiodes DP0, DN0, DP1, DN1	ISUM= I(DP0) +I(DN0) +I(DP1) +I(DN1)			0		360	nA
702	I(LED)	Permis. Driver Current in LED				0		80	mA
703	Vs(LED)	Saturation Voltage at LED	I(LED)= 80mA, I(ISET)> 20µA, V(CSR)= VCC	-40 27 85 125			0.96 0.88 0.79 0.72	1.35	V V V V V
704	V(ISET)	Voltage at ISET	R(ISET/AGND)= 10..150kΩ			1.15	1.22	1.35	V
705	CR()	Current Ratio I(ISET) / I(CSR)	V(CSR)= 0.3V, ISUM= 0, R(ISET)= 10..150kΩ	-40 27 85 125		8	12.0 11.9 11.75 11.65	15	
706	CR()	Current Ratio I(CSR) / ISUM	V(CSR)= 1..3V, I(ISET)= 0			70	92	130	
707	Vc()hi	Clamp Voltage hi at ISET, LED, CSR	Vc()hi= V()-VCC; I()= 3mA			0.4		1.5	V
708	Vc()lo	Clamp Voltage lo at ISET, LED, CSR	VCC= 0V, I()= -3mA			-1.5		-0.4	V

ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC= 5V ±10%, Tj= -40..125 °C, unless otherwise noted.

Item	Symbol	Parameter	Conditions	Tj °C	Fig.	Min.	Typ.	Max.	Unit
Control Monitor NER									
801	Vs()	Saturation Voltage lo	I(NER)= 3.2mA				0.27	0.4	V
802	Isc()	Short-Circuit Current lo	V(NER)= VCC				15	27	mA
803	I0()	Collector Off-state Current	NER: off, V(NER)= 0..6V					10	µA

DESCRIPTION OF FUNCTIONS

LED current control

The integrated LED current control with a driver stage controls the LED in accordance with the sum of the photocurrents from the tracks 0 and 1. Compensation is made for age and dirt, as well as for the reduced efficiency of the LED caused by rises in temperature.

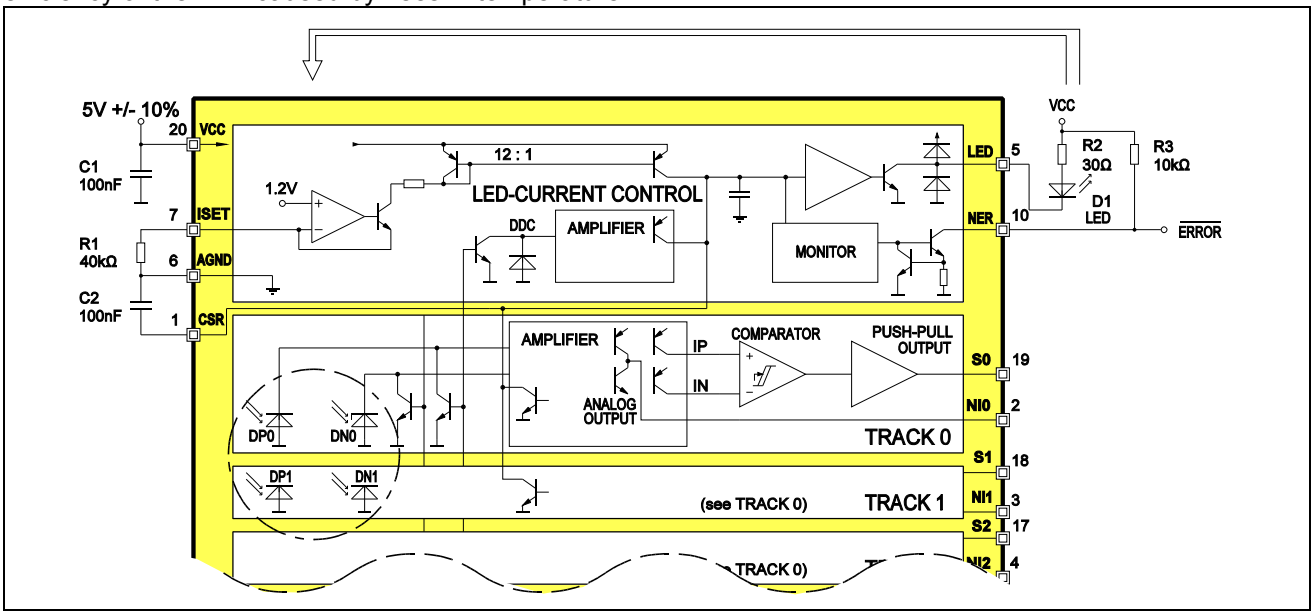


Fig. 1: LED Current Control and Monitoring

The photodiodes DPO, DNO, DP1 and DN1 act as reference diodes. The sum is output via a current sink to the comparison point pin CSR. Simultaneously, the resistor R1 at pin ISET (the voltage at the ISET pin is kept at a constant of approximately 1.22V) supplies a reference current for the current source from VCC, which also works towards the comparison point pin CSR. The comparison point also receives the amplified current from the compensation diode DDC in order to compensate for dark currents and for the amplifier input currents.

If there is an optical feedback from the LED to the reference photodiodes, the voltage at the CSR pin adjusts to satisfy the needs of the power driver for the required transmit current at pin LED. In this instance, the voltage ratio between I(ISET) and the sum of the photodiode current ISUM is constant (Electrical Characteristics Nos. 706 and 707). The current flowing through the resistor R1 is the setpoint for the control and directly presets the desired level of illumination.

An internal capacitor ensures that the control is stable. The comparison point pin CSR is lead out in the BLCC20 package, enabling an external capacitor C2 to be connected to adapt the control behaviour. Lower values for R1 require larger values for C2, which also improve the power-supply rejection ratio for the control. Values from 10nF upwards are recommended.

A resistor in series with the LED limits the current in pin LED and sets the operating limits of the control.

The optical feedback between the LED and the reference photodiodes should be good enough to establish an LED current of less than 15mA at room temperature. Only under these conditions does the power driver have a sufficient current reserve to correct the LED's decline in efficiency even at high temperatures.

Control Monitor and Error Message Output
The control monitor observes the potential at the CSR pin. Voltages which bring the power driver to saturation or off-state are recognized and indicated at the open-collector output by NER= low.

APPLICATIONS INFORMATION

Using the test aid
The threshold current defined in the electrical characteristic No. 602 must be exceeded at both pins TIP and TIN simultaneously to activate the iC-OG's built-in test aid. Once it has been activated, the test aid does not switch back to off-state until the current drops below approx. 1µA.

A clamp circuit as shown in Figure 2 also prevents falling below the test aid turn-on threshold for a short time. The output polarity of the iC-OG is to be changed over with the switch.

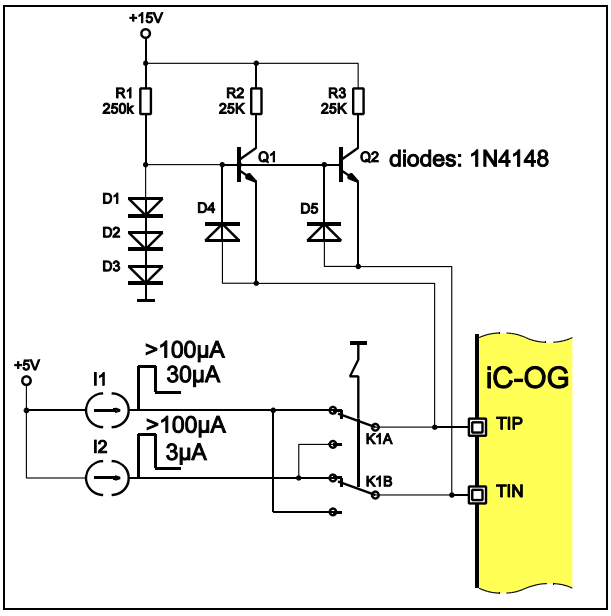


Fig. 2: Wiring the test aid

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We understand suitable application of our published designs to be state-of-the-art technology which can no longer be classed as inventive under the stipulations of patent law. Our explicit application notes are to be treated only as mere examples of the many possible and extremely advantageous uses our products can be put to.

ORDERING INFORMATION

Type	Package	Order designation
iC-OG	-	iC-OG *Chip*
iC-OG	BLCC OGC	iC-OG BLCC OGC

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