

# iC-LSHC

## 3-CHANNEL SIN/COS PHOTODIODE SENSOR ARRAY



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### FEATURES

- ◆ Monolithic array of independent photodiodes with excellent matching
- ◆ Compact photodiode size of 800  $\mu\text{m}$  x 330  $\mu\text{m}$  enabling smaller encoder systems
- ◆ Moderate alignment tolerance due to a track pitch of 1.08 mm
- ◆ Ultra low dark currents for operation to high temperature
- ◆ Low noise amplifiers with high transimpedance of typ. 1 M $\Omega$
- ◆ Short-circuit-proof, low impedance voltage outputs for enhanced EMI tolerance
- ◆ Low power consumption from single 4.1 to 5.5 V supply
- ◆ Operational temperature range of -40  $^{\circ}\text{C}$  to +125  $^{\circ}\text{C}$
- ◆ Space saving optoQFN and optoBGA packages (RoHS compliant)
- ◆ Available options
  - reticle assembly, code discs
  - customized COB modules

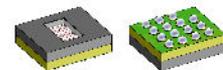
### APPLICATIONS

- ◆ Optical position encoding from analog sine/cosine signals
- ◆ Absolute position encoders using nonius scales

### PACKAGES

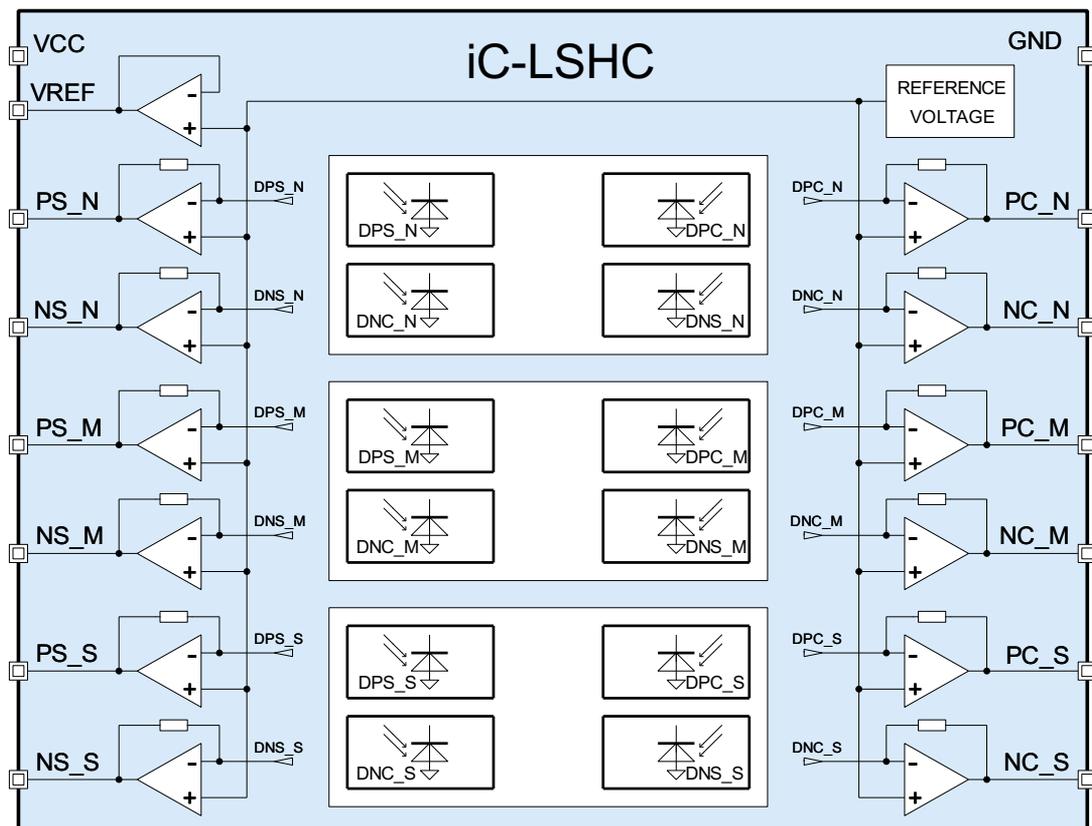


32-pin optoQFN  
5 mm x 5 mm x 0.9 mm  
RoHS compliant



15-pin optoBGA  
6.2 mm x 5.2 mm  
RoHS compliant

### BLOCK DIAGRAM



# iC-LSHC

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### DESCRIPTION

The iC-LSHC photodiode is a general purpose optoelectronic scanner made to suit a variety of encoding applications, such as rotary and linear encoders used for motion control, robotics, brushless DC motor commutation, power tools etc.

iC-LSHC features 12 monolithically integrated photodiodes with active areas of  $800\ \mu\text{m} \times 330\ \mu\text{m}$  each. A high transimpedance gain of typically  $1\ \text{M}\Omega$  generates output signals of a few hundred millivolts already from illumination levels of typ.  $1.7\ \text{mW}/\text{cm}^2$ . In most cases no additional measures must be considered to filter for noise and interferences.

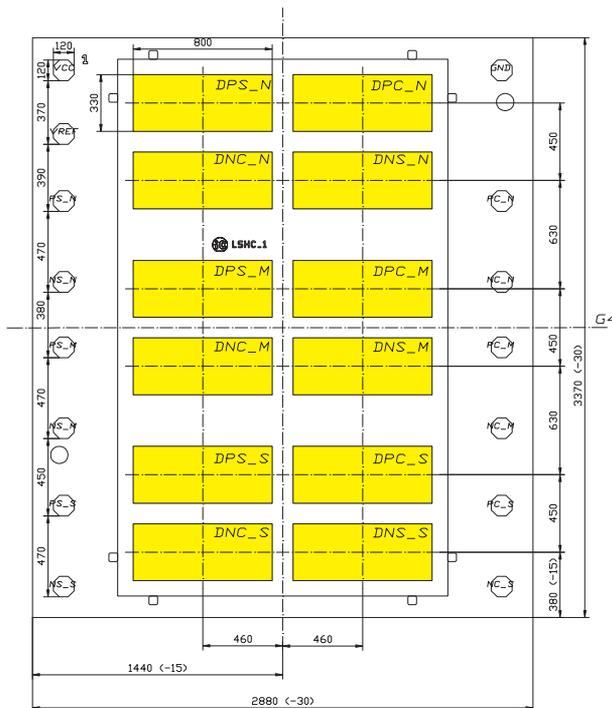
Sine/cosine encoders are the typical application for iC-LSHC. Its 3-track scanning features a set of 4 pho-

tosensors each per track, generating positive and negative going sine signals, as well as positive and negative going cosine signals. An excellent matching and common mode behavior of the differential signal paths is obtained by a paired amplifier design, reducing the needs for external signal calibration to an absolute minimum.

The spectral sensitivity range includes visible to near infrared light, with the maximum sensitivity being close to a wavelength of 680 nm. When using iC-LSHC for encoder applications with typical disc and mask codes, a signal amplitude of approximately some 100 mV is typical under low light conditions, for instance when iC-LSHC is illuminated at only  $3.0\ \text{mW}/\text{cm}^2$  by an 740 nm LED.

### PACKAGING INFORMATION

#### PAD LAYOUT



#### PAD FUNCTIONS

##### No. Name Function

Refer to the description of pin functions.  
Note: Dimension G4 is the reference radius of the chip center.

# iC-LSHC

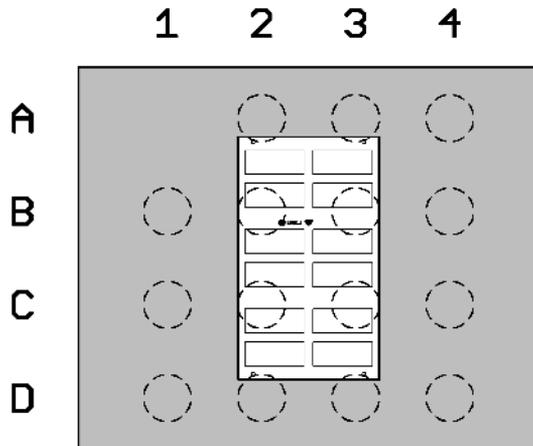
## 3-CHANNEL SIN/COS PHOTSENSOR ARRAY



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### PIN CONFIGURATION

oBGA LSH2C (6.2 mm x 5.2 mm)



### PIN FUNCTIONS

No. Name Function

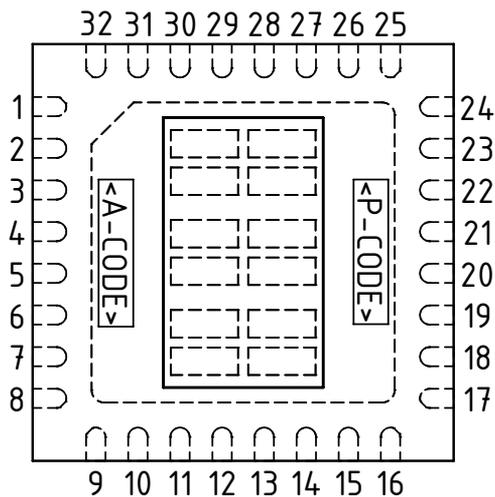
A2	VCC	+4.1...5.5 V	Supply Voltage
A3	VREF		Reference Voltage Output
A4	GND		Ground
B1	PS_N		N-Track Sine +
B2	NS_N		N-Track Sine -
B3	NC_N		N-Track Cosine -
B4	PC_N		N-Track Cosine +
C1	PS_M		M-Track Sine +
C2	NS_M		M-Track Sine -
C3	NC_M		M-Track Cosine -
C4	PC_M		M-Track Cosine +
D1	PS_S		S-Track Sine +
D2	NS_S		S-Track Sine -
D3	NC_S		S-Track Cosine -
D4	PC_S		S-Track Cosine +

NB: All outputs supply analog voltages.

For dimensional specifications refer to the relevant package data sheet, available separately.

### PIN CONFIGURATION

oQFN32-5x5 (5 mm x 5 mm)



### PIN FUNCTIONS

No. Name Function

1	VCC	+4.1...5.5 V	Supply Voltage
2	VREF		Reference Voltage Output
3	PS_N		N-Track Sine +
4	NS_N		N-Track Sine -
5	PS_M		M-Track Sine +
6	NS_M		M-Track Sine -
7	PS_S		S-Track Sine +
8	NS_S		S-Track Sine -
9-16	n.c. <sup>1)</sup>		
17	NC_S		S-Track Cosine -
18	PC_S		S-Track Cosine +
19	NC_M		M-Track Cosine -
20	PC_M		M-Track Cosine +
21	NC_N		N-Track Cosine -
22	PC_N		N-Track Cosine +
23	n.c. <sup>1)</sup>		
24	GND		Ground
25-32	n.c. <sup>1)</sup>		
	BP <sup>2)</sup>		Backside paddle

NB: All outputs supply analog voltages.

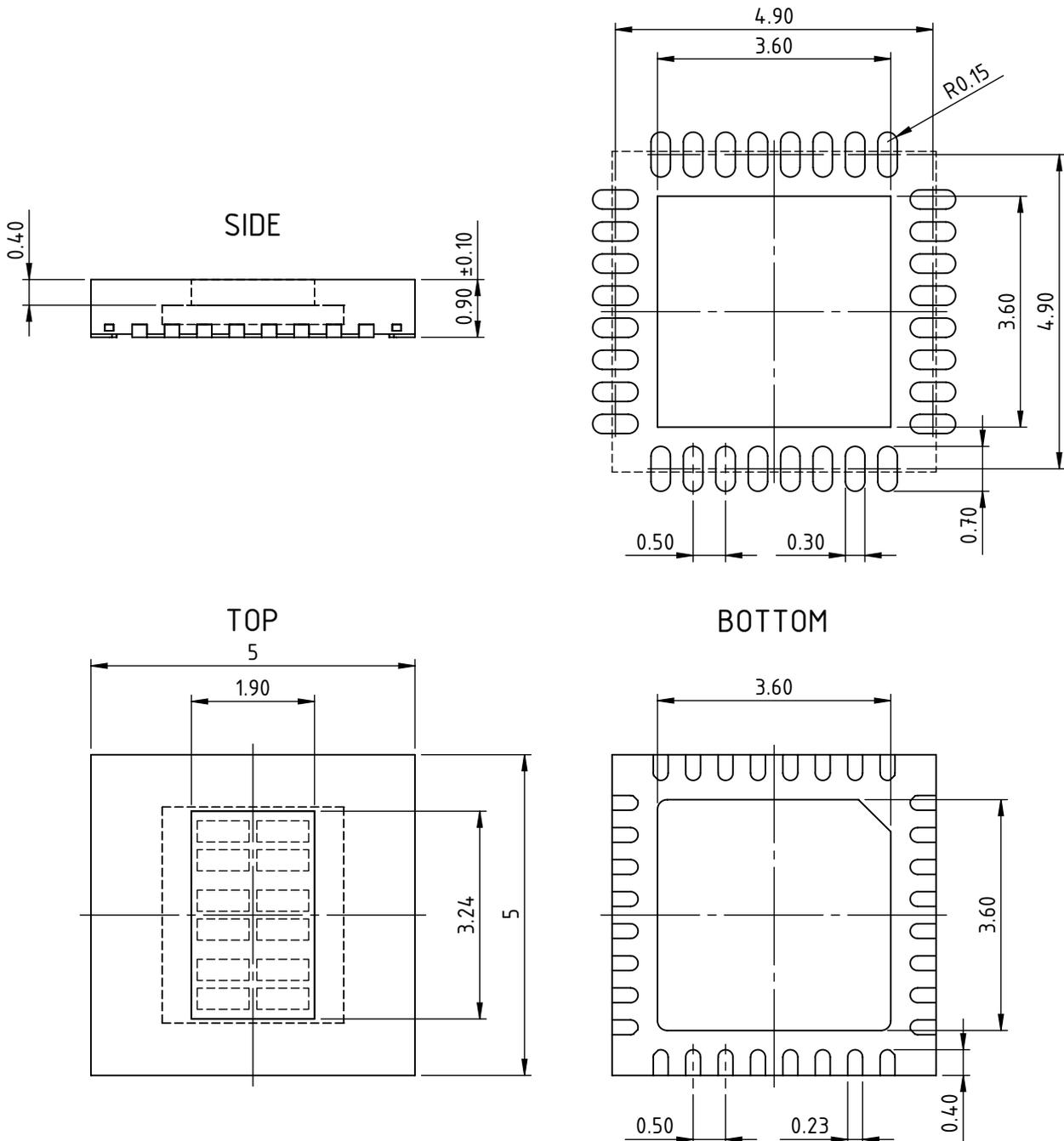
IC top marking: <P-CODE> = product code, <A-CODE> = assembly code (subject to changes);

1) Pin numbers marked n.c. are not connected.

2) Connecting the backside paddle is recommended by a single link to GND (use as shield). A current flow across the paddle is not permissible.

### PACKAGE DIMENSIONS oQFN32-5x5

### RECOMMENDED PCB-FOOTPRINT



All dimensions given in mm. Tolerances of form and position according to JEDEC MO-220.  
Tolerance of sensor pattern:  $\pm 70\mu\text{m}$  /  $\pm 1^\circ$  (with respect to center of backside pad).  
Maximum molding excess  $+20\mu\text{m}$  /  $-75\mu\text{m}$  versus surface of glass/reticle.

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### ABSOLUTE MAXIMUM RATINGS

These ratings do not imply operating conditions; functional operation is not guaranteed. Beyond these ratings device damage may occur.

Item No.	Symbol	Parameter	Conditions			Unit
				Min.	Max.	
G001	VCC	Voltage at VCC		-0.3	6	V
G002	I(VCC)	Current in VCC		-20	20	mA
G003	V()	Pin Voltage, all signal outputs		-0.3	VCC + 0.3	V
G004	I()	Pin Current, all signal outputs		-20	20	mA
G005	Vd()	ESD Susceptibility, all pins	HBM, 100 pF discharged through 1.5 kΩ		2	kV
G006	Tj	Junction Temperature		-40	150	°C
G007	Ts	Chip Storage Temperature		-40	150	°C

### THERMAL DATA

Operating conditions: VCC = 4.1 V ... 5.5 V

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range	package oQFN32-5x5	-40		125	°C
			package oBGA LSH2C	-40		110	°C
T02	Ts	Storage Temperature Range	package oQFN32-5x5	-40		125	°C
			package oBGA LSH2C	-40		110	°C
T03	Tpk	Soldering Peak Temperature	package oQFN32-5x5;				
			tpk < 20 s, convection reflow tpk < 20 s, vapor phase soldering  MSL 5A (max. floor life 24 h at 30 °C and 60 % RH); Please refer to customer information file No. 7 for details.			245 230	°C °C
T04	Tpk	Soldering Peak Temperature	package oBGA LSH2C				
			tpk < 20 s, convection reflow tpk < 20 s, vapor phase soldering  TOL (time on label) 8 h; Please refer to customer information file No. 7 for details.			245 230	°C °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.

# iC-LSHC

## 3-CHANNEL SIN/COS PHOTODIODE ARRAY



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### ELECTRICAL CHARACTERISTICS

Operating conditions: VCC = 4.1...5.5 V, Tj = -40...125 °C, unless otherwise stated

Item No.	Symbol	Parameter	Conditions				Unit
				Min.	Typ.	Max.	
<b>Total Device</b>							
001	VCC	Permissible Supply Voltage		4.1		5.5	V
002	I(VCC)	Supply Current in VCC	no output load, photocurrents within linear operating range (no override)		9.5	15	mA
003	Vc()hi	Clamp-Voltage hi at all pins	I() = 4 mA			11	V
004	Vc()lo	Clamp-Voltage lo at all pins	I() = -4 mA	-1.2		-0.3	V
<b>Photosensors</b>							
101	$\lambda_{ar}$	Spectral Application Range	$Se(\lambda_{ar}) = 0.25 \times S(\lambda_{pk})$	400		950	nm
102	$\lambda_{pk}$	Peak Sensitivity Wavelength			680		nm
103	Aph()	Radiant Sensitive Area	0.8 mm x 0.33 mm		0.264		mm <sup>2</sup>
104	S( $\lambda$ )	Spectral Sensitivity	$\lambda_{LED} = 460$ nm $\lambda_{LED} = 740$ nm $\lambda_{LED} = 850$ nm		0.30 0.45 0.30		A/W A/W A/W
106	E()mxr	Irradiance For Maximum Signal Level	$\lambda_{LED} = 740$ nm, Vout() not yet saturated		1.7		mW/cm <sup>2</sup>
<b>Photocurrent Amplifiers</b>							
201	Iph()	Permissible Photocurrent Operating Range		0		1120	nA
202	$\eta()$ r	Photo Sensitivity (light-to-voltage conversion ratio)	$\lambda_{LED} = 740$ nm	0.2	0.3	0.5	V/ $\mu$ W
203	Z()	Equivalent Transimpedance Gain	Z = Vout() / Iph()	0.7	1.0	1.4	M $\Omega$
204	TCz	Temperature Coefficient of Transimpedance Gain			-0.12		%/°C
209	$\Delta Z()$ pn	Transimpedance Gain Matching	P vs. N path per diff. channel	-0.2		0.2	%
210	$\Delta V_{out}()$ pn	Signal Matching	no illumination, any output to any output	-35		35	mV
211	$\Delta V_{out}()$ pn	Signal Matching	no illumination, P.. output vs. corresponding N.. output	-2.5		2.5	mV
212	fc()hi	Cut-off Frequency (-3 dB)			400		kHz
213	VNoise()	RMS Output Noise	illuminated to 500 mV signal level above dark level, 500 kHz band width		0.5		mV
<b>Signal Outputs</b>							
301	Vout()mx	Permissible Maximum Output Voltage	illumination to E()mxr, linear gain; VCC = 4.5...5.5 V VCC = 4.1 V	2.4 2.0			V V
302	Iout()mx	Permissible Max. Load Current		-100		250	$\mu$ A
303	Vout()d	Dark Signal Level	no illumination, load 20 k $\Omega$ vs. +2 V	575	770	1000	mV
305	Isc()hi	Short-Circuit Current hi	load current to ground	100	420	1000	$\mu$ A
306	Isc()lo	Short-Circuit Current lo	load current to IC	250	480	700	$\mu$ A
307	Ri()	Internal Output Resistance	f = 1 kHz	70	110	180	$\Omega$
308	ton()	Power-On Settling Time	VCC = 0 V $\rightarrow$ 5 V			100	$\mu$ s
<b>Reference Voltage VREF</b>							
401	VREF	Reference Voltage	I(VREF) = -100...+300 $\mu$ A	575	770	1000	mV
402	dVout()	Load Balancing	I(VREF) = -100...+300 $\mu$ A	-10		+10	mV
403	Isc()hi	Short-Circuit Current hi	load current to ground	200	420	1400	$\mu$ A
404	Isc()lo	Short-Circuit Current lo	load current to IC	0.4	4.5	10	mA

### APPLICATION CIRCUITS

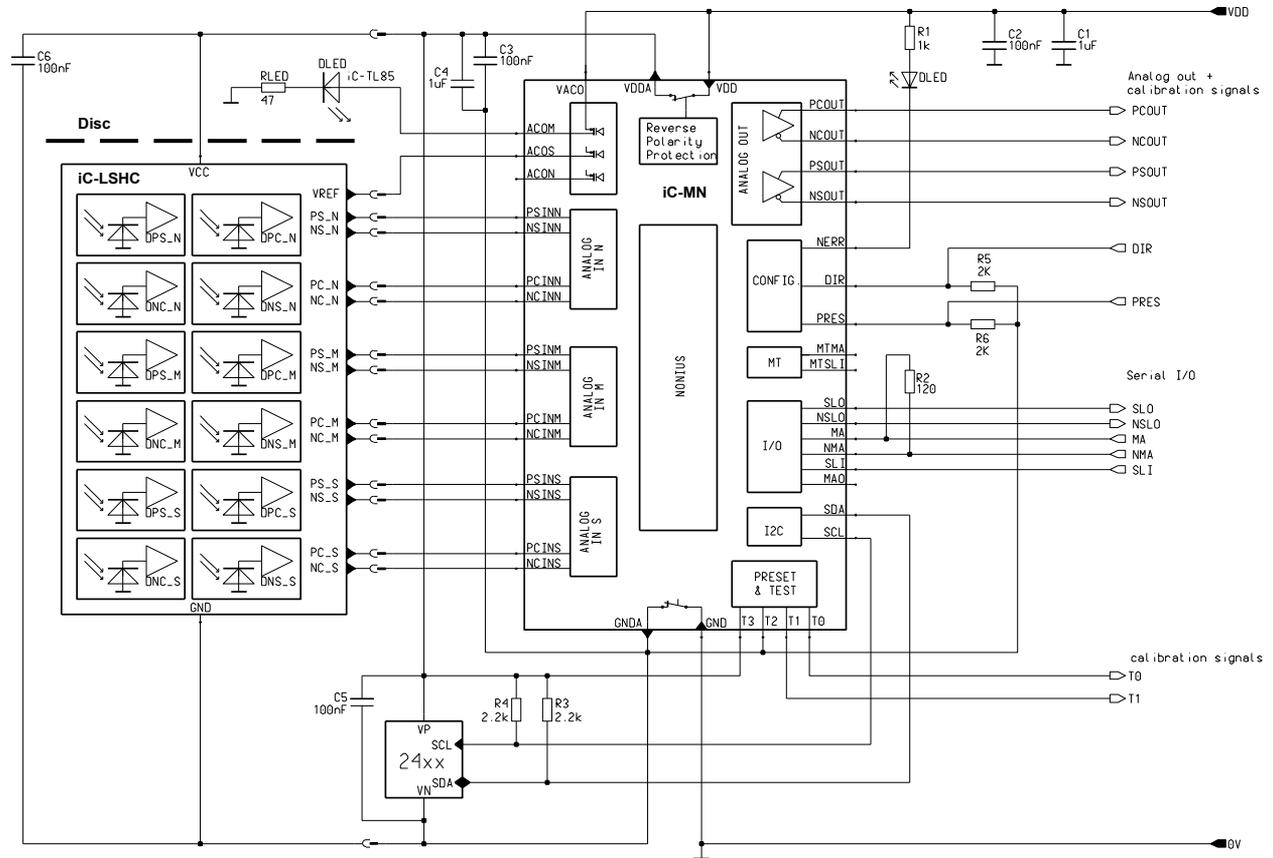


Figure 1: Application example of absolute encoder

### DESIGN REVIEW: Notes On Chip Functions

iC-LSHC 2		
No.	Function, Parameter/Code	Description and Application Hints
1		Please refer to former datasheet release B1.

Table 4: Notes on chip functions regarding iC-LSHC chip release 2.

iC-LSHC Z		
No.	Function, Parameter/Code	Description and Application Hints
1		No further notes at time of printing.

Table 5: Notes on chip functions regarding iC-LSHC chip release Z.

### REVISION HISTORY

Rel.	Rel. Date <sup>1</sup>	Chapter	Modification	Page
D1	2017-08-03	FEATURES	Preliminary label removed Supply voltage extended to include 4.1 V Operational temperature up to 125 °C	1
		PACKAGING INFORMATION	oQFN with top marking, revision of footnote, update of oQFN package drawing	3, 4
		THERMAL DATA	Operating temperature up to 125 °C for oQFN	5
		ELECTRICAL CHARACTERISTICS	Operating conditions: VCC supply voltage extended to include 4.1 V Item 001: min. limit; item 101, condition: reference to $\lambda_{pk}$ Item 104: 460 nm supplemented Items 301, 303: conditions and limits (4.1 V added) Item 302: new item Item 304: removed Item 401: min. limit, item 403: max. limit	6
		APPLICATION CIRCUITS	Fig. 1 updated	7

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<sup>1</sup> Release Date format: YYYY-MM-DD

**ORDERING INFORMATION**

Type	Package	Options	Order Designation
iC-LSHC	15-pin optoBGA, 6.2 mm x 5.2 mm, thickness 1.7 mm RoHS compliant	glass lid	iC-LSHC oBGA LSH2C
		reticle 26-256 NMS	iC-LSHC oBGA LSH2C-4R
		reticle 26-1024 NMS custom reticle	iC-LSHC oBGA LSH2C-1R iC-LSHC oBGA LSH2C-xxR
iC-LSHC	32-pin optoQFN, 5 mm x 5 mm, thickness 0.9 mm RoHS compliant	glass lid	iC-LSHC oQFN32-5x5
		custom reticle	iC-LSHC oQFN32-5x5-xxR
Code Discs		255/256/240 CPR OD $\varnothing$ 26 mm, ID $\varnothing$ 11.6 mm, optical radius 10.905 mm (glass 1 mm)	LSHC4S 26-256N
		1023/1024/992 CPR OD $\varnothing$ 26 mm, ID $\varnothing$ 11.6 mm, optical radius 10.905 mm (glass 1 mm)	LSHC1S 26-1024N

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