

# iC-LSHB

## INCREMENTAL PHOTSENSOR ARRAY



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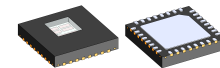
### FEATURES

- ◆ Monolithic array of independent photosensors with excellent matching
- ◆ Compact photosensor size of 800  $\mu\text{m}$  x 330  $\mu\text{m}$  enabling smaller encoder systems
- ◆ Moderate track pitch for reasonable alignment tolerances
- ◆ 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
- ◆ Space saving optoBGA and optoQFN package (RoHS compliant)
- ◆ Low power consumption from single 4.1 V to 5.5 V supply
- ◆ Operational temperature range of -40 °C to +125 °C
- ◆ Available options
  - reticle assembly, code discs
  - customized COB modules

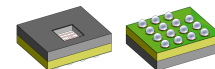
### APPLICATIONS

- ◆ Incremental rotary encoders
- ◆ Linear scales

### PACKAGES

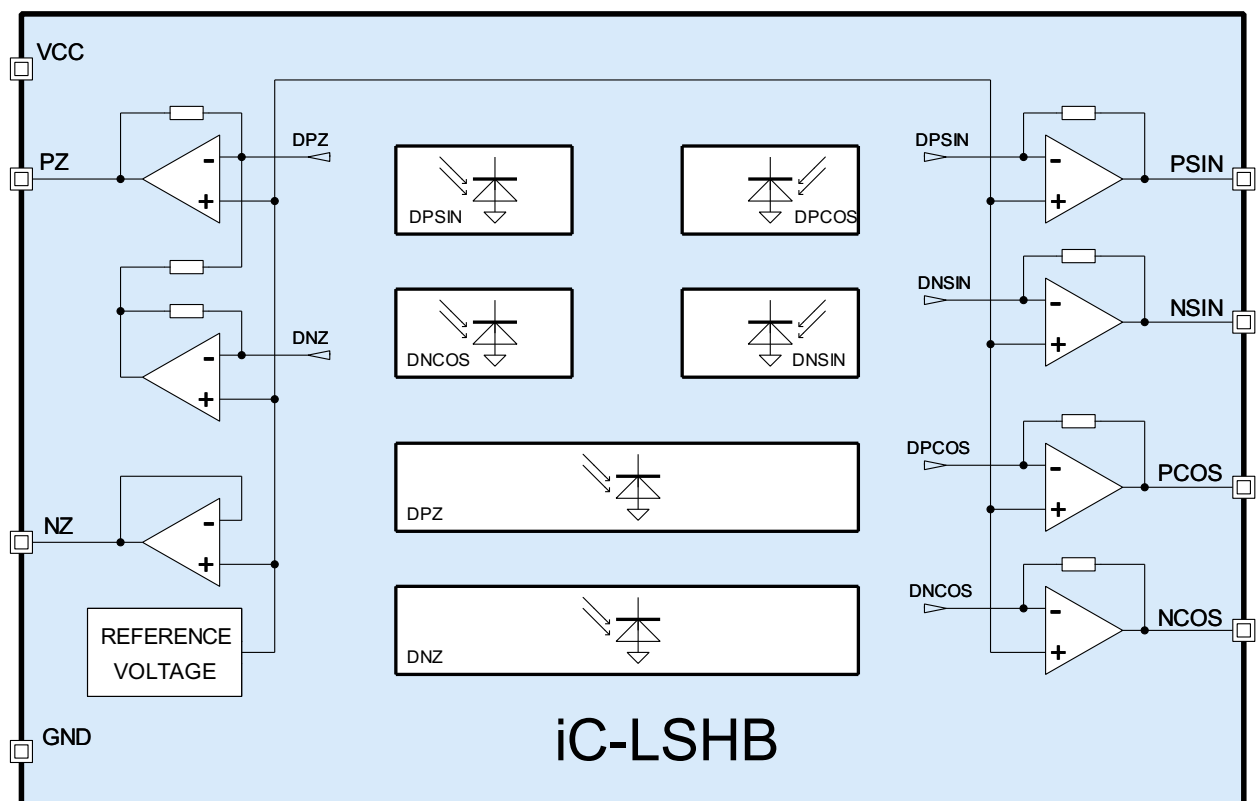


32-pin optoQFN  
5 mm x 5 mm x 0.9 mm  
RoHS compliant



15-pin optoBGA  
6.2 mm x 5.2 mm  
RoHS compliant

### BLOCK DIAGRAM



# iC-LSHB

## INCREMENTAL PHOTODIODE SENSOR ARRAY



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### DESCRIPTION

iC-LSHB is an optical sensor IC with 6 integrated photodiodes whose signal currents are converted into output voltages by low-noise transimpedance amplifiers.

The IC is well suited for the operation of interpolation circuits for linear or rotary incremental encoders with an index signal. iC-LSHB thus has a shamrock-style sensor layout of four photodiodes, each with an active area of  $800\ \mu\text{m} \times 330\ \mu\text{m}$ . Both a positive and negative sine signal and a positive and negative cosine signal are generated from a single shared code track. The signal amplifier layout ensures excellent paired channel matching, reducing signal differences to an absolute minimum.

Two separate photodiodes, with active areas of  $1720\ \mu\text{m} \times 150\ \mu\text{m}$  apiece, are employed for the differential scanning of the index track and to generate the zero signal.

The spectral sensitivity ranges from visible to near infrared light, with the maximum sensitivity close to a wavelength of 680 nm.

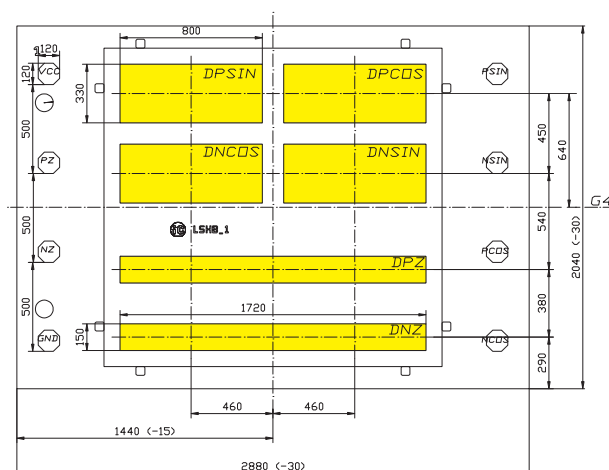
A high transimpedance gain of typically  $1\ \text{M}\Omega$  generates output signals of a few hundred Millivolts already from illumination levels of  $0.8\ \text{mW}/\text{cm}^2$ .

A threefold intensity is sufficient when using iC-LSHB for encoder applications with typical disc and mask codes. Therefore, a relatively low LED current is enough to operate the sensor, proving beneficial to the life expectancy of the LED at high operating temperatures.

iC-LSHB is suitable for on-chip or LED-end mounting of the grating (reticle), so that the period count, signal waveform, phase shift and index marker code can be selected with flexibility.

### PACKAGING INFORMATION

#### PAD LAYOUT (2.88 mm x 2.04 mm)



#### PAD FUNCTIONS

##### No. Name Function

Refer to the description of pin functions.

Note: Dimension G4 is the reference radius of the chip center.

# iC-LSHB

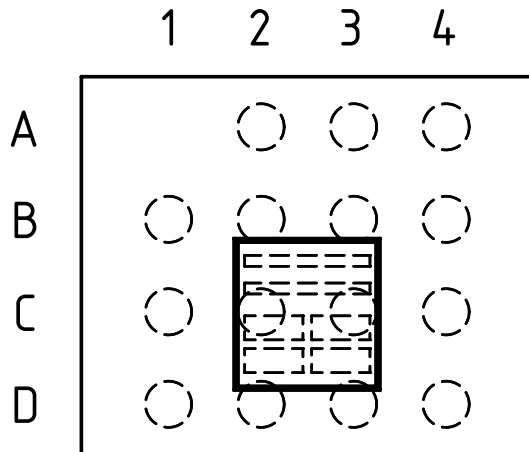
## INCREMENTAL PHOTSENSOR ARRAY



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### PIN CONFIGURATION

oBGA LSH2C (6.2 mm x 5.2 mm)



### PIN FUNCTIONS

No. Name Function

A2 n.c.<sup>1</sup>

A3 n.c.

A4 n.c.

B1 n.c.

B2 n.c.

B3 n.c.

B4 n.c.

C1 NCOS Cosine -

C2 PCOS Cosine +

C3 NZ Reference Voltage Output

C4 GND Ground

D1 NSIN Sine -

D2 PSIN Sine +

D3 VCC +4.1...5.5 V Supply Voltage

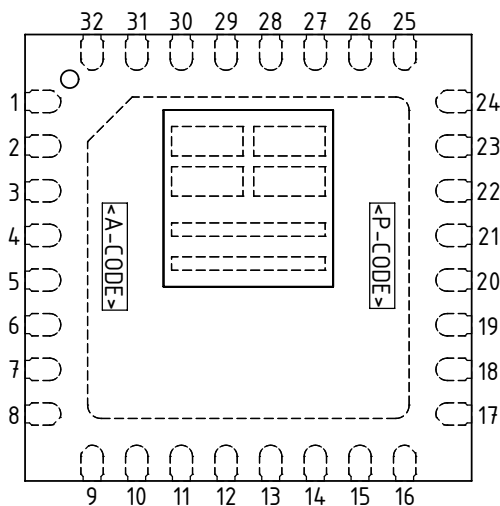
D4 PZ Zero Signal (Index)

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 n.c.<sup>1</sup>

2 VCC +4.1...5.5 V Supply Voltage

3 PZ Zero Signal (Index)

4 NZ Reference Voltage Output

5 GND Ground

6-19 n.c.

20 NCOS Cosine -

21 PCOS Cosine +

22 NSIN Sine -

23 PSIN Sine +

24-32 n.c.

BP<sup>2</sup> Backside paddle

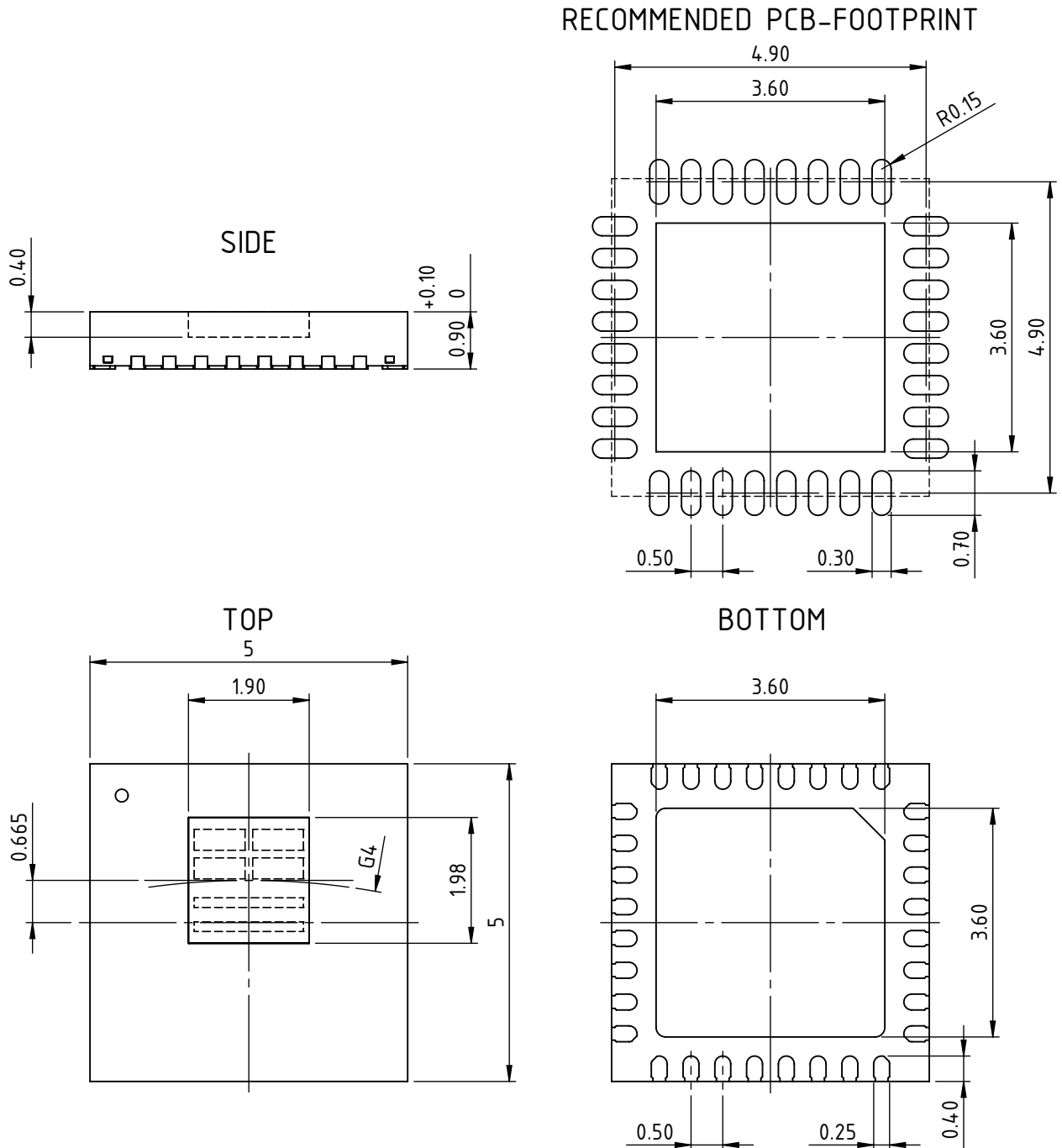
NB: All outputs supply analog voltages.

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

<sup>1</sup> Pin numbers marked n.c. are not connected.

<sup>2</sup> 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**



All dimensions given in mm. General Tolerances of form and position according to JEDEC MO-220.  
 Positional tolerance of sensor pattern:  $\pm 70\mu\text{m}$  /  $\pm 1^\circ$  (with respect to center of backside pad).  
 G4: radius of chip center (refer to the relevant encoder disc and code description).  
 Maximum molding excess  $+20\mu\text{m}$  /  $-75\mu\text{m}$  versus surface of glass. Small pits in the mold surface, which may occasionally appear due to the manufacturing process, are cosmetic in nature and do not affect reliability.

# iC-LSHB

## INCREMENTAL PHOTODIODE ARRAY



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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); Refer to <a href="#">Handling and Soldering Conditions</a> 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; Refer to <a href="#">Handling and Soldering Conditions</a> 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-LSHB

## INCREMENTAL PHOTSENSOR 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)		6.5	12	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 of DPSIN, DPCOS, DNSIN, DNCOS	0.8 mm x 0.33 mm		0.264		mm <sup>2</sup>
104	Aph()	Radiant Sensitive Area of DPZ, DNZ	1.72 mm x 0.15 mm		0.258		mm <sup>2</sup>
105	S( $\lambda_r$ )	Spectral Sensitivity	$\lambda_{LED} = 460$ nm $\lambda_{LED} = 740$ nm $\lambda_{LED} = 850$ nm		0.25 0.5 0.35		A/W A/W A/W
107	E()mx	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 Of Paired Amplifiers	P.. channel vs. corresponding N.. channel	-0.2		0.2	%
210	$\Delta Vout()$ pn	Signal Matching	no illumination, any output vs. any output	-35		35	mV
211	$\Delta Vout()$ 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 PSIN, NSIN, PCOS, NCOS, PZ</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 NZ</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 HINTS

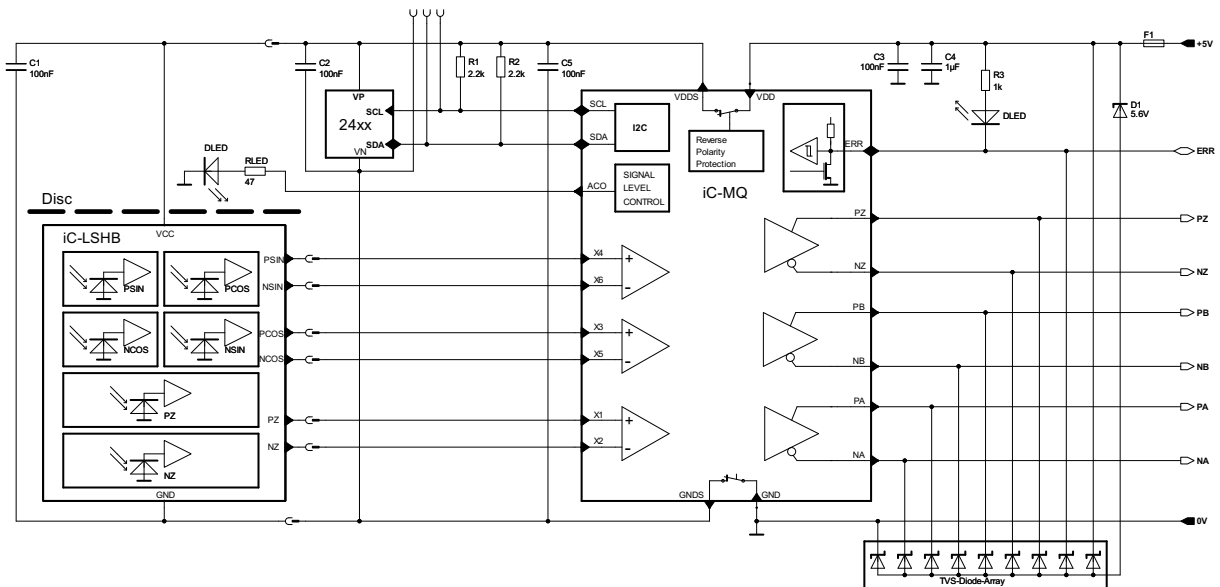


Figure 1: Example of incremental encoder with RS422 output

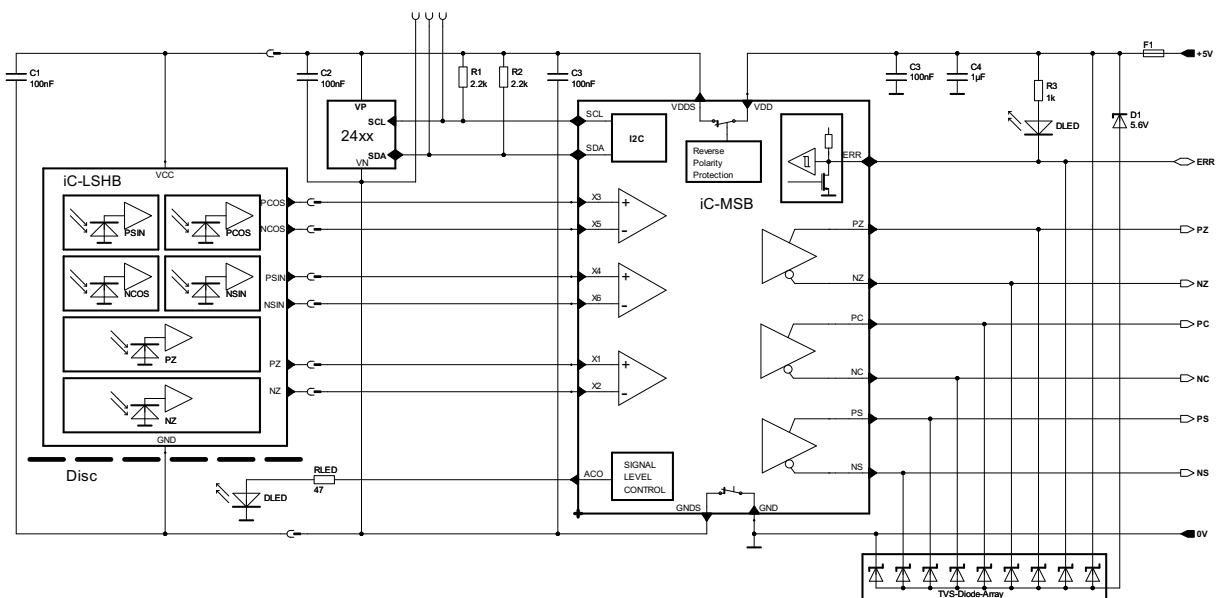


Figure 2: Example of sine encoder with 1 Vpp output

### DESIGN REVIEW: Notes On Chip Functions

iC-LSHB 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-LSHB chip release 2.

iC-LSHB Z, Z1		
No.	Function, Parameter/Code	Description and Application Hints
1		No further notes at time of printing.

Table 5: Notes on chip functions regarding iC-LSHB chip release Z, Z1.

### REVISION HISTORY

Rel.	Rel. Date <sup>1</sup>	Chapter	Modification	Page
D1	2017-08-04	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 105: 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
		DESIGN REVIEW	Chip release Z1 supplemented.	8
		ORDERING INFORMATION	Listing updated	9

Rel.	Rel. Date <sup>1</sup>	Chapter	Modification	Page
D2	2018-10-10	PACKAGING INFORMATION	Package LSH2C: correction of pin functions	3
		ELECTRICAL CHARACT.	Item 105: limits adapted	6

Rel.	Rel. Date <sup>1</sup>	Chapter	Modification	Page
D3	2021-05-12	PACKAGING INFORMATION, PACKAGE DIMENSIONS	Update of package drawings and footnotes	3, 4
		THERMAL DATA	Item T03, T04: hyperlink to customer information	5

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



### ORDERING INFORMATION

Type	Package	Options	Order Designation
iC-LSHB	15-pin optoBGA, 6.2 mm x 5.2 mm, thickness 1.7 mm RoHS compliant	glass lid	iC-LSHB OBGA LSH2C
		reticle LSHB2R 42-1024	iC-LSHB OBGA LSH2C-2R
		reticle LSHB4R 42-4096	iC-LSHB OBGA LSH2C-4R
		reticle LSHB5R 26-3600 custom reticle	iC-LSHB OBGA LSH2C-5R iC-LSHB OBGA LSH2C-xxR
iC-LSHB	32-pin optoQFN, 5 mm x 5 mm, thickness 0.9 mm RoHS compliant	glass lid	iC-LSHB oQFN32-5x5
		reticle LSHB2R 42-1024	iC-LSHB oQFN32-5x5-2R
		custom reticle	iC-LSHB oQFN32-5x5-xxR
Code Discs		1024 CPR OD $\varnothing$ 42 mm, ID $\varnothing$ 18 mm (glass 1 mm)	LSHB2S 42-1024
		4096 CPR OD $\varnothing$ 42 mm, ID $\varnothing$ 18 mm (glass 1 mm)	LSHB4S 42-4096
		3600 CPR OD $\varnothing$ 26 mm, ID $\varnothing$ 14 mm (glass 1 mm)	LSHB5S 26-3600

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