

iC-LSHC

3-CHANNEL SIN/COS PHOTODIODE ARRAY

preliminary



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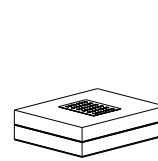
FEATURES

- ◆ Monolithic array of independent photodiodes with excellent matching
- ◆ Compact photodiode size of $800\ \mu\text{m} \times 330\ \mu\text{m}$ 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. $4\ \text{M}\Omega$
- ◆ Short-circuit-proof, low impedance voltage outputs for enhanced EMI tolerance
- ◆ Low power consumption from single 5 V supply
- ◆ Operational temperature range of -40 to $125\ ^\circ\text{C}$
- ◆ Space saving 15-pin optoBGA package (RoHS compatible)
- ◆ Available options
 - reticle assembly, code discs
 - customized COB modules

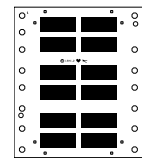
APPLICATIONS

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

PACKAGES

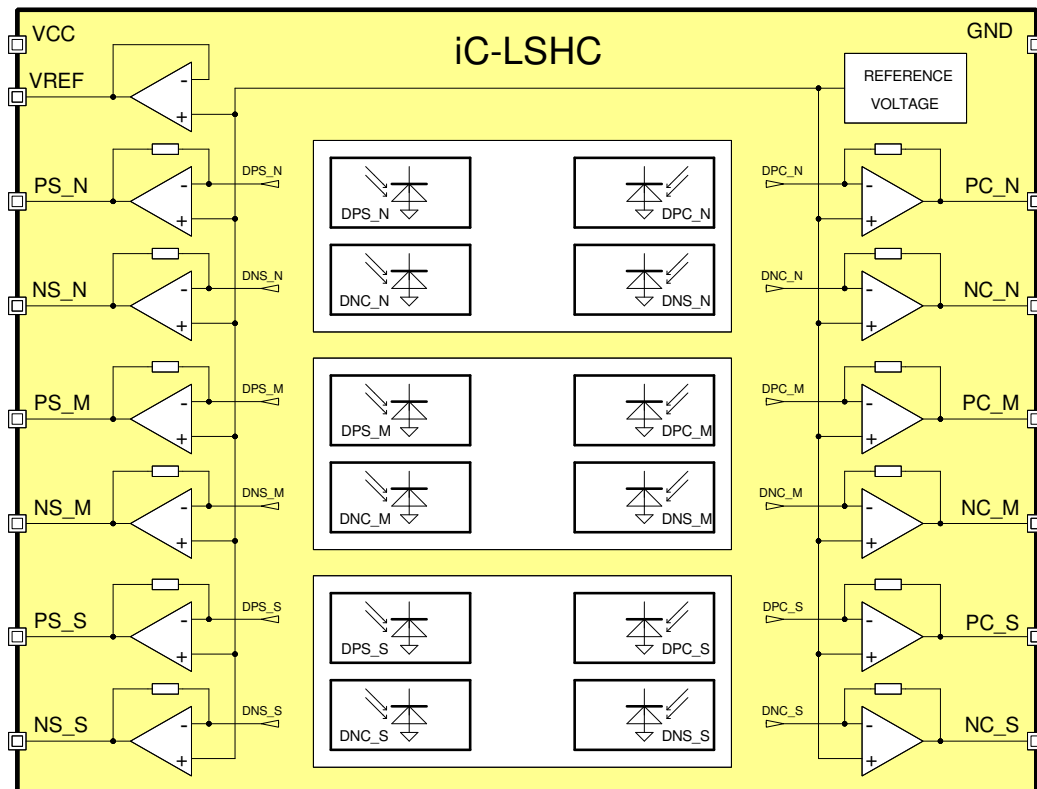


15-pin optoBGA
6.2 mm x 5.2 mm



Chip
2.88 mm x 3.37 mm

BLOCK DIAGRAM



iC-LSHC

3-CHANNEL SIN/COS PHOTODIODE ARRAY



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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 μm x 330 μm each. A high transimpedance gain of typically 4 M Ω generates output signals of a few hundred Millivolts already from illumination levels of 0.3 to 0.7 mW/cm². In most cases no additional measures must be considered to filter for noise and interferences.

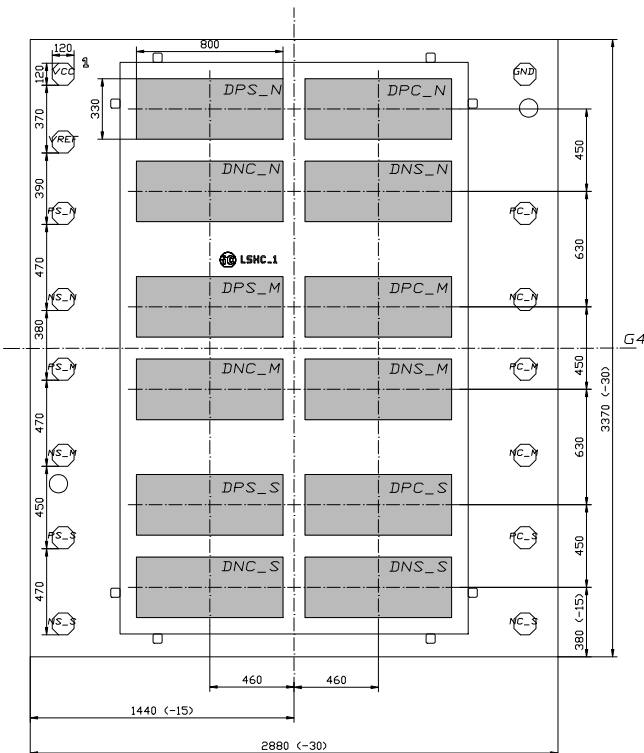
Sine/cosine encoders are the typical application for iC-LSHC. Its 3-track scanning features a set of 4 pho-

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 1 V is typical under low light conditions, for instance when iC-LSHC is illuminated at only 1.5 mW/cm² by an 740 nm LED.

PACKAGES

PAD LAYOUT (2.88 mm x 3.37 mm)



PAD FUNCTIONS

No. Name Function

- 1 VCC +4.5..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 NC_S S-Track Cosine -
- 10 PC_S S-Track Cosine +
- 11 NC_M M-Track Cosine -
- 12 PC_M M-Track Cosine +
- 13 NC_N N-Track Cosine -
- 14 PC_N N-Track Cosine +
- 15 GND Ground

Notes: All outputs supply analog voltages.

Dimension G4 is the reference radius of the chip center.

iC-LSHC

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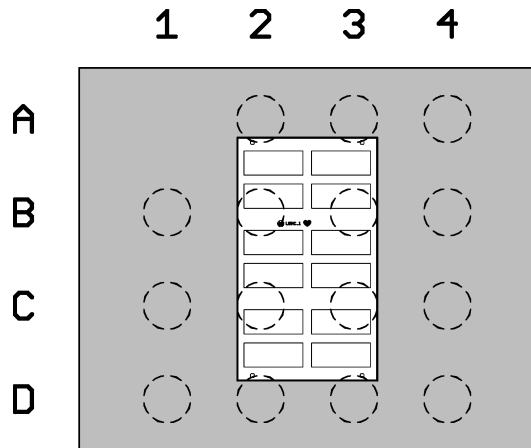
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PIN CONFIGURATION

oBGA LSH2C (6.2 mm x 5.2 mm)



PIN FUNCTIONS

No. Name Function

A2	VCC	+4.5..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 +

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	Limits		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 k Ω		2	kV
G006	Tj	Junction Temperature		-40	150	$^{\circ}$ C
G007	Ts	Chip Storage Temperature Range		-40	150	$^{\circ}$ C

THERMAL DATA

Item No.	Symbol	Parameter	Conditions	Limits			Unit
				Min.	Typ.	Max.	
T01	Ta	Operating Ambient Temperature Range	package oBGA LSH2C (extended temperature range on request)	-20		90	$^{\circ}$ C
T02	Ts	Storage Temperature Range	package oBGA LSH2C	-40		110	$^{\circ}$ C
T03	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	$^{\circ}$ C $^{\circ}$ 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: VCC = 4.5...5.5 V, Tj = -40...125 °C, unless otherwise stated

Item No.	Symbol	Parameter	Conditions				Unit
				Min.	Typ.	Max.	
Total Device							
001	VCC	Permissible Supply Voltage		4.5		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
Photosensors							
101	λ_{ar}	Spectral Application Range	$Se(\lambda_{ar}) = 0.25 \times S(\lambda)_{max}$	400		950	nm
102	λ_{pk}	Peak Sensitivity Wavelength			680		nm
103	Aph()	Radiant Sensitive Area	0.8 mm x 0.33 mm		0.264		mm ²
104	S(λ)	Spectral Sensitivity	$\lambda_{LED} = 740$ nm		0.5		A/W
105	S(λ_{pk})max	Maximum Spectral Sensitivity	$\lambda_{LED} = \lambda_{pk}$		0.55		A/W
106	E()mxr	Irradiance For Maximum Signal Level	$\lambda_{LED} = 740$ nm, Vout() not yet saturated	0.15	0.5	0.8	mW/cm ²
Photocurrent Amplifiers							
201	Iph()	Permissible Photocurrent Operating Range		0		280	nA
202	$\eta()$ r	Photo Sensitivity (light-to-voltage conversion ratio)	$\lambda_{LED} = 740$ nm	0.8	1.2	2.0	V/ μ W
203	Z()	Equivalent Transimpedance Gain	$Z = Vout() / Iph()$	2.69	4.0	5.46	M Ω
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	$\Delta Vout()$ pn	Signal Matching	no illumination, any output to 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)		120	180	280	kHz
213	VNoise()	RMS Output Noise	illuminated to 500 mV signal level above dark level, 500 kHz band width		0.5		mV
Signal Outputs							
301	Vout()mx	Permissible Maximum Output Voltage	illumination to E()mxr, linear gain	2.45	2.72	3.02	V
302	Vout()d	Dark Signal Level	no illumination, load 20 k Ω vs. +2 V	600	770	1000	mV
303	Vout()acmx	Maximum Signal Level	$Vout()acmx = Vout()mx - Vout()d$	1.48	1.96	2.35	V
304	Isc()hi	Short-Circuit Current hi	load current to ground	100	420	800	μ A
305	Isc()lo	Short-Circuit Current lo	load current to IC	250	480	700	μ A
306	Ri()	Internal Output Resistance	f = 1 kHz	70	110	180	Ω
307	ton()	Power-On Settling Time	VCC = 0 V \rightarrow 5 V			100	μ s
Reference Voltage VREF							
401	VREF	Reference Voltage	I(VREF) = 0...+1.6 mA	600	770	1000	mV
402	dVout()	Load Balancing	I(VREF) = 0...+1.6 mA	-10		+10	mV
403	Isc()hi	Short-Circuit Current hi	load current to ground	200	420	800	μ A
404	Isc()lo	Short-Circuit Current lo	load current to IC	2	4.5	10	mA

APPLICATION CIRCUITS

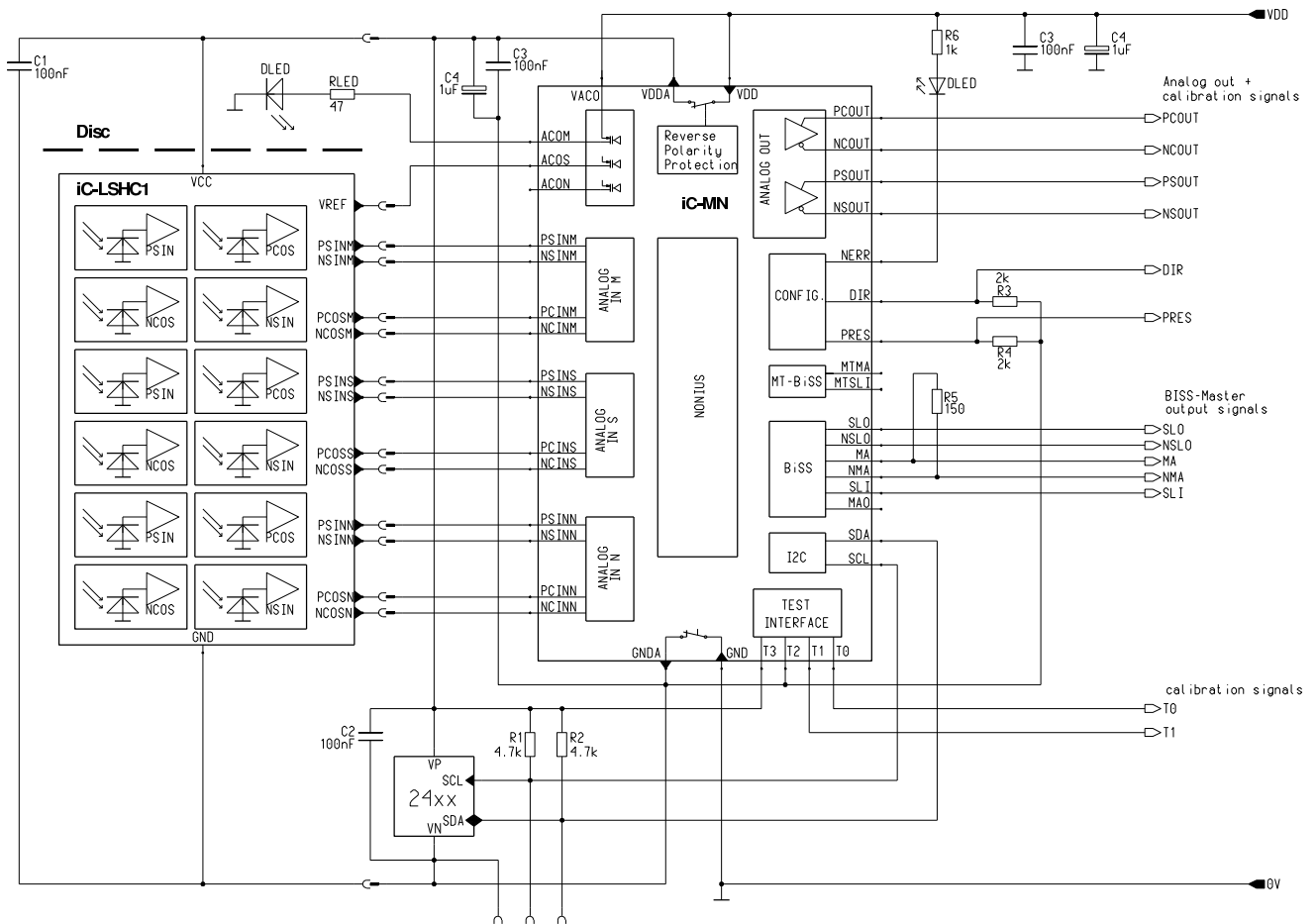


Figure 1: Application example of absolute encoder

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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	Options	Order Designation
iC-LSHC	- optoBGA 6.2 mm x 5.2 mm optoBGA 6.2 mm x 5.2 mm optoBGA 6.2 mm x 5.2 mm optoBGA 6.2 mm x 5.2 mm optoBGA 6.2 mm x 5.2 mm	reticle 26-256 NMS reticle 26-1024 NMS reticle 26-2048 NMS reticle 42-2048 NMS Nonius Code Disc 255/256/240 PPR, OD/ID \varnothing 26/11.6 mm, glass Nonius Code Disc 255/256/240 PPR, OD/ID \varnothing 26/7 mm, plastic Nonius Code Disc 1023/1024/992 PPR, OD/ID \varnothing 26/11.6 mm, glass Nonius Code Disc 2047/2048/2016 PPR, OD/ID \varnothing 26/11.6 mm, glass Nonius Code Disc 2047/2048/2016 PPR, OD/ID \varnothing 42/18 mm, glass	iC-LSHC chip iC-LSHC OBGA LSH2C iC-LSHC OBGA LSH2C-4R iC-LSHC OBGA LSH2C-1R iC-LSHC OBGA LSH2C-2R iC-LSHC OBGA LSH2C-6R LSHC4S 26-256N LSHC5S 26-256N LSHC1S 26-1024N LSHC2S 26-2048N LSHC6S 42-2048N

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

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

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

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