

iC-LSHB

INCREMENTAL PHOTSENSOR ARRAY

preliminary



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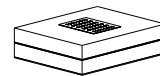
FEATURES

- ◆ Monolithic array of independent photosensors with excellent matching
- ◆ Compact photosensor size of 800 μm x 330 μm 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. 4 $\text{M}\Omega$
- ◆ Short-circuit-proof, low impedance voltage outputs for enhanced EMI tolerance
- ◆ Space saving 15-pin optoBGA package (RoHS compatible)
- ◆ Low power consumption from single 4.5 V to 5.5 V supply
- ◆ Operational temperature range of -40 to 125 $^{\circ}\text{C}$
- ◆ Available options
 - reticle assembly, code discs
 - customized COB modules

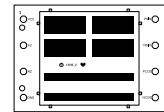
APPLICATIONS

- ◆ Incremental rotary encoders
- ◆ Linear scales

PACKAGES

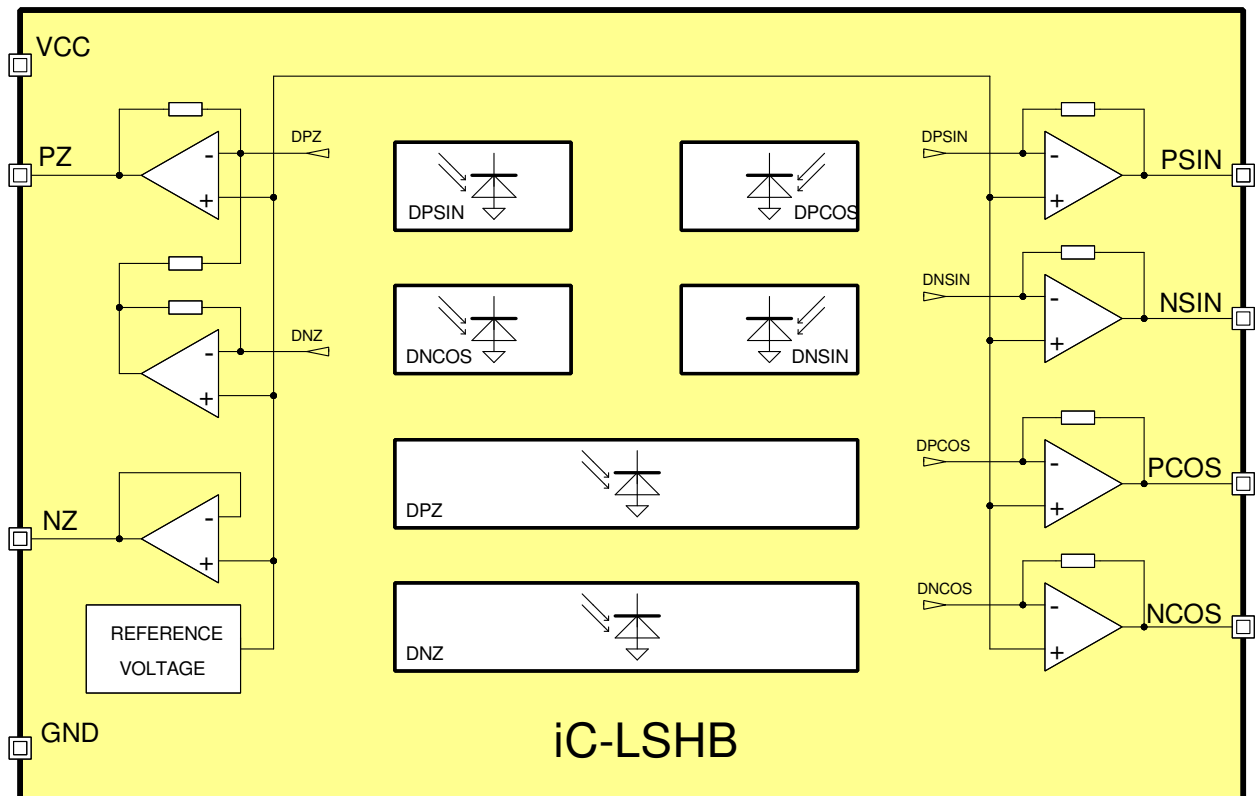


15-pin optoBGA
6.2 mm x 5.2 mm



Chip
2.88 mm x 2.04 mm

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.

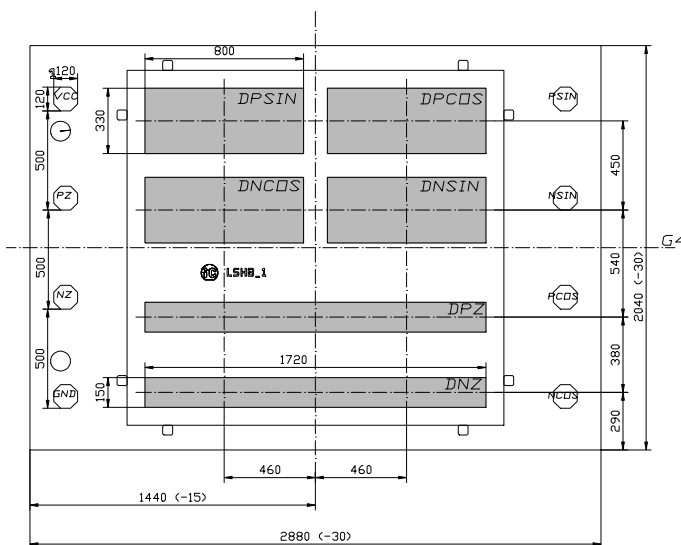
Due to a high transimpedance gain of typically $4\ \text{M}\Omega$, signal voltages of several hundred millivolts are obtained at low illumination levels. An output signal amplitude of 1 V is typical in low light conditions, for instance when iC-LSHB is illuminated at only $0.2\ \text{mW}/\text{cm}^2$ by a 740 nm LED.

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.

PACKAGES

PAD LAYOUT (2.88 mm x 2.04 mm)



PAD FUNCTIONS

No. Name Function

- | | | |
|---|------|----------------------------|
| 1 | VCC | +4.5..5.5 V Supply Voltage |
| 2 | PZ | Zero Signal (Index) |
| 3 | NZ | Reference Voltage Output |
| 4 | GND | Ground |
| 5 | NCOS | Cosine - |
| 6 | PCOS | Cosine + |
| 7 | NSIN | Sine - |
| 8 | PSIN | Sine + |

Notes: All outputs supply analog voltages.

Dimension G4 is the reference radius of the chip center.

iC-LSHB

INCREMENTAL PHOTSENSOR ARRAY

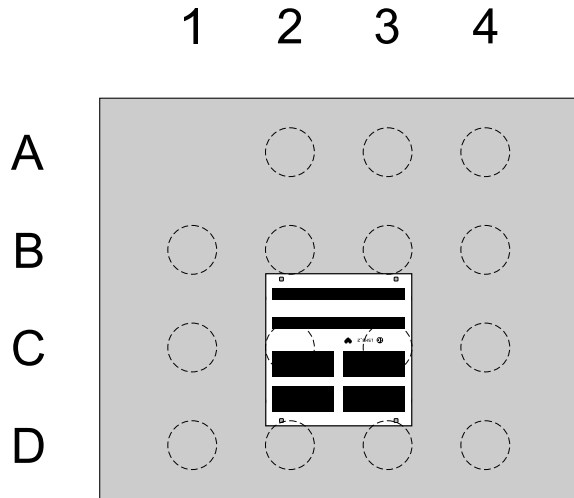
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PIN CONFIGURATION

oBGA LSH2C (6.2 mm x 5.2 mm)



LSH2C_LSHB2_PIN-BELEGUNG

PIN FUNCTIONS

No. Name Function

| | | |
|----|------|----------------------------|
| A2 | | |
| A3 | | |
| A4 | | |
| B1 | | |
| B2 | | |
| B3 | | |
| B4 | | |
| C1 | NCOS | Cosine - |
| C2 | PCOS | Cosine + |
| C3 | NZ | Reference Voltage Output |
| C4 | GND | Ground |
| D1 | NSIN | Sine - |
| D2 | PSIN | Sine + |
| D3 | VCC | +4.5..5.5 V Supply Voltage |
| D4 | PZ | Zero Signal (Index) |

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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 | Min. Max. | | 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

| Item No. | Symbol | Parameter | Conditions | Min. Typ. Max. | | | Unit |
|----------|--------|-------------------------------------|--|--------------------|------|------------|----------|
| | | | | Min. | Typ. | Max. | |
| T01 | Ta | Operating Ambient Temperature Range | package oBGA LSH2C | -40 | | 125 | °C |
| T02 | Ts | Storage Temperature Range | package oBGA LSH2C | -40 | | 125 | °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 | °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.

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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) | | 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 |
| 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 of DPSIN, DPCOS, DNSIN, DNCOS | 0.8 mm x 0.33 mm | | 0.264 | | mm ² |
| 104 | Aph() | Radiant Sensitive Area of DPZ, DNZ | 1.72 mm x 0.15 mm | | 0.258 | | mm ² |
| 105 | $S(\lambda_r)$ | Spectral Sensitivity | $\lambda_{LED} = 740 \text{ nm}$ | | 0.5 | | A/W |
| 106 | $S(\lambda)_{max}$ | Maximum Spectral Sensitivity | $\lambda_r = \lambda_{pk}$ | | 0.55 | | A/W |
| 107 | E()mx | Irradiance For Maximum Signal Level | $\lambda_{LED} = 740 \text{ nm}$, 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) | $\lambda_{LED} = 740 \text{ nm}$ | 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 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) | | 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 PSIN, NSIN, PCOS, NCOS, PZ | | | | | | | |
| 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 |
| Reference Voltage NZ | | | | | | | |
| 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 HINTS

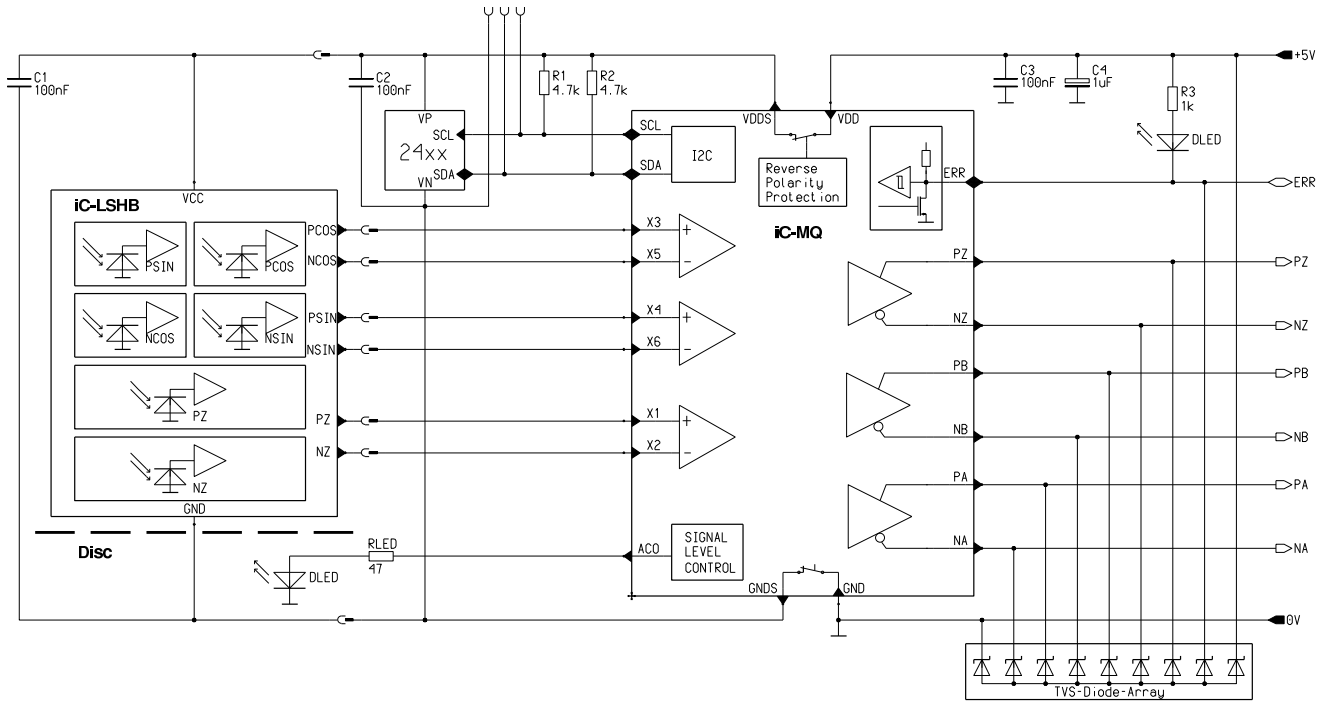


Figure 1: Example of incremental encoder with RS422 output

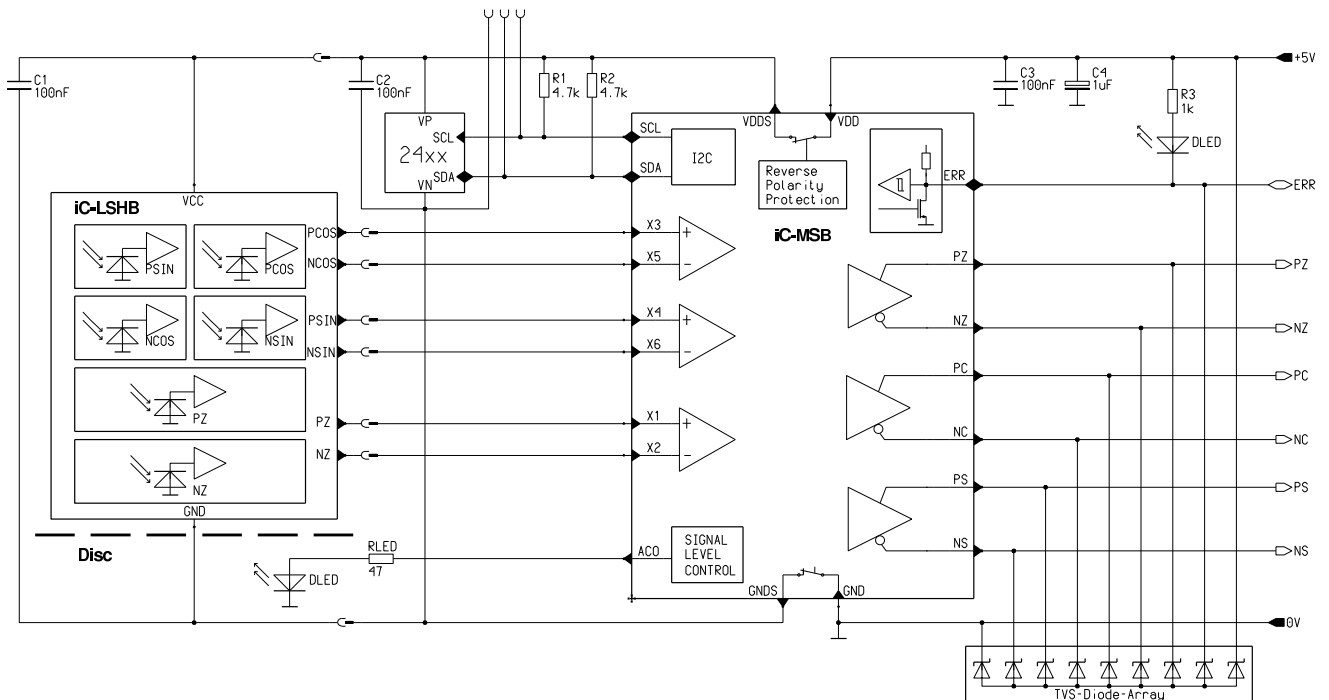


Figure 2: Example of sine encoder with 1 Vpp output

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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.

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ORDERING INFORMATION

| Type | Package | Options | Order Designation |
|---------|---|--|--|
| iC-LSHB | 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 42-1024 reticle 42-4096 Code Disc 1024 PPR, OD/ID \varnothing 42/18 mm, glass Code Disc 4096 PPR, OD/ID \varnothing 42/18 mm, glass | iC-LSHB chip iC-LSHB OBGA LSH2C iC-LSHB OBGA LSH2C-2R iC-LSHB OBGA LSH2C-4R LSHB2S 42-1024 LSHB4S 42-4096 |

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

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