

iC-PT 3310

6-CH. PHASED ARRAY OPTO ENCODER (33-1000)

preliminary



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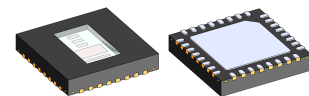
FEATURES

- Monolithic photodiode array with excellent signal matching
- Very compact size for small encoders
- Moderate track pitch for relaxed assembly tolerances
- Low noise signal amplifiers with high EMI tolerance
- Single-pin programming of 3 operating modes: analog, digital, and x2 interpolation
- A-AND-B gated Z index signal
- Complementary outputs: A, B, Z and NA, NB, NZ
- U, V, W commutation signals (digital/analog)
- All outputs +/- 4 mA push-pull, current-limited and short-circuit-proof
- LED power control with 40 mA high-side driver
- Single 3.5 V to 5.5 V operation, low power consumption
- Operating temperature range of -40 to +85 °C (optional -40 to +120 °C)
- Suitable code disc: PT2S 33-1000 (glass)
- OD \varnothing 33.2 mm, ID \varnothing 13.0 mm, optical radius 14.5 mm, 1000 ppr and 3 ppr commutation (120°)

APPLICATIONS

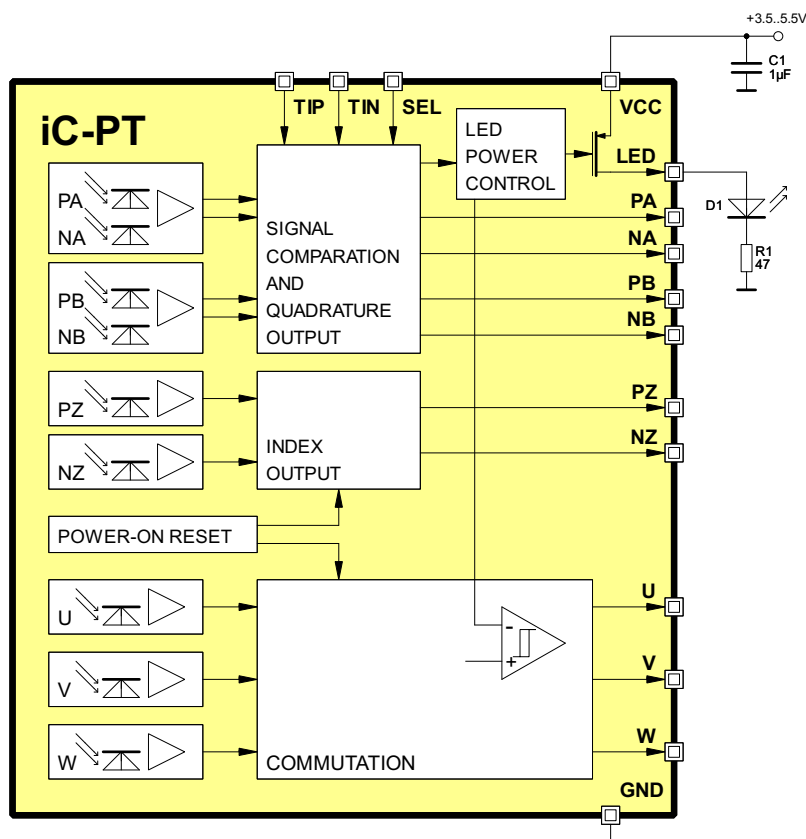
- Incremental encoder
- BLDC motor commutation

PACKAGES



optoQFN32-5x5
5 mm x 5 mm x 0.9 mm

BLOCK DIAGRAM



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DESCRIPTION

iC-PT 3310 is an optical sensor IC with integrated photosensors whose signals are converted into voltages by low-noise transimpedance amplifiers. Precise voltage comparators with hysteresis are used to generate the digital signals, supplied to the output pins via differential +/- 4 mA push-pull drivers.

The built-in LED power control with its 40 mA driver stage permits a direct connection of the encoder LED. Regardless of aging or changes in temperature the received optical power is kept constant. An external resistor presets the photocurrent operating point and thus the desired illumination level.

Selection input SEL chooses for three different operating modes: regular A/B operation, A/B operation with 2-fold interpolation, or analog operation. With analog operation the amplified signal voltages are

available at the outputs for inspection and monitoring encoder assembly.

Typical applications of iC-PT devices are incremental encoders for motor feedback and commutation. To this end, device version iC-PT 3310 provides differential A/B tracks and a differential index track, each consisting of multiple photo sensors. The layout of the signal amplifiers is such that there is an excellent paired channel matching, eliminating the needs for signal calibration in most cases.

Additionally, three more tracks are provided to generate motor commutation information for the U, V and W outputs, for instance with 120 degree phase shift to operate 3-phase brushless motors (period count and phase shift can be varied by the code disc applied).

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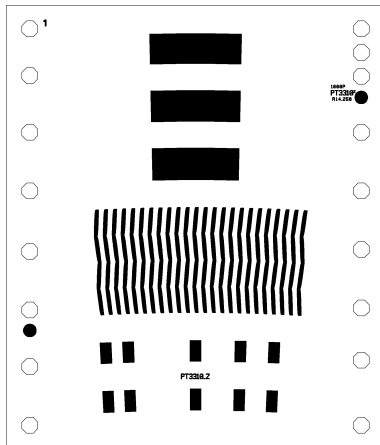


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PACKAGES

PAD LAYOUT

Chip size 2.88 mm x 3.37 mm



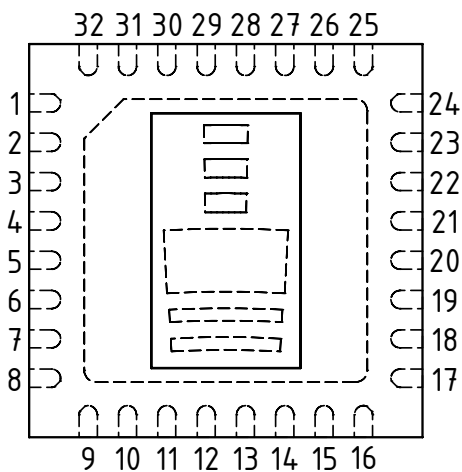
PAD FUNCTIONS

No. Name Function

See pin configuration.

PIN CONFIGURATION

oQFN32-5x5 (5 mm x 5 mm)



PIN FUNCTIONS

No. Name Function

| | | |
|--------|------|--|
| 1 | VCC | +3.5..5.5 V Supply Voltage |
| 2 | LED | LED Controller, High-Side Current Source Output |
| 3 | PA | Push-Pull Output A+ / Test Sig. Sin+ |
| 4 | NA | Push-Pull Output A- / Test Sig. Sin- |
| 5 | PB | Push-Pull Output B+ / Test Sig. Cos+ |
| 6 | NB | Push-Pull Output B- / Test Sig. Cos- |
| 7 | PZ | Push-Pull Output Z+ / Test Signal Z+ |
| 8 | NZ | Push-Pull Output Z- / Test Signal Z- |
| 9..16 | n.c. | |
| 17 | SEL | Op. Mode Selection Input: lo = digital hi = x2 interpolated open = analog (alignment aid) |
| 18 | W | Push-Pull Output W / Test Signal W |
| 19 | TIN | Negative Test Current Input |
| 20 | V | Push-Pull Output V / Test Signal V |
| 21 | TIP | Positive Test Current Input |
| 22 | U | Push-Pull Output U / Test Signal U |
| 23 | n.c. | |
| 24 | GND | Ground |
| 25..32 | n.c. | |
| | BP | Backside Paddle |

Pin numbers marked n.c. are not in use. The backside paddle is not intended as an electrical connection point; when used as shield a single link to GND is permissible. The test pins TIP and TIN may remain unconnected. Capacitive pin loads must be avoided when using the analog test signals for alignment purposes.

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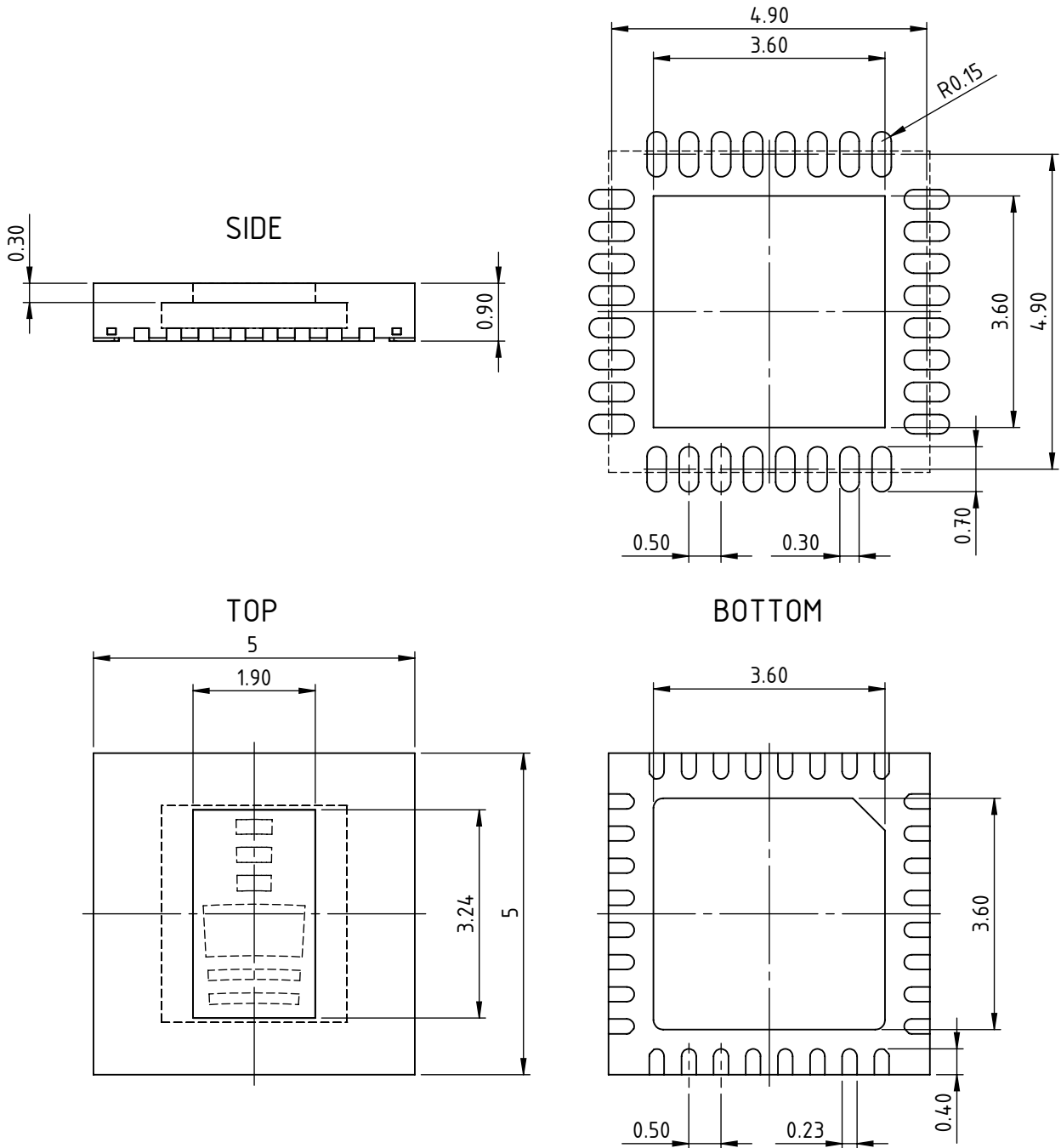
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PACKAGE DIMENSIONS

RECOMMENDED PCB-FOOTPRINT



dra_pt33xx-oqfn32-2_pack_1, 10:1

Maximum molding excess +20 µm / -200 µm versus surface of glass.
All dimensions given in mm.

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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 | Supply Voltage | | -0.3 | 6 | V |
| G002 | I(VCC) | Current in VCC | | -20 | 20 | mA |
| G003 | V() | Voltage at Output Pins PA, NA, PB, NB, PZ, NZ, U, V, W | | -0.3 | VCC + 0.3 | V |
| G004 | I() | Current in Output Pins PA, NA, PB, NB, PZ, NZ, U, V, W | | -20 | 20 | mA |
| G005 | V() | Voltage at LED | | -0.3 | VCC + 0.3 | V |
| G006 | I() | Current in LED | | -120 | 20 | mA |
| G007 | V() | Voltage at TIP, TIN, SEL | | -0.3 | VCC + 0.3 | V |
| G008 | I() | Current in TIP, TIN, SEL | | -20 | 20 | mA |
| G009 | Vd() | ESD Susceptibility, all pins | HBM, 100 pF discharged through 1.5 kΩ | | 2 | kV |
| G010 | Tj | Junction Temperature | | -40 | 150 | °C |
| G011 | Ts | Chip-Storage Temperature Range | | -40 | 150 | °C |

THERMAL DATA

| Item No. | Symbol | Parameter | Conditions | Min. Typ. Max. | | | Unit |
|----------|--------|--|---|--------------------|------|------------|----------|
| | | | | Min. | Typ. | Max. | |
| T01 | Ta | Operating Ambient Temperature Range (extended range on request) | | -40 | | 85 | °C |
| T02 | Ts | Permissible Storage Temperature Range | | -40 | | 85 | °C |
| T03 | Tpk | Soldering Peak Temperature | tpk < 20 s, convection reflow tpk < 20 s, vapor phase soldering MSL 5A (max. floor live 24 h at 30 °C and 60 % RH); 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 = 3.5...5.5 V, Tj = -40...125 °C, $\lambda_{LED} = \lambda_r = 740$ nm, unless otherwise noted

| Item No. | Symbol | Parameter | Conditions | | | | Unit |
|---|----------------------------------|--|---|--------------|-------------------------|------------|--|
| | | | | Min. | Typ. | Max. | |
| Total Device | | | | | | | |
| 001 | VCC | Permissible Supply Voltage | | 3.5 | | 5.5 | V |
| 002 | I(VCC) | Supply Current in VCC | no load, photocurrents within op. range | | 3 | 10 | mA |
| 003 | Vc(lo) | Clamp-Voltage lo at all pins | I() = -4 mA, versus GND | -1.2 | | -0.3 | V |
| 004 | Vc(hi) | Clamp-Voltage hi at all pins | I() = 4 mA | | | 11 | V |
| 005 | Vc(hi) | Clamp-Voltage hi at LED, PA, NA, PB, NB, PZ, NZ, U, V, W | I() = 4 mA, versus VCC | 0.3 | | 1.2 | V |
| 006 | Vc(hi) | Clamp-Voltage hi at SEL, TIP, TIN | I() = 4 mA, versus VCC | 0.7 | | 2.2 | 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 | PA, PB, NA, NB (sum of segments) U, V, W (per segment) PZ, NZ (sum of segments) | | 0.137 0.16 0.068 | | mm ² mm ² mm ² |
| 104 | S(λ_r) | Spectral Sensitivity | $\lambda_{LED} = 740$ nm | | 0.5 | | A/W |
| 105 | S(λ) _{max} | Maximum Spectral Sensitivity | $\lambda_{LED} = \lambda_{pk}$ | | 0.55 | | A/W |
| 106 | E() _{mxpk} | Permissible Irradiance | $\lambda_{LED} = \lambda_{pk}$, Vout() < Vout() _{mx} ; PA, PB, NA, NB U, V, W PZ, NZ | | 1.3 0.9 2 | | mW/ cm ² mW/ cm ² mW/ cm ² |
| Photocurrent Amplifiers | | | | | | | |
| 201 | Iph() | Permissible Photocurrent Operating Range | | 0 | | 550 | nA |
| 202 | $\eta()$ _r | Photo Sensitivity (light-to-voltage conversion ratio) | for PA, PB, NA, NB for PZ, NZ, U, V, W | 0.1 0.2 | 0.3 0.4 | 0.5 0.6 | V/ μ W V/ μ W |
| 203 | Z() | Equivalent Transimpedance Gain | Z = Vout() / Iph(), Tj = 27 °C; for PA, PB, NA, NB for PZ, NZ, U, V, W | 0.56 0.66 | 0.75 1.0 | 1 1.36 | M Ω M Ω |
| 204 | TCz | Temperature Coefficient of Transimpedance Gain | | | -0.12 | | %/°C |
| 205 | $\Delta Z()$ _{pn} | Transimpedance Gain Matching | SEL open, P vs. N path per diff. channel | -0.2 | | 0.2 | % |
| 206 | $\Delta V_{out}()$ | Dark Signal Matching of A, B | SEL open, output vs. output | -8 | | 8 | mV |
| 207 | $\Delta V_{out}()$ | Dark Signal Matching of U, V, W | SEL open, output vs. output | -12 | | 12 | mV |
| 208 | $\Delta V_{out}()$ | Dark Signal Matching of A, B, Z, U, V, W | SEL open, any output vs. any output | -24 | | 24 | mV |
| 209 | $\Delta V_{out}()$ _{pn} | Dark Signal Matching | SEL open, P vs. N path per diff. channel | -2.5 | | 2.5 | mV |
| 211 | fc() _{hi} | Cut-off Frequency (-3 dB) | | | 400 | | kHz |
| Analog Outputs PA, NA, PB, NB, PZ, NZ, U, V, W | | | | | | | |
| 301 | Vout() _{mx} | Maximum Output Voltage | illumination to E() _{mxpk} | 1.04 | 1.27 | 1.8 | V |
| 302 | Vout() _d | Dark Signal Level | load 100 k Ω vs. +2 V | 640 | 770 | 985 | mV |
| 303 | Vout() _{acmx} | Maximum Signal Level | Vout() _{acmx} = Vout() _{mx} - Vout() _d | 0.3 | 0.5 | 0.75 | V |
| 304 | Isc() _{hi} | Short-Circuit Current hi | SEL open, load current to ground | 100 | 1800 | 3000 | μ A |
| 305 | Isc() _{lo} | Short-Circuit Current lo | SEL open, load current to IC | 20 | 40 | 200 | μ A |
| 306 | Ri() | Internal Output Resistance | f = 1 kHz | 250 | 750 | 2250 | Ω |

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ELECTRICAL CHARACTERISTICS

Operating conditions: VCC = 3.5...5.5 V, Tj = -40...125 °C, $\lambda_{LED} = \lambda_r = 740$ nm, unless otherwise noted

| Item No. | Symbol | Parameter | Conditions | | | | Unit |
|--|----------|---|---|------|------|------|------------|
| | | | | Min. | Typ. | Max. | |
| Comparators | | | | | | | |
| 401 | Vt()hi | Upper Comparator Threshold | $I_{ph}()p \times Z()p > I_{ph}()n \times Z()n$, resp. $I_{ph}()p \times Z()p > \text{internal VREF}$ | 5 | 12 | 25 | mV |
| 402 | Vt()lo | Lower Comparator Threshold | $I_{ph}()p \times Z()p < I_{ph}()n \times Z()n$, resp. $I_{ph}()p \times Z()p < \text{internal VREF}$ | 5 | 12 | 25 | mV |
| 403 | Vt()hys | Comparator Hysteresis | $Vt()hys = Vt()hi - Vt()lo$ | 10 | 24 | 50 | mV |
| LED Power Control | | | | | | | |
| 501 | Iop() | Permissible LED Output Current | | -40 | | 0 | mA |
| 502 | Vs()hi | Saturation Voltage hi | $Vs()hi = VCC - V(LED)$; I() = -40 mA | 0.25 | 0.5 | 1 | V |
| 503 | Isc()hi | Short-Circuit Current hi | V() = 0 V | -150 | | -50 | mA |
| Digital Outputs PA, NA, PB, NB, PZ, NZ, U, V, W | | | | | | | |
| 601 | Vs()lo | Saturation Voltage lo | VCC = 4.5...5.5 V, I() = 4 mA, Tj = 70 °C | | | 0.4 | V |
| 602 | Vs()lo | Saturation Voltage lo | VCC = 4.5...5.5 V, I() = 4 mA, Tj = 85 °C | | | 0.5 | V |
| 603 | Vs()lo | Saturation Voltage lo | VCC = 3.5...4.5 V, I() = 4 mA | | | 0.6 | V |
| 604 | Isc()lo | Short-Circuit Current lo | V() = VCC | 7 | | 70 | mA |
| 605 | Vs()hi | Saturation Voltage hi | $Vs()hi = VCC - V()$, I() = -4 mA; VCC = 4.5...5.5 V | | | 0.4 | V |
| 606 | Vs()hi | Saturation Voltage hi | $Vs()hi = VCC - V()$, I() = -4 mA; VCC = 3.5...4.5 V | | | 0.6 | V |
| 607 | Isc()hi | Short-Circuit Current hi | V() = 0 V | -70 | | -7 | mA |
| Selection Input SEL | | | | | | | |
| 701 | Vt1()hi | Upper Threshold Voltage hi | for A/B mode with x2 interpolation | 78 | 80 | 82 | %VCC |
| 702 | Vt1()lo | Upper Threshold Voltage lo | for A/B mode with x2 interpolation | 68 | 70 | 72 | %VCC |
| 703 | Vt1()hys | Upper Threshold Hysteresis | $Vt1()hys = Vt1()hi - Vt1()lo$ | 8 | 10 | 12 | %VCC |
| 704 | Vt2()hi | Lower Threshold Voltage hi | for A/B mode | 28 | 30 | 32 | %VCC |
| 705 | Vt2()lo | Lower Threshold Voltage lo | for A/B mode | 18 | 20 | 22 | %VCC |
| 706 | Vt2()hys | Lower Threshold Hysteresis | $Vt2()hys = Vt2()hi - Vt2()lo$ | 8 | 10 | 12 | %VCC |
| 707 | V0() | Pin-Open Voltage | for analog mode | 45 | 50 | 55 | %VCC |
| 708 | Rpd() | Pull-Down Resistor | SEL to GND, V(SEL) = VCC | 70 | 100 | 140 | k Ω |
| 709 | Rpu() | Pull-Up Resistor | VCC to SEL, V(SEL) = 0 V | 70 | 100 | 140 | k Ω |
| 710 | Vpd() | Pull-Down Voltage vs. VCC/2 | $Vpd() = V() - VCC/2$; I() = 0...5 μ A | | | 0.5 | V |
| 711 | Vpu() | Pull-Up Voltage vs. VCC/2 | $Vpu() = V() - VCC/2$; I() = -5...0 μ A | -0.5 | | | V |
| Test Circuit Inputs TIP, TIN | | | | | | | |
| 801 | I()test | Permissible Test Current Range | test mode active | 10 | | 600 | μ A |
| 802 | V()test | Test Pin Voltage | test mode active, I() = 200 μ A | 1.25 | 1.5 | 1.75 | V |
| 803 | Ipd() | Test Pin Pull-Down Current | test mode not active, V() = 0.4 V | 60 | 100 | 160 | μ A |
| 804 | Ipd() | Test Pin Pull-Down Current | V() = VCC | 0.7 | 2 | 3 | mA |
| 805 | It()on | Test Mode Activation Threshold | | 80 | 130 | 190 | μ A |
| 806 | CR() | Test Mode Current Ratio I()/Iph() | test mode active, I() = 200 μ A | 1500 | 3000 | 5000 | |
| Power-On-Reset Circuit | | | | | | | |
| 901 | VCCon | Turn-on Threshold VCC (power-on release) | increasing voltage at VCC | | 2.6 | 3.45 | V |
| 902 | VCCoff | Turn-off Threshold VCC (power-down reset) | decreasing voltage at VCC | 1.4 | 2.4 | | V |
| 903 | VCChys | Threshold Hysteresis | $VCChys = VCCon - VCCoff$ | 50 | 170 | 300 | mV |

Z INDEX SIGNAL

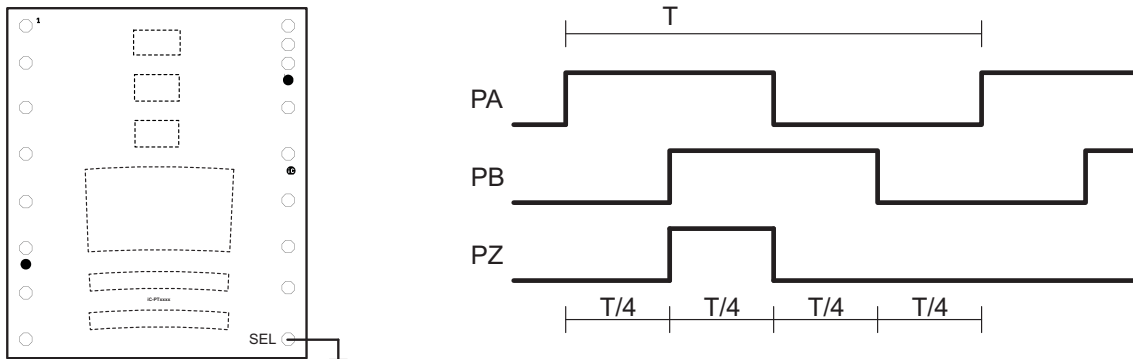


Figure 1: A-AND-B gated Z index signal at x1 interpolation (SEL = lo)

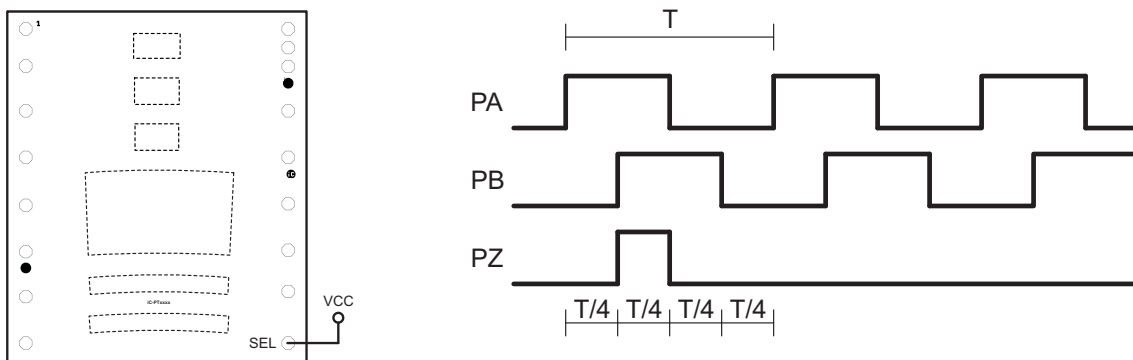


Figure 2: A-AND-B gated Z index signal at x2 interpolation (SEL = hi)

APPLICATION CIRCUITS

For encoder circuit examples, refer to the data sheet of iC-PT3313, available separately.

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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-PT3310 | 32-pin optoQFN, 5 mm x 5 mm, 0.9 mm thickness | glass lid Encoder Disc 1000 PPR +3 PPR, OD/ID \varnothing 33.2/13.0 mm, glass | iC-PT3310 oQFN32-5x5 PT2S 33-1000 |

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

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