preliminary





Rev A4, Page 1/10

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

Ungated/gated Z index signal (1 T, 0.5 T)

Complementary outputs: A, B, Z and NA, NB, NZ

 $\mbox{U},\mbox{V},\mbox{W}$ commutation signals, analog and digital

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: PT5S 33-2500 (glass)

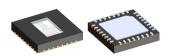
OD Ø33.2 mm, ID Ø13.0 mm, optical radius 14.5 mm,

2500 ppr and 4 ppr commutation (90°)

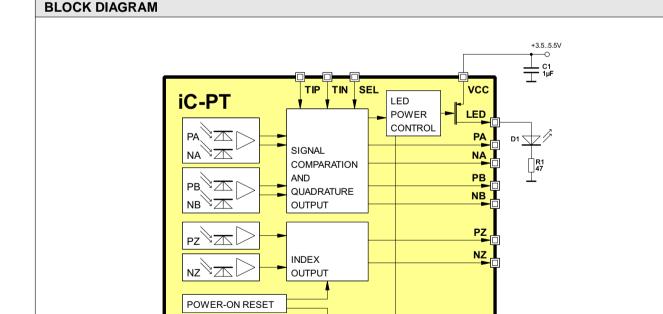
APPLICATIONS

Incremental encoder BLDC motor commutation

PACKAGES



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



Copyright © 2011 iC-Haus http://www.ichaus.com

GND

COMMUTATION

preliminary



6-CH. PHASED ARRAY OPTO ENCODER (33-2500)

Rev A4, Page 2/10

DESCRIPTION

iC-PT 3325 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 3325 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 90 degree phase shift to operate 4-phase brushless motors (period count and phase shift can be varied by the code disc applied).

preliminary (12.222)

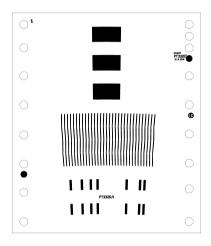




Rev A4, Page 3/10

PACKAGES

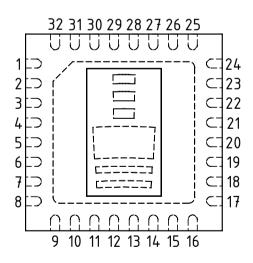
PAD LAYOUT Chip size 2.88 mm x 3.37 mm



PAD FUNCTIONS No. Name Function

See pin configuration.

PIN CONFIGURATION oQFN32-5x5 (5 mm x 5 mm)



PIN FUNCTIONS

No.

Name Function

-	VCC LED	+3.55.5 V Supply Voltage LED Controller, High-Side Current Source Output
3	PA	Push-Pull Output A+ / Test Sig. Sin+
	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	PΖ	Push-Pull Output Z+ / Test Signal Z+
8	NZ	Push-Pull Output Z- / Test Signal Z-
916	n.c.	
17	SEL	Op. Mode Selection Input:
		lo = digital
		hi = x2 interpolated
		open = analog (alignment aid)
	W	Push-Pull Output W / Test Signal W
	TIN	Negative Test Current Input
20	-	Push-Pull Output V / Test Signal V
	TIP	Positive Test Current Input
22	-	Push-Pull Output U / Test Signal U
	n.c.	
	GND	Ground
2532		
	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.

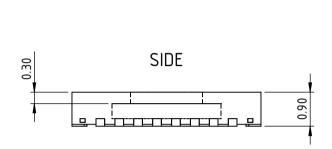
preliminary (33-2500) (CHaus

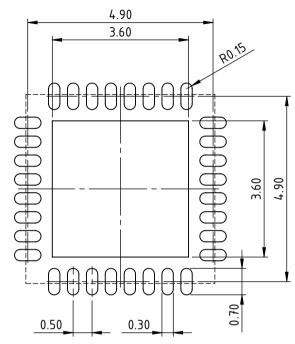
6-CH. PHASED ARRAY OPTO ENCODER (33-2500)

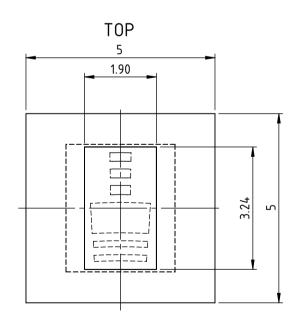
Rev A4, Page 4/10

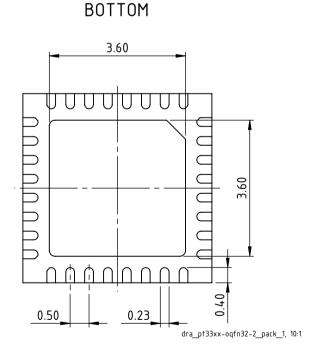
PACKAGE DIMENSIONS

RECOMMENDED PCB-FOOTPRINT









preliminary





Rev A4, Page 5/10

ABSOLUTE MAXIMUM RATINGS

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

Item	Symbol	Parameter	Conditions			Unit
No.				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	Symbol	Parameter	Conditions				Unit
No.				Min.	Тур.	Max.	
T01	Та	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			245 230	°C
			MSL 5A (max. floor live 24 h at 30 °C and 60 % RH); Please refer to customer information file No. 7 for details.				





Rev A4, Page 6/10

ELECTRICAL CHARACTERISTICS

Operating conditions: VCC = 3.5...5.5 V, Tj = -40...125 °C, λ_{LED} = λ r = 740 nm, unless otherwise noted

Item No.	Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
Total I	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
Photo	sensors						
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)		0.072 0.1 0.038		mm² mm² mm²
104	S(λr)	Spectral Sensitivity	$\lambda_{LED} = 740nm$		0.5		A/W
105	$S(\lambda)$ max	Maximum Spectral Sensitivity	$\lambda_{LED} = \lambda pk$		0.55		A/W
106	E()mxpk	Permissible Irradiance	$\lambda_{\text{LED}} = \lambda_{\text{pk}}$, Vout() < Vout()mx; PA, PB, NA, NB		2.3		mW/ cm ²
			U, V, W		1.1		mW/ cm ²
			PZ, NZ		3.2		mW/ cm ²
Photo	current Am	olifiers					
201	lph()	Permissible Photocurrent Operating Range		0		550	nA
202	η()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/µW V/µW
203	Z()	Equivalent Transimpedance Gain	Z = Vout() / lph(), 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	MΩ MΩ
204	TCz	Temperature Coefficient of Transimpedance Gain			-0.12		%/°C
205	ΔZ ()pn	Transimpedance Gain Matching	SEL open, P vs. N path per diff. channel	-0.2		0.2	%
206	△Vout()	Dark Signal Matching of A, B	SEL open, output vs. output	-8		8	mV
207	∆Vout()	Dark Signal Matching of U, V, W	SEL open, output vs. output	-12		12	mV
208	△Vout()	Dark Signal Matching of A, B, Z, U, V, W	SEL open, any output vs. any output	-24		24	mV
209	△Vout()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
		A, NA, PB, NB, PZ, NZ, U, V, W	1	II.	1		I
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 kΩ vs. +2 V	640	770	985	mV
303		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	μA
				_			
305	lsc()lo	Short-Circuit Current lo	SEL open, load current to IC	20	40	200	μA





Rev A4, Page 7/10

ELECTRICAL CHARACTERISTICS

Operating conditions: VCC = 3.5...5.5 V, Tj = -40...125 °C, λ_{LED} = λ r = 740 nm, unless otherwise noted

Item No.	Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
Comp	arators						
401	Vt()hi	Upper Comparator Threshold	$lph()p \times Z()p > lph()n \times Z()n,$ resp. $lph()p \times Z()p > internal VREF$	5	12	25	mV
402	Vt()lo	Lower Comparator Threshold	$lph()p \times Z()p < lph()n \times Z()n,$ resp. $lph()p \times Z()p < internal VREF$	5	12	25	mV
403	Vt()hys	Comparator Hysteresis	Vt()hys = Vt()hi - Vt()lo	10	24	50	mV
LED P	ower Contr	ol					
501	lop()	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
Digita	Outputs P	A, NA, PB, NB, PZ, NZ, U, V, W					
601	Vs()lo	Saturation Voltage lo	VCC = 4.55.5 V, I() = 4mA, Tj = 70 °C			0.4	V
602	Vs()lo	Saturation Voltage lo	VCC = 4.55.5 V, I() = 4mA, Tj = 85 °C			0.5	V
603	Vs()lo	Saturation Voltage lo	VCC = 3.54.5 V, I() = 4mA			0.6	V
604	lsc()lo	Short-Circuit Current lo	V() = VCC	7		70	mA
605	Vs()hi	Saturation Voltage hi	Vs()hi = VCC - V(), I() = -4 mA; VCC = 4.55.5 V			0.4	V
606	Vs()hi	Saturation Voltage hi	Vs()hi = VCC - V(), I() = -4 mA; VCC = 3.54.5 V			0.6	V
607	Isc()hi	Short-Circuit Current hi	V() = 0 V	-70		-7	mA
Select	tion Input S	EL					
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	kΩ
709	Rpu()	Pull-Up Resistor	VCC to SEL, V(SEL) = 0 V	70	100	140	kΩ
710	Vpd()	Pull-Down Voltage vs. VCC/2	Vpd() = V() - VCC/2; I() = 05 μA			0.5	V
711	Vpu()	Pull-Up Voltage vs. VCC/2	Vpu() = V() - VCC/2; I() = -50 μA	-0.5			V
Test C	ircuit Input	s TIP, TIN		"			
801	I()test	Permissible Test Current Range	test mode active	10		600	μΑ
802	V()test	Test Pin Voltage	test mode active, I() = 200 µA	1.25	1.5	1.75	V
803	lpd()	Test Pin Pull-Down Current	test mode not active, V() = 0.4 V	60	100	160	μΑ
804	lpd()	Test Pin Pull-Down Current	V() = VCC	0.7	2	3	mA
805	It()on	Test Mode Activation Threshold		80	130	190	μΑ
806	CR()	Test Mode Current Ratio I()/Iph()	test mode active, I() = 200 µA	1500	3000	5000	
Power	r-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
Index	Gating Sele	ection Input T1	1		1	1	ш
A01	Rpu()	Pull-Up Resistor	VCC to T1, V(T1) = 0V	85	125	750	kΩ
	1 ' '	<u>'</u>	1 ' ' /		L	L	L

6-CH. PHASED ARRAY OPTO ENCODER (33-2500)



Rev A4, Page 8/10

Z INDEX SIGNAL

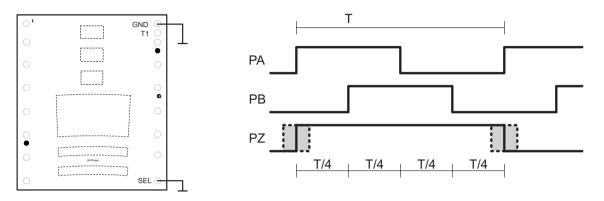


Figure 1: Ungated Z index signal at x1 interpolation (SEL = lo; T1 open)

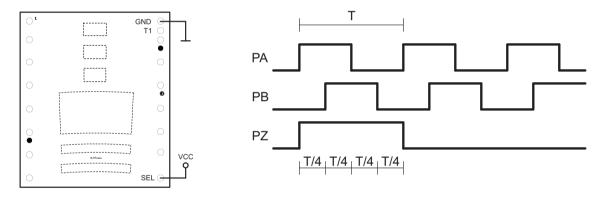


Figure 2: T gated Z index signal at x2 interpolation (SEL = hi; T1 open)

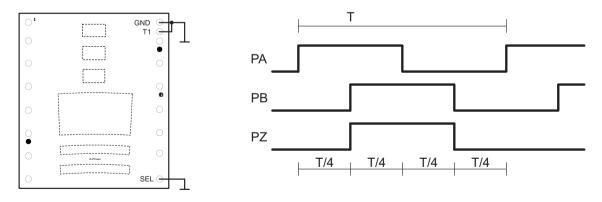


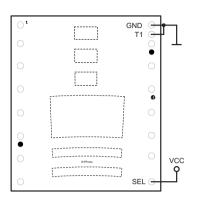
Figure 3: B gated Z index signal at x1 interpolation (SEL = Io; T1 = Io)

preliminary





Rev A4, Page 9/10



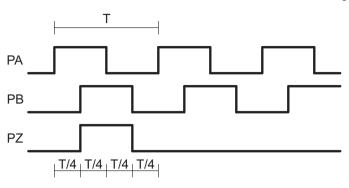


Figure 4: B gated Z index signal at x2 interpolation (SEL = hi; T1 = lo)

APPLICATION CIRCUITS

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

iC-Haus expressly reserves the right to change its products and/or specifications. An info letter gives details as to any amendments and additions made to the relevant current specifications on our internet website www.ichaus.de/infoletter; this letter is generated automatically and shall be sent to registered users by email

Copying - even as an excerpt - is only permitted with iC-Haus' approval in writing and precise reference to source.

iC-Haus does not warrant the accuracy, completeness or timeliness of the specification and does not assume liability for any errors or omissions in these materials.

The data specified is intended solely for the purpose of product description. No representations or warranties, either express or implied, of merchantability, fitness for a particular purpose or of any other nature are made hereunder with respect to information/specification or the products to which information refers and no guarantee with respect to compliance to the intended use is given. In particular, this also applies to the stated possible applications or areas of applications of the product.

iC-Haus conveys no patent, copyright, mask work right or other trade mark right to this product. iC-Haus assumes no liability for any patent and/or other trade mark rights of a third party resulting from processing or handling of the product and/or any other use of the product.

As a general rule our developments, IPs, principle circuitry and range of Integrated Circuits are suitable and specifically designed for appropriate use in technical applications, such as in devices, systems and any kind of technical equipment, in so far as they do not infringe existing patent rights. In principle the range of use is limitless in a technical sense and refers to the products listed in the inventory of goods compiled for the 2008 and following export trade statistics issued annually by the Bureau of Statistics in Wiesbaden, for example, or to any product in the product catalogue published for the 2007 and following exhibitions in Hanover-Messe).

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.

preliminary (22 2500)

6-CH. PHASED ARRAY OPTO ENCODER (33-2500)

Rev A4, Page 10/10

ORDERING INFORMATION

Туре	Package	Options	Order Designation	
iC-PT3325	32-pin optoQFN, 5 mm x 5 mm, 0.9 mm thickness	glass lid	iC-PT3325 oQFN32-5x5	
		Encoder Disc		
		2500 PPR +4 PPR, OD/ID Ø33.2/13.0 mm, glass	PT5S 33-2500	

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

iC-Haus GmbH Tel.: +49 (61 35) 92 92-0
Am Kuemmerling 18 Fax: +49 (61 35) 92 92-192
D-55294 Bodenheim Web: http://www.ichaus.com
GERMANY E-Mail: sales@ichaus.com

Appointed local distributors: http://www.ichaus.com/sales_partners