iC-PX Series
REFLECTIVE OPTO ENCODERS

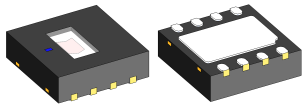
FEATURES

- Lensless, reflective opto-encoder iCs, compact, high-resolution, incremental
- Suitable reflective code discs of ⌀ 26 mm, ⌀ 30 mm, ⌀ 32 mm, ⌀ 36 mm and ⌀ 43 mm
- Monolithic *HD Phased Array* with excellent signal matching
- Integrated blue LED, *EncoderBlue*®
- LED power control with 20 mA driver
- Low-noise signal amplifiers with high EMI tolerance
- Pin-selectable modes of operation: Digital A/B (x1, x2, x4, x8, x16 interpolated)
- Short-circuit-proof, current-limited, +/- 4 mA push-pull outputs
- Operating temperature range of -40 °C to +105 °C
- Low power consumption from single 4.5 V to 5.5 V supply
- Compact and lensless optoDFN mold package
- Evaluation kits on request

APPLICATIONS

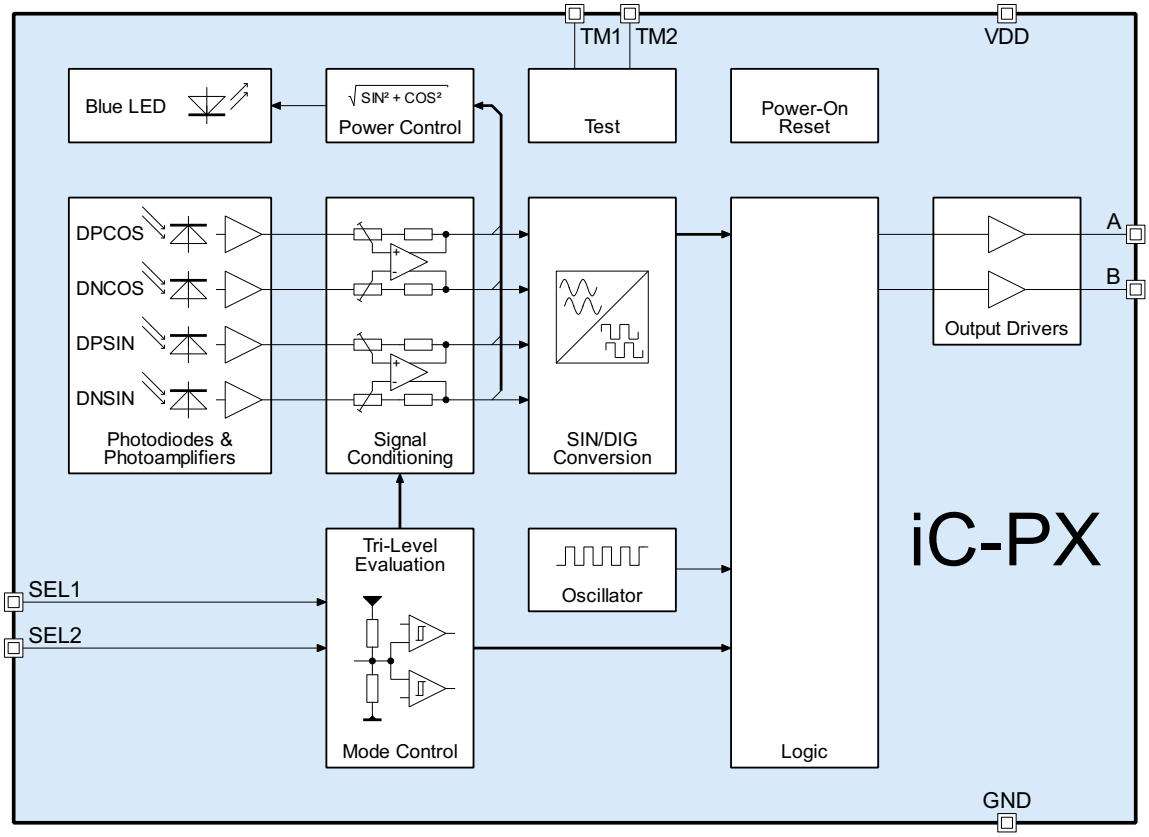
- Incremental encoders
- Miniature motors and actuators
- X-Y and linear stages
- Factory automation robots
- Consumer robots

PACKAGES



optoDFN8-3x3
3 mm x 3 mm x 0.9 mm
RoHS compliant

BLOCK DIAGRAM



DESCRIPTION

iC-PX series devices are advanced optical, reflective, lensless encoder iCs featuring integrated HD Phased Array photosensors and a blue LED chip. They provide high signal quality with relaxed alignment tolerances. Digital A/B outputs with or without interpolation are available. Typical applications are incremental encoders for motor control.

Blue-enhanced photosensors are adapted to the short wavelength of the embedded blue LED, and provide low-jitter outputs due to improved signal contrast. The unique assembly technology of the blue LED emitter and sensors results in low optical crosstalk.

Low-noise transimpedance amplifiers, arranged in a paired layout to ensure excellent channel matching, are used to convert the sensor signals into voltages of several hundred millivolts.

Precision comparators with hysteresis generate digital signals subsequently, either native or interpolated, which are evaluated and then output by ± 4 mA push-pull drivers.

Various operation modes are selectable via tri-level inputs SEL1 and SEL2: Digital A/B outputs with native (x1) or interpolated resolution (x2, x4, x8 or x16).

The built-in LED power controller with its 20 mA driver keeps the optical power constant regardless of aging effects, varying temperature or changes in working distance (iC to code disc).

iC-PX devices feature a low power consumption. They run at single-sided supplies of 4.5 V up to 5.5 V.

iC-PX2604

Code disk ∅:	26.0 mm
Optical radius:	10.8 mm
Native CPR:	360

iC-PX3212

Code disk ∅:	30.0 mm
Optical radius:	13.35 mm
Native CPR:	500

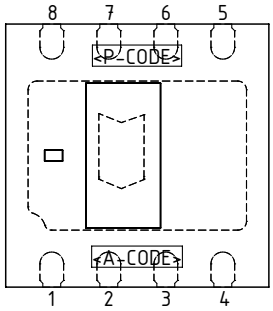
Code disk ∅:	32.0 mm
Optical radius:	14.08 mm
Native CPR:	512

Code disk ∅:	36.0 mm
Optical radius:	16.69 mm
Native CPR:	625

Code disk ∅:	43.0 mm
Optical radius:	19.8 mm
Native CPR:	720

PACKAGING INFORMATION

PIN CONFIGURATION
oDFN8-3x3 (3 mm x 3 mm)

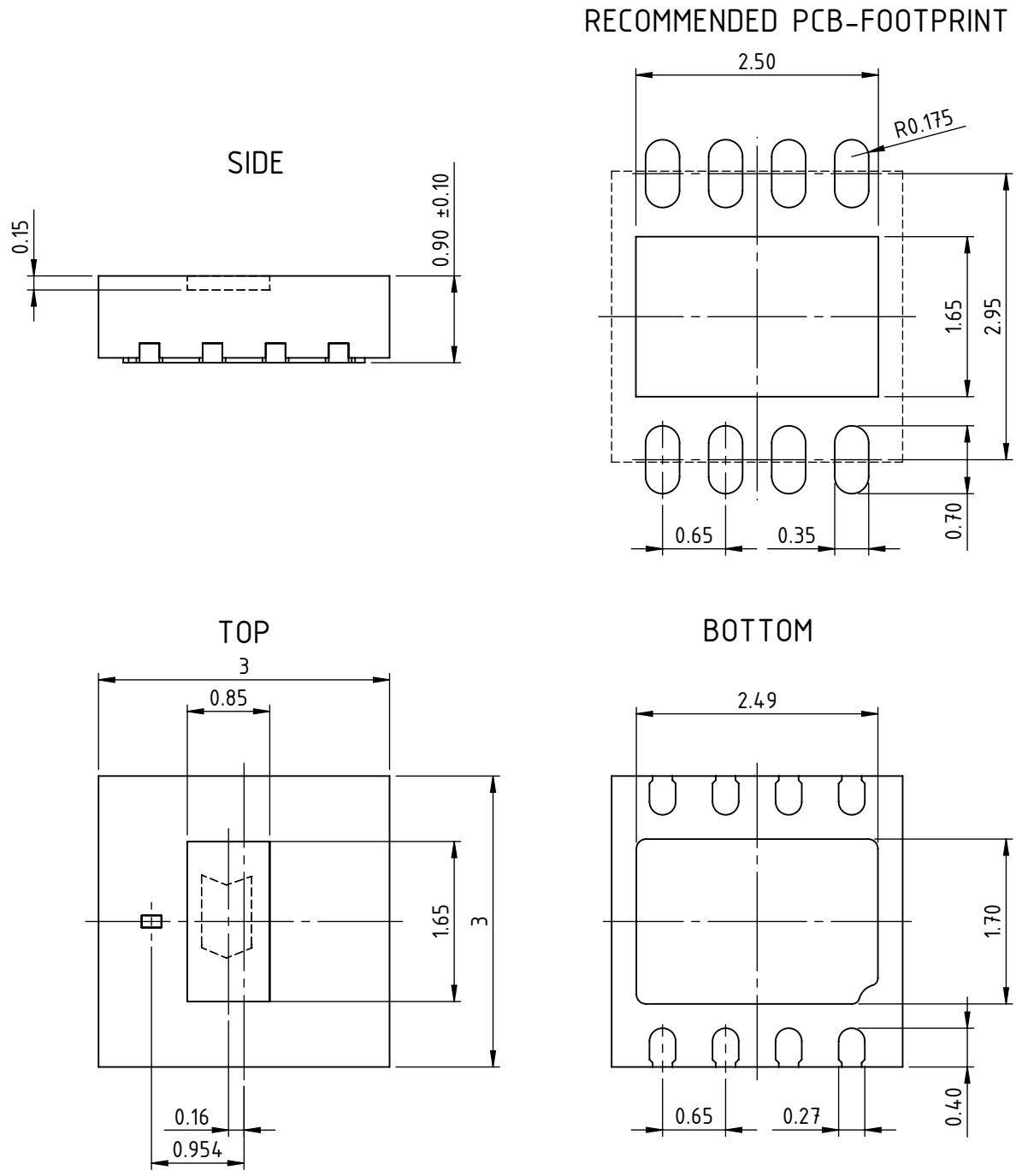


PIN FUNCTIONS

No.	Name	Function
1	TM1	Test Mode Input 1 [1]
2	TM2	Test Mode Input 2 [1]
3	SEL1	Mode Selection Input 1
4	SEL2	Mode Selection Input 2
5	B	Incr. Output B
6	A	Incr. Output A
7	VDD	Supply Voltage 4.5 V...5.5 V
8	GND	Ground
	BP	Backside Paddle [2]

IC top marking: <P-CODE> = product code, <A-CODE> = assembly code (subject to changes);
1) The test pins may remain unconnected. TM1 and TM2 can be tied to GND to increase the noise immunity.
2) The backside paddle has to be connected by a single link to GND. A current flow across the paddle is not permissible.

PACKAGE DIMENSIONS



All dimensions given in mm. Tolerances of form and position according to JEDEC MO-229.
Positional tolerance of sensor pattern: ±70µm / ±1° (with respect to center of backside pad).
Maximum molding excess +20µm / -75µm versus surface of glass/reticle.

dra_odfn8-3x3_pxxxx_pack_1, 15:1

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
G001	VDD	Voltage at VDD		-0.3	6	V
G002	I(VDD)	Current in VDD		-20	120	mA
G003	V()	Pin Voltage, all signal outputs		-0.3	VDD + 0.3	V
G004	I()	Pin Current, all signal outputs		-20	20	mA
G005	Vd()	Electrostatic Discharge	Margin vs. ESD Susceptibility according to JEDEC, all pins	2		kV
G006	Tj	Junction Temperature		-40	150	°C
G007	Ts	Chip Storage Temperature		-40	150	°C

[1] JEDEC document JEP 155: 500V HBM allows safe manufacturing with a standard ESD control process
[2] JEDEC document JEP 157: 250V CDM allows safe manufacturing with a standard ESD control process

THERMAL DATA

Operating conditions: VDD = 4.5...5.5 V

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range		-40		105	°C
T02	Ts	Permissible Storage Temperature Range		-40		105	°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
T04	Rthja	Thermal Resistance Chip to Ambient	Package mounted on PCB according to JEDEC standard		50		W/K

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: VDD = 4.5...5.5 V, Tj = -40...105 °C, unless otherwise noted

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Total Device							
001	VDD	Permissible Supply Voltage		4.5		5.5	V
002	I()	Supply Current	I(VDD), Photocurrent Amplifiers within op. range, fout() <250 kHz, no load refer to Table 5 for details		13		mA
Digital Outputs A, B							
101	fout()	Maximum Frequency per Output	Mode DX1 Mode DX2 Mode DX4 Mode DX8 Mode DX16	0.2 0.4 0.8 1.6 1.85			MHz MHz MHz MHz MHz
102	AArel	AB Duty Cycle Variation	Mode DX1 Modes DX2, DX4, DX8, DX16 see also Figure 1	-5 -10		5 10	% %
103	HysD	Digital Hystersis of Interpolator	Hysteresis with respect to one A/B period in mode DX1		5.6		°
104	Vs()lo	Saturation Voltage low	I() = 4 mA			0.4	V
105	Isc()lo	Short-Circuit Current low	V() = VDD	7		70	mA
106	Vs()hi	Saturation Voltage high	Vs()hi = VDD - V(), I() = -4 mA			0.4	V
107	Isc()hi	Short-Circuit Current high	V() = 0 V	-70		-7	mA
108	Tedc()	Edge Distance Control Time		45	80	135	ns
Tri-Level Programming Inputs SEL1, SEL2							
201	Vt()lo	Tri-Level Threshold Voltage low		5			%VDD
202	Vt()hi	Tri-Level Threshold Voltage high				95	%VDD
203	Vt()mid	Tri-Level Threshold Voltage mid		30		70	%VDD
204	V0()	Pin-Open Voltage		45	50	55	%VDD
205	Rpd()	Pull-Down Resistor	V() = VDD	65			kΩ
206	Rpu()	Pull-Up Resistor	V() = GND	65			kΩ
LED Power Control							
301	Iop()	Permissible LED Current		0.5		20	mA
302	Ictrl()	Controlled LED Output Current	Refer to Table 5 for details		5 ..10		mA

SIGNAL DEFINITIONS

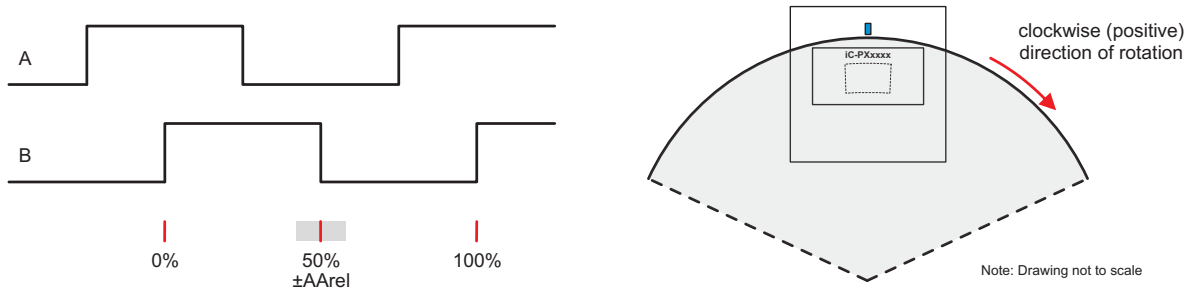


Figure 1: Signal definitions for clockwise (positive) direction of rotation.

OPERATION MODES

The iC-PX series features 5 operation modes, which are selectable by the voltages applied to the pins SEL1 and SEL2, as summarized in Table 4 and illustrated in Figure 2.

These tri-level inputs might be connected to a voltage below Vt()lo (low, see 201), a voltage above Vt()hi (high, see 202) or a voltage between the specified values of Vt()mid (open, see 203). For other voltages the function is undefined.

The open configuration can be easily obtained by an external voltage divider. Alternatively, when the pin is left unconnected, the iC itself biases the input at 50% VDD (see 204).

Note: Static pin voltages at SEL1 and SEL2 are required during operation. If changing the setting of SEL1 or SEL2 during operation, power-on reset of iC-PX is required.

SEL1	SEL2	Mode	Description
low	high	DX1	digital A/B (x1 interpolation)
high	low	DX2	digital A/B (x2 interpolation)
high	high	DX4	digital A/B (x4 interpolation)
low	open	DX8	digital A/B (x8 interpolation)
high	open	DX16	digital A/B (x16 interpolation)

Table 4: Operation modes selectable by pins SEL1/2.

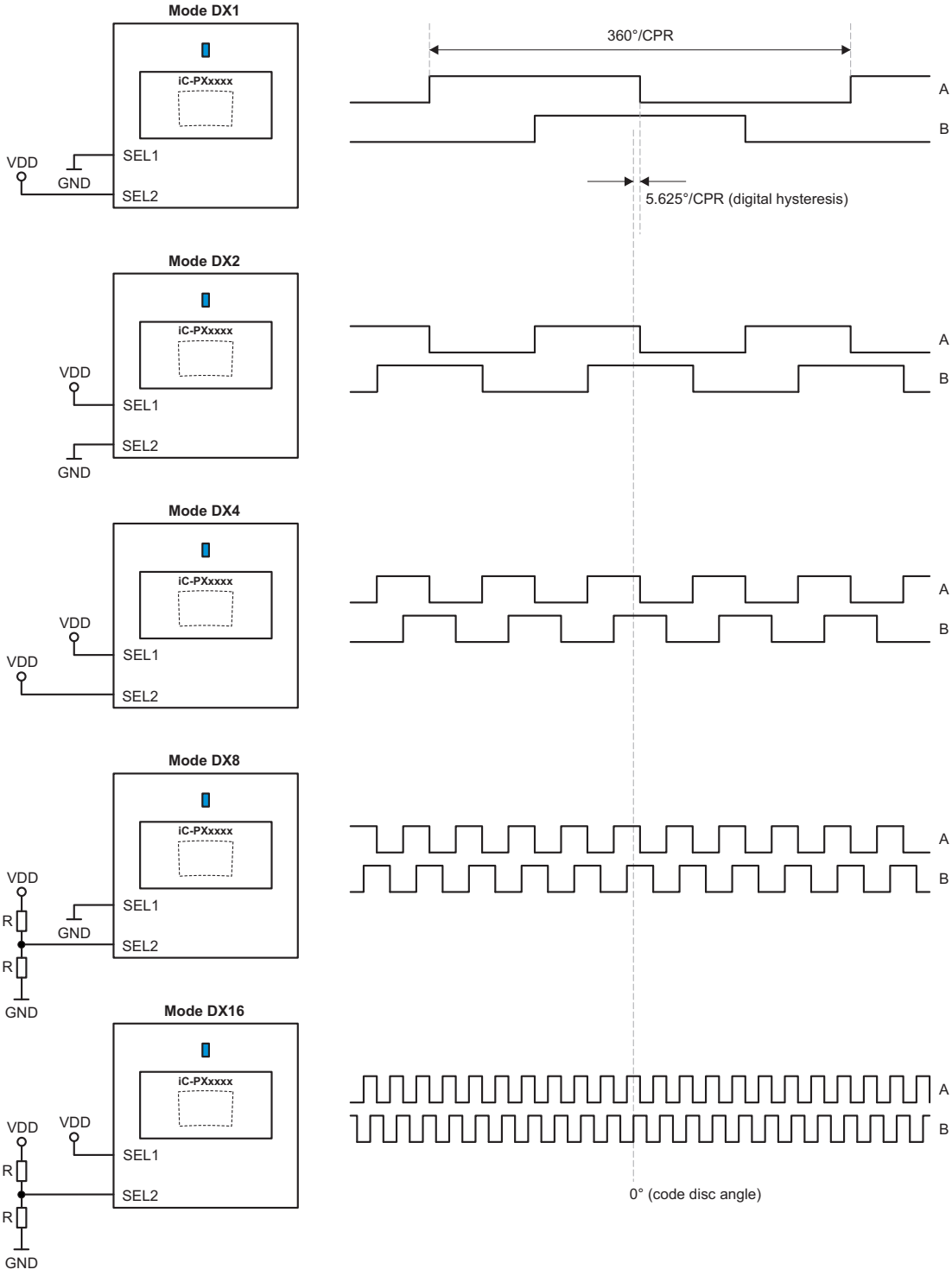


Figure 2: Illustration of operation modes selectable by pins SEL1/2.

DIGITAL HYSTERESIS

The iC-PX series features a digital angular hysteresis of $\frac{360°}{64 \cdot CPR}$ (see 103), i.e., 1 LSB of the angular resolution in mode DX16. As illustrated in Figure 3, the digital hysteresis corresponds to a slip existing between the two rotating directions. In this way multiple switching of the incremental signals at the reversing point of a changing direction of rotation is prevented.

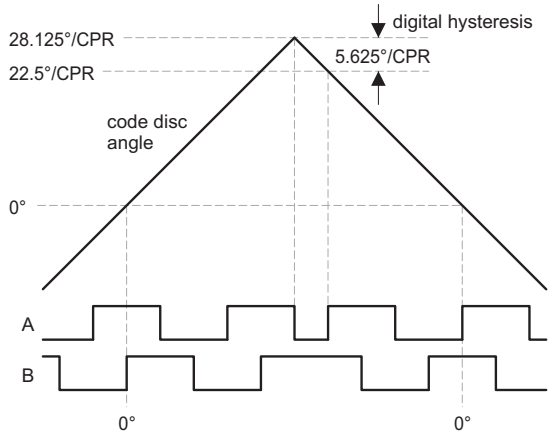


Figure 3: Digital hysteresis in mode DX16.

STARTUP BEHAVIOR

When iC-PX devices are powered on, the digital outputs are held in a defined state:

A = B = low

Once the logic has found and verified the code disc position, valid A/B signals are then output henceforth.

Note: iC-PX will also enter or remain in the startup state at too low supply voltages or when the regulated LED current exceeds a specific value, e.g. due to code disc misalignment. Once the LED current returns to a valid range, the logic will again search for the code disc position and output valid A/B signals afterwards.

POWER CONTROL

iC-PX devices regulate the current through the integrated blue LED, keeping the optical power constant regardless of aging effects, varying temperature or changes in working distance (iC to code disc).

In case of strong code disc misalignment or in the absence of any code disc, a maximum current is sent through the LED, which corresponds to an overall supply current of typ. 80 mA.

When code disc and iC-PX are properly aligned, the LED current is significantly reduced and mainly depends on the code disc type and the working distance (see Table 5 for typ. supply current values).

DEVICE OVERVIEW

Device	CPR	Code Disc		Supply Current / mA		Max. RPM	
	native	P/O Code	Type	1.5 mm[1]	2.0 mm[1]	DX1/2/4/8	DX16
⌀ 26 Series							
iC-PR2604	360	PX01S	tbd.	12	14	32000	18000
⌀ 30 Series							
iC-PX3212	500	tbd.	tbd.	13	15	23000	13000
⌀ 32 Series							
iC-PX3212	512	PX02S	F	13	15	23000	13000
⌀ 36 Series							
iC-PX3212	625	tbd.	tbd.	13	15	18000	10000
⌀ 43 Series							
iC-PX3212	720	tbd.	tbd.	13	15	16000	9000

Type M = Makrolon
Type P = Polycarbonate
Type F = Film

Reflectance of Al-coated bars >85%.

Device availability on request.

Table 5: Device overview

[1] Working distance iC to code disc.

APPLICATION NOTES

Application notes for iC-PX series devices are shown separately.

ORDERING INFORMATION

Type	Package	Options	Order Designation
iC-PXnnnn	8-pin optoDFN, 3 mm x 3 mm, 0.9 mm thickness RoHS compliant	nnnn = device version	iC-PXnnnn oDFN8-3x3

Please send your purchase orders to our order handling team:

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