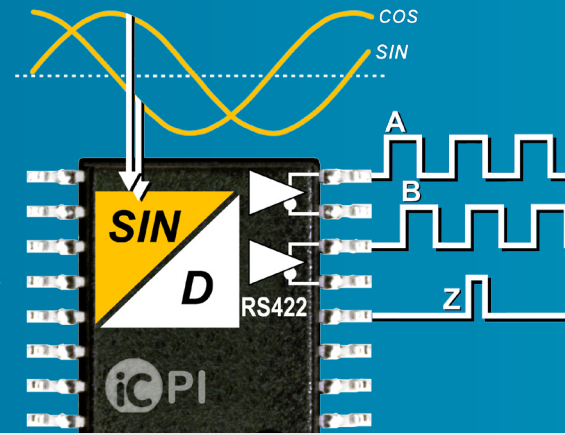


# iC-PI

## Programmable 12-Bit Sin/Cos Interpolation iC with RS422 Driver



### Description

iC-PI is an interpolator with a non-linear A/D converter which digitizes sine/cosine sensor signals using a count-safe vector tracking conversion with selectable resolution and hysteresis.

The angle position is output incrementally by differential RS422 drivers as an encoder quadrature signal with a zero pulse.

A pre-selectable minimum edge distance ensures glitch-free output signals and prevents counting errors which in turn boosts the noise immunity of the position encoder.

The integrated signal conditioning unit allows signal amplitudes and offset voltages to be calibrated accurately and any phase error between the sine and cosine signals to be corrected. As angle data is offered to the I<sup>2</sup>C interface, signal adaption can be easily automated using an MCU.

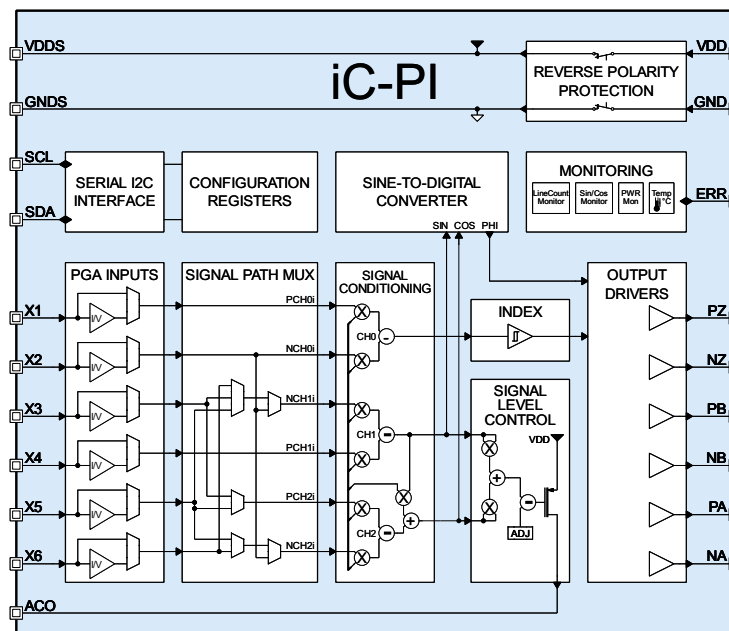
### Applications

- Rotary and linear encoders
- Magnetic or optical angle sensor modules
- Brushless motor commutation

### Features

- Latency-free sine-to-digital conversion
- Decimal/binary resolutions of up to 4000/4096 steps per input cycle
- High input frequency: 500 kHz (x10), 80 kHz (x100), 8 kHz (x1000)
- Flexible pin assignment using signal path multiplexers
- PGA inputs for differential and single-ended signals
- Variable input resistance for current/voltage conversion
- Signal conditioning for offset, amplitude, and phase
- Controlled 50 mA current source for LED or MR sensor supply
- Fault-tolerant RS422 output via adjustable drivers up to 50 mA
- Glitch-free due to guaranteed minimum edge distance
- Zero signal conditioning and electronic index pulse generation
- Output of motor commutation signals: UVW with 1 to 8 cycles
- 15-bit period counter for the evaluation of distance-coded reference points
- I<sup>2</sup>C slave interface for both period and angle data as well as in-circuit calibration
- I<sup>2</sup>C multi-master interface for configuration from external EEPROM
- Adjustable over-temperature alarm and shutdown
- Supply from 4.3 to 5.5 V, operation from -40 to +100 °C
- Reverse-polarity-proof, including the sub-system

### Block Diagram





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### Key Specifications

#### Inputs and Signal Conditioning

Max. Input Frequency	500 kHz
Input Signal Amplitude	Differential 10 to 500 mV (up to 2V using divider) Single-ended 20 mV to 1V (up to 4V using divider)
Input Resistance	High impedance (typ. 20 k $\Omega$ using divider) Typ. 1.6 to 4.6 k $\Omega$ (current mode)
Input Current Range	$\pm 10$ to $\pm 300$ $\mu$ A (current mode)
Input Gain	x2 to x100 (up to x25 using divider)
Gain Ratio Calibration	40 to 250% (sine to cosine), in steps of 0.09%
Offset Calibration	range $\pm 100\%$ , in steps of 0.1% (3.2% for index) range $\pm 1200\%$ , in steps of 1.2% (38% for index)
Calibration References	0.25V, 0.5V, VDC, 5% V (ACO)
Phase Calibration	Up to $\pm 10.4^\circ$ (sine to cosine), in steps of 0.02 $^\circ$

#### Sine-to-Digital Conversion

Conversion Rate	Up to 40 Msps
Accuracy (INL)	typ. 0.13 el. $^\circ$ per input cycle
AB Interpolation	1, 2, 4, 5, 8, 10, 16, 20, 25, 32, 40, 50, 64, 100, 125, 128, 200, 250, 256, 500, 512, 1000, 1024 AB cycles per input cycle
UVW Interpolation	1 to 8 UVW cycles per input cycle
Angle Hysteresis	0.09 $^\circ$ to 22.5 $^\circ$

#### Output Signals

Max. A/B Frequency	10 MHz
Min. A/B Edge Distance	25 ns to 6.4 $\mu$ s
Z Index Position	Adjustable in 128 steps
Z Index Width	90 $^\circ$ , 180 $^\circ$ , 270 $^\circ$ , 360 $^\circ$ of AB cycle
Driver Configuration	Push-pull (CMOS ... RS422), highside, lowside; with adjustable current limit and slew rate

#### Serial Interface

I/O Engine	I <sup>2</sup> C multi-master with slave function (max. clock rate 400 kHz)
Angle Data (ST)	12-bit angle data plus 2 bits for X2/X1 pin states
Period Data (MT)	15-bit period count, or cycle count for distance-coded reference points

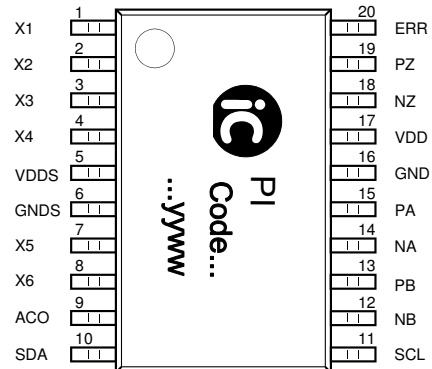
#### Signal Level Control

Control Modes	Constant current, sin/cos square with hyste- resis, sum
Operating Range	Up to 50 mA (short-circuit-proof), Vs 1.2V max.
Control Alarm	At 3% and 90% of range limits

#### Sub-System Power Switch

Permissible Load Current	Up to 20 mA
Drop-Out Voltage	150 mV per switch (at 10 mA)

### Pin Configuration TSSOP20 4.4 mm



### Pin Functions

Name	Function
X1	Signal Input 1 (Index + / Sector Input MSB)
X2	Signal Input 2 (Index - / Sector Input LSB)
X3 to X6	Signal Input 3 to 6
PA, PB, PZ	Incremental Output A+, B+, Z+
NA, NB, NZ	Incremental Output A-, B-, Z- Commutation Output U, V, W
VDDS	Switched Supply Output and Internal Analog Supply Voltage
GNDS	Switched Ground
ACO	Signal Level Controller Output
SDA	Serial I <sup>2</sup> C Interface, data line
SCL	Serial I <sup>2</sup> C Interface, clock line
GND	Ground
VDD	4.3 to 5.5V Supply Voltage
ERR	Error Signal Input/Output

### Key Specifications (continued)

#### Other Operational Data

Supply Voltage	Single 4.3 to 5.5V, 35 mA max. (reversed polarity current < 1 mA)
Operational Temperature	-40 to +100 $^\circ$ C
Device Configuration	From serial I <sup>2</sup> C EEPROM or microcontroller
Package	TSSOP20 4.4 mm (6.5 mm x 6.4 mm)
Monitoring and Alarms	Lack of input signal (due to wire breakage, short-circuit, loss of magnet, etc.), excessive input signal level, signal level controller out of range, thermal overload, power up configuration error