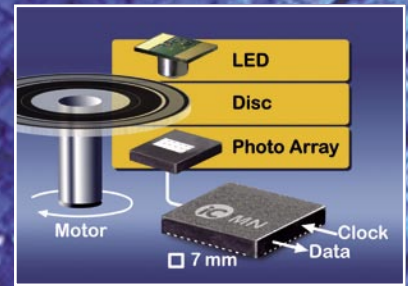# iC-MN
25-BIT NONIUS ENCODER WITH 3-CHANNEL SAMPLING 13-BIT SIN/D INTERPOLATION

Encoder device iC-MN is a 3-channel, simultaneous sampling sine-to-digital converter which interpolates sine/cosine sensor signals using a high precision SAR converter with a selectable resolution of up to 13 bits. Each input has a separate sample-and-hold stage which halts the track signal for the subsequent sequential digitization. Various 2- and 3-track Nonius scale computations (after Vernier) can be configured for the calculation of high resolution angle positions; these computations permit angle resolutions of up to 25 bits.

The absolute angle position is output via the serial BiSS Interface with clock rates of up to 10 Mbit/s. The RS422 transceiver required to this end is integrated on the chip.

Applications

– Optical and magnetic position sensors
– Singleturn and multiturn absolute encoders
– Linear scales for absolute position

Features

– 3-Ch. simultaneous sampling 13 bit sine-to-digital conversion
– 2- and 3-track Nonius scale computation (after Vernier)
– Reduced conversion times due to internal flash counter
– Synchronization of multiturn sensors via on-chip BiSS master
– Differential PGA inputs, single-ended signal capable
– Selectable input resistance permits voltage or current signals
– Signal conditioning for offset, amplitude and phase
– Short-circuit-proof RS422 drive to 10 Mbit/s for BiSS data line
– SSI data output formats selectable
– Short-circuit-proof sine/cosine output drivers (1 Vpp to 100 Ω)
– Signal level controllers for direct supply of encoder LEDs and MR bridges
– Configurable system monitoring and alarm indication
– Position preset function
– Device setup from serial EEPROM and BiSS
– Full reverse polarity protection including the sub-system
– Immune against faulty output or supply connections
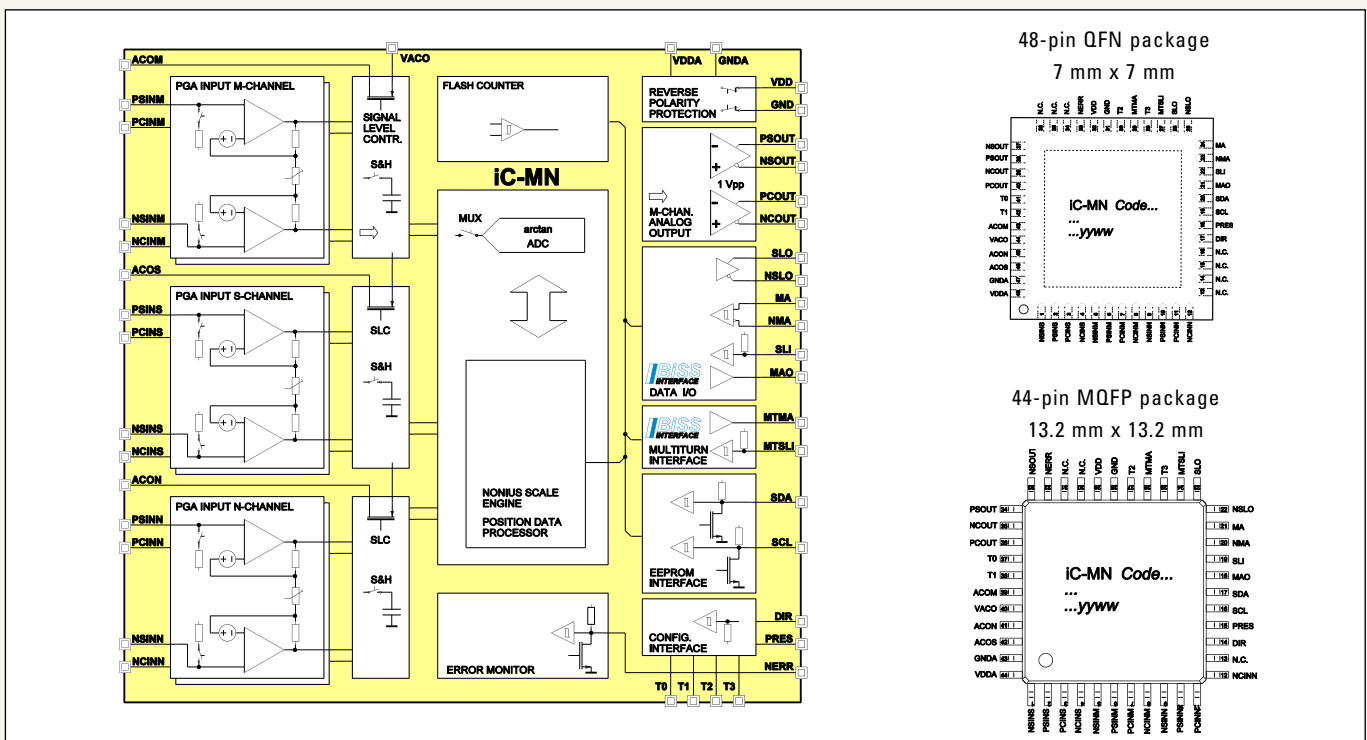
48-pin QFN package
7 mm x 7 mm

44-pin MQFP package
13.2 mm x 13.2 mm

For the purpose of input signal stabilization the conditioned signals are fed into level controllers featuring current source outputs of up to 50 mA (master channel). These ACOx source pins either power the LEDs of an optical encoder or the magneto resistor bridges of a magnetic encoder. If the control thresholds are reached this event can be released for alarm messaging using the BiSS Interface or the NERR output. Both major chip functions and sensor errors are also monitored and can be enabled for alarm indication. In this manner typical sensor errors, such as signal loss due to wire breakage, short circuiting, dirt or aging, for example, can be signaled by alarms.

The device has other digital encoder functions governing the correction of phase errors between the tracks, for example, or the zeroing or default setting of a specific position offset for data output. Using the BiSS master also integrated on the chip position data from multiturn sensors, provided by a second iC-MN, for example, can be read in and synchronized.

Key Specifications

Operating Modes

- 3-Channel S&H interpolation
- 2- and 3-track Vernier calculation
- Config. multiturn modes (e.g. gearbox 3x 1:16, from 4 to 24 bit data)

Compatible Sensors

Photodiode arrays, AMR sensors, GMR sensors

Signal Conditioning

Differential Input Signal Range	20 mVpp to 1 Vpp, 80 mVpp to 4 Vpp
Input Current Range	+/- 10 µA to +/- 300 µA
Input Resistance	typ. 1.6 kΩ to 4.6 kΩ (I mode) typ. 20 kΩ or high impedance (V mode)
Permissible Input Frequency	to 200 kHz
Input Gain Range	1x to 50x and 4x to 200x
Gain Ratio Calibration Range	40 % to 250 % (sine vs. cosine)
Gain Calibration Step	0.09 %
Offset Calibration Range	to +/- 200, 400, 1200, 2400 %*
Offset Calibration Step	0.2 % , 0.4 %, 1.2 %, 3.2 %* *) based on calibration ref.
Calibration Reference	0.25 V, 0.5 V, VDC, 5 % V(ACOM)
Phase Calibration Range	+/- 10.4 degree (sine vs. cosine)
Phase Calibration Step	0.02 degree

Sine-to-Digital Conversion

Conversion Time	250 to 500 ns per bit
Conversion Time @ 24 bit Nonius	typ. 5 µs with cyclic readouts (15 µs for initialisation)
Acceptable Nonius Scale Signal	2^4 to 2^{12} master signal periods per turn (ie. 16 to 4096)
Angle Resolution	1 to 13 bits per signal period 6 to 13 bits per signal period for Nonius calc.
Angle Accuracy	typ. 0.18° per signal period (calibrated)

Data I/O Interface

Interface Performance	10 Mbit/s for BiSS, 100 kHz / 2 MHz clock rate for SSI
Differential RS422 Output	to +/- 50 mA push-pull, >2.5 V at RL 100 Ω
Differential RS422 Receiver	Rin 20 kΩ, -7 to +12 V tolerant

Analog Output

Output Amplitude	to 300 mVp (@ RL 100 Ω pin-to-pin)
Output Short-Circuit Current	typ. 30 mA
Output Cutoff Frequency (-3 dB)	> 500 kHz

Signal Level Controller

Operating Modes	constant current, sine square, sum
Operating Ranges	to 5, 10 mA and to 25, 50 mA for master channel
Source Saturation Voltage	1 V max.
Control Alarm Thresholds	approx. 2 % and 100 % of range limit

Sub-System Power Switch

Permissible Load Current	to 20 mA
Drop Out Voltage	typ. 200 to 300 mV @ 20 mA

Other Operational Data

Supply Voltage	single 4.5 to 5.5 V, typ. 45 mA (no current draw with reversed polarity)
Op. Temperature Range	-40 °C to +95 °C (extended range on request)
Package	MQFP44 (13.2 mm x 13.2mm), QFN48 (7x7 mm), bare die
Device Configuration	via BiSS or I2C interface from serial EEPROM
Monitoring and Alarms	lack of input signal (due to wire breakage, short-circuit, loss of magnet, etc), calculation error due to excessive input level or phase, signal level controller out of range, thermal overload, power up configuration error
Other Operational Modes	bias and temperature sensor calibration mode, device test mode, digital calib. mode

Pin Functions

Name	Function
VDD*	+4.5 to 5.5 V Supply Voltage
GND*	Ground
VDDA	Sub-System Positive Supply Output
GNDA	Sub-System Ground Output
VACO*	+4.5 to 5.5 V Signal Level Controller Supply
ACOx*	Signal Level Controller Output
PSINx, NSINx PCINx, NCINx	Pos./Neg. Sine Signal Input Pos./Neg. Cosine Signal Input
PSOUT*, NSOUT* PCOUT*, NCSOUT*	Analog Pos./Neg. Sine Output Analog Pos./Neg. Cosine Output
SLO*, NSLO*	BiSS Interface, Pos./Neg. Data Output
MA*, NMA*	BiSS Interface, Pos./Neg. Clock Input
SLI	BiSS Interface, Data Input
MAO	BiSS Interface, Clock Repeater Output
MTMA	BiSS Master Interface, Clock Output
MTSLI	BiSS Master Interface, Data Input
SDA	Serial E2PROM Interface, Data Line
SCL	Serial E2PROM Interface, Clock Line
DIR	Sense of Rotation Preselection
PRES	Position Preset Trigger Input
NERR*	Alarm Message Output / System Error Message Input
T0...T3	Test and Calibration I/O Pins

x= m (master), n (nonius), s (segment)
*) Immune against faulty output or supply connections