Manual

GP-NIP

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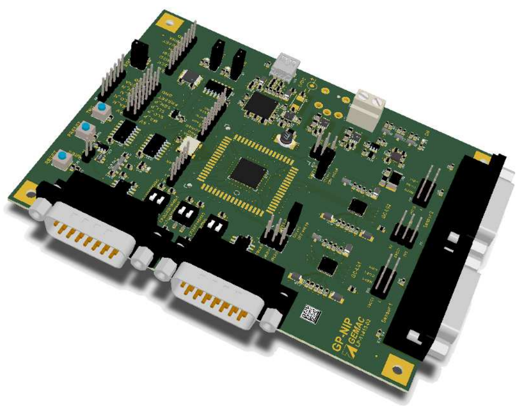

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Revision Overview

Date	Revision	Change(s)
21.01.13	1.0	Document created
15.03.13	1.1	Photo of p.c. board replaced
21.03.13	1.2	“Start-up“ and “Troubleshooting” chapters added
18.04.13	1.3	Adaptation to new hardware revision (X9, X10, block diagram), modified IC properties: Number of stages of digital phase potentiometer
29.04.13	1.4	Software description updated
30.05.13	1.5	Operating modes of the GC-NIP adapted

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1 Overview

The GP-NIP demo board can be used to test all functions of the GC-NIP nonius interpolation circuit.

The GP-NIP is designed for a hardware-oriented function test of the IC. The board possesses various measuring points that allow to check all important signals. Thus, adaptation to the most varied encoder systems is possible.

The configuration of the IC and reading-out of the measured values are performed either via the USB, SPI or SSI/BiSS interface. To this end, in addition to connection to an external micro-controller or FPGA system, it is also possible to use the supplied “GC NIP Monitor” software. Furthermore, ABZ square-wave signals for external counters can be output via the RS422 interface.

The demo board can be supplied with operating voltage either via USB, a power pack (connectors or screw terminals) or the appropriate interface.

The desired interface (USB, SPI, SSI/BiSS) can be selected by way of the appropriate jumper.

The supply voltage for the connected sensor (3.3 V or 5 V) can also be set by way of jumpers.

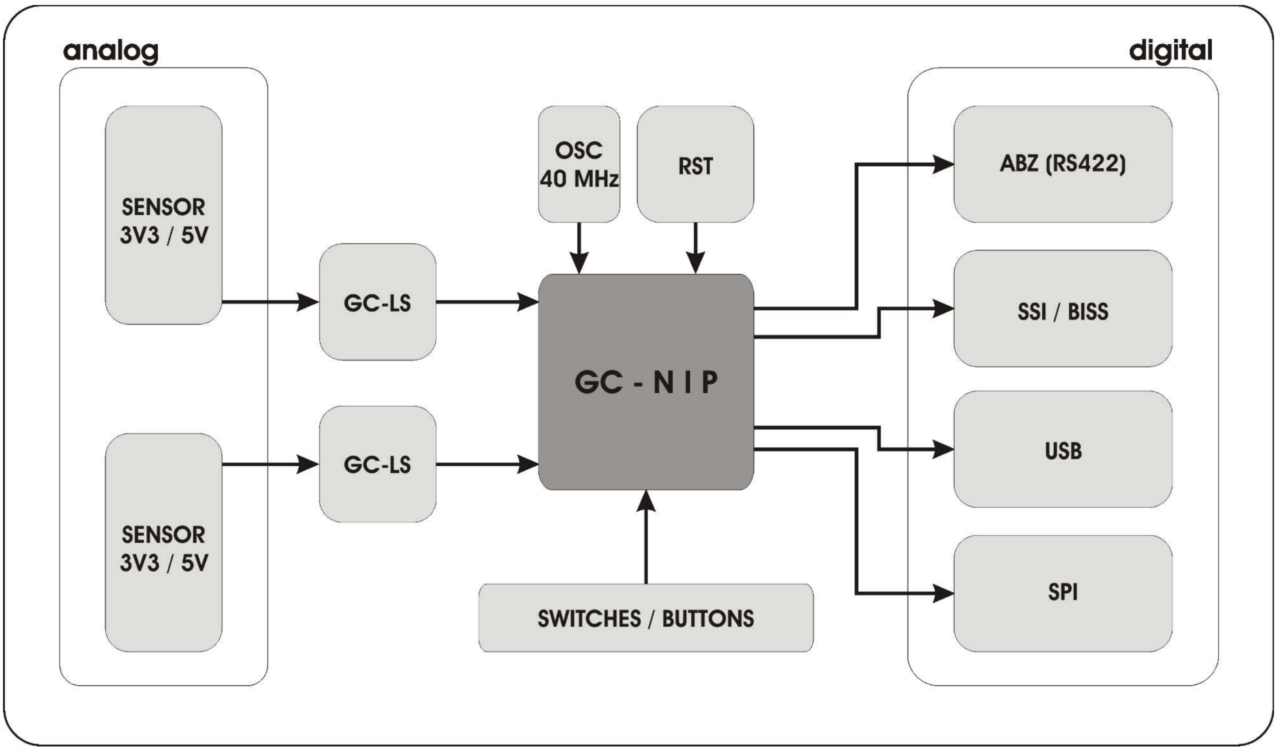


Fig. 1: Block diagram

2 Properties

Interfaces	
Analog input	■ Sinusoidal / cosinusoidal / reference (index) signals,; differential or single-ended ■ Adjustable amplification for 660 mV_{pp} / 250 mV_{pp} / 120 mV_{pp} / 60 mV_{pp} ■ Maximum input frequency 150 kHz for nonius calculation ■ Maximum input frequency 90 kHz for interpolation
ABZ	■ 90° square-wave sequences (A/B/Z) for both channels ■ Adjustable width of zero signal Z to ¼ or 1 period A/B ■ Error signal ■ Interrupt signal for external processing ■ Service signals for sensor adjustment
SPI	■ 30-bit counter value for the interpolation channels ■ Up to 22-bit value for the absolute position ■ 9-bit sensor status information on each channel ■ Compatible with standard-SPI: 16-bit, MSB first, up to 15 MHz
SSI and BiSS	■ Up to 30-bit counter value ■ 2-bit sensor status ■ Gray code / binary code ■ Adjustable timing ■ SSI ring operation
Additional inputs	■ Trigger input for storage of the measured value ■ Preset signal for adjustment and storage of the counter value ■ Reference position alignment using external signal
Configuration options	■ Integrated EEPROM ■ Configuration inputs ■ Serial interface (SPI/BiSS)
Interpolation / nonius calculation / signal processing	
Interpolation rate	■ 256 to 8192, divisible by 8 ■ Adjustable divider 1/2/4/8 for the A/B-signals and counter values on each channel
Nonius graduation	■ Number of periods per turn for absolute position calculation ■ Interpolation rate / [8 / 16 / 32 / 64]
Nonius correction	■ Correction coefficients stored in the EEPROM ■ Software based calibration process for determination of the correction coefficients
Signal correction	■ Patented digital controller for the offset, control range ±10% of the nominal amplitude ■ Patented digital controller for the amplitude, control range factor 60% ... 120% of the nominal amplitude ■ Digital potentiometer with 64 stages for phase correction; selectable range ±5° or ±10° ■ Input signal monitoring with configurable error indication
Fault suppression	■ Adjustable low-pass filter 10 kHz, 75 kHz, 150 kHz ■ Digital hysteresis for suppression of the edge noise at the output (configurable 0...7) ■ Selectable minimum edge distance at the output (bandwidth limitation)
Reference signal processing	■ Adjustable reference mark position in 32 steps, 0 … 360° ■ Optional: high precision alignment of the reference mark position (configuration via external signals possible) ■ Determination of the optimum reference position by way of SPI/BiSS or auxiliary signals ■ Processing of distance coded reference marks ■ Measured-value trigger at the reference-mark position
Further information	■ Optional Master-SPI interface for output and manipulation of SSI/BiSS-Data ■ 2-stage measured value trigger ■ Constant delay between sampling and measured value for all resolutions: Count value (both channels): 4.4µs, Absolute nonius position: 8µs
Important characteristics: Demo board	
Operating voltage	3.3 VDC / 5 VDC
I/O voltage, digital	3.3 VDC or 5 VDC
Temperature range	0 … 70°C
Dimensions of the GP-NIP	PCB 100 mm x 130 mm
Interface frequency	SPI: 15 MHz, BiSS: 10 MHz, SSI: 5 MHz

Table 1: Properties

For further information on the GC-NIP IC, refer to the Data Sheet which is available for download from our website www.gemac-chemnitz.de/en/products/interpolation.

3 Hardware

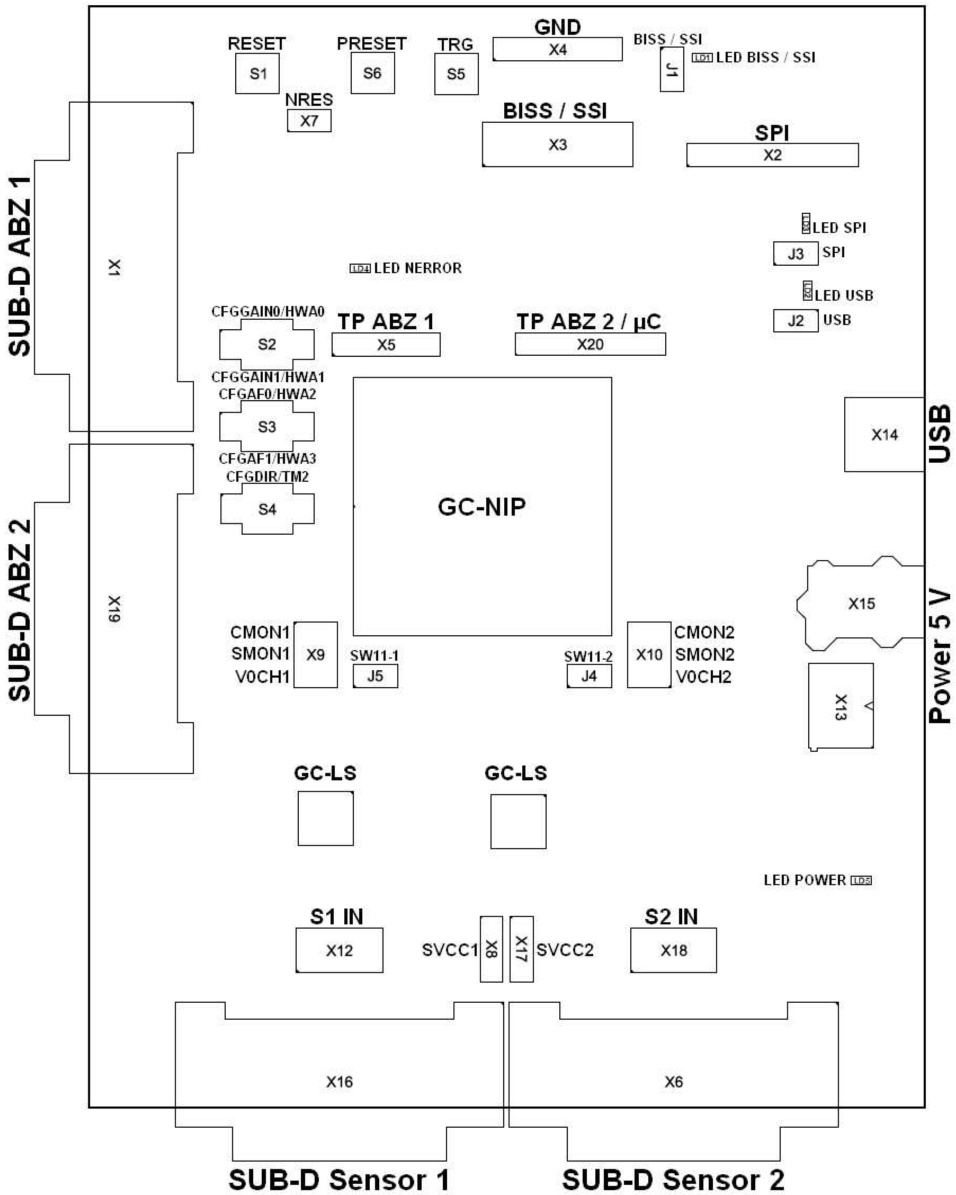


Fig. 2: GP-NIP demo board

3.1 Connections

Attention: When configuring the hardware of the demo board, first make sure that it is disconnected from the power supply!

3.1.1 SUB-D X1 pin connector assignment (ABZ – RS422, channel 1)

Pin	Designation	Function
1	AP	Square-wave signal A positive
2	GND	GND
3	BP	Square-wave signal B positive
4	5 V / 3,3 VDC	5 V / 3.3 VDC power supply
5	EP	Error signal NERR positive
6	PRESET	Preset signal → for the zero position independent of reference marks
7	ZN	Square-wave signal Z negative
8	TRIG	Trigger signal → acceptance of count value to trigger hold register
9	AN	Square-wave signal A negative
10	GND	GND
11	BN	Square-wave signal B negative
12	5 V / 3,3 VDC	5 V / 3.3 VDC power supply
13		
14	ZP	Square-wave signal Z positive
15	EN	Error signal NERR negative

Table 2: SUB-D X1 pin connector assignment (ABZ – RS422, channel 1)

3.1.2 X2 push-on terminal strip pin assignment (SPI)

Pin	Designation	Function
1	5 V	5 V / 3.3 VDC power supply
2	SCK	SPI Clock
3	MISO	SPI MISO
4	MOSI	SPI MOSI
5	SEN_SPI	SPI Enable
6	PRESET	Pin PRESET for the GC-NIP
7	TXENA/TRG	Pin TXENA / TRIGGER of the GC-NIP
8	GND	GND

Table 3: X2 push-on terminal strip pin assignment (SPI)

3.1.3 X3 push-on terminal strip pin assignment (BiSS / SSI)

Pin	Designation	Function
1	5 V	5 V / 3.3 VDC power supply
2	5 V	5 V / 3.3 VDC power supply
3	MA_P	SSI / BiSS MA positive
4	MA_N	SSI / BiSS MA negative
5	SLO_P	SSI / BiSS SLO positive
6	SLO_N	SSI / BiSS SLO negative
7	SLI_P	SSI / BiSS SLI positive
8	SLI_N	SSI / BiSS SLI negative
9	SEN_SSI/BiSS_P	SSI / BiSS enable positive
10	SEN_SSI/BiSS_N	SSI / BiSS enable negative
11	PRESET	Pin PRESET des GC-NIP
12	TXENA / TRG	Pin TXENA / TRG des GC-NIP
13	GND	GND
14	GND	GND

Table 4: X3 push-on terminal strip assignment (BiSS / SSI)

3.1.4 X4 push-on terminal strip pin assignment (GND)

Pin	Designation	Function
1 – 6	GND	AGND GC-NIP (analog ground)

Table 5: X4 push-on terminal strip pin assignment (GND)

3.1.5 X5 push-on terminal strip pin assignment (test points for ABZ, channel 1)

Pin	Designation	Function
1	A	Square-wave signal output A, channel1, directly on the GC-NIP
2	B	Square-wave signal output B, channel1, directly on the GC-NIP
3	Z	Square-wave signal output Z, channel 1, directly on the GC-NIP
4	NERR	Square-wave signal output NERR, directly on the GC-NIP
5	GND	DGND GC-NIP (digital ground)

Table 6: X5 push-on terminal strip pin assignment (test points for ABZ, channel 1)

3.1.6 SUB-D X6 pin connector assignment (sensor 2)

Pin	Designation	Function
1	SINP	Sensor sinusoidal signal input, positive, channel 2
2	GND	AGND GC-NIP (analog ground)
3	COSP	Sensor cosine signal input, positive, channel 2
4	SVCC2	5 V / 3.3 VDC power supply
5	-	-
6	-	-
7	REFN	Sensor reference-point signal input, negative, channel 2
8	-	-
9	SINN	Sensor sinusoidal signal input, negative, channel 2
10	GND	AGND GC-NIP (analog ground)
11	COSN	Sensor cosine signal input, negative, channel 2
12	SVCC2	5 V / 3.3 VDC power supply
13	V0CH2	Center voltage output 1.1 V (for 3.3 V sensors only!), channel 2
14	REFP	Reference-point signal input, positive, channel 2
15	-	-

Table 7: SUB-D X6 pin connector assignment (sensor 2)

3.1.7 X7 jumper (NRES)

Pin	Designation	Function
1	NRES	Open → reset inactive Closed → reset active
2	GND	

Table 8: X7 jumper (NRES)

3.1.8 X8 jumper pin assignment (selection of the supply voltage for the sensor at channel 1)

Pin	Designation	Function
1	5 V	5 VDC supply voltage
2	SVCC1	Pin for the selected voltage → e.g. 1 - 2 = 5V sensor power supply
3	3V3	3.3 VDC supply voltage

Table 9: X8 jumper pin assignment (Selection of the supply voltage for the sensor at channel 1)

3.1.9 X9 monitor signals, channel 1

Stecker	Designation	Function
1	AGND	Analog ground
2	CMON1	Test point for cosine monitor signal from channel 1 of GC-NIP
3	AGND	Analog ground
4	SMON1	Test point for sinusoidal monitor signal from channel 1 of GC-NIP
5	AGND	Analog ground
6	V0CH1	Test point for center voltage from channel 1 of GC-NIP

Table 10: X9 monitor signals, channel 1

3.1.10 X10 monitor signals, channel 2

Stecker	Designation	Function
1	AGND	Analog ground
2	V0CH2	Test point for center voltage from channel 2 of GC-NIP
3	AGND	Analog ground
4	SMON2	Test point for sinusoidal monitor signal from channel 2 of GC-NIP
5	AGND	Analog ground
6	CMON2	Test point for cosine monitor signal from channel 2 of GC-NIP

Table 11: X10 monitor signals, channel 2

3.1.11 X12 connector pin assignment (test points for the input signals at channel 1)

Pin	Designation	Function
1	AGND	Analog ground
2	SVCC1	Selected sensor supply voltage
3	REFN	Reference-point signal input, negative, channel 1
4	REFP	Reference-point signal input, positive, channel 1
5	COSN	Cosine signal input, negative, channel 1
6	COSP	Reference-point signal input, positive, channel 1
7	SINN	Reference-point signal input, negative, channel 1
8	SINP	Reference-point signal input, positive, channel 1

Table 12: X12 connector pin assignment (test points for the input signals at channel 1)

3.1.12 X13, X14, X15 connections (power, USB)

Stecker	Designation	Function
X13	Input 1 → GND Input 2 → + 5 VDC	GND Operating voltage 5 V / 3.3 VDC
X14	USB	Mini USB
X15	Socket for DC connector 5.0 x 2.1 mm	Operating voltage 5 V / 3.3 VDC

Table 13: X13, X14, X15 connections (power, USB)

3.1.13 SUB-D X16 connector pin assignment (sensor 1)

Pin	Designation	Function
1	SINP	Sensor sinusoidal signal input, positive, channel 1
2	GND	AGND GC-NIP (analog ground)
3	COSP	Sensor cosine signal, positive, channel 1
4	SVCC1	5 V / 3.3 VDC power supply
5	-	-
6	-	-
7	REFN	Sensor reference point signal input, negative, channel 1
8	-	-
9	SINN	Sensor sinusoidal signal input, negative, channel 1
10	GND	AGND GC-NIP (analog ground)
11	COSN	Sensor cosine signal input, negative, channel 1
12	SVCC1	5 V / 3.3 VDC power supply
13	V0CH1	Center voltage output 1.1 V (for 3.3 V sensors only!), channel1
14	REFP	Reference-point signal input, positive, channel 1
15	-	-

Table 14: SUB-D X16 connector pin assignment (sensor 1)

3.1.14 X17 jumper pin assignment (selection of the supply voltage for the sensor at channel 2)

Pin	Designation	Function
1	5 V	5 VDC supply voltage
2	SVCC2	Pin for the selected voltage → e.g. 1 - 2 = 5V sensor supply
3	3V3	3.3 VDC supply voltage

Table 15: X17 jumper pin assignment (selection of the supply voltage for the sensor at channel 2)

3.1.15 X18 push-on terminal strip pin assignment (test points for the input signals at channel 2)

Pin	Designation	Function
1	AGND	Analog ground
2	SVCC2	Selected sensor supply voltage
3	REFN	Reference-point signal input, negative, channel 2
4	REFP	Reference-point signal input, positive, channel 2
5	COSN	Cosine signal input, negative, channel 2
6	COSP	Reference-point signal input, positive, channel 2
7	SINN	Reference-point signal input, negative, channel 2
8	SINP	Reference-point signal input, positive, channel 2

Table 16: X18 push-on terminal strip pin assignment (test points for the input signals at channel 2)

3.1.16 SUB-D X19 connector pin assignment (ABZ – RS422, channel 2)

Pin	Designation	Function
1	AP	Square-wave signal A positive
2	GND	GND
3	BP	Square-wave signal B positive
4	5 V / 3.3 VDC	5 V / 3.3 VDC power supply
5	EP	Error signal NERR positive
6	PRESET	Preset signal → for the zero position independent of reference marks
7	ZN	Square-wave signal Z negative
8	TRIG	Trigger signal → acceptance of the count value to the trigger hold register
9	AN	Square-wave signal A negative
10	GND	GND
11	BN	Square-wave signal B negative
12	5 V / 3,3 VDC	5 V / 3.3 VDC power supply
13		
14	ZP	Square-wave signal Z positive
15	EN	Error signal NERR negative

Table 17: SUB-D X19 connector pin assignment (ABZ – RS422, channel 2)

3.1.17 X20 push-on terminal strip pin assignment (test points for ABZ, channel 2 / micro-controller interface)

Pin	Designation	Function
1	TXENA / TRG	Pin TXENA / TRG des GC-NIP
2	MCMISO	MISO µC interface
3	STSAMP / A2	Square-wave signal output A, channel 2 / STSAMP, µC interface
4	MCMOSI / B2	Square-wave signal output B, channel 2 / MOSI, µC interface
5	MCSCK / Z2	Square-wave signal output Z, channel 2 / SCK, µC interface
6	NERR	Square-wave signal output NERR, directly on the GC-NIP
7	GND	DGND GC-NIP (digital ground)

Table 18: X20 push-in terminal strip pin assignment (test points for ABZ, channel 2 / micro-controller interface)

3.1.18 J1 – J5 jumpers

Jumper	Designation	Function
J1	Pin 1 → BiSS / SSI (ENABLE) Pin 2 → GND	Open → BiSS / SSI deactivated Closed → BiSS / SSI active (LD1 active)
J2	Pin 1 → USB (ENABLE) Pin 2 → GND	Open → USB deactivated Closed → USB active (LD2 active)
J3	Pin 1 → GND Pin 2 → SPI (ENABLE)	Open → SPI deactivated Closed → SPI active (LD3 active)
J4	Pin 1 → 5 V Pin 2 → LSB	Open → for the 5V sensors at channel 2 (gain 0.66) Closed → for the 3.3V sensors at channel 2 (gain 1)
J5	Pin 1 → 5 V Pin 2 → LSB	Open → for the 5V sensors at channel1 (gain 0.66) Closed → for 3.3V sensors at channel 1 (gain 1)

Table 19: J1 – J5 jumpers

3.2 Switches and buttons

Switch	Functions	Description
S1	Reset button → demo board reset	Initialization of GC-NIP and selected interface
S2	Switch 1 → CFGGAIN(0) / HWA(0) Switch 2 → CFGGAIN(1) / HWA(1)	Configuration of nominal amplitude / hardware address Konfiguration Nominal amplitude / hardware address
S3	Switch 1 → CFGAF(0) / HWA(2) Switch 2 → CFGAF(1) / HWA(3)	Configuration of analog filter / hardware address Configuration of analog filter / hardware address
S4	Switch 1 → CFGDIR / TM2 Switch 2 → –	Configuration of counting direction for nonius / test mode
S5	TRG button	Acceptance of count value to trigger hold register
S6	PRESET button	Setting of zero position independent of reference marks

Table 20: Switches and buttons

3.3 LEDs

LED	Function
LD1	LED OFF → BiSS / SSI inactive LED ON (yellow) → BiSS / SSI active
LD2	LED OFF → USB inactive LED ON (yellow) → USB active
LD3	LED OFF → SPI inactive LED ON (yellow) → SPI active
LD4	LED OFF → no error signal at NERROR LED ON (rot) → error signal at NERROR → error occurred
LD5	LED OFF → no operating voltage present LED ON (green) → operating voltage present

Table 21: LEDs

4 Demo Board Specifications

Parameter	Min.	Typ.	Max.	Unit
Supply voltage	4,75	5,0	5,5	VDC
Power supply, internal		3,3 / 5,0		VDCS
I/O voltages		3,3 / 5,0		V
Current consumption		tbd		mA
Operating temperature	0		70	°C
External clock		25		MHz
Center voltage V0	1,08	1,1	1,12	V
Output current V0			1	mA

Table 22: Specifications

For the specifications of the GC-NIP IC, refer to the Data Sheet which can be downloaded from our website www.gemac-chemnitz.de/en/products/interpolation.

5 GC-NIP Monitor Software

5.1 Overview

The parameters and specifications of the GC-NIP are controlled and visualized by way of the GC-NIP Monitor Software. It is designed for Windows operating systems and communicates with the IC directly via USB (USB-to-SPI conversion on the board) or the GEMAC USB/SPI converter. Optionally, the configuration is also possible by way of the software via the BiSS interface with an appropriate BiSS user interface (e.g. iCHaus MB4U).

5.2 System requirements

To ensure proper program execution, your PC or notebook should meet at least the following system requirements and possess one of the following operating systems:

- **Hardware:**
  - Processor: 2GHz or higher (recommended: multi-core system)
  - Min. 512 MB RAM
  - Min. 1 GB free harddisk memory (for the measuring data)
  - 24-bit VGA card (recommended: 32-bit)
  - Display resolution: 1,024x768 pixels or higher
  - Free USB interface
- **Supported operating systems:**
  - Microsoft Windows® 2000
  - Microsoft Windows® XP
  - Microsoft Windows® Server 2003
  - Microsoft Windows® Vista
  - Microsoft Windows® 7

5.3 Installation

The software and required USB drivers for the interfaces are installed by way of the executable file (installer) 44800-SW-x-x-GC-NIP Setup.exe.

5.4 Program structure

The graphical user interface of the application is divided into a dialog bar, a status bar and up to three areas for display of the measured values. The dialog bar is located directly beneath the toolbar. In this area, the interface – SPI or BiSS - is selected. Furthermore, a measurement can be started here and the time for the interrogation interval can be selected; it is also possible to trigger commands (reset counters). The available GC-NIP measurement values and status information are represented in the three measurement windows. To this end, a measurement must be started via the dialog bar. The measured values are refreshed at the set interrogation interval.

After starting the application, as shown in Fig. 3, the software checks that the hardware is present. Once the hardware is detected according to the selected interface, its identifier is displayed in the status bar. If a circuit is connected correctly and activated, in addition the designation of the integrated circuit (e.g. “IC: GC-NIP”) is displayed in the status bar. If no integrated circuit was detected, “Unknown” is displayed.

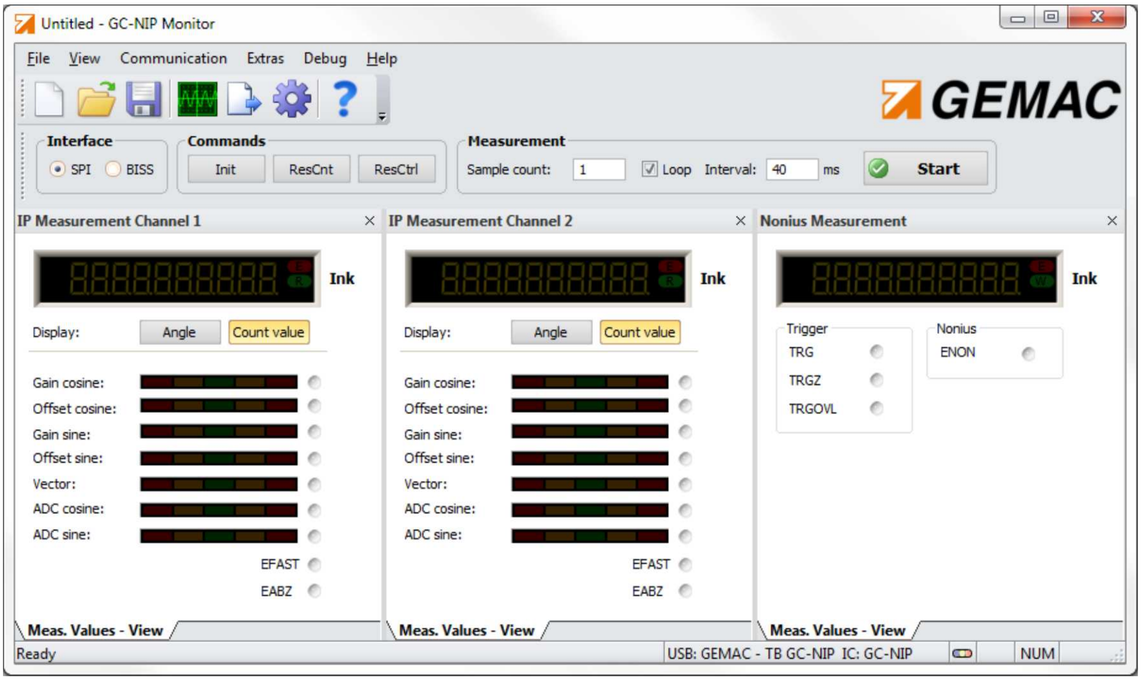
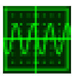


Fig. 3: GC-NIP Monitor main window

If the BiSS interface is used, it is imperative that the connections between integrated circuit and interface, as well as between interface and PC are present to enable the software to find the hardware during the hardware scan for new devices. In some cases, the interface selection must be changed after connecting the hardware once more to restart the hardware scan.

5.5 Menu bar

	New document	Creates an empty document.
	Open document	Reads the program settings from an existing document.
	Save document	Saves the program settings in a document.
	Oscilloscope view	Opens the oscilloscope view; see Chapter 5.9.
	Export data	Exports the measured data to a file.
	Configuration	Opens the configuration window; see Chapter 5.8.
	About	Displays information about the program and the connected hardware.

5.6 Help functions

When the configuration program was developed, special attention was devoted to a clear and self-explaining graphical user interface. Many elements of the user interface show detailed explanations when you position the mouse pointer on them (tooltip or status text).

The settings made in the program can be saved in a setup document with the extension ".gcnip" and restored when necessary.

5.7 Measurement

Once a GC-NIP IC was connected to the PC and detected by the software, you can start a live measurement by clicking on the "Start" button. The displays in the three measurement windows are refreshed at the set intervals. The specification for the measurement interval is a direction specification. The actual measurement interval is dependent on the software configuration, interface and PC capability and capacity utilization.

5.7.1 Measuring the interpolation in channel 1 and channel 2

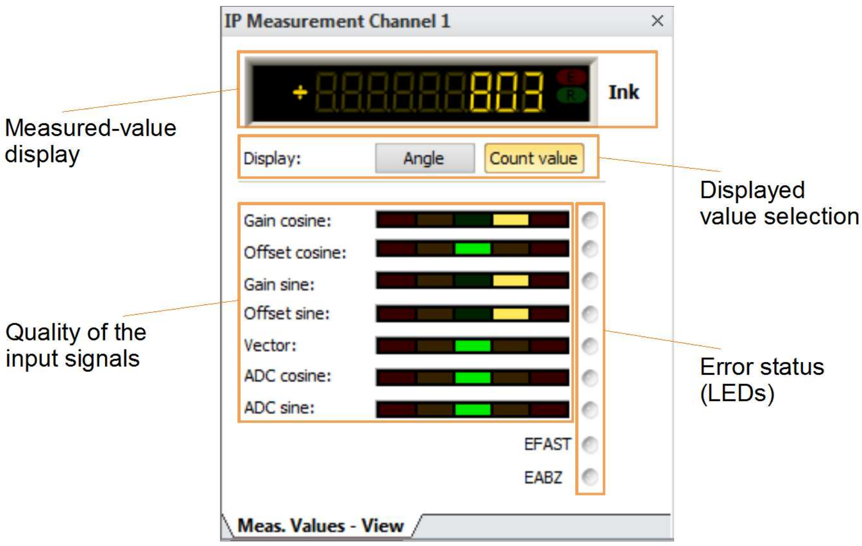


Fig. 4: Measuring the interpolation in channel 1 and channel 2

The two interpolation channels with status and error information for the input signals are displayed in the windows separately. During a measurement, either the interpolated count value or the current phase angle can be displayed for the individual channels.

The parameters of the sensor signals and the controller are represented by way of LED bars (see Table 23 and Table 24). Errors are displayed by way of LED visualization.

Table 23: Sensor monitoring

Name	Art	Function
Cosine gain Sinusoidal gain	LED bar	Controller correction value for the signal amplitude
	LED	The gain controller for the input signal has reached its limit.
Cosine offset Sinusoidal offset	LED bar	Controller offset correction value
	LED	The input signal offset controller has reached its limit.

Name	Art	Function
Vector	LED bar	Amount of vector for the input signals
	LED	The signal vector formed from cosine and sinusoidal signals is too small.
ADC cosine ADC sinusoidal	LED bar	Range of values of the AD converter
	LED	The AD converter for the sinusoidal / cosine signals is overdriven.
EFAST	LED	The maximum frequency of the input signals is exceeded. The maximum input frequency depends on the operating mode and the configuration.
EABZ	LED	The A, B and Z signals are faulty due to the excessive input frequency. The maximum frequency is dependent on the set minimum edge spacing and the set interpolation rate.

The displays of the error LEDs are dependent on the configuration of the integrated circuit. The errors can be activated or deactivated separately or permanently saved in the `CFG1` configuration register. The behavior of the LEDs is adapted accordingly. Further information about sensor monitoring and configuration of the integrated circuit can be found in the GC-NIP Data Sheet.

Table 24: Range of values for sensor monitoring

Dislpay	Function
LEDs Green Yellow, left Yellow, right Red, left Red, right	Value... ... lies in permissible range ... is too small; sensor signal should be adjusted. ... is too large; sensor signal should be adjusted. ... is too small; measurement results faulty. ... is too large; measurement results faulty.

5.7.2 Nonius measurement

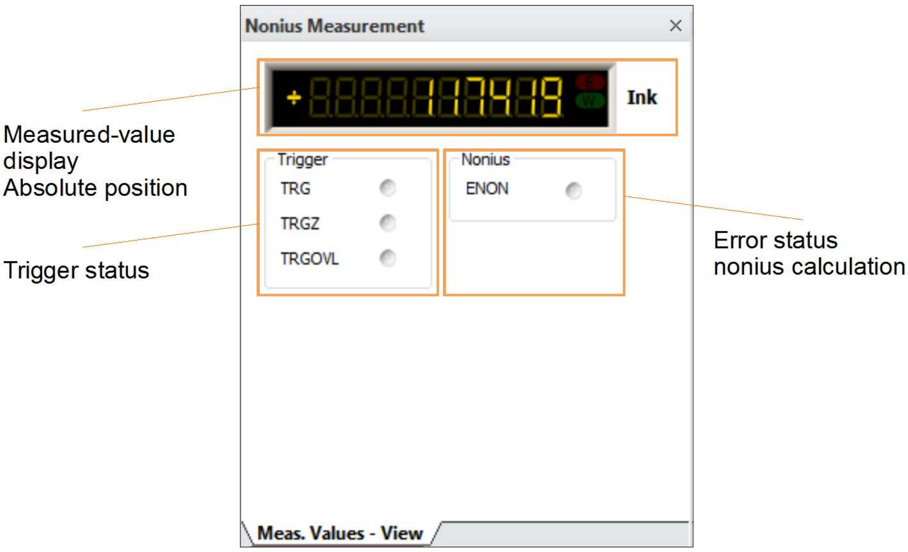


Fig. 5: Nonius measurement

The “Nonius measurement” window displays the corrected absolute position calculated from both tracks (`POSIT` register). In addition, status LEDs are displayed for trigger events and for the overflow error of the trigger hold register, as well as in case of errors in the nonius calculation. For the functions of the status and error LEDs, refer to Table 25.

Table 25: Status LEDs for the nonius measurement

Status-LED	Function
TRG	Trigger status (pin) Active: The next measured value read by the MVAL register was triggered by the TRG pin. Inactive: The MVAL register comprises the current position value (POSIT register).
TRGZ	Trigger status (reference signal) Active: The next measured value read by the MVAL register was triggered by the reference material. Inactive: The MVAL register comprises the current position value (POSIT register).
TRGOVL	Trigger overflow Active: Overflow of the trigger hold register; a trigger event was lost. Inactive: No overflow of the trigger hold register; max. two trigger events are stored.
ENON	Nonius error Active: Implausible jump of the detected nonius value caused by faulty input signals or correction values. The nonius sensor should be re-calibrated.

5.8 Configuration

Once the IC was detected successfully, the software attempts to read out the current configuration. The user can either confirm or create a new configuration (Data -> New; “White page” icon). Furthermore, it is also possible to load a previously saved configuration with the extension *.gcnip (File -> Open; “Folder” icon).

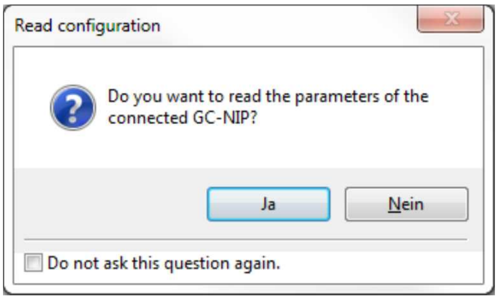


Fig. 6: Reading out the configuration

The configuration window can be opened using the menu (Options -> Configuration) or by way of the toolbar. Then, various tabs for basic and extended IC configurations and for the software settings are available.

The configuration is stored with saving in the internal EEPROM of the IC and validated automatically. Thus, the configuration used is loaded from the EEPROM either during power-on of the IC or after reset. The validity of the configuration is stored at EEPROM address 0x00. If you wish to use the manufacturer's configuration or configuring by way of pins for operation of the IC, first the EEPROM content must be validated. To this end, an appropriate button is provided in the configuration window (“Sensor – Expert”). Furthermore, the EEPROM validity is displayed.

Further information about the manufacturer's and user's configurations can be found in the GC-NIP Data Sheet.

5.8.1 Basic configuration: "*Sensor – Parameters*" *tab*

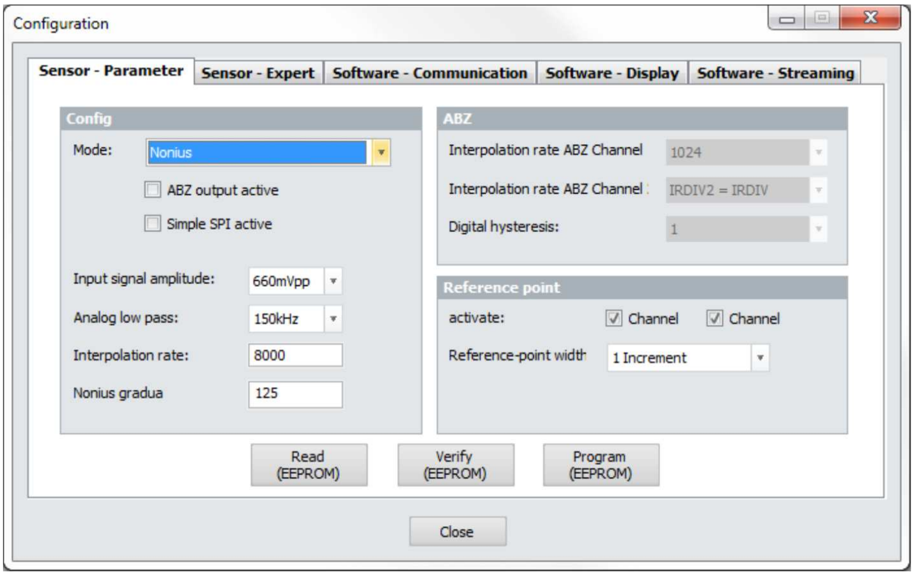


Fig. 7: "Sensor - Parameters" configuration

The first tab of the "Sensor – Parameters" configuration can be used to make general settings, such as interpolation rate and nonius graduation and the parameters for the input signals. Thus, the basic functions of the GC-NIP can be switched without great effort.

Configuring the operating mode:

Nonius: The absolute position is calculated as the nonius value from the input signals of both channels. The absolute position is stored in the `POSIT` register (= value displayed in the "Nonius measurement" window). The `CNT1` and `CNT2` registers comprise the interpolation counters for the appropriate channel (= count value in the windows "IP measurement, channel 1" or "IP measurement, channel 2"). To ensure proper operation, the nonius graduation must be configured. It is also possible to store coefficients for correction of the nonius value in the EEPROM by way of a software-based calibration process. For more information regarding the calibration process, see Section 5.10.

Interpolator (2-channel): For use of the IC with one single or two independent sensors. The registers `CNT1` or `CNT2` comprise the interpolation counters for the appropriate channel. In this mode, it is not necessary to configure the nonius graduation.

Sensor adjustment 1, 2 and Z: Auxiliary signals are issued at the A, B and Z pins allowing analog adjustment of the sensor signals. For further information, refer to the GC-NIP Data Sheet.

ⓘ Note: The display in the "Nonius measurement" window corresponds to the content of the POSIT register and is specified by way of `CFGBISS/STSEL(1:0)`independent of the set operating mode. For further information on the operating modes of the IC, refer to the GC-NIP Data Sheet.

The settings selected for the EEPROM of the GC-NIP are saved by clicking on the “Programming” button. The “Verify” button can be used for comparison of the data between the software and the EEPROM and delivers the result of the comparison at the end. If any differences are detected, it is possible to read out the EEPROM values by clicking on the “Read” button and to accept them to the display of the software.

5.8.2 Extended configuration: “*Sensor – Expert” tab*

The “Sensor - Expert” tab is designed for further configuration of the GC-NIP. It is based directly on the definitions of the configuration registers `CFG1-3, CFGBISS`, `PREST1`, `PREST2` and `NONOFFS` which can be programmed by these registers separately. For detailed descriptions and explanations of the individual parameters, refer to the Data Sheet. Reading, programming and verification of the parameters can be performed similarly to the approach for the “Sensor – Parameters” tab.

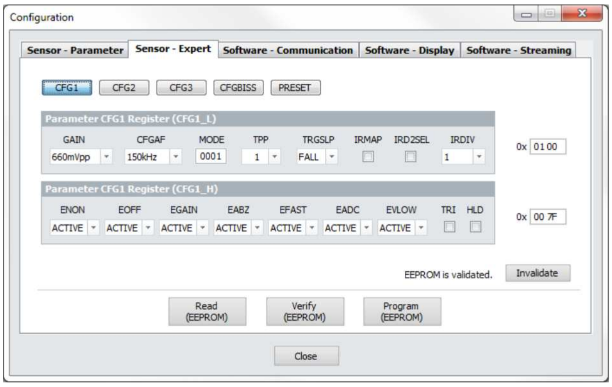


Fig. 8: “Sensor - Expert” CFG1

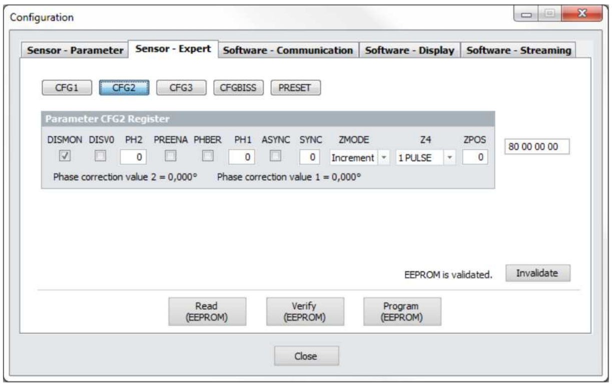


Fig. 9: “Sensor - Expert” CFG2

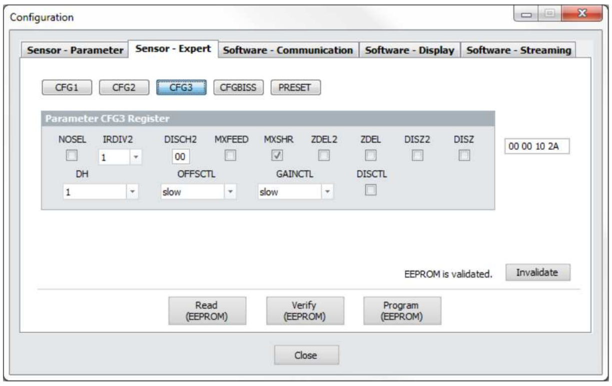


Fig. 10: “Sensor - Expert” CFG3

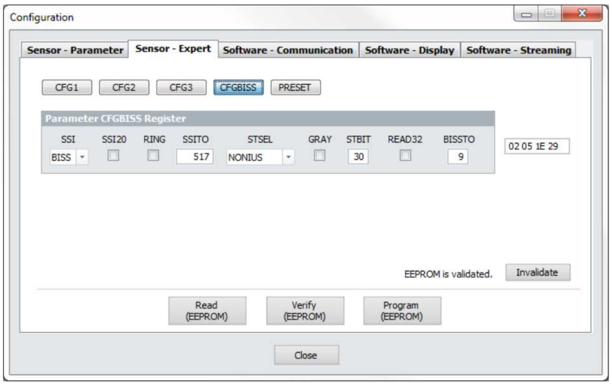


Fig. 11: “Sensor - Expert” CFGBISS

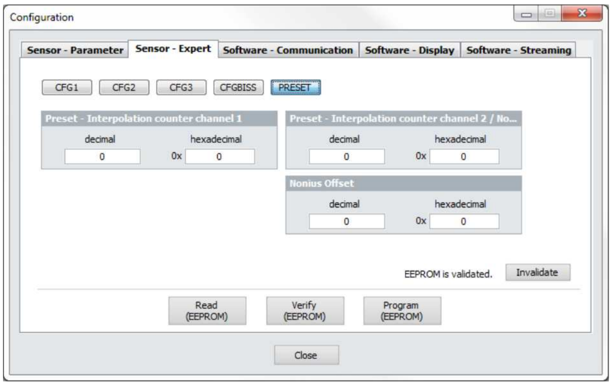


Fig. 12: “Sensor - Expert” PRESET

5.8.3 Configuring the interface: "*Software – Communication" interface*

This tab is used to make the settings for communication via the interfaces. For communication via the SPI or BiSS interface, in addition to the clock setting for the interface, it is also possible to enter the hardware address for the addressing of several slaves.

For the SPI interface, it is also possible to specify the waiting time after read access (for further information, refer to the GC-NIP Data Sheet).

In the area for the BiSS interface, the XML configuration file (idbiss4743.xml) must be specified to enable the software to identify the IC. It can also be selected here whether only the position data (single-cycle data) or all measurement data registers are to be read out during a measurement.

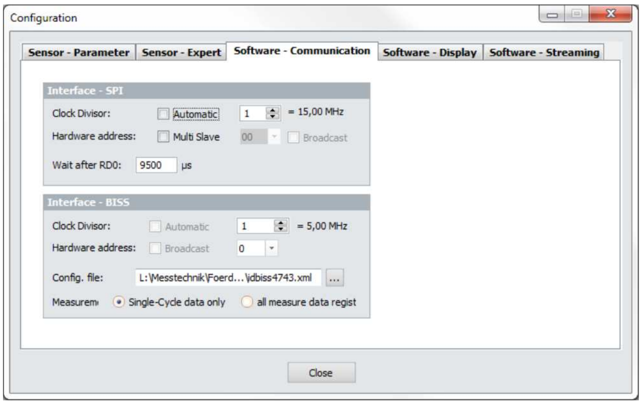


Fig. 13: Software - Communication

5.8.4 "Software – Display" configuration

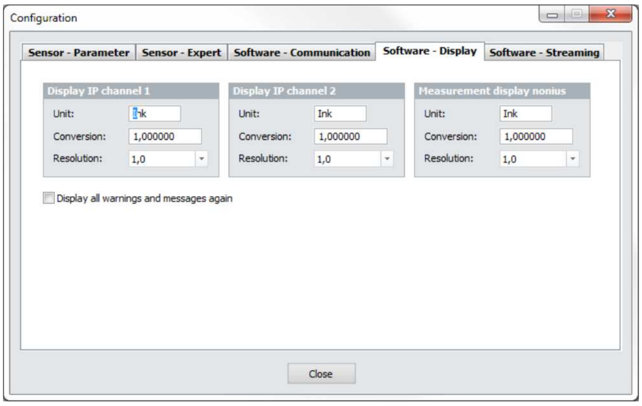


Fig. 14: Software display

Measuring unit and scaling for representation of the measured value in the software (IP measurements 1 and 2, display of the count value; nonius measurement) can be changed in the "Display" area. Furthermore, any warning and information dialogs which were possibly been hidden by the operator can be reactivated here.

5.8.5 Configuring the data recording: "*Software - Streaming" tab*

The "Streaming" item can be used to record parameters of the GC-NIP, such as corrected or uncorrected ADC values, PHI and BQ continuously. The data can then be exported as measured data or raw data as a CSV or metlab data using the "Export" function (Options -> Export; icon "White paper?? with arrow").

Thus, it is possible to evaluate, edit and document the data later. The recorded data can be visualized simultaneously in the oscilloscope view.

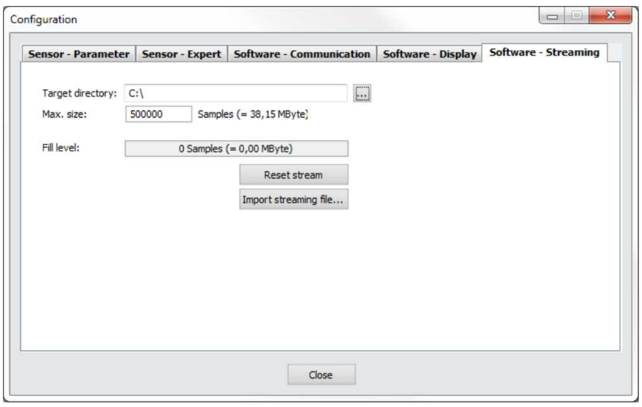


Fig. 15: "Software - Streaming"

5.9 *Oscilloscope*

Furthermore, the software can be used to display the ADC values and parameters of the GC-NIP, for example, graphically. Generally, it is possible to switch between the time-based mode and the XY representation.

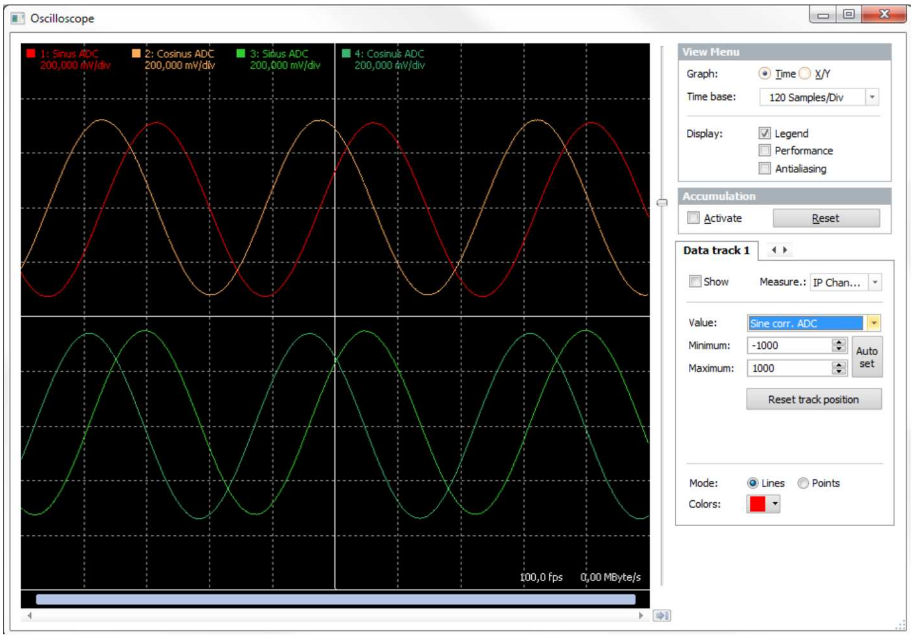


Fig. 16: Time-based oscillogram

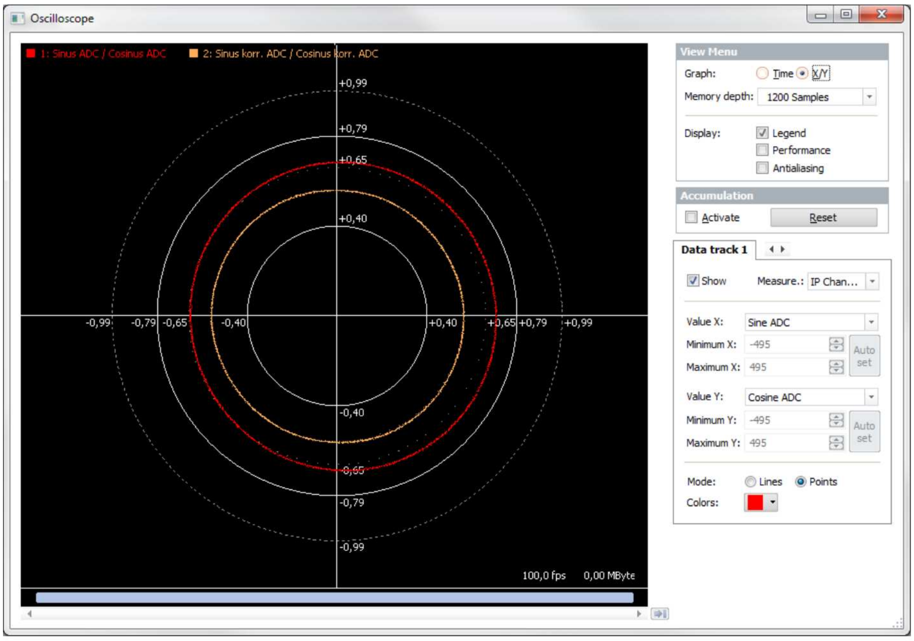


Fig. 17: xy representation

5.9.1 View

The “View” panel can be used to select whether a representation is to be displayed as a function of the time or in the XY system (Lissajous). The time basis or memory extent can be used to configure the number of samples represented. In addition, further display elements can be activated/deactivated by way of switches.

5.9.2 Accumulation

If “Accumulation” is activated, a permanent overlay of several points of each displayed wave form is obtained until the “Activate” switch is canceled and the “Reset” button is actuated.

5.9.3 Data tracks

The oscilloscope view provides up to 16 data tracks which can be assigned freely (channels). The display can be turned on / off separately for each channel, as can the range of values for the display (also by way of a button as an “Auto set” function), the mode of representation and the color. The list boxes “Measurement” and “Value” can be used to specify the data value for the display.

5.10 Calibration process

The calibration process serves to determine the correction coefficients for a measuring system by way of a nonius period such that errors in the determined absolute position can be detected and corrected. Upon completion of the calibration process, the coefficients are stored in the EEPROM of the IC, and the correction is active for the subsequent measurements.

In addition to determination of the correction coefficients, the controller start values can be determined during the calibration process and to adjust the phase shift of the input signals.

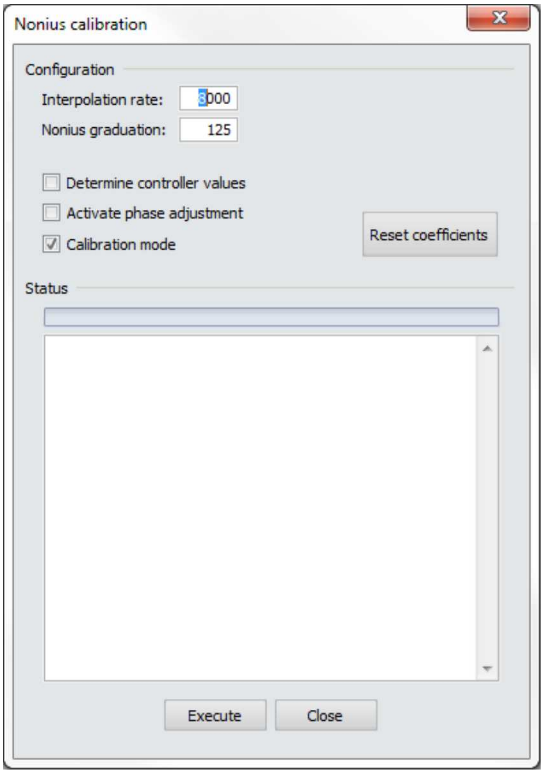


Fig. 18: Calibration process

Table 26: Configuring the calibration process

Value	Description
Interpolation rate	Interpolation rate to be used for calculation. The relevant value is accepted from the configuration window. The configuration is written to the IC when the calibration process is started.
Nonius graduation	Nonius graduation of the measuring system master track; corresponds to the number of sinusoidal periods within a complete nonius period. The master track corresponds to the track with the higher number at sinusoidal periods (mechanically lower pole width) and is to be connected to the input of channel 1.
Determine controller values	Activates the determination of the controller starting values for reduction of the settling time after power-on. After settling of the controllers, a minimum number of samples is recorded and the controller average values determined for at least one nonius period. For calculation, a continuous movement of the measuring system over a complete nonius period is required. The values determined are stored in the EEPROM of the IC.
Activate phase adjustment	Determines the optimum settings for the phase correction of the GC-NIP in both channels. For calculation, a continuous movement of the measuring system over a complete nonius period is required. The phase correction values determined are stored in the EEPROM of the IC at the end of calculation. It is recommended to check the configuration after the phase adjustment by way of a measurement (e.g. in the oscilloscope view, xy representation).
Calibration mode	Activates the determination of the correction coefficient. For calculation, a continuous movement of the measuring system over **one c**omplete nonius period is required. The coefficients determined are written to EEPROM of the IC after calculation, and the correction is activated.

After starting the calibration process by clicking on the “Execute” button, the progress is displayed by way of a progress bar. The text window displays further information regarding the current status, any error states and the quality of the calibration process.

If the calibration process was completed without errors, the determined correction coefficients are stored in the EEPROM and are used in subsequent measurements for error correction.

The “Reset coefficients” button can be used to delete correction values saved in the IC, thus deactivating the correction. To accept the deactivation, the IC must be reset.

ⓘ Note: In case of any modifications to the mechanical design of the measuring system, the dimensions, the electrical input signals or in case of changes in the circuit configuration, the correction coefficients must be redetermined by way of a calibration process.

6 Quick Start

Quick-start initial configuration:

- Power supply of the demo board via USB
- Sensor with 5 V supply voltage
- Sensor with differential output signals
- The starting configuration is read from the EEPROM as the default configuration.
- Further configuration and measured-value acquisition are performed via USB and using the PC program.

Board configuration:

Jumper J1 open → SSI / BISS interface inactive
Jumper J2 closed → USB interface active (LD2 lights)
Jumper J3 open → SPI interface inactive
Jumper J4 open → The gain of the GC-LS for channel 2 is 0.66, as the 5V sensor is connected.
Jumper J5 open → The gain of the GC-LS for channel 1 is 0.66, as the 5V sensor is connected.
Jumper X7 (NRES) open → IC is not in the reset state.
Jumper X8 and X17 (SVCC1 and SVCC2) each on 1 – 2 → sensor supply = 5 V

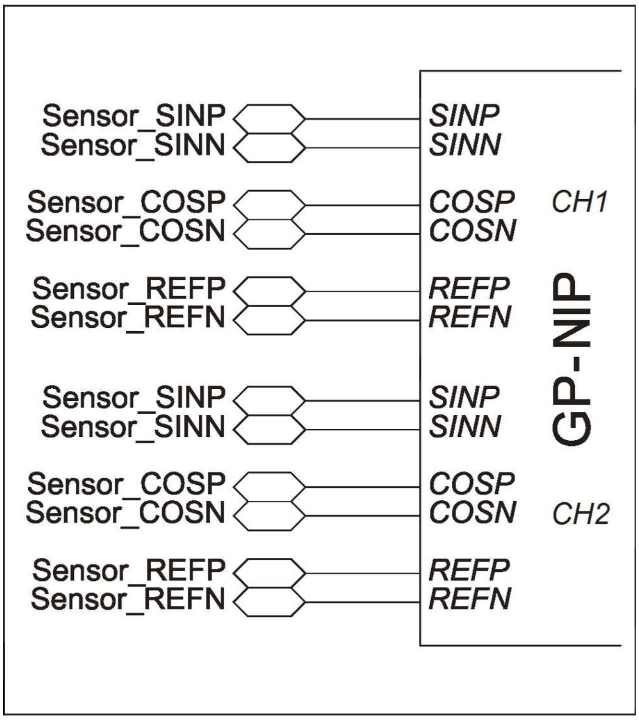


Fig. 19: Differential input signals

7 Start-up

The GP-NIP demo board is prepared such that it is ready for operation after connecting the supply voltage and once the GC-NIP has been initialized with the default settings from the internal EEPROM or by way of the configuration pins. For a detailed description of the configuration from the EEPROM, refer to the Data Sheet.

7.1 Power supply

The test board is powered by connecting a 5V DC voltage to X13 or X15. If the USB interface at X14 is used, the power can also be supplied directly via USB.

7.2 Selecting the interface

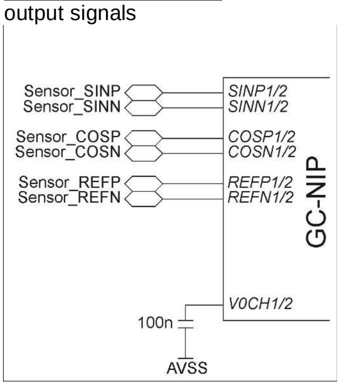
The demo board possesses the following serial interfaces: USB, SPI or BiSS which are selected by way of the jumpers J1, J2 and J3 (see Table 19).

7.3 Signal supply

The sinusoidal, cosine and reference channels are connected directly to the GC-NIP via the 15-pin SUB-D-female socket connectors X16 (Table 14) for channel1 and via X6 (Table 7) for channel 2 or via the push-on terminal strip connectors X12 (Table 12) for channel 1 and X18 (Table 16) for channel 2.

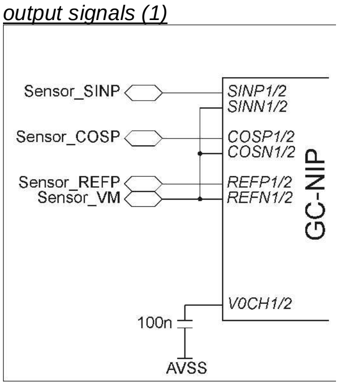
Sensors with a supply voltage of 5V or 3.5V can be connected to the demo board directly. Both single-ended and differential sensor signals can be processed. The illustrations below show examples of connecting different sensor types as examples.

Sensor with differential output signals



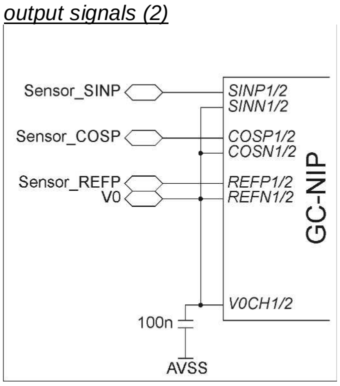
- The amplitude of the sensor and the nominal amplitude of the GC-NIP are matched to each other by way of the configuration bits `GAIN(1:0`.
- The reference level `V0` is formed **internally**.

Sensor with single-ended output signals (1)



- The amplitude of the sensor and the nominal amplitude of the GC-NIP are matched to each other by way of the configuration bits `GAIN(1:0)`.
- The reference level `V0` is provided **by the sensor**.

Sensor with single-ended output signals (2)



- The amplitude of the sensor and the nominal amplitude of the GC-NIP are matched to each other by way of the configuration bits `GAIN(1:0)`.
- The reference level `V0` is formed **internally** and connected to the sensor.

For further notes and application examples, see the GC-NIP Data Sheet.

7.4 *Connecting the sensor*

7.4.1 Supply voltage

Before the sensor is connected to the GP-NIP demo board, the supply voltage for the sensor must be set by way of the jumpers X8 (channel , Table 9) and X17 (channel 2, Table 15). 5V and 3.3V types are differentiated:

Sensor supply voltage	Jumper configuraton	Function
5V DC voltage	Pin 1 – pin 2	5V DC supply voltage to the sensor
3.3V DC voltage	Pin 2 – pin 3	3.3V DC supply voltage to the sensor

Table 27: Connecting the sensor

7.4.2 Configuring the nominal amplitude / setting the gain

To adapt the analog input stage to the amplitude of the input signals, it is imperative to set the gain of the GC-NIP. Normally, 5V systems operate at a higher signal amplitude compared to 3.3V systems. Adaptation of the amplitudes to the input stage of the GC-NIP is provided by way of the level-shifter circuit GC-LS on the demo board. To this end, it is possible to switch the gain of the GC-LS between 1 and 0.66 by way of jumper J5 (channel 1) and jumper J4 (channel 2). The configuration of the GC-LS and setting of the gain for the GC-NIP are shown for different input signals in the table below.

Input voltage, nominal U_{DfNom} (mV_{pp})	Sensor voltage (typical)	GC-LS		Gain settings	
		Gain	Jumper J4	GAIN1	GAIN0
1	5V	0.66	OFF	0	0
660	3.3V	1	ON	0	0
330	5V	0.66	OFF	0	1
250	3.3V	1	ON	0	1
180	5V	0.66	OFF	1	0
120	3.3V	1	ON	1	0
80	5V	0.66	OFF	1	1
60	3.3V	1	ON	1	1

Table 28: Configurations for different input amplitudes

7.5 *Configuring the IC*

Generally, the configuration of the GC-NIP IC can be differentiated by initialization from the internal EEPROM and the default or pin configuration. The source for configuration is selected by way of a validity identifier in the EEPROM. The EEPROM is marked valid if the identifier 0x134A is present at the EEPROM address 0x00. Otherwise, the default settings or the pin configuration are used for initialization when the IC is reset. A detailed description of configuration using the internal EEPROM can be found in the GC-NIP Data Sheet.

The following settings are available for configuration by way of pins:

Setting	Switch
Nominal amplitude	S2
Analog low-pass filter	S3
Nonius counting direction	S4

Table 29: Pin configuration settings

The counting direction when calculating the absolute position can always be specified by way of the `CFGDIR` pin, independently of the validity of the EEPROM.

CFGGAIN1 (switch position)	CFGGAIN0 (switch position)	Function
0 (OFF)	0 (OFF)	Nominal amplitude 660mV$_{pp}$
0 (OFF)	1 (ON)	Nominal amplitude 250mV$_{pp}$
1 (ON)	0 (OFF)	Nominal amplitude 120mV$_{pp}$
1 (ON)	1 (ON)	Nominal amplitude 60mV$_{pp}$

Table 30: Nominal amplitude configuration

CFGAF1 (switch position)	CFGAF0 (switch position)	Function
0 (OFF)	0 (OFF)	Analog low-pass filter 150kHz (-0.5dB)
0 (OFF)	1 (ON)	Analog low-pass filter 75kHz (-1dB)
1 (ON)	0 (OFF)	Analog low-pass filter 10kHz (-1dB)
1 (ON)	1 (ON)	Analog low-pass filter inactive

Table 31: Analog low-pass filter configuration

CFGDIR (switch position)	Function
0 (OFF)	Counting direction forward (as the incremental counter, channel 1)
1 (ON)	Counting direction reverse

Table 32: Nonius counting direction configuration

8 Troubleshooting

Error:

The USB device was not detected. The message “No device detected” is displayed in the status bar of the software.

Solution:

- Check that the demo board is connected correctly. If so, the ON LED (LD5, green) and the interface LED (LD1, LD2 or LD3, yellow) must light.
- Were the device drivers installed correctly? Check that the demo board is specified in the Windows device manager as “GEMAC – TB GC-NIP A” or “GEMAC – TB GC-NIP B” (additional version information may be appended to the string). If not, reinstall the software.
- Is the correct interface selected? When using the USB interface on the demo board or the USB SPI adapter, select the SPI interface in the toolbar of the software. Similarly, when using the USB-BiSS adapter, select the BiSS interface.

Error:

The USB device was detected, but “Unknown” is displayed for the IC type.

Solution:

- Was the correct interface selected on the demo board? Use the jumpers J1, J2 or J3 for selection of the interface.
- Is the device address on the demo board the same as set in the software? When using the demo board, only one IC is operated at the SPI bus in most cases. In this case, the “Multi slave” option in the “Configuration” window, “Software – Communication” area is activated. If several GC-NIP ICs are to be used at one SPI bus, the hardware address must be the same as set in the software. If configuration by way of pins is used (in case of invalid EEPROM), the hardware address "00" is valid, and only one IC can be operated at the SPI bus.
- Is the clock frequency for the interface you are using too high? Select the clock frequency for the SPI or BiSS communication using the list boxes "Clock Divisor:" in the area "Software - Communication" in the configuration window. If the IC was not detected, it is recommended to select a lower clock frequency. For the SPI interface, the timing can be additionally adapted by increasing the "Wait after RD0" value.
- Is the configuration file for the BiSS interface specified? To identify the IC via the BiSS interface, a BiSS xml file is used. The path to this file is selected in the area "Software - Communication" of the configuration window under "Config. file:". For GEMAC ICs, the file "idbiss4743.xml" is used which is stored in the program directory by default when the software is installed.

9 Notes