16.5 NC352

16.5.1 General Information

The NC352 ultrasonic transducer module is used for measuring path and speed.

Features

- 3 channels for ultra sonic transducer using the RS422 interface
- 3 digital inputs that can be operated in different count modes
  - Event counter
  - Gate and frequency measurement
  - A/B counter with internal/external count frequency
- 1 digital output

16.5.2 Order Data

Model Number	Short Description	Image
3NC352.6	2005 ultrasonic transducer module, 3 inputs for ultrasonic transducer, 3 digital inputs, 24 VDC, sink, can be configured as event counter, or gate/frequency measurement, or as incremental encoder input, 1 digital output, 24 VDC, 20 mA. Order TB708 terminal blocks separately.	
0TB708.91	Accessory terminal block, 8-pin, cage clamp, 1.5 mm²	

Table 391: NC352 order data

16.5.3 Technical Data

Product ID	NC352		
General Information			
C-UL-US Listed	In preparation		
B&R ID Code	$9A		
Module Type	B&R 2005 I/O module		
Slot Main Rack Expansion Rack	 Yes Yes		
Static Characteristics			
Number of Path Measurement Inputs/Outputs	3		
Number of Digital Inputs	3		
Number of Digital Outputs	1		
Power Consumption 5 V 24 V Total	 Max. 2.3 W Max. 1.7 W Max. 4 W		
Channels for Path and Speed Measurements			
Supported Encoder Types	Ultrasonic transducer with RS422 interface (start/stop, stop, gate time)		
Encoder Input	9-pin DSUB socket		
Encoder Supply	24 VDC external supply Distribution to the encoder and short circuit protection through NC352, with configurable overvoltage/undervoltage monitoring (±10%, ±15%, ±20%, ±25%)		
Number of Channels	3		
Electrical Isolation Channel - PLC Channel - Channel	 Yes No		
Input and Output Levels	RS422 differential level		
Multi-magnet Measurement	Yes (max. 4 magnets in total – possible combinations):		
	Magnets on Channel 1	Magnets on Channel 2	Magnets on Channel 3
	1	1	1
	1	1	2
	2	2	0
	1	3	0
Outputs Durational Initialization Pulse	 1.6 µs		
Inputs Resolution/Measurement Range for Path Measurement Speed Measurement Precision	 0.01 mm / ±5.2 m 0.1 mm/s / ±3.2 m/s ±25 ppm		

Table 392: NC352 technical data

Product ID	NC352
Digital Output	
Number of Outputs	1
Type	Highside driver (Source)
Switching Voltage Minimum Nominal Maximum	 18 V 24 V 30 V
Output Current	20 mA
Switching Delay	Max. 5 µs
Short Circuit Protection	Yes
Overload Protection	Yes
Status display	LED (yellow)
Digital Input	
Number of Inputs	3
Wiring	Sink
Input Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC
Input Delay at Nominal Voltage	< 12 µs
Switching Threshold Low High	 < 5 V > 15 V
Input Current at Nominal Voltage	Approx. 8.7 mA
Status Display	LED (green)
Counter Modes Mode 1 Mode 2 Mode 3	 32-bit event counter in input 1 (max. 20 KHz at nominal voltage) AB counter 32-bit (A: input 1, B: input 2) max. 10 KHz at nominal voltage Input 1: Gate or period measurement Measurement Frequency: 8 MHz, 31.25 kHz, external counter frequency on input 3: Max. 20 kHz
Operating Characteristics	
Electrical Isolation Input - PLC Input - Output Output - PLC	 Yes No Yes
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 392: NC352 technical data (cont.)

16.5.4 Status LEDs

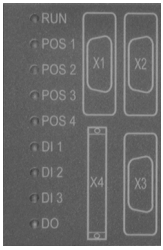
Image	LED	Description
	RUN	**Off** The NC352 has not booted and/or the CPU has not accessed the NC352. **Blinking symmetrically, 1 time per second** NC352 is ready for operation, the configuration files for the transducer have not been spooled on the NC352. **Blinking symmetrically, 8 times per second** Spooled during new Firmware on the NC352. **Always lit** NC352 is ready for operation and configured - Normal operation.
	POS 1 - POS 4	Lit as soon/until it receives a valid measurement signal from the assigned measurement channel.
	DI 1 - DI 3	These LEDs are lit when the status of the assigned digital inputs is logical "1".
	DO	This LED is lit when the status of the digital output is logical "1".

Figure 216: NC352 status LEDs

16.5.5 Operational and Connection Elements

Status LEDs, connections for the encoder and the terminals for the encoder supply and digital inputs/outputs, can all be found behind the module door.

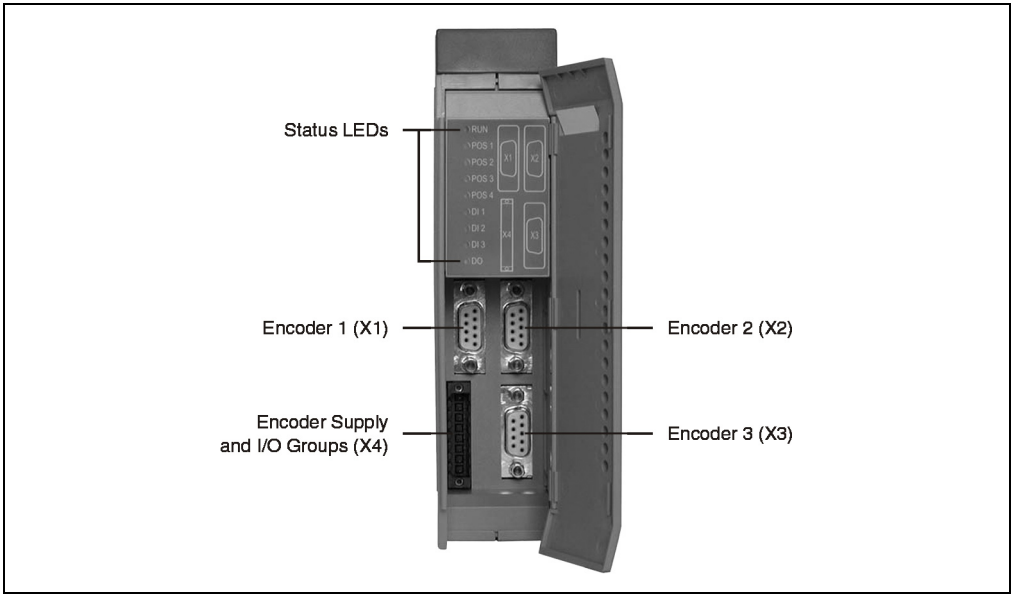
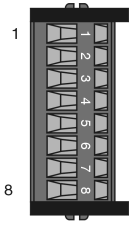


Figure 217: NC352 operational and connection elements

16.5.6 Pin Assignments

Connections for 8-pin Terminal Block (X4)



TB708

Terminal	Description
1	GND encoder supply
2	+24 VDC encoder supply
3	GND reference for digital inputs /outputs
4	Digital output
5	Shield
6	Digital input 3
7	Digital input 2
8	Digital input 1

Table 393: NC352 connections for 8-pin terminal blocks (X4)

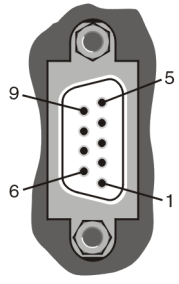
Assignment for the 9-pin DSUB Sockets

Encoder Connections Assignment:

X1..... Transducer rod 1

X2..... Transducer rod 2

X3..... Transducer rod 3



9 pin DSUB Socket

Pin	Description
1	NC
2	Init +
3	Start/Stop +
4	NC
5	GND Supply
6	+24 VDC Supply
7	Init -
8	Start/Stop -
9	NC

Table 394: NC352 pin assignments for the 9-pin DSUB socket

16.5.7 Specifications for the 9-pin DSUB Plug

Subject	Specification
Housing	Metal plated, with 45° cable output
Dimensions	L ≤ 31.5 mm W ≤ 15.4 mm H ≤ 37.0 mm
Manufacturer Information	e.g. TYCO: V42254-A6000-G109 or Fischer electronics: Art. No. DH09KM

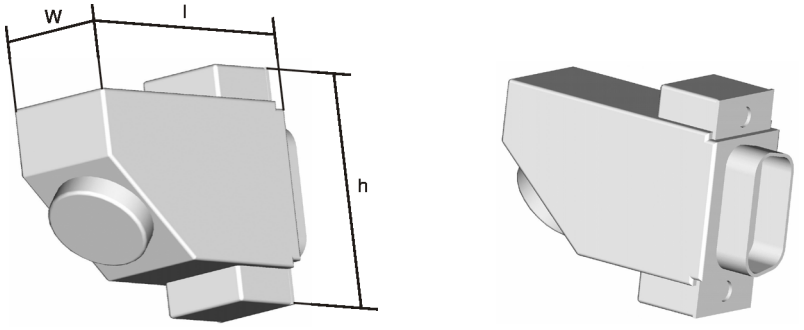


Table 395: NC352 specification for 9-pin DSUB plug

16.5.8 Input/Output Circuit Diagram

Input Circuit Diagram

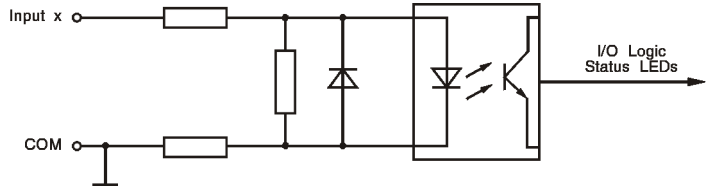


Figure 218: NC352 input circuit diagram

Output Circuit Diagram

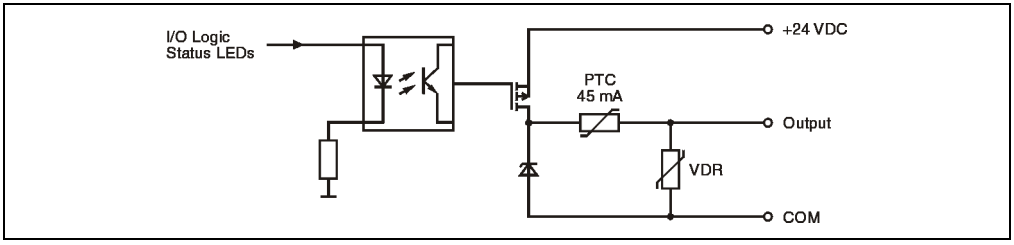


Figure 219: NC352 output circuit diagram

16.5.9 Ultrasonic Transducer Supply

The ultrasonic transducer can be connected using shielded cable and metal plated DSUB plug. The shield is connected to ground in the NC352 module.

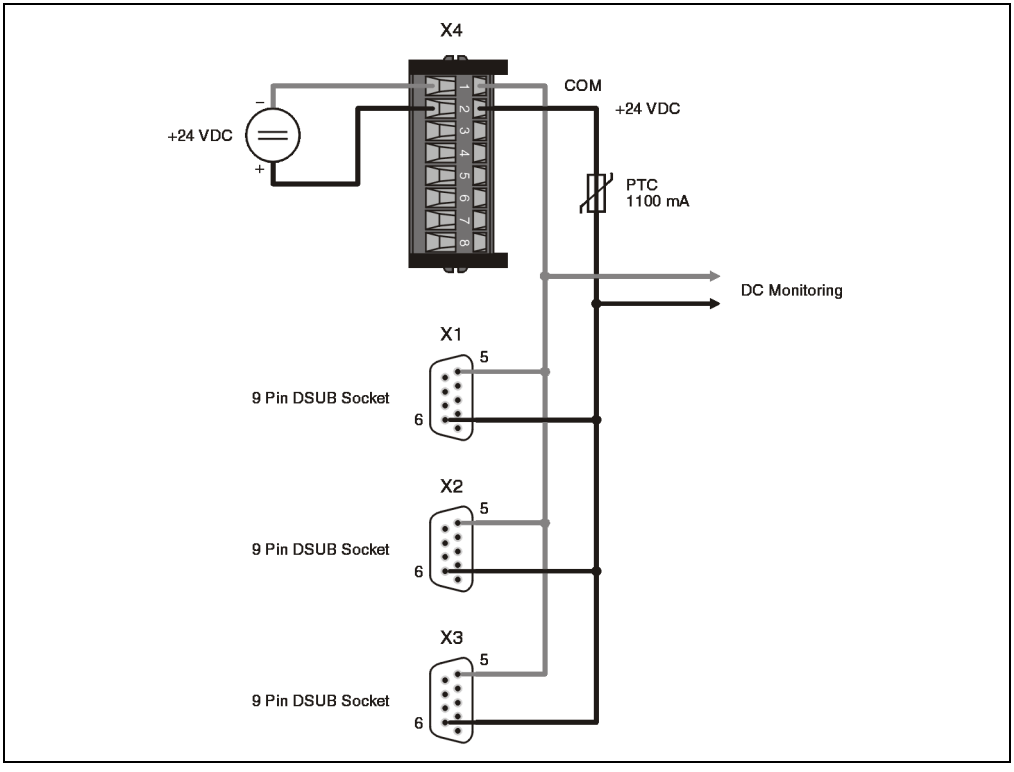


Figure 220: NC352 ultrasonic transducer supply

16.5.10 Digital Input/Output Connection Example

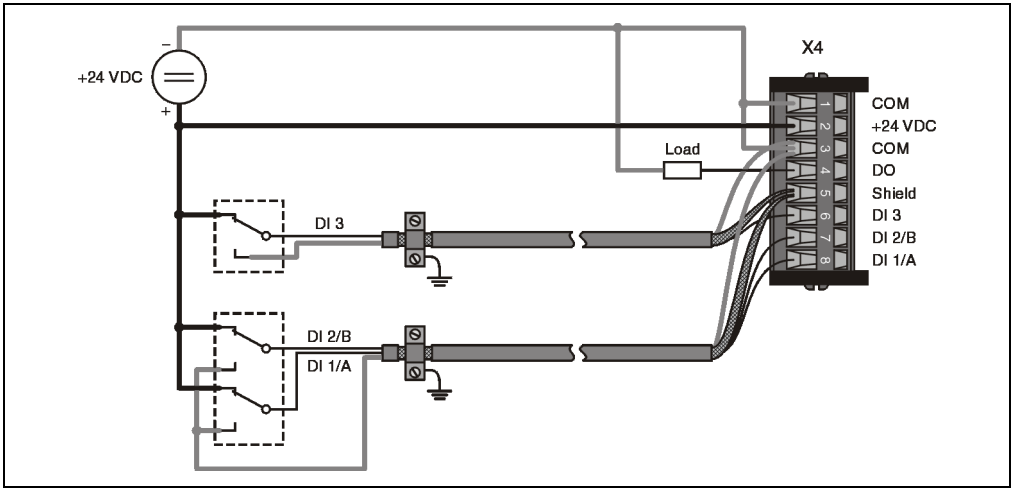


Figure 221: NC352 digital inputs/outputs connection example

16.5.11 Variable Declarations

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Displacement Gauge 1	tc_global	DINT	1	Analog In	1 ... 2
Displacement Gauge 2	tc_global	DINT	1	Analog In	3 ... 4
Displacement Gauge 3	tc_global	DINT	1	Analog In	5 ... 6
Displacement Gauge 4 / Incremental Encoder/ Comparator Value	tc_global	DINT	1	Analog In	7 ... 8
Configuration 1	tc_global	UINT	1	Analog Out	1
Configuration 2	tc_global	UINT	1	Analog Out	2
Path Measurement 1 Mode Register	tc_global	UINT	1	Analog Out	3
Path Measurement 2 Mode Register	tc_global	UINT	1	Analog Out	4
Path Measurement 3 Mode Register	tc_global	UINT	1	Analog Out	5
Reserved	tc_global	UINT	1	Analog Out	6
Comparator Set Value	tc_global	DINT	1	Analog Out	7 ... 8
Reserved for Spooler	tc_global	USINT	1	Status Out	0 ... 7

Table 396: NC352 variable declaration

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Comparator Actual Value	tc_global	USINT	1	Status In	0
Error & Status Register	tc_global	USINT	1	Status In	1 ... 3
Module Code = $B1	tc_global	USINT	1	Status In	4
Module Number = $9A	tc_global	USINT	1	Status In	5
Timer Reference Value	tc_global	USINT	1	Status In	6
Firmware Version / Reserved as a Return Channel for Spooler	tc_global	USINT	1	Status In	7

Table 396: NC352 variable declaration (cont.)

Displacement Gauges 1 - 4

Since only 32-bit reference data is available for data transfer with each measurement magnet, there are limitations where simultaneous path and speed measurements are needed. There are two modes. With the first mode, path data and speed data are retrieved in sequence using direct IO access. This procedure delivers both sets of data with full resolution and full measurement range, but requires additional CPU resources.

In the second mode, data is provided in a UDINT variable. However this limits the resolution and/or the maximum value for the path and speed. The same maximum resolution is always used internally so that no computing errors occur.

The position and speed are encoded in the displacement gauge value. The separation between speed and path can be configured between bit 16 and 19. The counter always internally counts using 20-bits.

Bits 31-16	Bits 19-0
Speed in 0.1 - 1.6 mm/s	Path in 0.01 mm - 0.16 mm

Table 397: NC352 coding of position and speed

Displacement gauge 4 has three functions and can be used for incremental encoder operation to represent the counter status, as well as in comparator operation for storing comparator values.

Configuration 1

The mode for the incremental or event counter is set in this register.

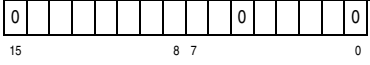
The signal source of the event counter/incremental encoder can be set using bit 3. In contrast to the event counter, incremental encoder operation evaluates all edges of the signal (4-x).

The signal source for period measurement can also be the event counter or the incremental encoder.

In order to recognize a standstill within a sufficient time frame, the counter size for the incremental encoder period measurement is limited to 24-bit (2 s at 8 MHz, 520 s at 31.25 kHz count frequency).

Additionally, 24 V monitoring can be controlled in 5% steps with this configuration register. Likewise, the multiplexer for status register 1, 2 and 7 and displacement gauge register 4 can also be controlled.

Configuration Register 1	Bit	Description
	15	0
	14	0..... Default: Status register 7 is reserved as a return channel for spooler 1..... Status register 7 contains the firmware version [1]
	12 - 13	Analog In Channel 7 - 8 00.... Path measurement 4 01.... Comparator value 10.... Incremental encoder/ event counter 11.... Reserve
	10 - 11	Error counter in status register 1 and 2 00.... Sum of plausibility errors + error measurements 01.... Number of error measurements 10.... Number of plausibility errors 11.... Reserve
	8 - 9	00.... 24 V monitoring ±25% 01.... 24 V monitoring ±20% 10.... 24 V monitoring ±15% 11.... 24 V monitoring ±10%
	6 - 7	00.... Count frequency 8 MHz 01.... Count frequency 31250 Hz 10.... External count frequency (input 3) 11.... Reserve
	5	0
	4	0..... Beginning of measurement at rising edge 1..... Beginning of measurement at falling edge
	3	0..... Signal source: Event counter input A (= input 1) 1..... Signal source: Incremental encoder (A/B)
	1 - 2	Measurement mode for AB counters / event counter 00.... No measurement operation (counter is cleared) [2] 01.... Incremental encoder/ event counter 10.... Period measurement 11.... Gate measurement, see Section "Measurement Mode for Gate Measurement", on page 591
	0	0



1) WARNING: Spooling of configuration data or new firmware is **not** possible when this bit is set.

2) Configuring and reconfiguring the counter (edges, signal source, count frequency) must be made in the "No Measurement Operation", because invalid count edges can occur. The counter is reset to 0 every time the measurement mode is changed and begins immediately then to work in the new mode.

Measurement Mode for Gate Measurement

If the "Gate Measurement" mode has been selected, bit 4 is used as follows:

Bit 4	Gate Time
1	Gate Time = begin measurement at rising edge, stop measurement at falling edge
0	Gate Time = begin measurement at falling edge, stop measurement at rising edge

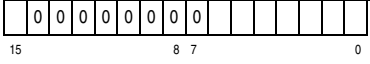
Table 398: NC352 gate measurement mode

Configuration 2

This register controls the following functions:

- Status of the digital outputs
- Comparator settings
- Configuring multi-magnet measurement
- Activation of the raw values mode

Configuration Register 2	Bit	Description
	15	0..... Default 1..... Raw values [1] for the counter are output on analog in register 1 - 8
	7 - 14	0
	5 - 6	00.... No multi-channel measurements 01.... 2 channel measurement transducer rod 3 10.... 3 channel measurement transducer rod 2 (transducer rod 3 is deactivated) 11.... 2 channel measurement transducer rod 1 and 2 (transducer rod 3 is deactivated)
	3 - 4	00.... Comparator affects displacement gauge 1 01.... Comparator affects displacement gauge 2 10.... Comparator affects displacement gauge 3 11.... Comparator affects displacement gauge 4
	2	0..... Comparator is triggered when > comparison value (see analog out 7 - 8) 1..... Comparator is triggered when < comparison value
	1	0..... Comparator function deactivated 1..... Comparator function activated
	0	0..... Digital output off (only where the comparator function has been switched off) 1..... Digital output on (only where the comparator function has been switched off)



1) The raw value corresponds to the time required for the ultrasonic signal to travel from the location of the magnet to the receiver (in units of 3.125 ns).

Warning: When this bit is set, the raw values are output in metric units (and not positions/speeds) even after a configuration module has been spooled.

Description of the Comparator

If the comparator is activated (bit 1 in configuration 2), bit 0 in configuration 2 is ignored, and the actual value of the digital output is then determined by the status of the comparator.

If the comparator has been triggered once, i.e. the selected displacement gauge is above or below the set threshold value (refer to analog output 7 - 8), the digital output is set, bit 3 in status register 3 is set, the actual value of status register 6 is copied to status register 0 and the value of the selected displacement gauge when triggered can now be read from Analog In registers 7 - 8 (refer to also bit 12 - 13 in configuration 1). The comparator cannot be triggered each time by moving back and forth across the threshold value, but instead must be activated again.

This is achieved by resetting and applying a new setting to bit 1 in configuration 2. When resetting, bit 3 in status register 3 is cleared and the digital output is set according to bit 0 in configuration 2. The other entries (see above) are not influenced by this, and are only overwritten when the comparator has been triggered again.

Explanation of Multi-magnet Measurement (assignment of the displacement gauge register to transducer rods/magnets)

The assignment only depends on settings in configuration register 2. Measurement pulses from magnets which may be present but have not been configured are ignored.

If the reverse is the case and more magnets have been configured on a transducer rod than are actually present, the NC352 then delivers an error for the respective displacement gauge register (the error counter in status register 1 and 2 are increased).

Magnets are numbered per rod, increasing in order according to their relative distance to the ultrasonic receiver/evaluation electronics of the transducer rod.

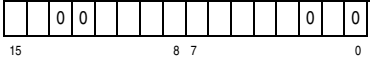
Mode	Displacement Gauge Register	Assigned Transducer Rod/Measurement Magnet
No multichannel measurements	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 2: Magnet 1
	3	Transducer Rod 3: Magnet 1
	4	No magnet assigned
2 channel measurement on transducer rod 3	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 2: Magnet 1
	3	Transducer Rod 3: Magnet 1
	4	Transducer Rod 3: Magnet 2
3 channel measurement on transducer rod 2 (transducer rod 3 is deactivated)	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 2: Magnet 1
	3	Transducer Rod 2: Magnet 2
	4	Transducer Rod 2: Magnet 3
2 channel measurement transducer rod 1 and 2 (transducer rod 3 is deactivated)	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 1: Magnet 2
	3	Transducer Rod 2: Magnet 1
	4	Transducer Rod 2: Magnet 2

Table 399: NC352 numbering of magnets

Path Measurement Mode 1 - 3

This register contains settings, which are specifically for the transducer rod with the corresponding number. They determine the transducer rod type, the method of path measurement and the content of the displacement gauge register.

Mode Registers 1 -3	Bit	Description
	14 - 15	Transducer rod type (measurement from to) 00..... Start/Stop Signal: rising edge - rising edge 01..... Start/Stop Signal: falling edge - falling edge 10..... Start/Stop Signal: rising edge - falling edge (gate time) 11..... Only Stop Signal. Start with trigger of signal (initialization pulses).
	12 - 13	0
	9 - 11	Types of displays for packed mode. Description: See Table 400 "NC352 types of displays for packed mode.", on page 595
	7 - 8	Displacement Gauge Register 00..... Magnet position (path) 01..... Magnet speed 10..... Path and speed in packed form 11..... Reserve
	6	0..... Default (is reset by the module) 1..... Strobe - trigger for measurement start
	3 - 5	Cycle time for path measurement (in cyclic operation) 000.... 131.072 ms 001.... 65.536 ms 010.... 8.192 ms 011.... 4.096 ms 100.... 2.048 ms 101.... 1.024 ms 110.... 512 µs 111.... Reserved
	2	0
	1	0..... Cyclic measurement according to a specified cycle time, see bits 3 - 5 1..... Measurement triggered by strobe signal (2 measurements separated by half cycle time, see bits 3 - 5)
	0	0



Types of displays for packed mode.

Bit	Status	Path Resolution	Speed Resolution	Max. Path	Max. Speed	Speed on Bit	Path on Bit
9 - 11	000	0.01 mm	1.6 mm/s	± 5.24 m	±3.28 m/s	31 - 20	19 - 0
9 - 11	001	0.04 mm	0.4 mm/s	± 5.24 m	±3.28 m/s	31 - 18	17 - 0
9 - 11	010	0.16 mm	0.1 mm/s	± 5.24 m	±3.28 m/s	31 - 16	15 - 0
9 - 11	011	0.01 mm	0.1 mm/s	± 5.24 m	±0.20 m/s	31 - 20	19 - 0
9 - 11	100	0.01 mm	0.1 mm/s	± 2.62 m	±0.41 m/s	31 - 19	18 - 0
9 - 11	101	0.01 mm	0.1 mm/s	± 1.31 m	±0.82 m/s	31 - 18	17 - 0
9 - 11	110	0.01 mm	0.1 mm/s	± 0.65 m	±1.64 m/s	31 - 17	16 - 0
9 - 11	111	0.01 mm	0.1 mm/s	± 0.33 m	±3.28 m/s	31 - 16	15 - 0

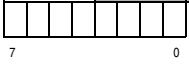
Table 400: NC352 types of displays for packed mode.

Maximum path and speed entries given in the above table are rounded off to two decimal places and calculated from the resolution multiplied by the largest number that can be represented using the defined number of bits.

Status Register 1 - 3

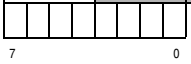
Status Register 1 - Error Counter Encoder 1 and 2 (hex format)

Status Register 1	Bit	Description
	4 - 7	Continuous (rotating) counter for error measurement of encoder 2
	0 - 3	Continuous (rotating) counter for error measurement of encoder 1



Status Register 2 - Error Counter Encoder 3 and 4 (hex format)

Status Register 2	Bit	Description
	4 - 7	Continuous (rotating) counter for error measurement of encoder 4
	0 - 3	Continuous (rotating) counter for error measurement of encoder 3



Status Register 3

Status Register 3	Bit	Description
	7	0 ..... Configuration data present 1 ..... Configuration data not present
	5 - 6	00 .... Default / OK 01 .... 24 V - under voltage 10 .... 24 V - over voltage 11 .... Reserved
	4	0 ..... Digital output: ok 1 ..... Digital output: Error (value which is read back does not match)
	3	0 ..... Selected displacement gauge has not exceeded the comparator threshold in either direction 1 ..... Selected displacement gauge has exceeded the comparator threshold in either direction
	2	0/1 ... Status digital input 3
	1	0/1 ... Status digital input 2
	0	0/1 ... Status digital input 1

7 0

Status Register 7

Depending on the configuration (see Section "Configuration 1", on page 589) this register is used either as a return channel when spooling or contains the firmware version in BCD format. Since the content of the first instance is of no interest to the user, the following table describes only the format for the firmware version.

Status Register 7	Bit	Description
	4 - 7	High nibble for firmware version (BCD)
	0 - 3	Low nibble for firmware version (BCD)

7 0

Configuration Module

An additional data module is required for the I/O registers when configuring the NC352. The module name can be selected. The full path measurement function (display of path and speed in metric units, plausibility test) is only available after a data module has been created (format see Table 401 "NC352 content of the configuration files", on page 597) and spooled on the NC352. This module can be either spooled in INIT SP or anytime during operation (FBK: SPDownModule). Settings for the last data module spooled are effective as soon as they have been completely transferred to the NC352.

When no configuration module has been spooled on the NC352, this is signaled by bit 7 of status register 3 and by the RUN LED blinking (after the configuration has been made the RUN LED is permanently lit).

The content of the configuration files is broken down in the following table:

Name	Length/Bit	Sign Change	Meaning	
Enable	16	No	Bit 0	0..... Deactivating measurements on transducer rod 1 1..... Activating measurements on transducer rod 1
			Bit 1	0..... Deactivating measurements on transducer rod 2 1..... Activating measurements on transducer rod 2
			Bit 2	0..... Deactivating measurements on transducer rod 3 1..... Activating measurements on transducer rod 3
			Bits 3-7	0
			Bit 8	0..... Default - Filter for transducer rod 1 is activated using a filter constant = 200 ns 1..... Filter for transducer rod 1 is deactivated
			Bit 9	0..... Default - Filter for transducer rod 2 is activated using a filter constant = 200 ns 1..... Filter for transducer rod 2 is deactivated
			Bit 10	0..... Default - Filter for transducer rod 3 is activated using a filter constant = 200 ns 1..... Filter for transducer rod 3 is deactivated
			Bits 11-15	0
Transducer Rod 1				
OFFSET	32	No	Common null position for all measurement magnets (raw value)	
CORR_FAC	32	No	Correction value for calibrating the path measurement (= v_us/100 * 2^19) [1)]	
PATH_MIN	32	Yes	Minimum valid path (in 0.01 mm/s)	
PATH_MAX	32	Yes	Maximum valid path (in 0.01 mm/s)	
V_MAX	32	No	Maximum valid path difference (absolute value) of two consecutive measurements (in 0.1 mm/s)	
RESERVE	16			
RESERVE	16			
RESERVE	16			
Transducer Rod 2				
OFFSET	32	No	Common null position for all measurement magnets (raw value)	
CORR_FAC	32	No	Correction value for calibrating the path measurement (= v_us/100 * 2^19) [1)]	
PATH_MIN	32	Yes	Minimum valid path (in 0.01 mm/s)	
PATH_MAX	32	Yes	Maximum valid path (in 0.01 mm/s)	
V_MAX	32	No	Maximum valid path difference (absolute value) of two consecutive measurements (in 0.1 mm/s)	
RESERVE	16			
RESERVE	16			
RESERVE	16			

Table 401: NC352 content of the configuration files

Name	Length/Bit	Sign Change	Meaning
Transducer Rod 3			
OFFSET	32	No	Common null position for all measurement magnets (raw value)
CORR_FAC	32	No	Correction value for calibrating the path measurement (= v_us/100 * 2^19) 1)
PATH_MIN	32	Yes	Minimum valid path (in 0.01 mm/s)
PATH_MAX	32	Yes	Maximum valid path (in 0.01 mm/s)
V_MAX	32	No	Maximum valid path difference (absolute value) of two consecutive measurements (in 0.1 mm/s)
RESERVE	16		
RESERVE	16		
RESERVE	16		

Table 401: NC352 content of the configuration files (cont.)

1) v_us: Ultrasonic speed according to the type plate of the transducer rod.

The correct order and length for entries must be taken into account. RESERVE words must be present. See also the following example:

```
;Enable(UINT)
$0007,

;Offset,  Corr_fac,  Path_min, Path_max, V_max,  reserve1,  reserve2,  reserve3
005000,   15040302,  0000000,  0100000,  001000, 0000,      0000,      0000,    ;
Channel 1
000000,   15040302,  0000000,  0100000,  000256, 0000,      0000,      0000,    ;
Channel 2
010000,   15040302, -0000010,  0013000,  005000, 0000,      0000,      0000     ;
Channel 3
```

The first time the configuration module is created, raw values for magnet positions can already be read before successful spooling of the configuration module, in which in configuration register 2-bit 15 is set.

An encoder magnet can now be moved on the desired zero mark. The path raw value measured is entered as an OFFSET parameter together with other parameters in the configuration files, before it can be spooled (again) on the NC352. The application does not need to be restarted because the process can be carried out at anytime in the cyclic part of the application!

If the offset is known, the OFFSET parameter can be calculated as follows:

OFFSET parameter = Offset (in 1/100 mm) * 3200/v_us

v_us ... Ultrasonic speed in the transducer rod in m/s (see type plate)

Guidelines for Configuring the NC352

Setting the period duration (bit 3 - 5 in path measurement mode register)	
Adjusting the Length of the Transducer Rod	Path measurement is not allowed to be started before the last measurement is completed. It is also recommended by most transducer rod manufacturers to wait until the specified recovery time of the bar has passed, which is double the time required for the ultrasonic signal to travel the length of the transducer rod. Therefore, the current path between the encoder position and the measurement receiver is not decisive, but rather the entire transducer rod length - the maximum possible ultrasonic signal travel time. Please note that when the NC352 is in strobe mode (CPU triggers measurement) , two measurements in the half distance of the set period duration are independently made. That means that the permitted rod length with the given period duration is halved compared to the periodic measurement operation.
Adjusting the Cycle Time for the CPU	To guarantee a correct evaluation of the error counter, the counter value can be increased to a maximum of 15 (4-bit counter) during a CPU cycle (t_{cycl}). That means a maximum of 15 path measurements can take place from the last reading of the error counter. Recommended measurement period (t_{per}): **$t_{cycl}/8 < t_{per} < t_{cycl}$**
Example for Cyclic Measurement Accepted ultrasonic speed v_us = 2800 m/s	**1. Transducer Rod Length = 0.15 m / t_{cycl} = 1 ms** Recovery time of the transducer rod:0.15/2800 * 2 = 0.107 ms This results in: Physically permitted t_{per} = 512 µs This period duration is also compliant with the CPU cycle time -> ok **2. Transducer Rod Length = 0.15 m / t_{cycl} = 10 ms** Recovery time of the transducer rod:0.15/2800 * 2 = 0.107 ms This results in: Physically permitted $t_{per} \geq$ 512 µs That means: In practice 8.192 ms $\geq t_{per} \geq$ 1.024 ms must be selected because otherwise more than 15 measurement errors could occur per CPU cycle which in turn could cause the error counter to overflow. **3. Transducer Rod Length = 3 m / t_{cycl} = 10 ms** Recovery time of the transducer rod:3/2800 * 2 = 2.14 ms This results in : Physically permitted t_{per} = 4.096 ms or t_{per} = 8.192 ms That means: 1 to 3 path measurements can be made per CPU cycle -> OK **4. Transducer Rod Length = 1 m / t_{cycl} = 1 ms** Recovery time of the transducer rod:1/2800 * 2 = 0.714 ms Only 512 µs as t_{per} makes sense due to the cycle time of 1 ms. This lies below the recovery time of the transducer rod. Only a maximum path of 0.73 m can be measured without reducing precision.
Speed Measurement	
If the NC352 is operated in periodic measurement mode, it uses path measurement results for the last 131 ms when determining the current speed. A time span of 100 ms is needed so that a change of the path measurement results in a digit (corresponding to 0.01 mm) with the minimum measurable speed of 0.1 mm/s. With shorter measurement intervals, losses in resolution properties for speed measurement must be taken into account. Very small speeds cannot be measured at all. Also note that measurement precision/resolution at the beginning of measurement or at reconfiguring the cycle time (bit 3 - 5 from measurement path mode register) increases in intervals and only after 131 ms has full precision been achieved. If the NC352 is operated in strobe mode (measuring triggered by CPU), the module makes two path measurements in half of the defined period duration. Only both these path measurements can be used to calculate the speed. Attainable resolution for speed in strobe mode = 0.1 mm/s * 200/period duration (in ms). **The periodic measuring operation which has been set as the default is recommended for measuring speed.**	

Table 402: Guidelines for configuring the NC352

24 VDC Supply	
Current Limitation	The 24 V supply is fed through to the transducer rods and is safeguarded with a protective element (minimum holding current :1.1 A at 20° C). For less than one second, 3 A can also be removed (starting currents for the transducer rods).
Tolerance Threshold	Selecting the tolerance threshold (±10% to ±25%) should be set up according to the information in the data sheet of the transducer rod's manufacturer. NC352 hardware tolerates 24 V ±25%.
Packed Mode	
The measurement range set must be adjusted to the physical requirements (length of the transducer rod or other limitations).	
Threshold Value	
Both the lower and upper threshold values for the plausibility test of the paths and comparator threshold values are DINT values (signed). The threshold value for the plausibility test of speed is however an unsigned UDINT value. Only the 24 lowest value bits of the NC352 are evaluated which applies to all threshold values.	
Error Counters are Read Cyclically	
Please note that the rate of measurement on the NC352 is set so that the error counter cannot overflow within one CPU cycle and therefore become ambiguous. It is up to the user to decide what particular actions should be taken to deal with sporadic errors.	
Filtering on the Start/Stop Interface	
The start/stop inputs for the NC352 are protected against disturbances with an additional digital filter. As a result disturbance pulses <200 ns are suppressed. This setting guarantees that the start/stop pulses for the most common measurement rods can take place unhindered because the duration is in the range >1 µs and therefore large enough to suppress the majority of disturbances. Using the configuration module, the user has the option to switch off this filtering for each individual rod (see "Enable" in Table 401 "NC352 content of the configuration files", on page 597). This option can be helpful when analyzing disturbances, but it is not recommended during normal operation.	

Table 402: Guidelines for configuring the NC352 (cont.)

Firmware Update

If necessary, firmware for the NC352 can be updated via the CPU. This takes place using a BR data module containing the new firmware, which must be spooled from the CPU on the NC352.

The download process on the NC352 is represented by the RUN LED blinking quickly. After completion of the process, the LED changes to slow blinking or is continually lit. The new firmware is booted the first time during the next start-up. The firmware version number can be checked by reading status register 7 (see also bit 14 of configuration register 1).