

16.4 ULTRASONIC TRANSDUCER MODULE - NC303

16.4.1 General Information

The NC303 ultrasonic transducer module consists of an intelligent I/O processor for an ultrasonic transducer with additional digital and analog inputs/outputs.

The ultrasonic transducer module is a programmable I/O module with four channels for distance measurement, one channel for RPM measurement (rotation speed measured with pulse counting and gate time measurement) as well as four analog inputs, five analog outputs, four digital inputs and five digital outputs.. When the software is installed, the processor for the ultrasonic transducer module independently executes distance measurement with plausibility checks and RPM measurement. The data of the ultrasonic transducer module is put into the DPR (Dual Ported RAM) and can be read cyclically from the PCC CPU.

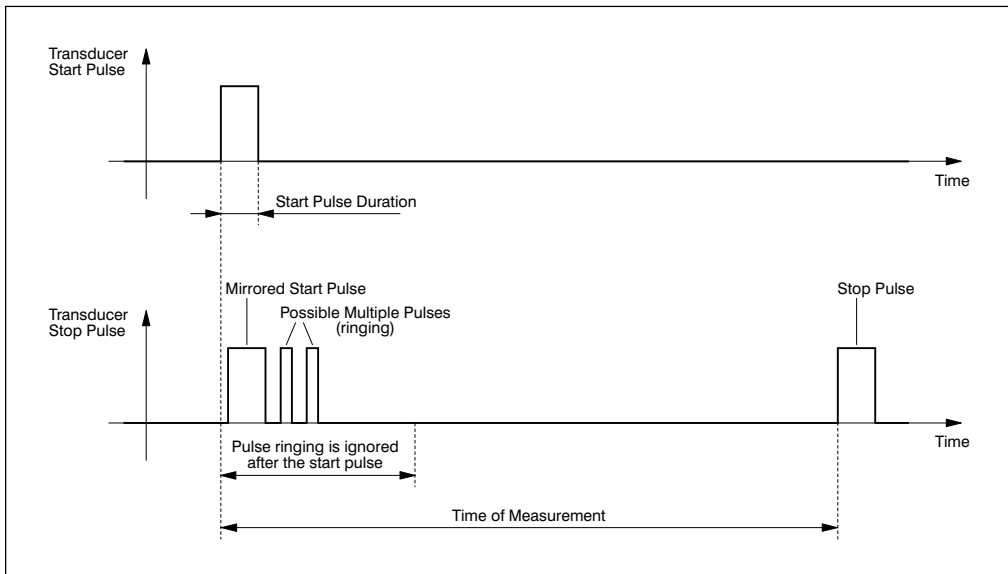
Distance and RPM measurement can be programmed by the user with function blocks. The respective software (with documentation) can be obtained through your local B&R representative.

Distance Measurement

An ultrasonic transducer with a Start/Stop interface is used for distance measurement..

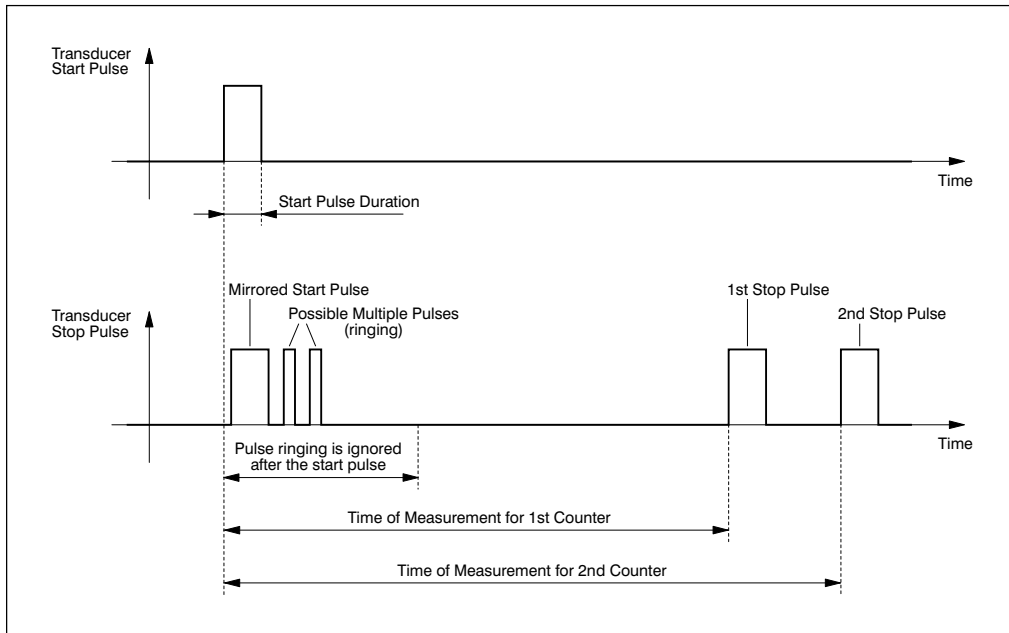
The ultrasonic transducer generates a high current pulse (start pulse), causing a ring formed magnetic field, which runs down the length of a torsion bar (measurement rod). This magnetic field collides with the field of a moving ring magnet and generates a magnetic contraction in a magnetostrictive rod. This contraction is sent out as an ultrasonic pulse. The ultrasonic pulse given to the transducer is received by an ultrasonic receiver and converted to an electrical pulse (stop pulse). The time between the positive edge of the start pulse and the positive edge of the stop pulse is directly proportional to the path distance. This time is measured in the module and evaluated.

Single Magnet Measurement



All pulses which are received within approximately 18 μsec after the start of the measurement are not evaluated so that multiple pulses (ringing) that occurs with some transducers do not affect measurements (pulse ringing after start pulse is ignored).

Double Magnet Measurement (only possible through channel 1)



RPM Measurement

For determining the RPM, encoder pulses are counted and the gate duration (time between the positive and the negative edges of a pulse) is measured.

16.4.2 Technical Data



Module ID	NC303	
Model Number	2NC303.60-1	
Description	2010 Ultrasonic Transducer Module, 1 pulse encoder input, 700 Hz, 24 VDC, 4 inputs for ultrasonic transducer, 56 MHz, 4 digital inputs 24 VDC, 10 msec, Sink, 4 transistor outputs 24 VDC, 1 A, 4 analog inputs 0 to 10 V, 12 Bit, 5 analog outputs +/- 10 V, 12 Bit, Order terminal blocks separately!	
C-UL-US Listed	Yes	
B&D ID Code	\$17	
Module Type	B&R 2010 I/O module	
Base Plate Module	BP200, BP201, BP210	
Communication	RISC processor	
Instruction Cycle Time	0.8 µsec	
Dual Ported RAM (DPR)	384 Byte SRAM (not buffered)	
System RAM	256 KByte SRAM (not buffered)	
Encoder Supply	Ultrasonic Transducer (with differential signals)	Pulse encoder
Encoder Supply Voltage	Internal	External
Load	24 V ±10 % Max. 160 mA	
Pulse Encoder Input	RPM measurement (pulse counter and gate measurement)	
Electrical Isolation	Yes (optocoupler)	
Input Voltage		
Nominal	24 VDC	
Maximum	30 VDC	
Input Resistance	4.5 kΩ	

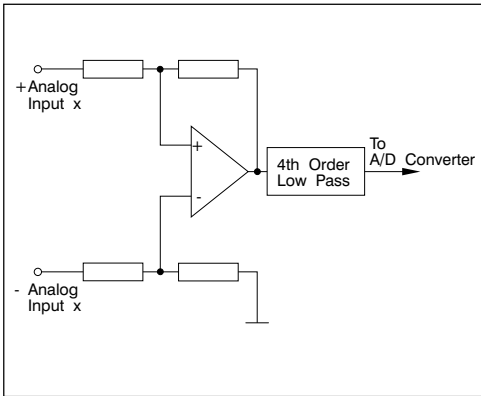
Module ID	NC303
Pulse Encoder Input	
Switching Threshold LOW Range Switching Range HIGH Range	<5 V 5 to 15 V >15 V
Pulse Frequency	Max. 700 Hz
Resolution for Gate Measurement	7.69 µsec
Channels for Path Measurement	
Encoder Type	Ultrasonic transducer with start/stop interface (differential signals)
Number of Channels	4
Electrical Isolation Channel - PCC Channel - Channel	Yes (optocoupler) No
Input Resistance	500Ω
Dual Magnet Measurement	Only for channel 1
I/O Signals	Differential level
Internal Counter Frequency	56 MHz (positive edge)
Counter Size	21 Bit
Start Pulse Duration	Approx. 1 µsec
Pulse Ignored after Start Pulse	Approx. 18 µsec
Resolution for Path Measurement	0.05 mm (ultrasonic speed = 2800 m/sec)
Analog Inputs	
Number of Analog Inputs	4 voltage inputs (unipolar)
Electrical Isolation Input - PCC Input - Input	Yes (optocoupler) No
Input Signal Nominal Min./Max.	0 to +10 V -20 V to +20 V
Resolution	12 Bit
Conversion Time for all Inputs	≥1 msec
Differential Input Resistance	>900 kΩ
Input Filter	Low pass 4th order / cutoff frequency: 500 Hz
Measurement Precision Basic Precision at 20 °C Precision (0 to 60 °C) Common Mode Rejection	±0.25 % ±0.5 % 40 dB / 50 Hz
Analog Outputs	
Number of Analog Outputs	5 voltage outputs (bipolar)
Electrical Isolation Output - PCC Output - Output	Yes (optocoupler) No
Output Signal	-10 V to +10 V
Resolution	12 Bit
Conversion Time for all Outputs	≥1 msec
Output Filter	Low pass 2nd order / cutoff frequency: 1 kHz
Max. Load per Output	10 mA (load ≥ 1kΩ)
Short Circuit Protection (current limit)	±15 mA

Module ID	NC303
Analog Outputs	
Measurement Precision Basic Precision at 20 °C Precision (0 to 60 °C)	$\pm 0.25\%$ $\pm 0.5\%$
Digital Inputs	
Number of Digital Inputs	4
Connection	Sink connection required (COM connections are to be connected to GND)
Electrical Isolation Input - PCC Input-Input	Yes (optocoupler) No
Input Voltage Nominal Maximum	24 VDC 30 VDC
Input Resistance	1.5 kW
Switching Threshold LOW Range Switching Range HIGH Range	<5 V 5 to 11 V >11 V
Switching Delay log. 0 - log. 1 log. 1 - log. 0	10 msec 10 msec
Input Current at Nominal Voltage	Approx. 5.7 mA
Maximum Peak Voltage	500 V for 50 μ sec max. every 100 msec
Digital Outputs	
Number of Digital Outputs	4
Type	Transistor (Sink connection required)
Electrical Isolation Output - PCC Output-Output	Yes (optocoupler) No
Supply Voltage (external) Nominal Maximum	24 VDC 30 VDC
Continuous Current per Output	Max. 1A
Switching Delay log. 0 - log. 1 (resistive load) log. 1 - log. 0 (resistive load)	Depends on load and current $\leq 100 \mu$ sec $\leq 100 \mu$ sec
Switching Frequency (resistive load)	Max. 500 Hz
Overload and Short Circuit Protection ¹⁾	Polymer PTC protection device (Polyswitch) ²⁾
Residual Voltage of Transistors	Max. 0.5 V (at 1A)
Power Consumption	21 W + 1.5 x encoder power
Dimensions (H, W, D) [mm]	285, 80, 185

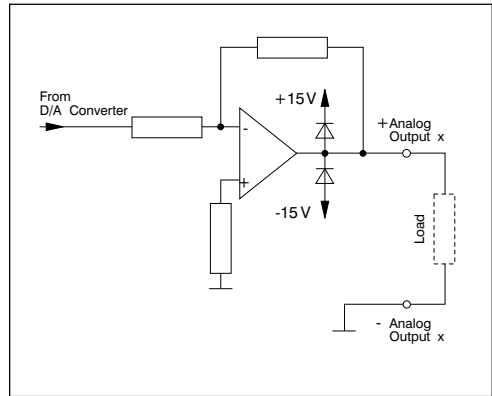
¹⁾ Every digital output uses a Polymer PTC protection device for overload and short circuit protection. If an overload or a short circuit occurs, the PTC is set to high resistance and breaks the current loop. To reactivate the output, the external supply must be switched off and the error (overload or short circuit) must be corrected. After a reset time of > 10 seconds, the protection device is set back to normal.

²⁾ Polyswitch™ is a registered trademark of RAYCHEM.

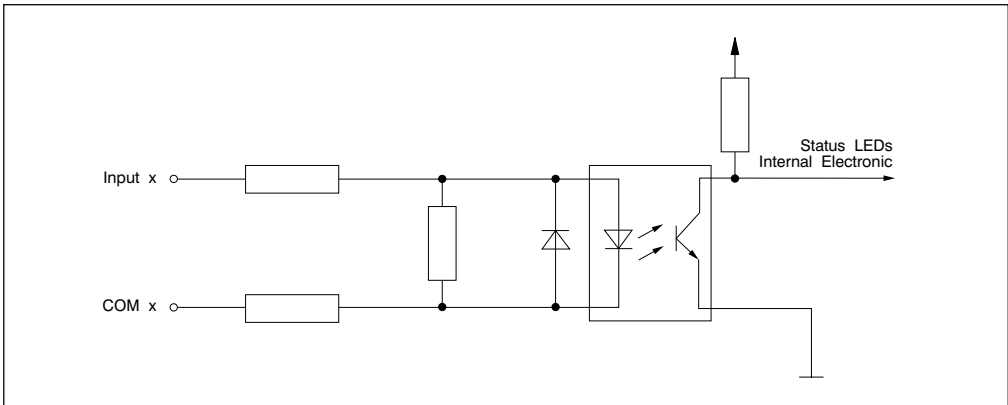
16.4.3 Analog Input Circuit



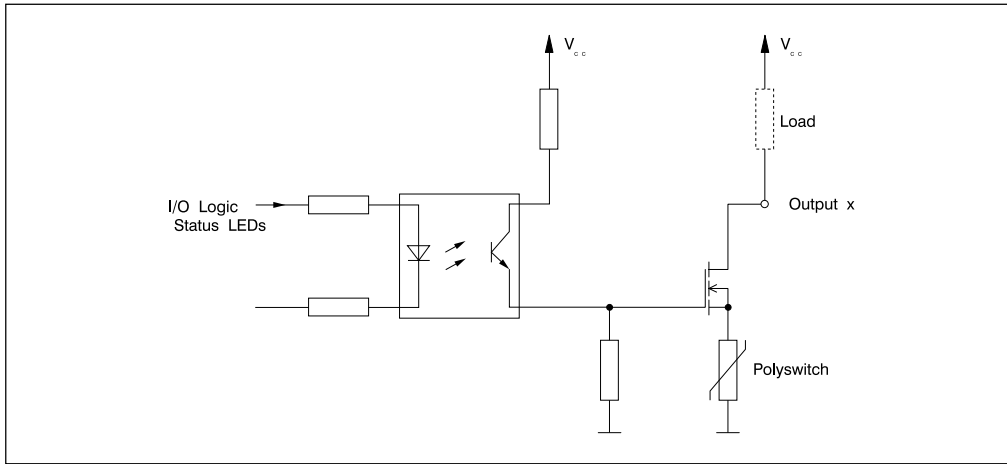
16.4.4 Analog Output Circuit



16.4.5 Digital Input Circuit



16.4.6 Digital Output Circuit



16.4.7 Status LEDs

Status LEDs on the left module half:

	Indicates the status of the terminal block, i.e. if this LED is lit either the terminal block is not connected or is not properly connected.
RUN	The LED "RUN" lights, if the application software is running.
ERROR	Error or undefined state.
PGM	This LED lights if programs are exchanged between the PCC CPU and intelligent I/O processors.
LDT1	This LED lights, if an ultrasonic transducer is connected to channel 1 and signals are delivered.
LDT2	This LED lights, if an ultrasonic transducer is connected to channel 2 and signals are delivered.
LDT3	This LED lights, if an ultrasonic transducer is connected to channel 3 and signals are delivered.
LDT4	This LED lights, if an ultrasonic transducer is connected to channel 4 and signals are delivered.
PULSE	This LED indicates the logical state of the pulse input. The LED lights if the pulse input is log. 1.



Status LEDs on the right module half:

- Indicates the status of the terminal block, i.e. if this LED is lit either the terminal block is not connected or is not properly connected.
- RUN** This LED indicates that the Digital/Analog and Analog/Digital converters are operating.
- DI1 ... DI4** These LEDs indicate the logical status of the assigned digital inputs. The LEDs light is the inputs are log. 1.
- DO1 ... DO4** These LEDs indicate the logical status of the assigned digital outputs. The LEDs light is the outputs are log. 1.

16.4.8 Terminal Assignments for the NC303 Module

Terminal Block Connections behind the left module door:

Pins		Termination	Pins		Termination
1		Reserved ¹⁾	21		Reserved ¹⁾
2		Shield	22		Reserved
3		Pulse input +	23		Pulse input -
4		Shield	24		----
5		+24 V	25		GND
6		Start pulse Channel1 +	26		Start pulse Channel1 -
7		Stop pulse Channel1 +	27		Stop pulse Channel1 -
8		Shield	28		Reserved
9		+24 V	29		GND
10		Start pulse Channel2 +	30		Start pulse Channel2 -
11		Stop pulse Channel2 +	31		Stop pulse Channel2 -
12		Shield	32		Reserved
13		+24 V	33		GND
14		Start pulse Channel3 +	34		Start pulse Channel3 -
15		Stop pulse Channel3 +	35		Stop pulse Channel3 -
16		Shield	36		Reserved
17		+24 V	37		GND
18		Start pulse Channel4 +	38		Start pulse Channel4 -
19		Stop pulse Channel4 +	39		Stop pulse Channel4 -
20		Shield	40		Reserved

¹⁾ Pins 1 and 21 are to be linked with a bridge by the user.



“Reserved” refers to connections (excluding pins 1 and 21) which may not be wired! For modules with a rev. < 05.00, pin 20 on the left terminal block is to be connected with pin 33 of the right terminal block.

Encoder Cable Shielding

For the connection of the pulse encoder, shielded cable is to be used. The shielding is to be connected to a shield connection on the terminal block. The maximum permitted length of the cable for a pulse encoder is 100 meters.

For the cable to an ultrasonic transducer, shielded cable is also to be used. The shield must be connected to the shield connector on the terminal block. The maximum permitted length of cables for ultrasonic transducers with differential signals is 100 meters.

The six shield connections are to be connected directly to ground (\perp , i.e.: contact spring and mounting rail).

Terminal Block Connections behind the right module door:

TB140

Pins	Termination	Pins	Termination
1	+ Analog input 1	21	+ Analog input 2
2	- Analog input 1	22	- Analog input 2
3	+ Analog input 3	23	+ Analog input 4
4	- Analog input 3	24	- Analog input 4
5	Shield	25	Shield
6	+ Analog output 1	26	+ Analog output 2
7	- Analog output 1	27	- Analog output 2
8	+ Analog output 3	28	+ Analog output 4
9	- Analog output 3	29	- Analog output 4
10	Shield	30	Shield
11	+ Analog output 5	31	Reserved
12	- Analog output 5	32	Reserved
13	Shield	33	Shield
14	Reserved	34	Reserved
15	Digital input 1	35	Digital input 2
16	Digital input 3	36	Digital input 4
17	COM (Digital input 1-4)	37	COM (Digital input 1-4)
18	+24 V (Digital output 1-4)	38	GND (Digital output 1-4)
19	Digital output 1	39	Digital output 2
20	Digital output 3	40	Digital output 4



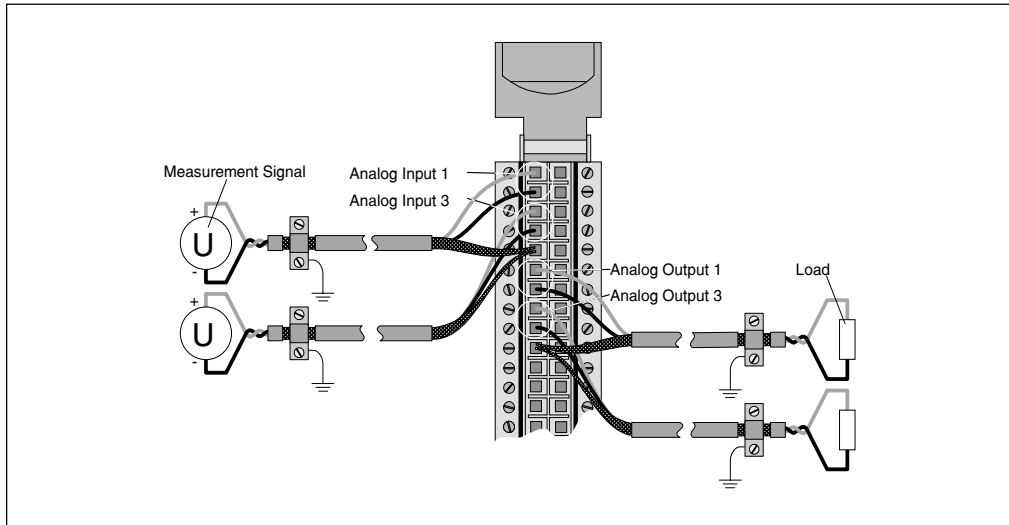
“Reserved” refers to connections which may not be wired!

For modules with a rev. < 05.00 , pin 20 on the left terminal block is to be connected with pin 33 of the right terminal block.

16.4.9 Analog Inputs and Outputs

Signal Cable Connection

Shielded cables are to be used for any analog input and output connections. The shielding is done for 2 analog inputs or 2 analog outputs at a time to the shield connection provided.



The six shield connections are to be connected directly to ground (\perp , i.e.: contact spring and mounting rail).

Numerical Value ↔ Input/Output Voltage Relationship

Input Voltage	Numerical Value		Output Voltage
	Hexadecimal	Decimal	
----	8000	-32768	-10 V
----	C000	-16384	-5 V
----	FFF0	-16	-4.88 mV
≤0 V	0000	0	0 V
2.44 mV	0008	8	0 V
4.88 mV	0010	16	4.88 mV
5 V	4000	16384	5 V
9.99756 V	7FF0	32752	10 V
10 V	7FF8	32760	10 V

The step lengths of the analog inputs and outputs are varied, since the 12 bit resolution is spread over 10 V for the inputs and over 20 V for the outputs (± 10 V).

16.4.10 Variable Declaration

The variable declaration for intelligent I/O processors is described in chapter “PG2000 Programming System” of the “B&R 2000 Software User’s Manual”.