

Operating Manual

Pressure Transmitter
with RS485 Modbus RTU Interface / i²C Interface

DCT 131, DCT 161, DCT 132, DCT 162,
DCT 531, DCT 561, DCT 532, DCT 562,
DCT 531i, DCT 532i



DCT 532

**READ THOROUGHLY BEFORE USING THE DEVICE
KEEP FOR FUTURE REFERENCE**

ID: BA_DCT_i2C-RS485_E| Version: 07.2018.0

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1. General and Safety-Related Information on this Operating Manual

This operating manual enables safe and proper handling of the product, and forms part of the device. It should be kept in close proximity to the place of use, accessible for staff members at any time.

All persons entrusted with the mounting, installation, putting into service, operation, maintenance, removal from service, and disposal of the device must have read and understood the operating manual and in particular the safety-related information.

Complementary to this operating manual the current data sheet has to be adhered to.

Download this by accessing www.bdsensors.com or request it by e-mail or phone: info@bdsensors.de
phone: +49 (0) 92 35 98 11 0

In addition, the applicable accident prevention regulations, safety requirements, and country-specific installation standards as well as the accepted engineering standards must be observed.

1.1 Symbols Used

	- Type and source of danger - Measures to avoid the danger
Warning word	
	- Imminent danger! - Non-compliance will result in death or serious injury.
DANGER	
	- Possible danger! - Non-compliance may result in death or serious injury.
WARNING	
	- Hazardous situation! - Non-compliance may result in minor or moderate injury.
CAUTION	

NOTE - draws attention to a possibly hazardous situation that may result in property damage in case of non-compliance.

✓ Precondition of an action

1.2 Staff Qualification

Qualified persons are persons that are familiar with the mounting, installation, putting into service, operation, maintenance, removal from service, and disposal of the product and have the appropriate qualification for their activity.

This includes persons that meet at least one of the following three requirements:

- They know the safety concepts of metrology and automation technology and are familiar therewith as project staff.
- They are operating staff of the measuring and automation systems and have been instructed in the handling of the systems. They are familiar with the operation of the devices and technologies described in this documentation.
- They are commissioning specialists or are employed in the service department and have completed training that qualifies them for the repair of the system. In addition, they are authorized to put into operation, to ground, and to mark circuits and devices according to the safety engineering standards.

All work with this product must be carried out by qualified persons!

1.3 Intended Use

The devices are used to convert the physical parameter of pressure into an digital electric signal.

The user must check whether the device is suited for the selected use. In case of doubt, please contact our sales department: info@bdsensors.de | phone: +49 (0) 92 35 98 11 0
BDSENSORS assumes no liability for any wrong selection and the consequences thereof!

Permissible media are gases or liquids, which are compatible with the media wetted parts described in the data sheet.

The technical data listed in the current data sheet are engaging and must absolutely be complied with. If the data sheet is not available, please order or download it from our homepage: <http://www.bdsensors.com>

	Danger through incorrect use - In order to avoid accidents, use the device only in accordance with its intended use.
WARNING	

1.4 Limitation of Liability and Warranty

Failure to observe the instructions or technical regulations, improper use and use not as intended, and alteration of or damage to the device will result in the forfeiture of warranty and liability claims.

1.5 Safe Handling

NOTE - Treat the device with care both in the packed and unpacked condition!

NOTE - The device must not be altered or modified in any way.

NOTE - Do not throw or drop the device!

NOTE - Excessive dust accumulation (over 5 mm) and complete coverage with dust must be prevented!

NOTE - The device is state-of-the-art and is operationally reliable. Residual hazards may originate from the device if it is used or operated improperly.

1.6 Scope of Delivery

Check that all parts listed in the scope of delivery are included free of damage, and have been delivered according to your purchase order:

- pressure transmitters
- for DIN 3852 mech. connectors: O-ring (pre-fitted)
- this operating manual

1.7 UL Approval (for Devices with UL Marking)

The UL approval was effected by applying the US standards, which also conform to the applicable Canadian standards on safety.

Observe the following points so that the device meets the requirements of the UL approval:

- The transducer must be operated via a supply with energy limitation (acc. to UL 61010) or an NEC Class 2 energy supply.
- Maximum operating range: see data sheet

2. Product Identification

The device can be identified by means of the manufacturing label with order code. The most important data can be gathered therefrom.

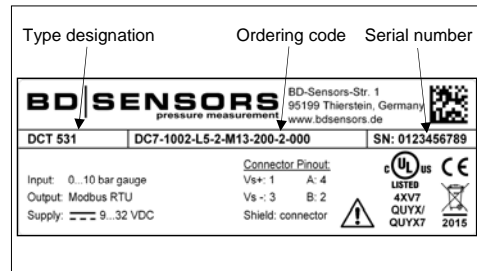


Fig. 1: Manufacturing label

NOTE - The manufacturing label must not be removed!

3. Mounting

3.1 Mounting and Safety Instructions

	Danger of death from airborne parts, leaking fluid, electric shock - Improper installation may result in electric shock! - Always mount the device in a depressurized and de-energized condition!
DANGER	

NOTE - If there is increased risk of damage to the device by lightning strike or overvoltage, increased lightning protection must additionally be provided!

NOTE - Treat any unprotected diaphragm with utmost care; this can be damaged very easily.

NOTES - for mounting outdoors or in a moist environment:

- Connect the device electrically straightaway after mounting or prevent moisture penetration, e.g. by a suitable protective cap. (The ingress protection specified in the data sheet applies to the connected device.)
- Select the mounting position such that splashed and condensed water can drain off. Stationary liquid on sealing surfaces must be excluded!
- If the device has a cable outlet, the outgoing cable must be routed downwards. If the cable needs to be routed upwards, this must be done in an initially downward curve.
- Mount the device such that it is protected from direct solar radiation. In the most unfavourable case, direct solar radiation leads to the exceeding of the permissible operating temperature.
- For devices with gauge reference in the housing (small hole next to the electrical connection), install the device in such a way, that the gauge reference is protected from dirt and moisture. Should the device be exposed to fluid admission, the functionality will be blocked by the gauge reference. An exact measurement in this condition is not possible. Furthermore this can lead to damages on the device.

NOTE - Provide a cooling line when using the device in steam piping.

NOTE - When installing the device, avoid high mechanical stresses on the pressure port! This will result in a shift of the characteristic curve or to damage, in particular in case of very small pressure ranges and devices with a pressure port made of plastic.

NOTE - In hydraulic systems, position the device in such a way that the pressure port points upward (ventilation).

NOTE - If the device is installed with the pressure port pointing upwards, ensure that no liquid drains off on the device. This could result in humidity and dirt blocking the gauge reference in the housing, and could lead to malfunctions. If necessary, dust and dirt must be removed from the edge of the screwed joint of the electrical connection.

NOTE - Do not remove the packaging or protective caps of the device until shortly before the mounting procedure, in order to exclude any damage to the diaphragm and the threads! Protective caps must be kept! Dispose of the packaging properly!

NOTE - The specified tightening torques must not be exceeded!

3.2 Conditions for Oxygen Applications

	Danger of death from explosion - when used improperly
DANGER	

Make sure that your device was ordered for oxygen applications and delivered accordingly. (see manufacturing label - ordering code ends with the numbers "007")

Unpack the device directly prior to the installation.

Skin contact during unpacking and installation must be avoided to prevent fatty residues remaining on the device. Wear safety gloves!

The entire system must meet the requirements of BAM (DIN 19247)!

For oxygen applications > 25 bar, devices without seals are recommended.

Transmitters with o-rings of FKM (Vi 567):
permissible maximum values: 25 bar / 150° C (BAM approval)

3.4 Mounting Steps for Connections According to DIN 3852

NOTE - Do not use any additional sealing material such as yarn, hemp or Teflon tape!

- ✓ The O-ring is undamaged and seated in the designated groove.
 - ✓ The sealing face of the mating component has a flawless surface. (R_z 3.2)
- 1 Screw the device into the corresponding thread by hand.
 - 2 Devices equipped with a knurled ring: only tighten by hand
 - 3 Devices with a spanner flat must be tightened using a suitable open-end wrench.
 - Wrench flat made of steel:
G1/4": approx. 5 Nm G1/2": approx. 10 Nm
G3/4": approx. 15 Nm G1": approx. 20 Nm
 - Wrench flat made of plastic: max. 3 Nm

3.5 Mounting Steps for Connections According to EN 837

- ✓ A suitable seal for the medium and the pressure to be measured is available. (e.g. a copper seal)
 - ✓ The sealing face of the mating component has a flawless surface. (R_z 6.3)
- 1 Screw the device into the corresponding thread by hand.
 - 2 Then tighten it using an open-end wrench:
G1/4": approx. 20 Nm; G1/2": approx. 50 Nm

3.6 Mounting Steps for NPT Connections

- ✓ Suitable fluid-compatible sealing material, e.g. PTFE tape, is available.
- 1 Screw the device into the corresponding thread by hand
 - 2 Then tighten it using an open-end wrench:
1/4" NPT: approx. 30 Nm; 1/2" NPT: approx. 70 Nm

4. Electrical Connection

4.1 Connection and Safety Instructions

	Danger of death from electric shock - Always mount the device in a depressurized and de-energized condition!
DANGER	

NOTE - If the device is equipped with a **cable gland** or **cable socket**, it must be ensured that the external diameter of the cable used is within the permissible clamping range. Moreover you have to ensure that it lies in the cable gland firmly and cleflessly!

NOTE - Use a shielded and twisted multicore cable for the electrical connection.

NOTE - for devices with **cable outlet**

- When routing the cable, following bending radiuses have to be complied with:

cable without ventilation tube:

static installation: 5-fold cable diameter
dynamic application: 10-fold cable diameter

cable with ventilation tube:

static installation: 10-fold cable diameter
dynamic application: 20-fold cable diameter

- In case of devices with **cable outlet** and integrated ventilation tube, the PTFE filter located at the cable end on the air tube must neither be damaged nor removed!

4.2 Electrical Installation

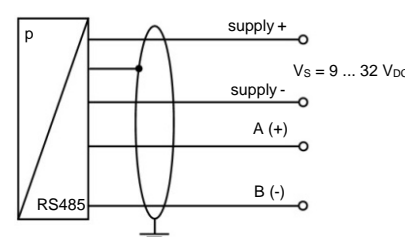
Establish the electrical connection of the device according to the technical data shown on the manufacturing label, the following table and the wiring diagram.

Pin configuration:

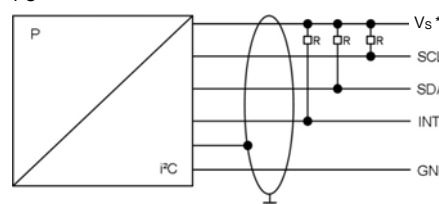
Interface	Electrical connections	M12x1 (4-pin) metal	Binder 723 (5-pin)	Cable colours (IEC 60757)
RS 485 Modbus RTU	Supply +	1	1	wh (white)
	Supply -	3	3	bn (brown)
	not inverted A +	2	2	gn (green)
	inverted B -	4	4	ye (yellow)
	Shielding	housing	housing	gnye (green-yellow)
Interface	Electrical connections	M12x1 (5-pin) metal	Binder 723 (5-pin)	Cable colours (IEC 60757)
i ² C	Supply+	1	1	wh (white)
	Supply -	3	3	bn (brown)
	SDA	2	2	ye (yellow)
	SCL	4	4	gn (green)
	INT	5	5	pk (pink)
	Shielding	housing	housing	gnye (green-yellow)

Wiring diagrams:

RS 485 / Modbus RTU



i²C



* max. I/O current 10 mA

NOTE - In the case of relative pressure gauges, the cable contains a ventilation tube for pressure equalization. Route the end of the cable into an area or suitable connection box which is as dry as possible and free from aggressive gases, in order to prevent any damage.

5. Commissioning

- ✓ The device has been installed properly.
- ✓ The device does not have any visible defect.

6. Modbus RTU Communication

6.1 Configuration of Modbus RTU

- ✓ Delay time (start-up time) of 500 msec has been considered.

Concerns only DCT 531i

Factory setting	1	1	1
Address	1 ... 247		
Baud-Rate			
4800		0	
9600		1	
19200		2	
38400		3	
Paritate			
none			0
odd			1
even			2

6.2 Explicit register description

Map of Input registers (read only, function #4 - Read Input Registers)		
Address	Register	Data type
0x0000	Serial Number	UInt32
0x0001		
0x0002	Date of last calibration	Date
0x0003		
0x0004	Upper range of pressure channel	Float, IEEE754
0x0005		
0x0006	Lower range of pressure channel	Float, IEEE754
0x0007		
0x0008	Actual pressure	Float, IEEE754
0x0009		
0x000A	Maximal Pressure	Float, IEEE754
0x000B		
0x000C	Minimal Pressure	Float, IEEE754
0x000D		
0x000E	Upper range of temperature channel	Float, IEEE754
0x000F		
0x0010	Lower range of temperature channel	Float, IEEE754
0x0011		
0x0012	Actual temperature	Float, IEEE754
0x0013		
0x0014	Maximal temperature	Float, IEEE754
0x0015		
0x0016	Minimal temperature	Float, IEEE754
0x0017		

Map of Holding registers (read, write, fce #3 - Read Holding Registers, fce #6 - Write Single Register)		
Address	Register (description)	Data type
0x0000	Unit of pressure channel	UInt16
0x0001	Unit of temperature channel	UInt16
0x0002	Device address	UInt16
0x0003	Baud rate	UInt16
0x0004	Parity	UInt16

Pressure unit enumeration	
Code (UInt16)	Unit
0x0003	mmH ₂ O
0x0004	mmHG
0x0005	psi
0x0006	bar
0x0007	mbar
0x0008	g/cm ²
0x0009	kg/cm ²
0x000A	Pa
0x000B	kPa
0x000C	torr
0x000D	atm
0x000E	mH ₂ O
0x000F	MPa

Temperature unit enumeration	
Code (UInt16)	Unit
0x0000	°C
0x0001	°K
0x0002	°F

Baud rate enumeration	
Code (UInt16)	Baud rate [Bd]
0x0004	4800
0x0005	9600
0x0006	19200
0x0007	38400

Parity enumeration	
Code (UInt16)	Parity
0x0000	none
0x0001	odd
0x0002	even

7. I²C-Interface

7.1 Configuration of I²C-Interface

Concerns only DCT 532i

Factory setting	050	0	0	0	0	0	00001
Slave address							
address	1						
	...						
	127						
Type of result register							
32bit IEEE float			0				
16bit integer			1				
Byte order of values							
Low byte first				0			
High byte first				1			
Mode of result register							
Value					0		
Percent of nominal					1		
Restore of address pointer							
no restore						0	
to last set address on next start						1	
Digital meaning							
Count of result							00001 ... 10000

7.2 Register overview

Register	Type 0 (Float)	Type 1 (Int 16)
0x00	Status	Status
0x01	Pressure	Pressure
0x02		
0x03		
0x04		
0x05	Temperature	
0x06		
0x07		
0x08		
0x40	Configuration	Configuration
0x41	Oversampling	Oversampling
0x42	Slave Address	Slave Address
0x44	Pressure unit	Pressure unit
0x45	Nominal pressure lower	Nominal pressure lower
0x46		Decimal places
0x47		
0x48	Nominal pressure upper	Nominal pressure upper
0x49		
0x4A		
0x4B		
0x4C		
0x4D	Temperature unit	Temperature unit
0x4E	Nominal temperature lower	Nominal temperature lower
0x4F		Decimal places
0x50		
0x51	Nominal temperature upper	Nominal temperature upper
0x52		
0x53		
0x54		
0x55		

7.3 Explicit register description

Explanation:

r = only readable

r/w = read and write capable

d = don't care

0x00 – Status register

7	6	5	4	3	2	1	0
ABS			ERR	SAT	OVER	UNDER	READY
r	d	d	r	r	r	r	r

bit 0	Result registers is READY	
	0 b =	Outdated values will be read
	1 b =	Registers contain new values
	Note:	This bit has same behaviour as hardware ready connector. Logic level is inverted because of open collector at output stage.
	Note:	It is possible to poll update without using hard wiring, or to check wch sensor has updatad if more than one is used on bus.
bit 2	Value is out of UNDER nominal range	
	0 b =	Pressure value is in nominal range
	1 b =	Pressure is to low
	Note:	OVER and UNDER flags are stored until state register is read.
bit 3	Value SAT urated	
	0 b =	No saturation
	1 b =	Output value or ADC is out of range
bit 4	Internal ERR or, transmitter does not work	
	0 b =	Transmitter is in normal operation
	1 b =	Internal error or wrong setting is active
bit 7	Transmitter is ABS olute	
	0 b =	Pressure type of transmitter is relative
	1 b =	Pressure type of transmitter is absolute

0x40 – Configuration register

7	6	5	4	3	2	1	0
ADD			RESTORE	MODE	ORDER	TYPE	
r/w	d	d	r/w	r/w	r/w	r/w	r/w

bit 0	TYPE of result register	
	0 b =	32bit IEEE float
	1 b =	16bit integer
bit 1	Byte ORDER of values	
	0 b =	Low byte first
	1 b =	High byte first
bit 2...3	MODE of result register	
	00b =	Value
	01b =	Percent of nominal
	10b =	reserved
	11b =	reserved
bit 4	RESTORE address pointer	
	0 b =	No restore
	1 b =	Restore to last set address on restart
	Note:	Using this setting causes reset of register pointer to last written after each stop condition of readout.
bit 7	Set new I2C slave ADDRESS	
	0 b =	Slave address stays as it is
	1 b =	Set this bit to apply previously set slave address

0x43 – Slave address register

7	6	5	4	3	2	1	0
SLAVE_ADDRESS							
r/w							d

bit 1...7	SLAVE ADDRESS which this transmitter acknowledges	
	Note:	To apply new address, it is necessary to set ADD bit in configuration register after new address is written.

0x44 – Pressure unit register

7	6	5	4	3	2	1	0
UNIT							
r/w							

bit 0...7	Pressure UNIT (according to units in HART protocol)	
	0x01	inH2O @ 68°F
	0x02	inHg @ 0°C
	0x03	ftH2O @ 68°F
	0x04	mmH2O @ 68°F
	0x05	mmHG @ 0°C
	0x06	psi
	0x07	bar
	0x08	mbar
	0x09	g/cm ²
	0x0A	kg/cm ²
	0x0B	Pa
	0x0C	kPa
	0x0D	Torr
	0x0E	atm
	0x91	inH2O @ 60°F
	0xAA	cmH2O @ 4°C
	0xAB	mH2O @ 4°C
	0xAC	cmHg @ 0°C
	0xAD	lb/ft ²
	0xAE	hPa
	0xB0	kg/m ²
	0xB1	ftH2O @ 4°C
	0xB2	ftH2O @ 60°F
	0xB3	mHg @ 0°C
	0xED	Mpa
	0xEE	inH2O @ 4°C
	0xEF	mmH2O @ 4°C

0x4d – Temperature unit register

7	6	5	4	3	2	1	0
UNIT							
r/w							

bit 0...7	Temperature UNIT (according to units in HART protocol)	
	0x20	°C
	0x21	°F
	0x22	°R
	0x23	K
0	Note:	If pressure or temperature unit is set to an invalid value, slave will not acknowledge.
	Note:	If 16bit integer mode is selected and nominal values can not be displayed with 0...5 decimal places, ERROR flag is set and DECIMAL_PLACES will be 0xff.

0x47 / 0x50 – Decimal places register

7	6	5	4	3	2	1	0
DECIMAL_PLACES							
r							

bit 0...7	Count of DECIMAL_PLACES	
	Note:	Available only when 16bit integer type is selected.
	Note:	Value will be calculated automatically according to nominal range.

8. Maintenance

	DANGER	Danger of death from airborne parts, leaking fluids, electric shock - Always service the device in a depressurized and de-energized condition!
	WARNING	Danger of injury from aggressive fluids or pollutants - Depending on the measured medium, this may constitute a danger to the operator. - Wear suitable protective clothing e.g. gloves, safety goggles.

If necessary, clean the housing of the device using a moist cloth and a non-aggressive cleaning solution.

The cleaning medium for the media wetted parts (pressure port/diaphragm/seal) may be gases or liquids which are compatible with the selected materials.

Deposits or contamination may occur on the diaphragm/pressure port in case of certain media. Depending on the quality of the process, suitable maintenance intervals must be specified by the operator. As part of this, regular checks must be carried out regarding corrosion, damage to the diaphragm and signal shift.

If the diaphragm is calcified, it is recommended to send the device to BD SENSORS for decalcification. Please note the chapter "Service/Repair" below.

NOTE – Wrong cleaning or improper touch may cause an irreparable damage on the diaphragm. Therefore, never use pointed objects or pressured air for cleaning the diaphragm

9. Troubleshooting

	DANGER	Danger of death from airborne parts, leaking fluids, electric shock - If malfunctions cannot be resolved, put the device out of service (proceed according to chapter 10 up to 12)
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In case of malfunction, it must be checked whether the device has been correctly installed mechanically and electrically. Use the following table to analyse the cause and resolve the malfunction, if possible.

Fault: no output signal	
Possible cause	Fault detection / remedy
Connected incorrectly	Checking of connections
Conductor/wire breakage	Checking of <u>all</u> line connections.
Defective measuring device (signal input)	Checking of ammeter (miniature fuse) or of analogue input of your signal processing unit
Fault: incorrect signal behaviour	
Possible cause	Fault detection / remedy
Load resistance too high	Checking of load resistance (value)
Supply voltage too low	Checking of power supply output voltage
Defective energy supply	Checking of the power supply and the supply voltage being applied to the device
Diaphragm of sensor is severely contaminated or damaged	Checking of diaphragm; if necessary, send the device to BDISENSORS for repair
Fault: wrong or no output signal	
Possible cause	Fault detection / remedy
Cable damaged mechanically, thermally or chemically	Checking of cable; pitting corrosion on the stainless-steel housing as a result of damage on cable; when damaged, send the device to BDISENSORS for repair

10. Removal from Service

	DANGER	Danger of death from airborne parts, leaking fluids, electric shock - Disassemble the device in a depressurized and de-energized condition!
	WARNING	Danger of injury from aggressive media or pollutants - Depending on the measured medium, this may constitute a danger to the operator. - Wear suitable protective clothing e.g. gloves, goggles.

NOTE - After dismounting, mechanical connections must be fitted with protective caps.

11. Service/Repair

Information on service / repair:

- www.bdsensors.com
- info@bdsensors.de
- Service phone: +49 (0) 92 35 98 11 0

11.1 Recalibration

During the life-time of a transmitter, the value of offset and span may shift. As a consequence, a deviating signal value in reference to the nominal pressure range starting point or end point may be transmitted. If one of these two phenomena occurs after prolonged use, a recalibration is recommended to ensure furthermore high accuracy.

11.2 Return

	WARNING	Danger of injury from aggressive media or pollutants - Depending on the measured medium, this may constitute a danger to the operator. - Wear suitable protective clothing e.g. gloves, goggles.
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Before every return of your device, whether for recalibration, decalcification, modifications or repair, it has to be cleaned carefully and packed shatter-proofed. You have to enclose a notice of return with detailed defect description when sending the device. If your device came in contact with harmful substances, a declaration of decontamination is additionally required.

Appropriate forms can be downloaded from our homepage. Download these by accessing www.bdsensors.com or request them:

info@bdsensors.de | phone: +49 (0) 92 35 / 98 11 0

In case of doubt regarding the fluid used, devices without a declaration of decontamination will only be examined after receipt of an appropriate declaration!

12. Disposal

	WARNING	Danger of injury from aggressive media or pollutants - Depending on the measured medium, this may constitute a danger to the operator. - Wear suitable protective clothing e.g. gloves, goggles.
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The device must be disposed of according to the European Directive 2012/19/EU (waste electrical and electronic equipment). Waste equipment must not be disposed of in household waste!



NOTE - Dispose of the device properly!

13. Warranty Terms

The warranty terms are subject to the legal warranty period of 24 months, valid from the date of delivery. If the device is used improperly, modified or damaged, we will rule out any warranty claim. A damaged diaphragm will not be accepted as a warranty case. Likewise, there shall be no entitlement to services or parts provided under warranty if the defects have arisen due to normal wear and tear.

14. EU Declaration of conformity / CE

The delivered device fulfils all legal requirements. The applied directives, harmonised standards and documents are listed in the EC declaration of conformity, which is available online at: <http://www.bdsensors.com>. Additionally, the operational safety is confirmed by the CE sign on the manufacturing label.