

Operating instructions - Series 09 Ultrasonic Sensors RS-232

Content

1	General information	2
1.1	General information	2
2	Installation	2
2.1	Installation methods and installation suggestions	2
2.2	Mechanical cascading of a number of sensors	2
2.3	Beam columnator	3
2.4	Positioning above containers (Sensors with beam columnator D1)	3
3	The RS-232 interface	4
3.1	General notes	4
3.2	Structure of commands	4
3.3	Sensor configuration	5
3.4	Factory configurations	5
3.5	Commands.....	5
3.6	Commands explained in detail.....	8
3.7	Trouble shooting	10
3.8	Examples	10

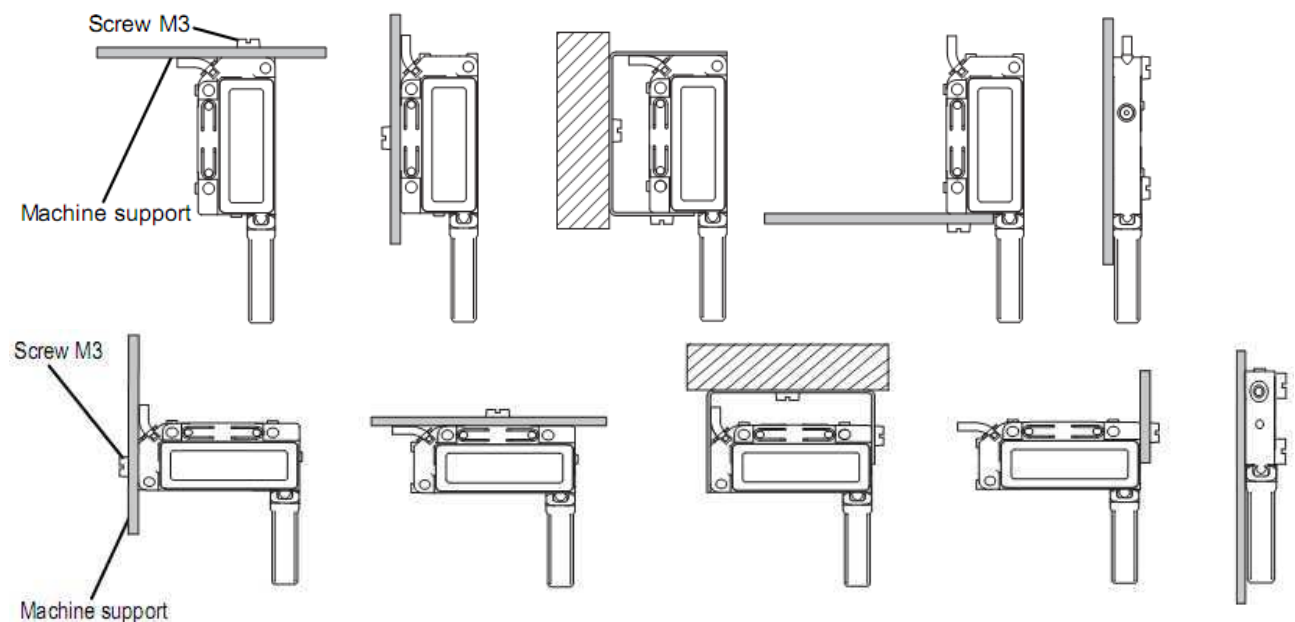
1 General information

1.1 General information

This instruction manual contains information covering installation, initial operation as well as the applicable communication standards of the Baumer Series 09 ultrasonic sensor family. It supplements the guidelines as published in the installation instruction sheet which is packed with every sensor shipped.

2 Installation

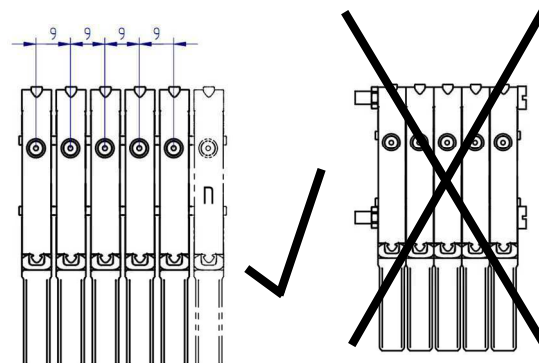
2.1 Installation methods and installation suggestions



2.2 Mechanical cascading of a number of sensors

In case of a number of sensors being installed side by side (cascading) they may not be screwed down directly touching each other. This is due to the mechanical tolerances of the sensor housings and the possible danger of transmitting structure-borne sound. The sensors must be fixed individually maintaining a pitch of at least 9 mm.

Cascading of the Series 09 Ultrasonic Sensors without beam columnator is not recommended.

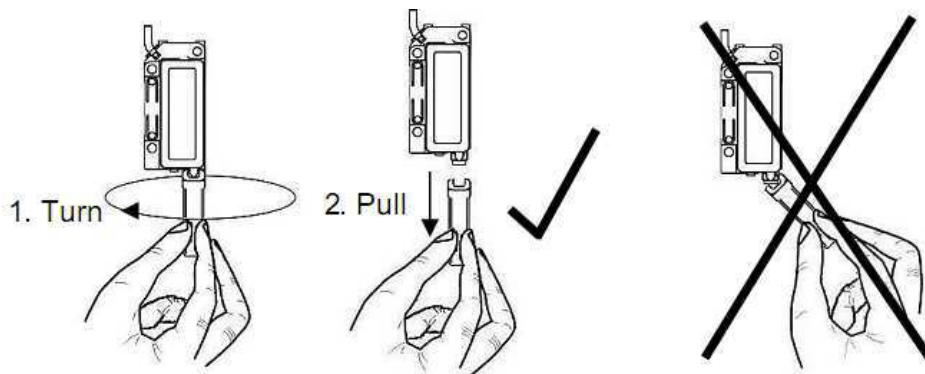


2.3 Beam columnator

Never attach a beam columnator to sensors designed for operation without beam columnator only. Sensors with beam columnator feature extended functions (sensitivity adjustment) which are not available for sensors without beam columnator.

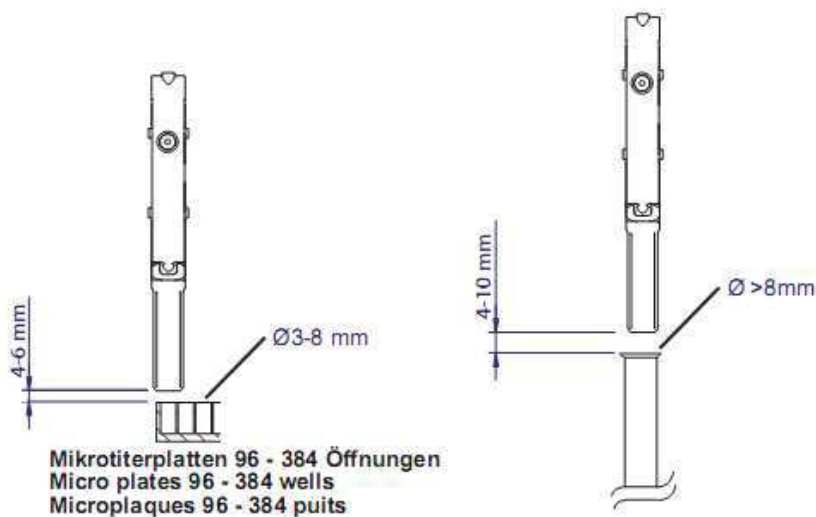
Disassembling the beam columnator

In order to prevent damage to either sensor or beam columnator always turn the beam columnator first ($\frac{1}{4}$ turn) before pulling it off. Never attempt to snap the beam columnator from the sensor without turning it first.



2.4 Positioning above containers (Sensors with beam columnator D1)

When measuring fill levels in micro titration plates or in similarly small containers it is imperative to align the sensors as accurately as possible above the openings. With reference to applicable mounting distances following reference values should be applied:



3 The RS-232 interface

3.1 General notes

- Step 1: Setting of the sensitivity mode A-D; Step 2: Teaching of the Scanning range
- In measuring mode: Yellow LED flashing = weak signal received. Conceivable corrective measures: teach object anew; move object closer to sensor; clean transducer.
- In measuring mode: Red LED on = object within blind range
- Provided the Teach-in sequence cannot be successfully completed the sensor defaults automatically to the previously saved settings.
- Power must be switched off before connecting the sensors.
- A soiled beam columnator may generate erroneous output signals. Therefore it must be checked from time to time and cleaned if necessary.
- Via the RS 232 interface measured data can be received and a number of functions are configurable.
- The sensors work with a baud rate of 115'200

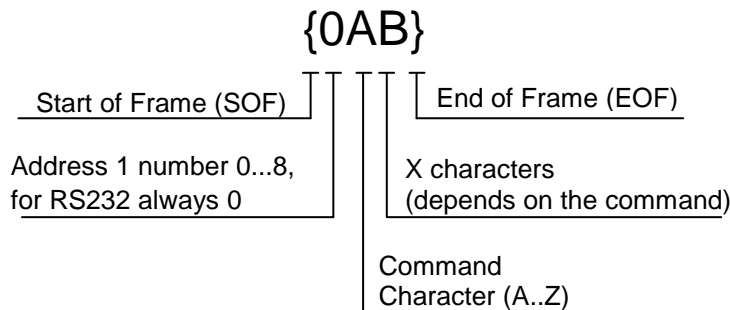
3.2 Structure of commands

All commands consist of ASCII characters only. One character consists of 1 start-Bit, 8 data-Bits and 1 Stop-Bit.

Address

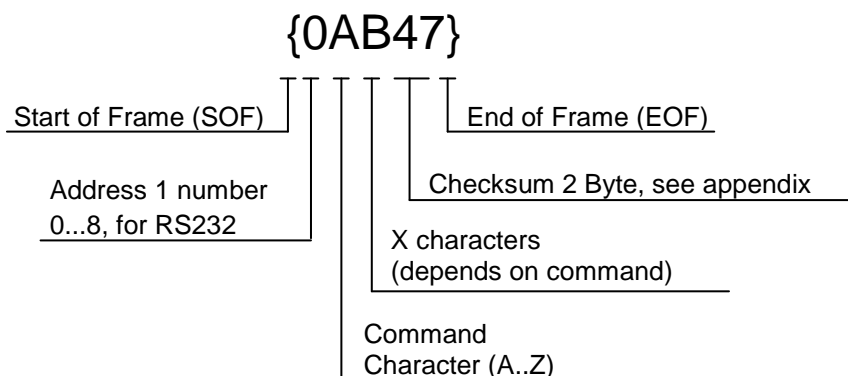
Address „0“ is the broadcast address, which is accepted by **every** sensor and which must be used when using RS232.

Telegram sent by the control to the sensor:



NO CHECKSUM!

Telegram (sensor response) sent from the sensor to the control:



For examples refer to chapter **3.8 Examples**.

3.3 Sensor configuration

There are a number of sensor characteristics which can be set via command which have been defined as configurations.

Configurations are:

- Measuring mode (absolute measurement or relative measurement within the Teach range)
- Output format when using permanent periodical measurement (ASCII or Binary)
- Sensor sensitivity (Sensors with beam columnator)
- Number of averagings
- Temperature compensation on, off
- Teach-in of Sdc and Sde

When leaving production a sensor is pre-configured with its factory settings. These factory settings can be restored using a special command which overwrites the currently set configuration.

Principle

The functionality of the sensors as well as the output format of the data measured can be set by means of the configuration commands.

Once the configuration has been carried out the data measured can be retrieved. It is provided according to the configuration set after every request for data sent. The chosen configuration is stored in a non-volatile memory and is not lost in a power down situation.

3.4 Factory configurations

Ex factory the sensor is shipped with the following pre-set configurations:

Measuring mode: B (relative)
 Output format: A (ASCII)
 Sensitivity level: A (Sensors with beam columnator)
 Number of averagings: C (4 averagings)
 Temperature compensation: 0 (off)

3.5 Commands

(ßß represents the check sum; address 0 is always used in this case)

Name	Command	Syntax	Sensor response	Parameter	Comment
Reset	R	{0R}	{0RV000019ßß}	None	This command stops all periodical data issues. The sensor responds with its software version (e.g. 000608) and with its address (0 in this case)

Configuration					
Load factory settings	D	{0D}	{0Dββ}		The Sensor is configured with its factory settings. <i>See chapter „Factory configurations“</i>
Set measuring mode	A	{0AX}	{0AXββ}	X	A: absolute measurement in 0.1mm steps B: relative measurement within the Teach-range 0...4096 <i>See chapter „Commands explained in detail“</i>
Set output format of permanent periodical data output	F	{0FX}	{0FXββ}	X	A: ASCII B: Binary <i>See chapter „Commands explained in detail“</i>
Set sensor sensitivity (Sensors with beam columnator)	B	{0BX}	{0BXββ}	X	A: Highest sensitivity Measuring into test tubes Measuring range: 3...150 mm B: Second highest sensitivity Measuring into plates size 96 with big hole diameter Measuring range: 3...110 mm C: Second lowest sensitivity Measuring into plates size 96 with small hole diameter Measuring range: 3...70 mm D: Lowest sensitivity Measuring into plates size 384 Measuring range 3...30 mm <i>See chapter „Commands explained in detail“</i>
Set number of averagings	C	{0CX}	{0CXββ}	X	A: not averaged B: 2 C: 4 D: 8 E: 16 F: 32 G: 64 <i>See chapter „Commands explained in detail“</i>
Temperature compensation on, off	G	{0Gx}	{0Gxββ}	x	0: Temperature compensation off 1: Temperature compensation on <i>See chapter „Commands explained in detail“</i>
Teach-in of Sdc	X	{0X}	{0XXββ}	X	Reads and stores close limit Sdc A: Teach-in successful B: No object within measuring range → basic setting for the sensitivity the currently set sensitivity level

Teach-in of Sde	Y	{0Y}	{0YXββ}	X	Reads and stores far limit Sde A: Teach-in successful B: No object within measuring range → basic setting for the sensitivity the currently set sensitivity level
Write two Byte (identification)	N	{0Nxx}	{0Nxxββ}	xx	Write two Bytes with any content. The sign must not be }.
Read two Byte (identification)	O	{0O}	{0Oxxββ}	xx	Read two Bytes stored
Get configuration	V	{0V}	{0V.....ββ}		Retrieves actually saved configurations: Measuring mode (absolute, relative) Output format (Binary, ASCII) Sensor sensitivity (Sensors with beam columnator) Number of averagings Temperature compensation on, off P-code SW document number SW version Identification (2 Byte) <i>See chapter „Commands explained in detail“</i>
Set configuration	U	{0U.....}	{0U.....ββ}		Configuration of sensor with a command: Measuring mode (absolute, relative) Output format (Binary, ASCII) Sensor sensitivity (Sensors with beam columnator) Number of averagings Temperature compensation on, off <i>See chapter „Commands explained in detail“</i>
Measuring					
Single measurement	M	{0M}	{0MXYxxxxββ}	XYxxxx	X=1 →Object within sensing range X=0 →Object not within sensing rg. Y=1 →Echo width big Y=0 →Echo width small xxxx Measured value in sensor units (0...4095) or in 0.1mm steps <i>See chapter „Commands explained in detail“</i>
Start of permanent periodical data output	P	{0P}	{0Pββ}		Provided ASCII has been selected the response is identical to the command „M“ <i>See chapter „Commands explained in detail“</i>

3.6 Commands explained in detail

Check sum

The checksum (CS) represents the sum of all values of the ASCII characters, the last two digits of which are used.

Example:

Temperature compensation off

Command 0 G 0

Check sum (ASCII values): 48+ 71+ 48 = 167, the two last digits are **67**

Command response with Checksum: {0G067}

Measuring mode absolute / relative

Absolute: The sensor refers to the factory calibration and provides absolute measured data in 0.1 mm steps. Should the object move into the sensor's blind region (less than 3 mm distance) the output provides the value 0. In the case of no object being within the measuring range the output shows the value 4095.

Relative always provides the sensor-internal unit: 1 unit = 1/4096 of the configured measuring range (range of values: 0...4095). When the measuring range has been limited by Teach-in the range of values (0...4095) applies to the actually used range. The resolution of the measurement has thereby not been improved. Should the object move into the sensor's blind region (less than 3 mm distance) the output provides the value 0. In the case of no object being within the measuring range the output shows the value 4095.

Binary format

The binary format is only used for the permanent periodical data output in order to transmit the data measured with the maximum data rate. For that reason the binary format is very compact with only a minimum of overhead.

First Byte	Bit 7 is 1 (Mark for start of data string)
	Bit6 = 1 → Object within measuring range
	Bit6 = 0 → no object within measuring range
	Bit 0...Bit 5 are Bit 6..11 of the measured value
Second Byte	Bit 7 is 0
	Bit6 = 1 → Echo width wide (big signal reserve)
	Bit6 = 0 → Echo width narrow (small signal reserve)
	Bit 0...Bit 5 are Bit 0...5 of the measured value

Special features of the permanent periodical data output

Data output is stopped by sending the reset command or by switching the sensor off.

Table „Set sensitivity of sensor“ standard values (Sensors with beam columnator)

Sensitivity	A (Standard)	B	C	D
Size of opening	> 8,5 mm	7...8,5 mm	5...7 mm	3...3,5 mm
Microtitration plates / Containers	Test tubes etc.	96 Wells	96 Wells	384 Wells
Measuring range	3...150 mm	3...110 mm	3...70 mm	3...30 mm

Averaging

By averaging a higher number of measurements both the repeat accuracy and the resolution can be improved. The measuring speed is thereby reduced.

Time per measurement = 7 ms, this corresponds for 8 measurements 8 x 7 ms = 56 ms.

Average algorithm: Floating average

Temperature compensation

The temperature compensation has been designed in to compensate the dependance of the speed of sound on temperature. Provided the temperature compensation is ON changes induced by varying environmental temperature are compensated to 2% of S_o (S_o = distance from sensor to object). Note: the compensation becomes active only 15 minutes after the power has been applied. When the temperature compensation is switched OFF, the sensor measures immediately and correctly at room temperature. Is the environmental temperature changing a measurement error of 0,18% Sde/K occurs.

Format of the „Get Configuration“ data output

Measuring mode	1 Byte
Output format	1 Byte
Sensor sensitivity	1 Byte (Sensors with beam columnator)
Number of averages	1 Byte
Temperature compensation	1 Byte
P-Code	4 Byte
SW document number	6 Byte
Software version	6 Byte
Identification	2 Byte

Format of „Set Configuration“

Measuring mode	1 Byte
Output format	1 Byte
Sensor sensitivity	1 Byte (Sensors with beam columnator)
Number of averages	1 Byte
Temperature compensation	1 Byte

3.7 Trouble shooting

General

The sensors work in a 3-step pattern

1. Waiting for Start of Frame (SOF)
2. Waiting for address or timeout
3. Waiting for End of Frame or timeout

Error conditions

Error according to SOF when:

1. Time between 2 characters exceeds 0.5 s (Timeout)
2. Number of characters does not correspond with the command.
3. Unknown command
4. Command contains wrong parameters
5. Wrong address

Error message

The syntax of an error message is identical to a standard sensor response message

Name	Command	Syntax	Sensor response message	Parameter	Comment
Error message	E	Faulty command	{0EXB}	X	F = Framing error = wrong string length T = after SOF or before EOF more than 0.5s distance between 2 characters U = Unknown command P = impermissible parameter A = Wrong address

Actions in case on an error:

- Sensor is emitting error message
- Sensor is waiting for SOF
- Output provided in case of a false measurement: measured value = 4095 (ASCII), BF 3F (binary)

3.8 Examples

Commands	Sent	Received	Content
Reset	{0R}	{0RV01000005}	
Set factory setting	{0D}	{0D16}	
Set measuring mode	{0AB}	{0AB79}	Relative measurement
Set output data format for permanent periodical data issue	{0FA}	{0FA83}	Set to ASCII
Set sensitivity	{0BC}	{0BC81}	Second highest sensitivity
Set number of averaging	{0CC}	{0CC82}	4 averaging
Temperature compensation	{0G1}	{0G168}	Temperature comp. ON

Teach-in of SDC	{0X}	{0XA01}	Teach-in successful, the present object position is stored as SDC
Teach-in of SDE	{0Y}	{0YB03}	Teach-in not successful, Teach-in range as defined in the factory settings is downloaded
Get Configuration	{0V}	{0VBADC1A1218110 27010000ab53}	Configuration: B : relative measurement A : ASCII for periodical measurements D : highest sensitivity C : 4 times averaged 1 : Temperature compensation ON. A121 : P-Code 811027 : SW doc no 010000 : SW Version ab : Identification 52 : Check sum
Set configuration	{0UABAF0}	{0UABAF047}	Configuration: A : absolute measurement B : Binary for periodical measurement A : lowest sensitivity F : 32 averagings 0 : temperature compensation OFF 47 : Check sum
Write 2 Byte(Identification)	{0N01}	{0N0123}	01 written to the sensor
Read 2 Byte (Identification)	{0O}	{0O0124}	01 read from the sensor
Single measurement	{0M}	{0M11140121}	1 : Object within range 1 : Echo width big 1401 : measured value
Start permanent periodical data output	{0P}	{0P28}	This is the first answer, data follows suit

Error messages (examples)

Error	Sent	Received	Explanation
Wrong address	{3M}	{0EA82}	A = Wrong address
Temperature compensation ON sent with wrong parameter (3 instead of 1)	{0G3}	{0EP97}	P = impermissible parameter
Wrong command	{0W}	{0EU02}	U = unknown command
EOF forgotten	{0M	{0ET01}	T = after SOF before EOF more than 0.5s distance between 2 characters
One ,0' too many	{0M0}	{0EF87}	F = Framing error = wrong string length