UCC****-50GK-B26 Series
Ultrasonic Sensors

Manual

Your automation, our passion.

PEPPERL+FUCHS

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1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal

Note

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Other documents

1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols

Note

This symbol brings important information to your attention.

Action

This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

1.4 Intended Use

The UCC****-50K-B26 series ultrasonic sensors use ultrasonic pulses to detect objects. The sensor emits ultrasound, which is reflected by the object and received again by the sensor. The measured sound propagation time is used to determine the distance to the object (pulse-echo principle). Objects in the following forms can be detected: solid, granular, powder, or liquid. The color and surface structure of the objects are irrelevant. Gases cannot be detected.

Note

UCC****-50K-B26 series ultrasonic sensors are not safety components within the meaning of the EC Machinery Directive 2006/42/EC. They must not be used for the purposes of avoiding risk to individuals or parts of the body.

Always operate the device as described in these instructions to ensure that the device and connected systems function correctly. The protection of operating personnel and plant is guaranteed only if the device is operated in accordance with its intended use.

The operator is responsible for complying with all local safety regulations.

Only use recommended original accessories.

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1.5 General Safety Notes

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Installation and commissioning of all devices may be performed only by trained and qualified personnel.

The device is only approved for appropriate and intended use. Ignoring these instructions will void any warranty and absolve the manufacturer from any liability.

If serious faults occur, stop using the device. Secure the device against inadvertent operation. In the event of repairs, return the device to your local Pepperl+Fuchs representative or sales office.

Note

Disposal

Electronic waste is hazardous. When disposing of the equipment, observe the current statutory requirements in the respective country of use, as well as local regulations.

1.6 Declaration of Conformity

This product was developed and manufactured in line with the applicable European standards and directives.

Note

A declaration of conformity can be requested from the manufacturer.

The product manufacturer, Pepperl+Fuchs Group, 68307 Mannheim, Germany, has a certified quality assurance system that conforms to ISO 9001.

ISO**9001**

2 Product Description

2.1 Use and Application

The UCC****-50GK-B26 series ultrasonic sensors use ultrasonic pulses to detect objects. The sensor emits ultrasound, which is reflected by the object and received again by the sensor. The measured sound propagation time is used to determine the distance to the object (pulse-echo principle). Objects in the following forms can be detected: solid, granular, powder, or liquid. The color and surface structure of the objects are irrelevant. Gases cannot be detected.

The series of ultrasonic sensors described here is limited to the output of distance data that the user can process for the user's application. The modular design means that the sensors can be installed in existing machine parts or accessories.

These ultrasonic sensors can be used in a variety of applications, such as:

- Level measurement in all types of refuse containers (e.g., waste paper, glass containers, biological waste, residual materials)
- Level measurement in grain and feed silos
- Level measurement in the treatment of water/waste water
- Collision avoidance in driverless cars

Function

The 50GK ultrasonic sensors are addressed via a LIN or UART interface and respond by reporting back the distance from the object. For performing simple measurement tasks, however, the sensor can also issue a voltage pulse cyclically in PWM mode that has a width proportional to the distance from the object.

The electrical connections can be accessed via an 8-pin flat connector. The way in which you choose to assign the connections allows you to select the voltage range as well as the method of communication.

The distance value that is output is temperature compensated by means of a temperature measurement in the sensor. In idle mode, power consumption is reduced to a minimum. The broad operating-voltage range even allows the sensor to be operated with a battery.

When delivered, PWM mode with measurement profile "C" (wide sound beam) is activated. Once the appropriate operating voltage has been supplied, the sensor issues a voltage pulse cyclically with a width that mirrors the distance from the object. If the sensor needs to be operated in communication mode LIN or UART, the corresponding connections must be established. The sensor is activated when the relevant operation code (OP code) is sent. If the sensor needs to be reverted back to cyclical PWM mode, PWM mode must be activated in communication mode using the corresponding OP code.

Each sensor has three profiles that primarily determine the characteristic response curves. These profiles can be called up in LIN and UART mode via the relevant OP code for each measurement.

Each time a profile is called up, it is possible to adapt the ultrasonic sensor to the application in the sensor's settings by transmitting the corresponding OP code. If you would like to make further adjustments, please contact us.

Variants

The ultrasonic sensor in the 50GK series is available with two different detection ranges:

- 150 mm to 2500 mm
- 250 mm to 4000 mm

The relevant ultrasonic transducer is protected against aggressive media by a protective film. The sensor is mounted using the metric M50 thread.

2.2 Interfaces and Connections

The circuitry of the connector connections in the UCC****-50GK-B26 series ultrasonic sensors allows you to select the voltage range and the method of communication.

You can choose between the following modes of communication for the transmission of measurement results:

- LIN mode with an operating voltage range of 8 – 18 VDC, typically 12 V
- UART mode with an operating voltage range of 2.5 – 5 VDC, typically 3.3 V
- PWM mode with an operating voltage range of 2.5 – 5 VDC, typically 3.3 V

Note

Depending on the mode of communication selected, you must supply the corresponding connection pins of the connector with the necessary operating voltage, and connect the relevant pins for the communication to the control level.

In UART and PWM mode, you can set the sensor to idle mode via "standby" pin 4. To do this, connect pin 4 to GND. This reduces the power consumption of the sensor to a minimum.

An "x" in the tables indicates that the pin for the respective mode of communication must be connected.

UART Mode

Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
UB1	UB2	GND	Standby	LIN	RX	TX	PWM
x		x	Optional		x	x	

Table 2.1

LIN Mode

Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
UB1	UB2	GND	Standby	LIN	RX	TX	PWM
	x	x		x	Connect to GND		

Table 2.2

PWM Mode

Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
UB1	UB2	GND	Standby	LIN	RX	TX	PWM
x		x	Optional				x

Table 2.3

3 Installation

3.1 Safety Information

Caution!
Risk of short circuit

Carrying out work while the system is energized may result in damage to the device.

- Always disconnect the supply voltage before carrying out work on the device.
- Only connect the device to the supply voltage once all work has been completed.

3.2 Preparation

Unpacking the Device

1. Check the packaging and contents for damage.

   ↳ In the event of damage, inform the shipping company and notify the supplier.
2. Check the package contents against your order and the shipping documents to ensure that all items are present and correct.

   ↳ Should you have any questions, direct them to Pepperl+Fuchs.
3. Retain the original packaging in case the device is to be stored or shipped again at a later date.

3.3 Connection

To supply voltage to the sensor, proceed as follows:

1. Plug the prepared connection cable into the single-ended male cordset provided on the back of the sensor. As described in the chapter "Interfaces and Connections," select the operating mode and operating voltage range by implementing the appropriate connection layout.
2. Connect the supply voltage to the cables provided for this purpose and switch it on.

   ↳ The sensor is now ready for operation.

4 Description of Communication

4.1 Overview

The sensor communicates on the basis of the physical LIN bus interface via a point-to-point connection or point-to-multipoint connection. The sensor functions as a "slave."

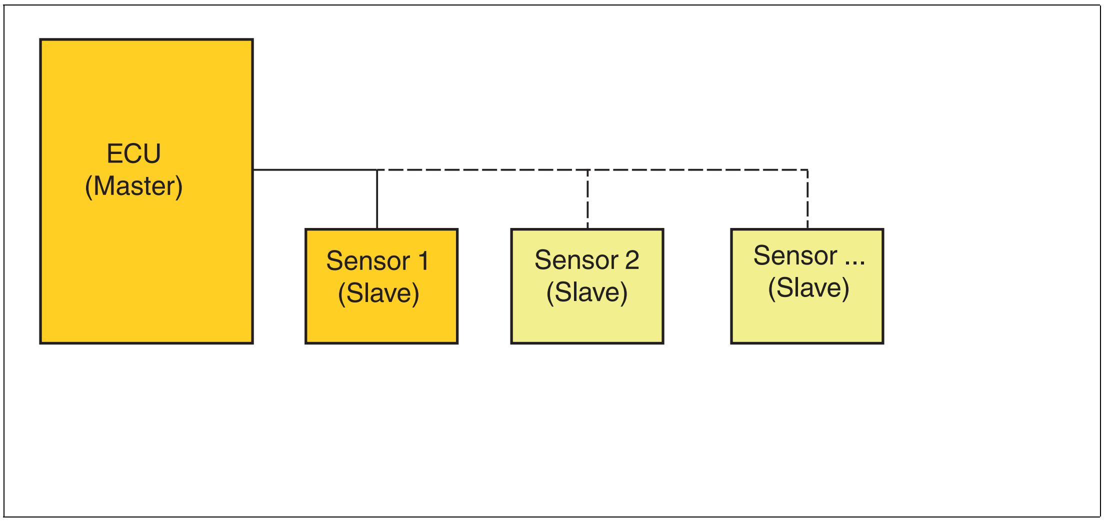

Figure 4.1

Communication	
Transfer rate	19.2 kBit/s
Bit coding	Compatible with LIN standard
Bit format	UART bitstream with 1 start bit, 8 data bits, 1 stop bit

Table 4.1

Master/Slave Principle

During the communication process, the external controller assumes the role of the master. The sensor always functions as the slave in this communication. These roles are never reversed, even in exceptional situations such as when starting or during fault repair.

The master controls the entire communication structure via a telegram sent from the master to the slave.

The Communication Process

Communication is based on the polling principle. The master sends a complete telegram to the sensor (slave) and waits for the sensor's response.

Communication Errors

Communication errors are either reported explicitly by the slave to the master via error messages or detected implicitly by the master (timeout, checksum). Responding is the sole responsibility of the master and is dependent on the application.

4.2 Sequence of a Measurement Process

The sequence of a measuring cycle generally consists of three phases:

- Communication of master with sensor (request)
- Measuring cycle
- Communication of sensor (slave) with master (response)

Depending on the measured profile, the time between the request and response message varies greatly. The timeout periods are described in detail in the individual measurement profiles.

End of a Measuring Process

The measurement stops after the set echo detection time. The sensor evaluates the echoes (filtering) and returns the result as a measured value.

Echo Evaluation

The sensor outputs the distance from the reflecting object. Interference and echoes with deficient amplitude are suppressed.

There are two different modes for outputting the measured value.

Serial communication mode (LIN, UART)

- If an object is detected within the sensing range, the output value is the measured distance.
  - UCC2500: emitted data = distance in cm
  - UCC4000: emitted data x 1.6 = distance in cm
- If no object is detected, the output value is 0x00.
- If an object is detected in the blind zone, the output value is 0x01.
  - Blind zone UCC2500: 0 ... 150 mm
  - Blind zone UCC4000: 0 ... 250 mm
- If an object is outside the maximum sensing range, the output value is 0xFF. For UCC2500, this is > 2.5 m, and for UCC4000, this is > 4 m.
  - UCC2500: sensing range 150 ... 2500 mm
  - UCC4000: sensing range 250 ... 4000 mm

PWM mode

- If an object is detected within the sensing range, the pulse width corresponds to the distance in mm (1 µs = 1 mm).
- If an object is detected in the blind zone, the pulse width is 100 µs for both sensor variants.
- If no object is detected or the object is outside the maximum sensing range, the pulse width for UCC2500 is equal to 5 ms and for UCC4000 is equal to 8 ms.

4.3 Description of the Various Measurement Profiles

The sensor emits the object distance standardized to 8 bit. It also emits a CHECK byte containing the detection bit (ACK) and the checksum of the response.

Depending on the sensor variant, the following applies:

- UCC2500: emitted data = distance in cm
- UCC4000: emitted data x 1.6 = distance in cm

The user can choose from 3 measurement profiles—A, B, or C—with different sensitivity levels (sound beam characteristics).

4.3.1 Sound Beam Characteristics

The following diagrams show the selectable sound beam widths with a flat surface and a round bar as reflectors.

UCC2500

Measurement profiles A to C for flat surface and round bar.

- Measurement profile A: narrow sound beam
- Measurement profile B: medium sound beam
- Measurement profile C: wide sound beam (default setting in PWM mode)

Characteristic response curve

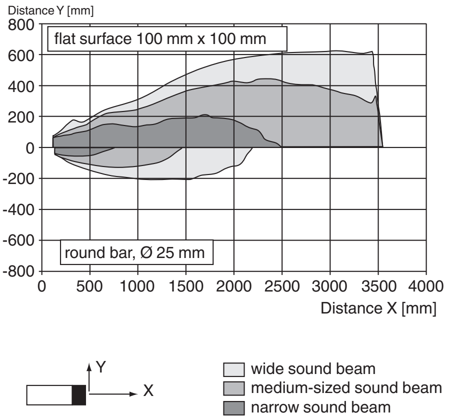

Figure 4.2

UCC4000

Measurement profiles A to C for flat surface and round bar.

- Measurement profile A: narrow sound beam
- Measurement profile B: medium sound beam
- Measurement profile C: wide sound beam (default setting in PWM mode)

Characteristic response curve

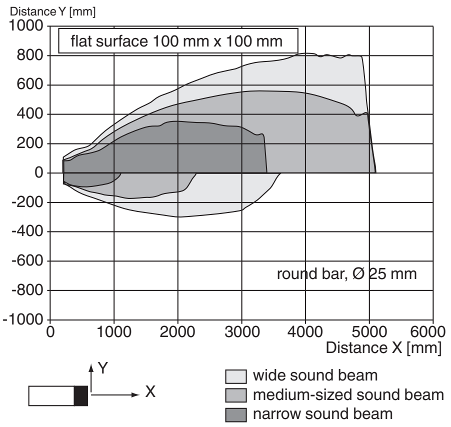

Figure 4.3

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Note

The response curve can be read to indicate the area in which reliable detection of a specific object is possible.

The response curve mainly depends on the reflective properties of the object. Objects with a large surface area and optimal orientation (large sound beam) are more easily recognized than small, round objects, or objects with poor reflective properties (small sound beam).

In the Pepperl+Fuchs datasheets, sound beam diagrams are given for different objects, e.g., standard measuring plate in 100 x 100 mm format, or round bar with a diameter of 25 mm.

4.4 Telegram Overview

4.4.1 Telegram Groups

The interface defines the communication structure in such a way that a response message directly follows each request message. This may be a positive or negative response to the request. The messages are grouped as follows:

- Read requests have 4 bytes
- Positive responses to read requests have different lengths (e.g., the sensor ID)
- Negative responses to read requests have 2 bytes
- Write requests have different lengths (e.g., parameters)
- Positive responses to write requests have 2 bytes
- Negative responses to write requests have 2 bytes

The respective telegram frame is recognized by a gap of 2 bytes length on the transmission link. Multi-byte telegrams are ended by a timeout with a length of 2 bytes.

4.4.2 Telegram Structure

Master-sensor communication consists of a request message from the master to the sensor and a response message from the sensor to the master. The two message types usually have the following telegram structure.

Request Message

The request message has the following components:

- The first byte of each request message is the SYNC byte
    - 4 synchronization bits
    - 1 read/write bit
    - 3 bit for the sensor address
- The second byte of each request message contains the operation code (OP code).
- The third byte of each request message contains the user data.
- The fourth and final byte of each read/write request message contains the CHECK byte.

1st byte		2nd byte		3rd byte		4th (final) byte
SYNC byte		OP code		Data		CHECK byte

Table 4.2 Typical telegram structure for a request message

Response Message

The response message is usually 2 bytes long and is typically structured as follows:

- The first byte contains the data, e.g., the measured value.
- The second byte is the CHECK byte, consisting of an error flag and checksum (mandatory value).

1st (...n.) byte		2nd (final) byte
Data (usually 1 byte, sometimes n bytes)		CHECK byte

Table 4.3 Typical telegram structure for a response message

- n byte response data

In some cases, more than 1 byte of user data is transmitted, e.g., the specification of the hardware version and software version of the sensor. In this case, the CHECK byte is the final byte.

In the current implementation, data strings with a length of 2 to 19 bytes are available.

Note

Using the "checksum calculation 0x00" OP code results in a deviation from this telegram structure (See chapter 4.4.8).

4.4.3 Structure of the SYNC Byte

Bit 7 ... 4	Bit 3	Bit 2 ... 0
0xA	1/0	0x...
SYNC sequence	R/W	Sensor address

Bit 7 ... 4

- SYNC sequence 0xA is mandatory

Bit 3:

- Read/write flag, read (R) = 1, write (W) = 0

Bit 2 ... 0:

- Sensor address—the factory default address is 0x7
- Possible values: 1 ... 7

4.4.4 Structure and List of OP Codes

Operation Codes (OP Codes)

The operation codes (OP codes) can be grouped as follows:

- Measurement profiles: telegrams at the start of the ultrasound measurement with various parameters
- Sensor system: telegrams for sensor functionality (restore factory settings)
- Production: telegram used only in production
- Parameter: telegrams that are used only for parameter access in the user-defined measurement profile

List of the Operation Codes (OP Codes)

Emitter Bytes from the Master

OP object ID	SYNC Bit 7 ...4	R/W Bit 3	ADR Bit 2...0	OP code	Data 1 byte	CHECK byte	Description
Measurement profile							
Temperature	0xA	R	...	0xFF	Number of measuring cycles	Yes	Requires temperature measurement
Profile_A	0xA	R	...	0xFE	Number of measuring cycles	Yes	Requires distance measurement
Profile_B	0xA	R	...	0xFD	Number of measuring cycles	Yes	Requires distance measurement
Profile_C	0xA	R	...	0xFC	Number of measuring cycles	Yes	Requires distance measurement
Sensor System							
FACTORY_Reset	0xA	W	...	0x36	0x55	Yes	Set factory settings: • Sensor address = 0x7 • Temperature compensation = on • PWM output = on
Sensor_Address	0xA	R/W	...	0x35	Read: 0xFF Write: sensor address	Yes	Read/set sensor address
Get_Sensor_AddressCast	0xA	R	0	0x00	0x00	0x43	Read sensor address, if unknown
HW_FW_Version	0xA	R	...	0x34	0xFF	Yes	Read sensor hardware version and software version
Get_Serial_Nr	0xA	R	...	0x33	0xFF	Yes	Read serial number
Get sensor document no.	0xA	R	...	0x32	0xFF	Yes	Read sensor document no.
Temp Comp	0xA	W	...	0x0A	On = 0xFF Off = 0x00	Yes	Temperature compensation On/Off
PWM output	0xA	W	...	0x0A	On = 0xFE Off = 0x01	Yes	PWM output On/Off
CRC_CALC	0xA	W	0	0x00	Special case: n bytes of data (command without CHECK byte)	no	Request for checksum calculation: Order to the sensor to calculate CHECK byte for n bytes of data.

Table 4.4

Number of measuring cycles: 0xFE = 1 measuring cycle, 0xFD = 2 measuring cycles, ... 0x00 = 254 measuring cycles, 0xFF = invalid value

Sensor address: possible values 1 ... 7, factory setting: 0x7

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Response bytes from the sensor

OP object ID	OP code 1 byte	Data		CHECK byte	
		n bytes	Description	ACK bit 7	Bit 5 ...0 checksum
Measurement profile					
Temperature	0xFF	1	Temperature [°C]	1	Yes
Profile_A	0xFE	1	Data = distance [bit]	1	Yes
Profile_B	0xFD	1	Data = distance [bit]	1	Yes
Profile_C	0xFC	1	Data = distance [bit]	1	Yes
Sensor System					
FACTORY_Reset	0x36	1	0xFF transmission successful	0	Yes
Sensor_Address	0x35	1	Sensor address (1...7)	1	Yes
Get_Sensor_AddressCast	0x00	1	Sensor address (1...7)	1	Yes
HW_FW_Version	0x34	17	ASCII code: e.g., HW: V0.1 SW: TV1.0	1	Yes
Get_Serial_Nr	0x33	14	ASCII code: 14 digit serial no.	1	Yes
Get sensor document no.	0x32	7	ASCII code: 7 digit document no.	1	Yes
Temp Comp	0x0A	1	On: 0xFF/Off 0x00	1	Yes
PWM output	0x0A	1	On: 0xFE/Off 0x01	1	Yes
CRC_CALC	0x00	1	Calculated checksum for requested command	Not available	

Table 4.5

4.4.5 Structure of the Data Bytes

The number of data bytes may differ depending on the task (See chapter 4.4.4, list of operation codes).

Typical data byte contents in operation include:

- In a read request from the master (request message) to the sensor for a measurement profile, 1 data byte contains the number of measuring cycles that the sensor is to process for the distance measurement.
- The sensor transmits the distance measurement for the object to the master with 1 data byte.
- In a read request from the master to the sensor for the serial number or for the hardware version and software version, the response may be up to 17 data bytes.

4.4.6 Structure of the CHECK Byte

Bit 7	Bit 6	Bit 5 ... 0
0	1	0x...
ACK/NACK	Mandatory	Checksum

With a request message, bit 7 is always 0.

With a response message, bit 7 is

- = 1 >> ACK (error-free transmission/measurement)
- = 0 >> NACK (error during transmission/measurement)
  (See chapter 4.4.7, error code table)

Bit 6 = 1 >> mandatory

Bit 5 ... 0 >> checksum

Calculating the Telegram Checksum

The telegram checksum provides data-integrity protection for the data transfer between master and sensor. Block signals are used in this process. All bytes of a telegram are XORed (exclusive ORed). The resulting checksum byte is compressed from 8 bit to 6 bit as per the conversion formula below and added to the CHECK byte of the transmitter. The receiver inverts the process. For the checksum calculation, a start value of 0x52 is used. This start value is used with the first byte for the XORing (exclusive ORing).

Compression from 8 bit to 6 bit occurs as follows:

$D5_6 = D7_8$ xor $D5_8$ xor $D3_8$ xor $D1_8$

$D4_6 = D6_8$ xor $D4_8$ xor $D2_8$ xor $D0_8$

$D3_6 = D7_8$ xor $D6_8$

$D2_6 = D5_8$ xor $D4_8$

$D1_6 = D3_8$ xor $D2_8$

$D0_6 = D1_8$ xor $D0_8$

Note

When calculating the checksum in the response telegram from the sensor, bit 7 of the CHECK byte must be accounted for in the checksum. After calculating the checksum, bit 6 must be set.

Calculation example of the response checksum	
Sensor response	0x23D1
0xD1 binary	1101 0001
Bit 7 as an extract from the checksum	1000 0000 => 0x80
Calculation of the checksum	0x52 xor 0x23 xor 0x80 => 0xF1
0xF1 binary	1111 0001
6 bit checksum	0001 0001
Set bit 6 to 1 (mandatory)	0**1**01 0001
Set bit 7 to its original value	**1**101 0001 => 0xD1

Table 4.6

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Note

For a request message, e.g., "Deactivate PWM output," you can have the checksum calculation completed by the sensor itself using the OP code 0x00 (CRC_CALC) as an alternative to this calculation. See chapter 4.4.8 for details.

4.4.7 Troubleshooting and Error Codes

Using bit 7 in the CHECK byte, the sensor communicates to the master whether the response is error-free (ACK) or contains an error (NACK).

An error-free measurement/transmission is identified with bit 7 = 1 (ACK).

In the event of an error, the sensor sets bit 7 = 0 (NACK), and transmits a corresponding error code in the data byte.

The following table lists the possible error codes.

Error Codes

Code	Description
0xFF	Response OK/no error
0x1	Checksum error
0x2	Telegram timeout
0x3	Telegram below threshold
0x4	Telegram above threshold
0x5	Parameter error
0x6	Session error
0x7	Transmission error
0x8	EEPROM error
0x9	OP code error
0xA	OP object is read-only
0xB	Temperature error

Table 4.7

4.4.8 OP Code Checksum Calculation 0x00

OP object ID: CLC_CALC = 0x00

With the checksum calculation, the master can have the CHECK byte calculated in advance by the sensor for a request message that it would like to send to the sensor, instead of performing the calculation itself. After the CHECK byte has been transmitted by the sensor, the master must send a complete request message to the sensor and can use the calculated CHECK byte for this purpose.

With this OP code, the telegram structure in the communication does not contain any CHECK bytes.

Example: checksum calculation for "Deactivate PWM output"

Master >> Sensor

The sensor should calculate the checksum for the future request message "0xA7 (SYNC), 0x0A (OP code), 0x01 (PWM off)."

SYNC byte		OP code		Data bytes		CHECK byte
0xA0		0x00		0xA7 0x0A 0x01		Not available

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Sensor >> Master

The sensor transmits the CHECK byte for the data "0xA7 0x0A 0x01"

1 data byte		CHECK byte
0x51		Not available

Full Command "Deactivate PWM Output"

SYNC byte		OP code		Data bytes		CHECK byte
0xA7		0x0A		0x01		0x51

4.4.9 Telegram Example: Read Request (Request Message) Measurement Profile A

A read request from the master to the sensor is structured as follows:

A) The Master Sends a Request Message to the Sensor

The content of the read request is: measurement profile A, 1 measuring cycle, sensor address 7

SYNC byte		OP code		Data byte		CHECK byte
0xAF		0xFE		0xFE		0x61

B1) Either: Transmission Successful

If the transmission was successful, the sensor sends a response message with the measured distance back to the master. In the example, the sensor reports the object distance "0x7A"

1 data byte		CHECK byte
0x7A (Object data)		0xFE.

Object data = object distance

0x7A = 122 decimal

- UCC2500 object data = 122 cm
- UCC4000 object data x 1.6 = 195 cm

If there is more than one measuring cycle, the object data is an average of all measuring cycles.

To indicate a successful measurement/transmission, bit 7 in the CHECK byte = 1 >> ACK

B2) Or: Transmission Not Successful

In the event of a failed transmission, the sensor sends back a response message with the error code.

1 data byte		CHECK byte
0x... (Error code)		0x...

To indicate a failed measurement/transmission, bit 7 in the CHECK byte = 0 >> NACK and the error code according to the error code table is stored in the data byte (See chapter 4.4.7).

4.4.10 Telegram Example: Write Request (Request Message) Set Sensor Address

A write request to set the sensor address is structured as follows:

A) The Master Sends a Request Message to the Sensor

Content of the write request is: change sensor address to 0x01.

SYNC byte		OP code		Data byte		CHECK byte
0xA7		0x35		0x01		0x61

B1) Either: Transmission Successful

If the transmission was successful, the sensor sends a response message with the new sensor address back to the master.

1 data byte		CHECK byte
0x01		0x04

B2) Or: Transmission Not Successful

1 data byte		CHECK byte
0x... (Error code)		0x...

To indicate a failed address change/transmission, bit 7 in the CHECK byte = 0 >> NACK and the error code according to the error code table is stored in the data byte (See chapter 4.4.7).

5 Overview of Communication Messages (OP Codes)

Communication messages are divided into the following groups:

- Measurement profiles: messages for the start of a measurement profile
- Sensor system: messages as sensor information (e.g., FW version)

The purpose of the classification is to provide a better overview of the various messages and has no technical relevance.

The following sections only describe the request and response messages that appear in the positive event of error-free communication. The entire process for error communication must be handled in the same manner. (See chapter 4.4.9, Telegram Example)

5.1 Measurement Profiles

The measurement profiles in this group are intended to start a measurement by the master.

5.1.1 OP Code Read Temperature 0xFF

OP object ID: temperature = 0xFF

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA...		0xFF		0xFF		0x...

Data byte: does not matter (0xFF is recommended due to the minimal power consumption)

2 Bytes, Sensor >> Master

1 data byte		CHECK byte
0x...		0x...

Data byte [signed integer] = temperature [°C]

5.1.2 OP Code Read Distance Measurement with Measurement Profile A 0xFE

OP object ID: profile_A = 0xFE

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA..		0xFE		0x...		0x...

Data byte: contains the number of measuring cycles to be executed (0xFE = 1 measuring cycle, 0xFD = 2 measuring cycles, ... 0x00 = 254 measuring cycles. 0xFF = invalid value)

2 Bytes, Sensor >> Master

1 data byte		CHECK byte
0x...		0x...

Data byte = distance [bit]

If more than one measuring cycle is executed, the output data is an average of all measuring cycles.

5.1.3 Read/Write Sensor Address 0x35

OP object ID: Sensor_Address = 0x35

Read Sensor Address

If one sensor is connected, transmission of the sensor address to the master is required with this command.

If more than one sensor is connected, the master can use this command to check whether all sensors are responding correctly.

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA...		0x35		0xFF		0x...

Data byte: does not matter (0xFF is recommended due to the minimal power consumption)

2 Bytes, Sensor >> Master

1 data byte		CHECK byte
0x...		0x...

Write Sensor Address

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA...		0x35		0x...		0x...

Data byte = new sensor address

2 Bytes, Sensor >> Master

1 data byte		CHECK byte
0x...		0x...

Data = new sensor address

Read Sensor Address with the Cast Command

If the device address of the sensor is unknown, you can read out the device address using a cast command. The device address of this command is 0.

In this case, only one sensor may be connected

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA8		0x00		0x00		0x...

2 Bytes, Sensor >> Master

1 data byte		CHECK byte
0x...		0x...

Data = new sensor address

5.1.4 Temperature Compensation/PWM Output On/Off

OP object ID: Temp Comp/PWM Output = 0x0A

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA..		0x0A		0x...		0x...

Data:

0xFF = temperature compensation on

0x00 = temperature compensation off

0xFE = PWM output on

0x01 = PWM output off

2 Bytes, Sensor >> Master

1 data byte		CHECK byte
0x...		0x...

The value previously written by the master for the command (e.g., 0x01) is reported back as a data byte.

5.2 Sensor System

Telegrams from the following group are required to read out sensor service information.

5.2.1 OP Code Read Sensor Hardware/Software Version 0x34

OP object ID: HW_FW_Version = 0x34

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA....		0x34		0xFF		0x...

Data byte: The content of the data is not relevant, but the transmission of some data is mandatory. Any value from 0x00 to 0xFF is allowed. We recommend 0xFF as a value, because the power consumption is minimal.

19 Bytes, Sensor >> Master

1 ... 18 data bytes		CHECK byte
0x...		0x...

Data bytes = the characters for the version are transmitted in ASCII format. A null value '\0' is used to conclude the string.

Example for Hardware Version V0.1 and Software Version V1.0

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hex	48	57	3A	56	30	2E	31	20	53	57	3A	56	31	2E	30	30	30	00	Checksum
ASCII	H	W	:	V	0	.	1		S	W	:	V	1	.	0	0	0	0	..

For example: 'H', 'W', ':', 'V', '0', '.', '1', ' ', 'S', 'W', ':', 'V', '.', '0', '0', '0', '\0'

5.2.2 OP Code Read Serial Number 0x33

OP object ID: serial_no = 0x33

4 Bytes, Master >> Sensor

SYNC byte		OP code		Data byte		CHECK byte
0xA....		0x33		0xFF		0x...

15 Bytes, Sensor >> Master

1 ... 14 data bytes		CHECK byte
0x...		0x...

Data bytes = the characters for the serial number are transmitted in ASCII format. A null value '\0' is used to conclude the string.

Example for Serial Number 4000000 16900001

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hex	34	30	30	30	30	30	31	36	39	30	30	30	30	31	Checksum
ASCII	4	0	0	0	0	0	1	6	9	0	0	0	0	1	..

For example: '4', '0', '0', '0', '0', '0', '1', '6', '9', '0', '0', '0', '0', '1', '\0'

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