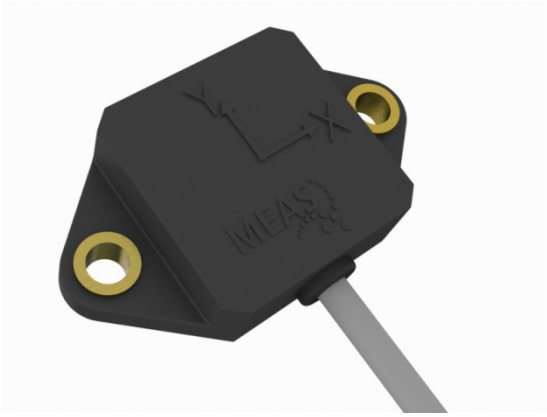
# UART-Interface Specification
# NS-xx/DOG2-UXZ




## Version 1.0

## Customer Acceptance

Company: .....

Address: .....

Date: .....

Signature: .....

Name: .....

Function: .....

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# 1 Description of TTL-level UART interface

Communication with the sensor is done using a standardized UART-Interface. A semi-duplex mode is supported.

For the sensor with UART output the levels are inverted at CMOS/TTL-Level as usual. The sensor is configured as “listener”, waiting for requests/commands (see below) from the host. Each command (10 Bytes) is replied to by the sensor. A checksum is included to detect communication errors and make the communication safe. It is up to the customer to decide whether the checksum is interpreted or not. For sensor requests, the checksum always has to be included as the inclinometer checks it.

## 1.1 Interface Parameter for the NS-xx/DOG2-UXZ

Baud rate: 57600 Baud (default for high refresh rates, can be reduced if required)

Settings: 8 data bits, 1 stop bit, no parity

## 1.2 UART-Protocol NS-xx/DOG2-UXZ:

The protocol uses a fix number of 10 bytes for both, read and write options. In the following the hexadecimal data format is used to describe the commands and sensor data. For example, a 0x01 is equivalent to send a decimal 1 to the sensor and a 0x40 is equivalent to the decimal 64 (=ASCII code for ‘@’).
To summarize the previous section, a binary transfer is used for high efficiency and reduction of communication traffic. Each data block transferred has 10 bytes.

Additionally, a synchronization of the sensor is possible. If, for example, the sensor receives less than 10 bytes, no reply will be sent. In this case, the master should send single (arbitrary) bytes until the inclinometer replies with a 10 byte error frame. However, if there is no error in terms of missing or additional bytes, there is no need to synchronize the sensor. Anyway, we strongly suggest to include a simple timeout feature for the host application that starts a synchronization if the sensor does not respond for some 10ms after a command/request has been sent. This gives additional safety and ensures immediate re-connection in case of an accidental power down or short term connection interrupts (defective cable/connector).

This is an overview of available commands:

Sensor connection:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x40 | 0x00 | 0x10 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0xAF |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x43 | 0x00 | 0x10 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0xAC |

Can be used to test the connection. The replied frame contains the device identifier.

Serial number readout:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x40 | 0x18 | 0x10 | 0x04 | 0x00 | 0x00 | 0x00 | 0x00 | 0x93 |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x43 | 0x18 | 0x10 | 0x04 | LSB | | | MSB | CHK |

X-tilt readout:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x40 | 0x10 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x4F |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x43 | 0x10 | 0x60 | 0x00 | LSB | | | MSB | CHK |

Y-tilt readout:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x40 | 0x20 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x3F |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x43 | 0x20 | 0x60 | 0x00 | LSB | | | MSB | CHK |

X-Offset readout:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x40 | 0x14 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x4B |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x43 | 0x14 | 0x60 | 0x00 | LSB | | | MSB | CHK |

X-Offset setting to currently value -> the current X-Angle will become 0°:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x23 | 0x14 | 0x60 | 0x00 | 0x10 | 0x60 | 0x00 | 0x00 | 0xF8 |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x60 | 0x14 | 0x60 | 0x00 | 0x10 | 0x60 | 0x00 | 0x00 | 0xBB |

X-Offset re-setting to manufacture value (use the factory 0° setting):

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x23 | 0x14 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x68 |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x60 | 0x14 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x2B |

Y-Offset readout:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x40 | 0x24 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x3B |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x43 | 0x24 | 0x60 | 0x00 | LSB | | | MSB | CHK |

Y-Offset setting to currently value -> the current Y-Angle will become 0°:

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x23 | 0x24 | 0x60 | 0x00 | 0x10 | 0x60 | 0x00 | 0x00 | 0xE8 |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x60 | 0x24 | 0x60 | 0x00 | 0x10 | 0x60 | 0x00 | 0x00 | 0xAB |

Y-Offset re-setting to manufacture value (use the factory 0° setting):

Write:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x23 | 0x24 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x58 |

Read:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x60 | 0x24 | 0x60 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x1B |

Any angle is given in milli degree (m° = 1/1000 degree). For the communication frame, a “signed long” data type in so called “little endian” format is used. This means, any angle value is splitted into 4 bytes, starting with the least significant byte and ending with the most significant byte.

Typically, the signed long numbers are represented by a two’s complement. In case the received bytes are just copied to the corresponding positions of a variable in the host memory (LSB to LSB ... MSB to MSB), the user does not need to care about representation of numbers. After copying the 4 bytes, the variable holds the current value including the sign.

**Two’s complement example for 8 bit value:**

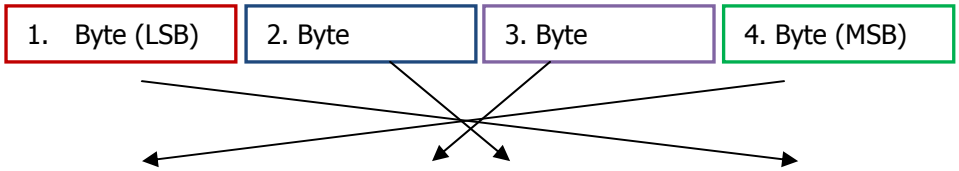
The value of a two's-complement binary number can be calculated by adding up the power-of-two weights of the "one" bits, but with a negative weight for the most significant (sign) bit; for example:

MSB ... LSB

$\mathbf{1}\ 111101\ \mathbf{1}_2 = -128 + 64 + 32 + 16 + 8 + 0 + 2 + 1 = (-2^7 + 2^6 + ...) = -5$

**32 bit (signed long) example:**

Received bytes (order of reception: LSB first)




Alignment of data bytes for conversation of two’s complement in signed decimal number


| ***MSB*** | | | ***LSB*** |
|---|---|---|---|
| ***1***0001010 | 01001110 | 01111000 | 0111001***1*** |

The simplest way may be to define a signed long variable in the host software and to copy the bytes received to the corresponding memory location. This makes a manual conversion obsolete.

## 2 Additional Information

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