

# Data Sheet for Joysticks

## 3D Finger Joystick

## SpaceMouse® Module



- Revolutionary, intuitive control of complex 3D movements
- Special industrial module: dust and splash water protection (IP54), long-lived handle material, strong spring tension and small dead zone
- 6 axes / 6 degrees of freedom (6DoF)
- Optoelectronic sensor, contactless and linear
- CANopen, UART (serial) or USB interface

The robust and high-precision SpaceMouse® Module is the ideal man-machine-interface for industrial applications. Its sensor is used in millions of 3D mice worldwide and enables manipulation with up to 6 degrees of freedom.

To meet the different requirements of industrial applications compared to desktop applications, spring tension, dead zone and controller cap material have been optimised, and the sealing has been improved to provide resistance to dust and splash water. It is also resistant to ageing, temperature and static magnetic fields. Combined with its low profile, it is the ideal choice for many industrial applications, from laboratories to production lines, such as robotics and automation.

The SpaceMouse® Module is available with CANopen, USB or serial (UART) interface. A rubber ring is available as a separate accessory for increased adhesion with plastic foils.

Technical Data	UART Interface (art.-no. 131034)	USB Interface (art.-no. 131002)	CANopen Interface (art.-no. 135873)
<b>Electrical</b>			
Sensor	Optoelectronic		
Digital Resolution	10 bit		8 bit / 10 bit (transfer in 8 or 16 bit data sets)
Resolution Translation	250 Increments / mm		
Resolution Rotation	170 Increments / degree		
Data Rate	Max. 100 / s		Bus data rate max. 1 Mbit, update rate max. 100/s
Supply Voltage	+3.3 to +5.5 V	5 V ±10 %	Nom. 24 VDC (4,75..28 VDC)
Current Consumption	max. 10 mA	max. 20 mA	max. 10 mA
<b>Physical</b>			
Height	52.2 mm		56 mm
Max. Ø Cap	53.8 mm		
Weight	60 g		71 g
Ø Installation Cut-Out	40.2 mm		
Thickness of Panel	1 to 5.5 mm		
Installation Depth	15 mm		18.5 mm
Vertical Actuation Force	11.0 N		
Horizontal Actuation Force	7.4 N		
Torque	171 Nmm		
Vertical Displacement	1.5 mm		
Horizontal Displacement	1.5 mm		
Twist & Tilt Angle (cw & ccw)	6°		
Cable Length	200 mm ± 10 mm included in delivery	1500 mm ±50 mm included in delivery	(300 + 25 mm, <u>not</u> included in delivery)
<b>Environmental Conditions</b>			
Operating Temperature	0°C to +50°C		
Storage Temperature	-30°C to +70°C		
Humidity (operating at T≤40°C)	Min. 10 % - Max. 85 % (non condensing)		
Humidity (storage at T≤40°C)	Min. 10 % - Max. 95 % (non condensing)		
Protection Class	IP54		
EMI	EN61000-4-3 (10 V, 10 V/m)		
ESD	EN61000-4-2 / Level 4		

### Table of Contents

<b>1</b>	<b>Product Description</b>	<b>3</b>
1.1	Usage Notes	3
1.2	Components	4
1.3	Default Axis Orientation	4
<b>2</b>	<b>Tests</b>	<b>5</b>
2.1	Degrees of Protection	5
2.3	Tolerance and Reliability	6
2.4	Service Life Test (only valid for UART and USB versions)	6
<b>3</b>	<b>Drawings</b>	<b>7</b>
3.1	Dimensions - UART Interface	7
3.2	Dimensions - USB Interface	8
3.3	Dimensions - CANopen Interface	9
3.4	Mounting Hole	10
<b>4</b>	<b>UART Interface Specification</b>	<b>11</b>
4.1	Electrical	11
4.3	Protocol	12
<b>5</b>	<b>USB Interface Specification</b>	<b>15</b>
5.1	Electrical & Protocol	15
5.2	Cable	15
<b>6</b>	<b>CANopen Interface Specification</b>	<b>16</b>
6.1	4-Pin Connector X1	16
6.2	Cable	16
6.3	Changing the DIP-Switches	16
6.4	CANopen protocol / commands	16

### 1 Product Description

#### 1.1 Usage Notes

The controller cap mounted on the measuring system can be moved in 6 degrees of freedom:

Horizontal shift in x-direction and z-direction, vertical shift in y-direction, rotational tilt around x-axis and z-axis, plus twist around y-axis. Several axes can be manipulated simultaneously.

Please note that the y-axis and the z-axis are interchanged and inverted in the serial variant compared to the USB variant. For definition of axis orientation, please refer to chapter 2.3 „Default Axis Orientation“.

For the USB version, the movements/axes are as follows:



The SpaceMouse® Module **UART** communicates via serial interface (UART = Universal Asynchronous Receiver Transmitter). The signal levels are 0 Volt (logic 0) or VCC (logic 1), hence they are not RS232 compliant. For further details, please refer to chapter 5 „UART INTERFACE SPECIFICATION“.

The SpaceMouse® Module **USB** is recognized by the operating system as a standard 6-axis joystick. The USB protocol follows the HID spec rev. 1.11, so no additional driver is required.

The following operating systems are supported:

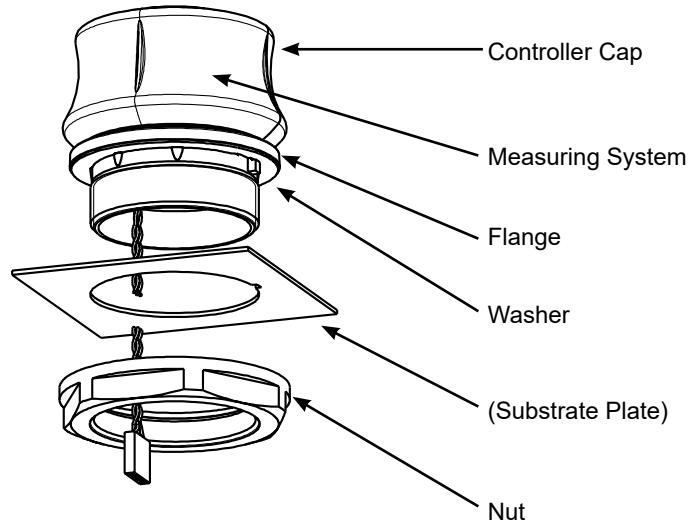
- Windows (11, 10, 8, 7, Vista, XP SP2)
- Linux with USB host support
- Other systems supporting USB joysticks

For further details, please refer to chapter 6 „USB INTERFACE SPECIFICATION“.

The SpaceMouse® **CANopen** module offers the full potential of CANopen and is particularly suitable for demanding applications in automation and mobile machinery. The CANopen interface operates in accordance with DS301 and DS401. All common baud rates up to 1 Mbit/s are supported. DIP switches can be used to select various default settings, such as the CANopen Node ID and the baud rate. The CAN interface can be used to set deadband values, zero position and much more.

Mechanical data and the description of the basic functions can be found in this data sheet. For further details on the interface, please refer to the separate document “CANopen Interface Description” (available on our website).

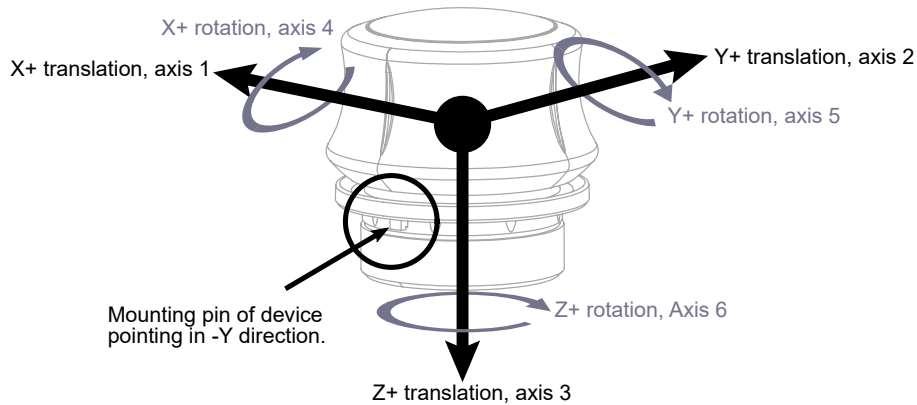
### 1.2 Components (shown for UART Module)



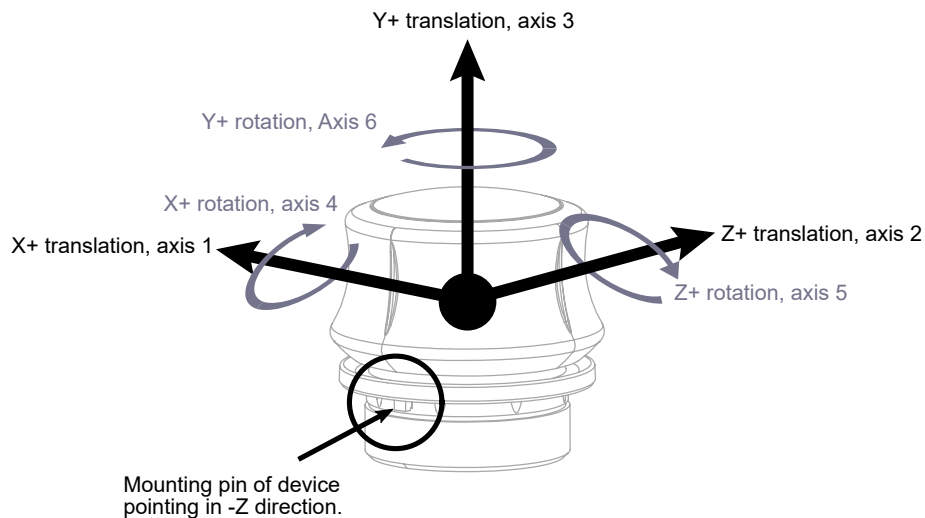
### 1.3 Default Axis Orientation

Attention: the y- and z-axes are interchanged in the two variants, and the vertical axis is inverted

#### Axis orientation USB and CAN versions



#### Axis orientation UART version



# Data Sheet for Joysticks

3D Finger Joystick

SpaceMouse® Module

## 2 Tests

All tests and measurements were conducted under the following conditions unless otherwise specified:

- Temperature: 23 °C (73.4 °F) ± 10 °C (50 °F)
- Humidity: 65 % ± 20 %RH
- Atmospheric Pressure: 86 kPa (860 mBar) ~ 106 kPa (1060 mBar)

### 2.1 Degrees of Protection

#### 2.1.1 Tightness

Protection Class at least IP54 (valid only for above panel when mounted)

Item	Test Conditions	Specifications
<b>First Digit: 5 (Dust protected)</b>	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact.	
<b>Second Digit: 4 (Splashing Water)</b>	Test duration: 5 min. Water volume: 10 l/min. Pressure: 80-100 kN/m <sup>2</sup>	Water splashing against the enclosure from any direction shall have no harmful effect.

Mounting conditions must be regarded for achieving this protection class.

#### 2.2.2 PWIS (paint-wetting impairment substances)

Cap with cosmetic treatment and complete SpaceMouse® Module were tested. No paint wetting impairment substances detected. (PWIS – free).

(German: LABS - frei: keine lackbenetzungstörende Substanzen)

Item	Test Conditions	Specifications
<b>Blast Test</b>	Test item is hanging free Indicating substrate: cleaned Al-sheet Gas medium: N2 Blast time: 30 s Paint: Duplicolour 1-0400	Blowing gas blast on test item. Indicating substrate is in discharged gas blast. After blast, indicating substrate is covered with paint. No crater or impurity on painted sheet are accepted.

#### 2.2.3 Fire Protection

For plastic part (Cap, Insert, Flange): Fire protection classification UL94: at least V1v (for CAN version only valid for cap)

# Data Sheet for Joysticks

3D Finger Joystick

SpaceMouse® Module

## 2.3 Tolerance and Reliability

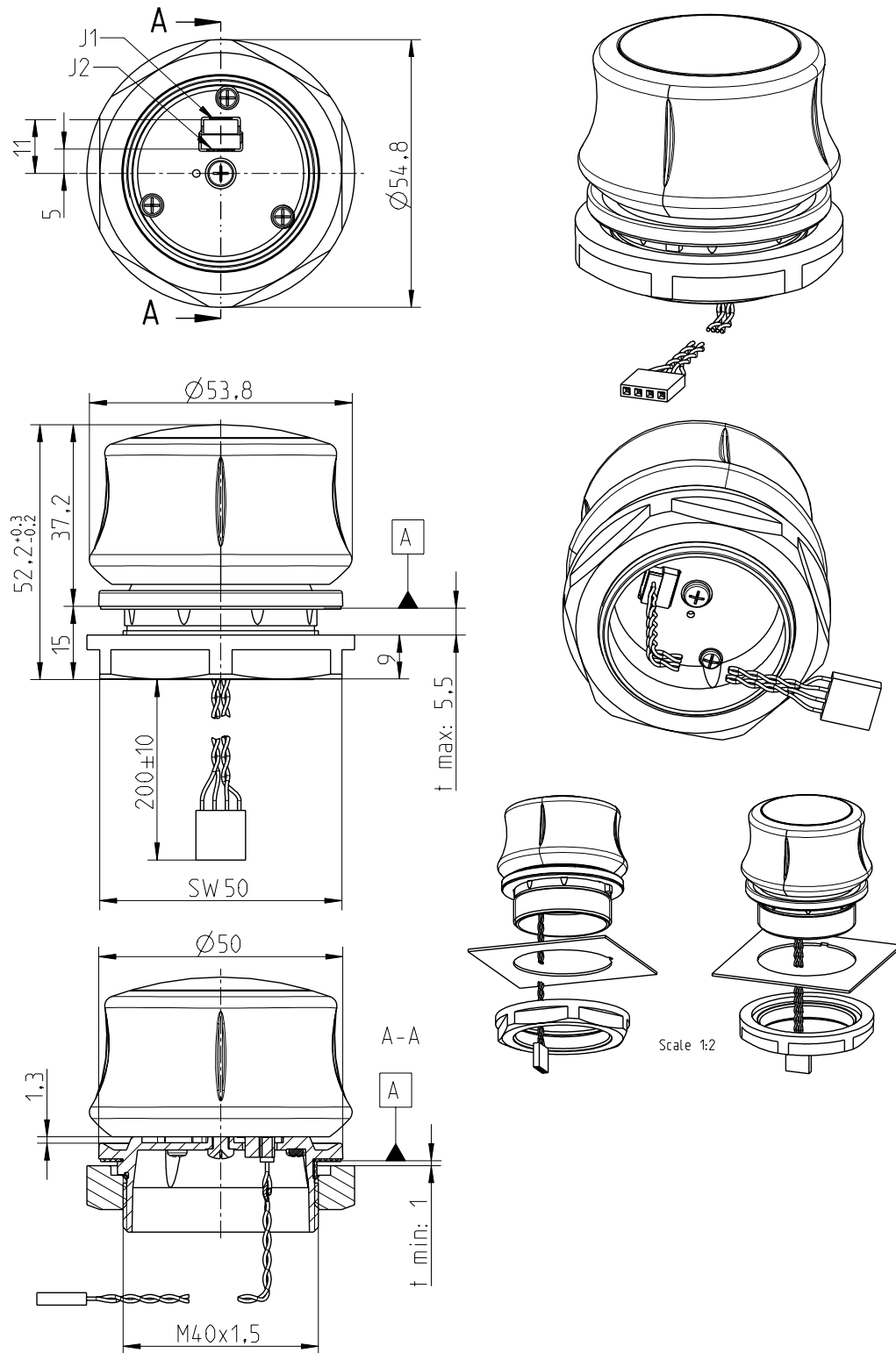
Item	Test Conditions	Specifications
<b>Controller Cap lifetime</b>	(1) Operating speed: 2-3 times/s (2) Force applied at center of cap-side: 7.4N ± 0.9N (740gf ±90gf)	Number of actuations: 1,000,000 times No functional defects for the cap actuation
<b>Drop test (only for reference)</b>	(1) Height: 100cm (2) Floor surface: Steel or concrete (3) Direction: 5 faces, except cable face (4) Number of drops: 5 (one drop per face)	No cracks or breakage (excl. cosmetic scratches). No functional defects for the buttons and Controller Cap actuation. Pop out of buttons and cap-insert is accepted when they can be pushed in again without impact to function.

## 2.4 Service Life Test (only valid for UART and USB versions)

Item	Test Conditions	Specifications
<b>Burn-In Test</b>	Expose device 24hrs to a temperature of 45°C	No functional defects, no cosmetic degeneration
<b>Mean Time Between Failure</b>	30 EA for 84 day burn-in at 45°C (can differ depending on the available resources at test lab.)	Confidence Level 80% MTBF = 150.000 hours

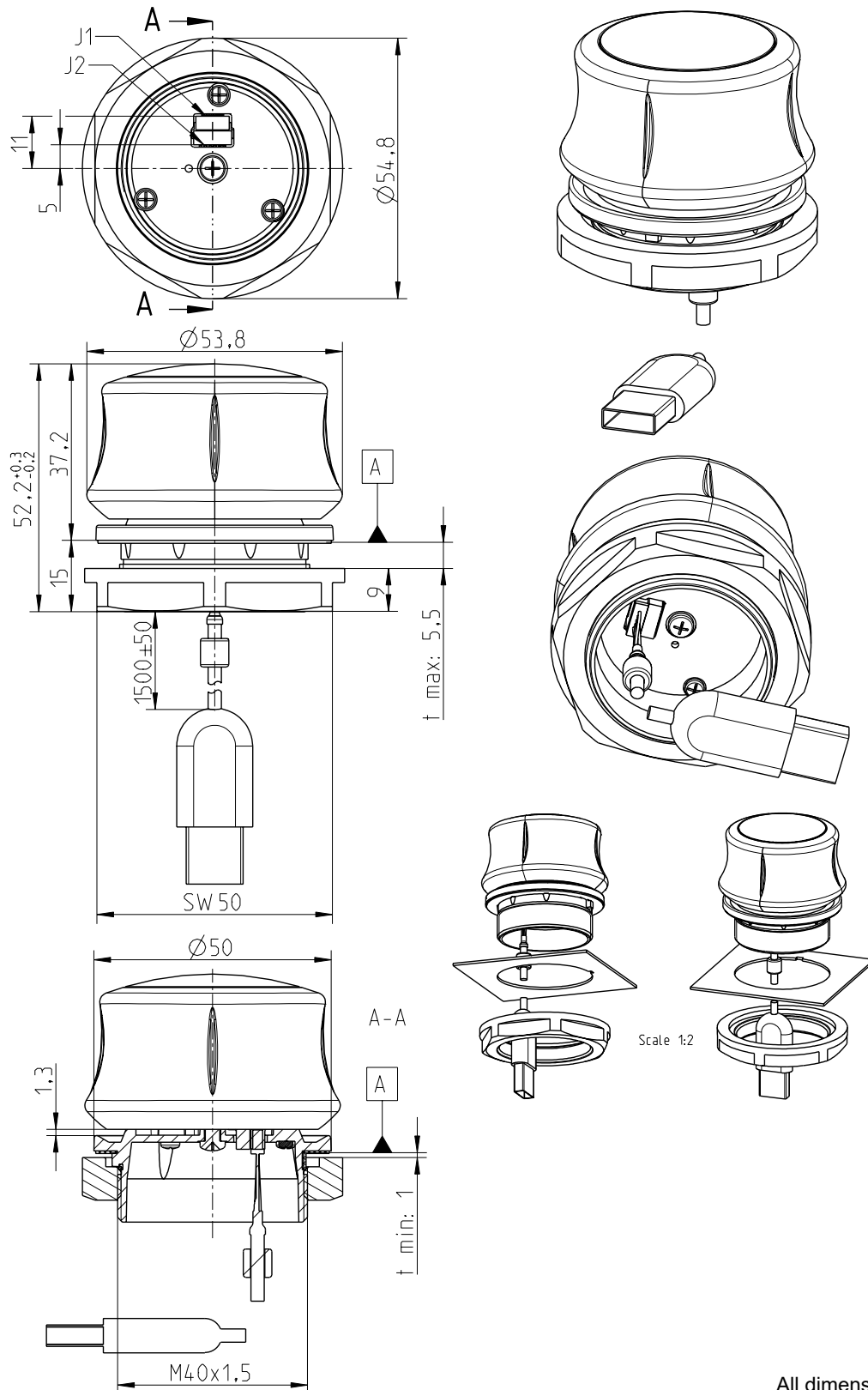
### 3 Drawings

#### 3.1 Dimensions - UART Interface



All dimensions in mm

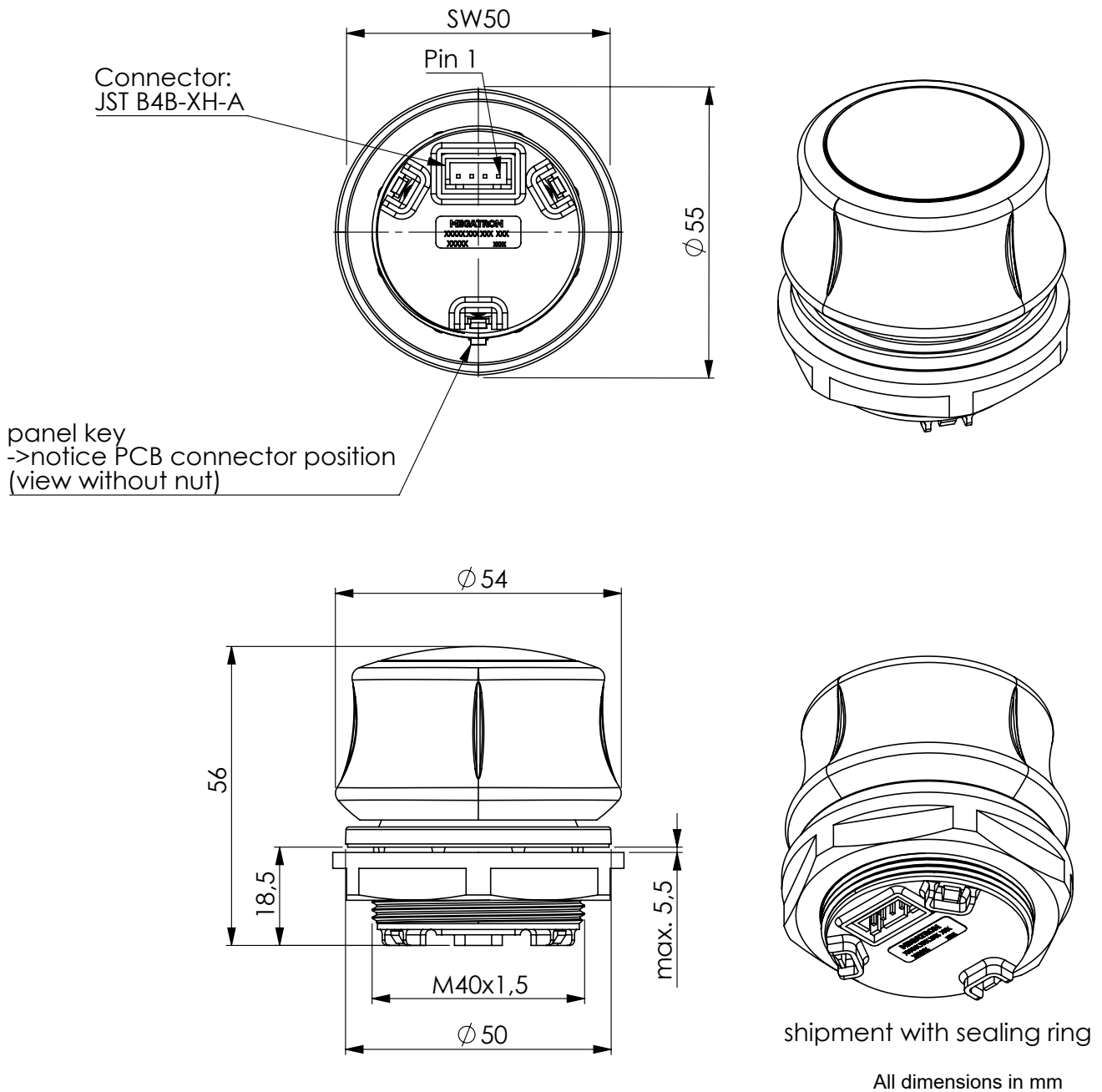
### 3.2 Dimensions - USB Interface



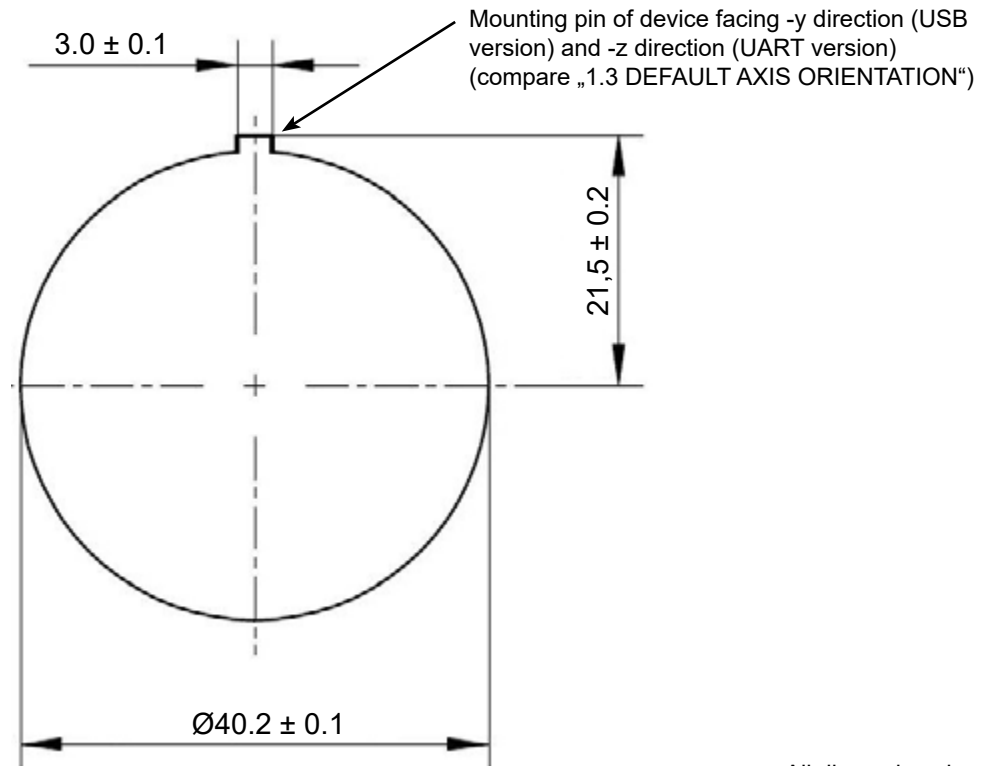
All dimensions in mm



### 3.3 Dimensions - CANopen Interface



### 3.4 Mounting Hole



All dimensions in mm

CANopen Interface  
Article number 135873

UART Interface  
Article number 131034

USB Interface  
Article number 131002



A cable (length 300 mm) with free ends can be ordered separately (art. no. 136030)



4-pin connector J1

A 4 core cable (length 20 cm) is included. For details see section 5.1.2.



5-pin connector J1

A USB cable (length 1.5 m) with type A connector is included

### 4 UART Interface Specification

#### 4.1 Electrical

##### 4.1.1 Data interface (UART) settings

The device communicates via serial interface (UART = Universal Asynchronous Receiver Transmitter). The signal levels are 0 Volt (logic 0) or VCC (logic 1), hence they are not RS232 compliant.

##### UART settings

Baud rate	38400
Data bits	8
Parity	none
Stop bits	1
Data rate	max. 100 / s

##### 4.1.1 4-Pin Connector J1

The UART Module has a 4-pin male connector with 1,0 mm grid pattern. The length of the provided 4-core twisted pair cable is 200 mm ± 10 mm. Cable connector: JST SHR-04V-S-B with crimp contact SSH-003T-P0.2 Connector on the module: JST BM04B-SRSS-TB

Pin	Function	Wire Colour
1	VCC +3.3 V to +5.0 V	red
2	TxD (output)	green
3	RxD (input)	orange
4	GND	black

##### 4.1.2 Cable

For connector to UART Module, please refer to chapter 5.1.2 „4 Pin Connector J1“

The connection to a console is achieved by a 4-pin female connector with 2.54mm grid pattern.

Pin	Function	Wire Colour
1	VCC +3.3 V to +5.0 V	red
2	GND	black
3	TxD (output)	green
4	RxD (input)	orange

# Data Sheet for Joysticks

## 3D Finger Joystick

## SpaceMouse® Module

### 4.3 Protocol

The UART Module listens to the following commands:

#### 4.2.1 Commands

Function	Command	Answer	Firmware version
Get internal test values	GET_PSD_LED	0xA1	V006 and above
Set dead band value to 0	SET_DEADBAND_ZERO	0xA2	V006 and above
Set dead band value to default (26)	SET_DEADBAND_DEFAULT	0xA3	V006 and above
Get / Set dead band value	GET/SET_DEADBAND_VALUE	0xA4	V006 and above
Get / Set axis limit values	GET/SET_AXIS_LIMIT	0xA5	V006 and above
Set axis limit values to default (350)	SET_AXIS_LIMIT_DEFAULT	0xA6	V006 and above
Enable / Disable re-zero on powerup	REZERO_ON_START ON/OFF	0xA7	V006 and above
Save dead band values to EEPROM	DEADBAND_SAVE	0xA8	V006 and above
Save axis limit values to EEPROM	AXIS_LIMIT_SAVE	0xA9	V006 and above
Re-enable module after error condition	RESET_ERROR	0xAA	V006 and above
Get version string	GET_VERSION	0xAB	V006 and above
Data request command	REQUEST_DATA	0xAC	
Zero command	SET_ZERO_POSITION	0xAD	
Start auto-data	AUTO_DATA_ON	0xAE	
Stop auto-data	AUTO_DATA_OFF	0xAF	

#### 4.2.1 Command structure

All commands are single byte commands with MSB set to logic 1.

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1	X	X	X	X	X	X	X

Each command is acknowledged by a response, each response of the 3D-Sensor is terminated by an end-byte 0x8D (MSB is set).

#### 4.2.2 UART commands

##### GET\_PSD\_LED

Function: get 14 internal measurements, only intended for production tests

Command: 0xA1

Returns: 30 bytes of data: 0xA1, V0 ... V27, 0x8D

##### SET\_DEADBAND\_ZERO

Function: Set dead band value to zero.

Command: 0xA2

Returns: 0xA2 0x8D

##### SET\_DEADBAND\_DEFAULT

Function: Set dead band value to the default value (26).

Command: 0xA3

Returns: 0xA3 0x8D

##### SET / GET DEADBAND\_VALUE

Function: Set dead band value for each axis.

Command: 0xA4 B1H B1L B2H B2L B3H B3L B4H B4L B5H B5L B6H B6L 0x8D

Returns: 0xA4 B1H B1L B2H B2L B3H B3L B4H B4L B5H B5L B6H B6L 0x8D

Function: Get dead band value for each axis.

Command: 0xA4 0x8D

Returns: 0xA4 B1H B1L B2H B2L B3H B3L B4H B4L B5H B5L B6H B6L 0x8D

The dead band values are unsigned 14-bit values coded like the axis data values

### SET / GET AXISLIMIT\_VALUE

Function: Set axis limit value for each axis.

Command: 0xA5 B1H B1L B2H B2L B3H B3L B4H B4L B5H B5L B6H B6L 0x8D

Returns: 0xA5 B1H B1L B2H B2L B3H B3L B4H B4L B5H B5L B6H B6L 0x8D

Function: Get axis limit value for each axis.

Command: 0xA5 0x8D

Returns: 0xA5 B1H B1L B2H B2L B3H B3L B4H B4L B5H B5L B6H B6L 0x8D

The axis limit values are unsigned 14-bit values coded like the axis data values.

### SET AXISLIMIT\_DEFAULT

Function: Set axis limit value to the default value (+350/-350).

Command: 0xA6

Returns: 0xA6 0x8D

### REZERRO\_ON\_START ON/OFF

Function: Enable re-zero on power up

Command: 0xA7 0x40 0x01 0x8D

Returns: 0xA7 0x40 0x01 0x8D

Function: Disable re-zero on power up

Command: 0xA7 0x40 0x00 0x8D

Returns: 0xA7 0x40 0x00 0x8D

Function: Get 're-zero on power up' setting

Command: 0xA7 0x8D

Returns: 0xA7 B1H B1L 0x8D

The setting value (0 or 1) is coded as an unsigned 14-bit value like the axis data values (see at the end of this chapter).

### DEADBAND\_SAVE

Function: Save modified dead band values in EEPROM

Command: 0xA8

Returns: 0xA8 0x8D

### AXIS\_LIMIT\_SAVE

Function: Save modified axis limit values in EEPROM

Command: 0xA9

Returns: 0xA9 0x8D

### RESET ERROR

Function: Re-enable module after error detection

Command: 0xAA

Returns: 0xAA 0x8D

### GET\_VERSION

Function: get vendor / module type / firmware revision information

Command: 171 (0xAB)

Returns: 46 bytes of data: 0xAB, V0 ... V43, 0x8D

Example String: 3Dconnexion 3DxSensor\_RS232\_KCP3\_V002\_010611

### SET\_ZERO\_POSITION

Function: sets the current position of the device as zero-position

Command: 173 (0xAD)

Returns: 0xAD 0x8D

During power-up of the device, the current position of the device is also set as the zero-position.

# Data Sheet for Joysticks

3D Finger Joystick

SpaceMouse® Module

## AUTO\_DATA\_ON

Function: starts automatic transmission of data (30 ms intervals)

Command: 174 (0xAE)

Returns: 0xAE 0x8D

## AUTO\_DATA\_OFF

Function: stops automatic transmission of data

Command: 175 (0xAF)

Returns: 0xAF 0x8D

## REQUEST\_DATA

Function: requests position data from the 3D-Sensor

Command: 172 (0xAC)

Returns: 16 bytes data

Structure: B1 B2 ... B16

Byte 1: start-byte 0x96 (150 decimal); every data set starts with this byte

Byte 2: high byte of X value

Byte 3: low byte of X value

Byte 4: high byte of Y value

Byte 5: low byte of Y value

Byte 6: high byte of Z value

Byte 7: low byte of Z value

Byte 8: high byte of A value (X rotation)

Byte 9: low byte of A value (X rotation)

Byte 10: high byte of B value (Y rotation)

Byte 11: low byte of B value (Y rotation)

Byte 12: high byte of C value (Z rotation)

Byte 13: low byte of C value (Z rotation)

Byte 14: high byte of Checksum

Byte 15: low byte of Checksum

Byte 16: end-byte 0x8D; every response ends with this byte

X, Y, Z, A, B, C values and the Checksum are transmitted as unsigned 14-Bit values. This is due to the fact, that the MSB of payload data is always cleared (logic 0).

### Calculating a value:

high byte (X) low byte (X)

14-bit value (unsigned)

$X_{\text{value}} = (\text{high byte (X)} * 128 + \text{low byte (X)}) - 8192$

### Transmitted Checksum:

$\text{Checksum}_{\text{trans}} = (\text{high byte (Checksum}_{\text{trans}}) * 128 + \text{low byte (Checksum}_{\text{trans}}))$

### Calculating the Checksum:

$\text{Checksum}_{\text{calc}} = (\text{Byte1} + \text{Byte2} + \dots + \text{Byte13}) \& 0x3FFF.$

By masking the Checksum with 0x3FFF (logic AND operation), the value is reduced to a 14-Bit value.

The value range for X, Y, Z, A, B, C values is -350 up to +350.

## 4.2.3 Hardware error detection

If some internal voltages differ from their normal operation levels all transmitted 3D values (X, Y, Z, A, B, C) are set to 0 and an error packet is sent (0xE1 B1 B2 B3 B4 0x8D). For instance, this algorithm can detect a broken spring. To reset the error condition a power off/on cycle or sending the command 'RESET ERROR' (0xAA) is needed.

# Data Sheet for Joysticks

3D Finger Joystick

SpaceMouse® Module

## 5 USB Interface Specification

### 5.1 Electrical & Protocol

#### 5.1.1 Data interface & Protocol

The SpaceMouse® Module USB is designed for USB 1.1 and 2.0. No additional power source is needed. The module acts like a standard USB joystick with 6 axes.

#### 5.1.2 5-Pin Connector J1

The USB Module has a 5-pin male connector with 1,0mm grid pattern.  
Cable connector: JST SHR-05V-S-B with crimp contact SSH-003T-P0.2  
Connector on the module: JST BM05B-SRSS-TB

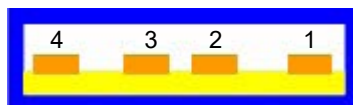
Pin	Function	Wire Colour
1	Shield	black
2	GND	black
3	VCC +5.0 V	red
4	D-	white
5	D+	green

### 5.2 Cable

For connector to USB Sensor Module, please refer to chapter 6.1.2 „5-Pin Connector J1“.

Electrical	Min	Typ	Max
Supply voltage	4.4 V	5.0 V	5.25 V
Supply current			60 mA
Suspend current			0.5 mA

Pin-out of USB connector



Pin-out of USB cable

USB Plug	Wire Colour	Pin Assigned in PCB	Signal
1	red	3	VCC
2	white	4	D- (inversed DATA)
3	green	5	D+ (DATA)
4	black	2	GND
Shell	drain wire	1	Shield

With Art.nr. 131002 a USB cable (length 1,5m) with type A connector is included

# Data Sheet for Joysticks

3D Finger Joystick

SpaceMouse® Module

## 6 CANopen Interface Specification

### 6.1 4-Pin Connector X1

The CANopen Module has a 4-pin male connector with 2.5 mm grid pattern.  
 Connector on customer side: XHP-4 with crimp contact SXH-001T-P0.6 (not enclosed in delivery)  
 Connector on the module: B4B-XH-A

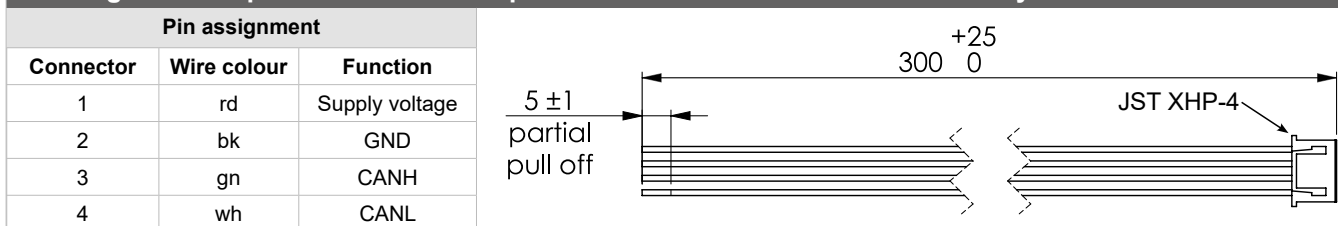
Pin	Function
1	operating voltage
2	GND, ground
3	CANH, CAN high signal
4	CANL, CAN low signal

Electrical	Min	Typ	Max
Supply voltage	4.75 V	+24 V	+28 V
Supply spikes max.			+32 (<100 msec)

### 6.2 Cable

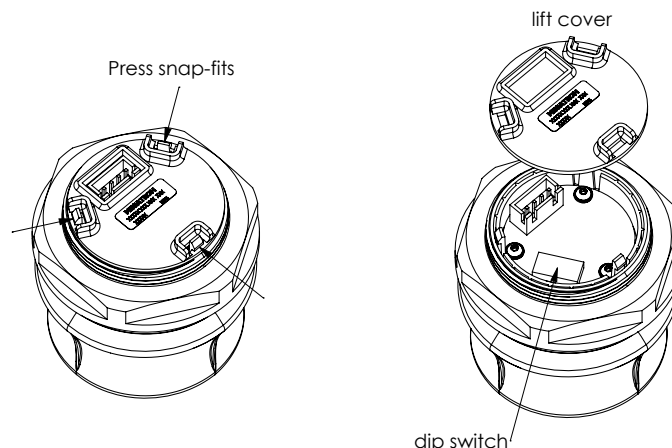
A separate connector cable is available for purchase under the part no. 136030 (strands 300+25 mm, 4-pole, AWG26).

**Drawing for CANopen cable harness – part no. 136030 – not included in delivery**



### 6.3 Changing the DIP-Switches

To change the DIP switches, please first press the snap fits and lift the cover. Close again after changing the DIP switches..



### 6.4 CANopen protocol / commands

For CANopen protocol details see separate specification document on the MEGATRON website.