Customer – Safety - Manual

MRW CAN

Order-no.: 10-02-03115

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Contents

1. General information

1.1. Changes

The text and graphic portions of this operator's manual were compiled with great care. Please notify your specialist dealer of any suggestions relative to the format and of possible errors. We will be happy to register and implement all useful remarks and suggestions for improvement.

1.2. Exclusion of liability

In order to retain our technological advantage, it may be necessary to make changes in the product and its operation without previous notification. The possibility exists that these changes may, under some circumstances, be incompatible with the operator's manual.
The manufacturer MOBA assumes no liability:

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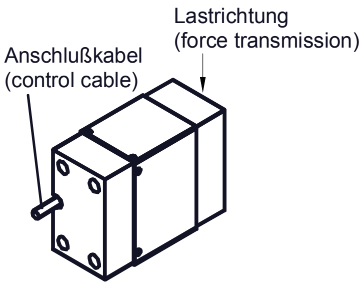
2. Definition

MRW CAN



2.1. Definition: moment - independent

Independent from the position of the load inside the working platform, the actual weight will be measured and after exceeding the configured limit values the alarms will be activated and a security switch will be opened respectively.

2.2. Definition: redundant

The load cell is designed in two channel technology, therefore the load cell meets the requirements of the norm EN280 and EN954-1 class III.
Those by the user provided superordinate limit value electronic must fulfill the standards specified above in the same way and must be checked by a notified approval body.

2.3. Patent

Protect by european **Patent 1382562**

3. Technical data:

Type:	**Single Point**
Rated capacity:	**max. 1000 kg**

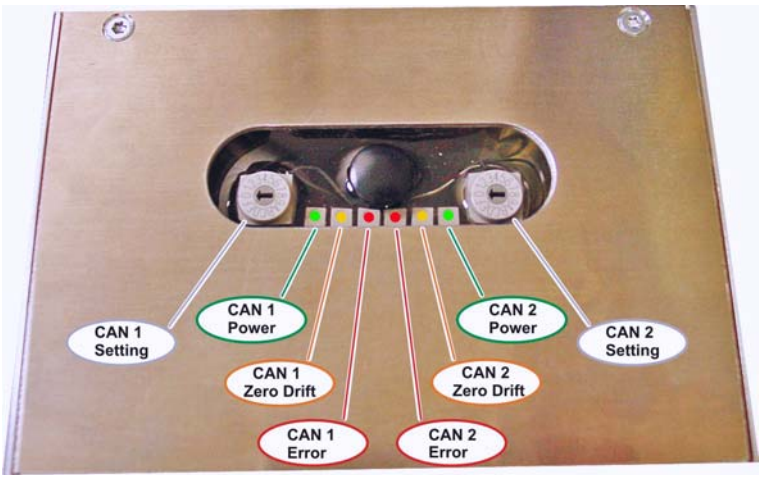
* Mechanical load and safe mechanical overload are reduced in dependency of lever arm, see: computation of company Dynatec: „Dimensioning and Load Limits“.

Electric load saving:	**150%** of rated capacity
Ambient temperature range:	**-30°C ... +70°C**
Storage temperature range:	**-40°C ... +80°C**

Combined error:	**<+/- 0,03%** of rated capacity
Maximum temperature effect on zero:	**<+/- 0,01%/ °C** of rated capacity
Supply voltage range / Current consumption:	**8,5 – 32 V (DC) / approx. 75mA**
Insulation resistance:	**> 2000 MOhm**
Enclosure protection:	**IP 67**
Weight:	**approx. 5 kg**
Material:	**AlZnMgCu1,5 F53**

4. Indicator and adjustment of CANopen parameter

With the switches **CAN1-Setting** (channel1) and **CAN2-Setting** (channel2) will set the parameters according to specific customer requirements.



The status display for channels 1 and 2 carried by the LED:

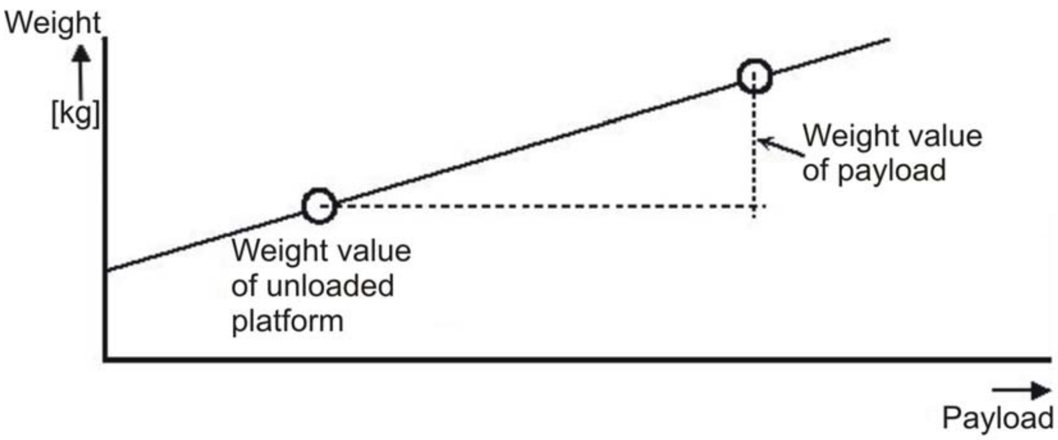
LED	Signal	Bedeutung	
Green	CAN1 Power	Continue activated: Pulsative activated:	Supply voltage OK Software active
Yellow	CAN1 Zero Drift	Continue activated:	Weight within range of +/- 15kg Control zero drift
Red	CAN1 Error	Continue activated: Flashing activated:	System alarm-redundance Platform has base contact
Green	CAN2 Power	Continue activated: Pulsative activated:	Supply Voltage OK Software active
Yellow	CAN2 Zero Drift	Continue activated:	Weight within range of +/- 15kg Control zero drift
Red	CAN2 Error	Continue activated: Flashing activated:	System alarm-redundance Platform has base contact

5. Settings of CANopen data

Specific customer settings for channel1 and 2 with the switches CAN1-Setting and CAN2-Setting.

Switch 1 and 2 position	Specific customer configuration
0	Baud rate: 250kB CAN1: Node-ID = 90 CAN2: Node-ID = 91
1	Baud rate: 125kB CAN1: Node-ID = 19 CAN2: Node-ID = 20
2	Baud rate: 250kB CAN1: Node-ID = 11 CAN2: Node-ID = 12
3…14	-
15	Via CAN-Object 3010h specific adjustment of baud rate and Node-ID

6. Taring and scaling via CANopen interface



6.1. Process of taring function

1. Release platform.
2. Command "SetTara". via CANopen interface (see chapter 7.7.2.3).
   Taring the scale and output of weight value 0kg.

6.2. Process of scaling function

Attention! Only perform if mechanically larger deviations between the channels are exist!

1. Release platform.
2. Command "SetTara" via CANopen interface (see chapter 7.7.2.3).
3. Load platform with known weight.
4. Command "Scaling" via CANopen interface (see chapter 7.7.2.3) with determination of actual payload. After calculation of the scaling factor, the actual payload is output via the CANopen interface.

7. CANopen interface

7.1. CANopen structure

CANopen is a CAN-based open protocol standard used in automation technology and has been standardised in the "CAN in Automation" (CiA) association. Like almost all field buses, CANopen is based on the ISO/OSI 7-layer model. The protocol uses the CAN bus as a transmission medium and defines the elements for network management, the use of CAN identifiers (message address), the time response on the bus, the type of data transmission, and application-related profiles. This is intended to ensure that CANopen devices from different manufacturers can be combined.
CANopen describes ISO/OSI layer 7 (Application Layer) as a communication profile that has been specified by the CiA in the standard CiA DS-301. This standard defines the type of communication for all devices. Furthermore, device and application profiles for certain device classes and applications are also defined in the CiA DS-4xx standard.

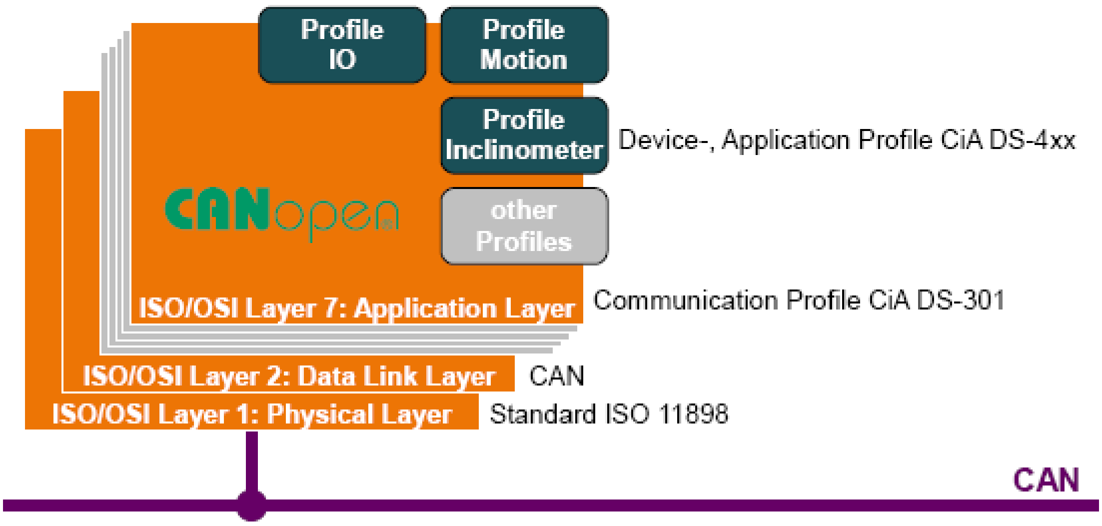


Fig. 1: CANopen structure

7.2. CANopen device model

Data is exchanged between CANopen devices using data objects. The CANopen communication profile provides the following object types for data exchange. The process data objects (PDOs) are high-priority telegrams which are used to exchange process data. Service data objects (SDOs) are used to access the parameters of the object directory of a device. Network management objects are used to control the state machine of the CANopen device and to monitor the nodes. There are also special objects for error messages (Emergency), synchronisation (SYNC) and time stamp. Each CANopen device has a CANopen object directory in which the parameters for all CANopen objects are entered.

7.3. COB IDs

The CAN identifiers of the communication objects are determined according to the pre-defined connection set at every reset (communication, application and hardware reset) depending on the set node ID. Table 1 shows the basis for calculation and the default values (node ID = 10).

Communication object	Calculation of COB ID	Default value (Node ID = 91)
NMT	0h	0h
SYNC	80h	80h
EMCY	80h + Node-ID	DBh
TPDO1	180h + Node-ID	1DBh
TPDO2	280h + Node-ID	1DBh
Default SDO (client->server)	600h + Node-ID	65Bh
Default SDO (server->client)	580h + Node-ID	5DBh
heartbeat	700h + Node-ID	75Bh

Table 1: Definition of COB IDs according to pre-defined connection set

7.4. Network management NMT

Fig. 2 shows the NMT state diagram of a CANopen device. Following initialisation, the device automatically assumes the pre-operational state. When doing so, the device sends a boot-up message. In this state, it can be configured via the object directory because the service data objects (SDOs) are already active. The process data objects are, however, still disabled.

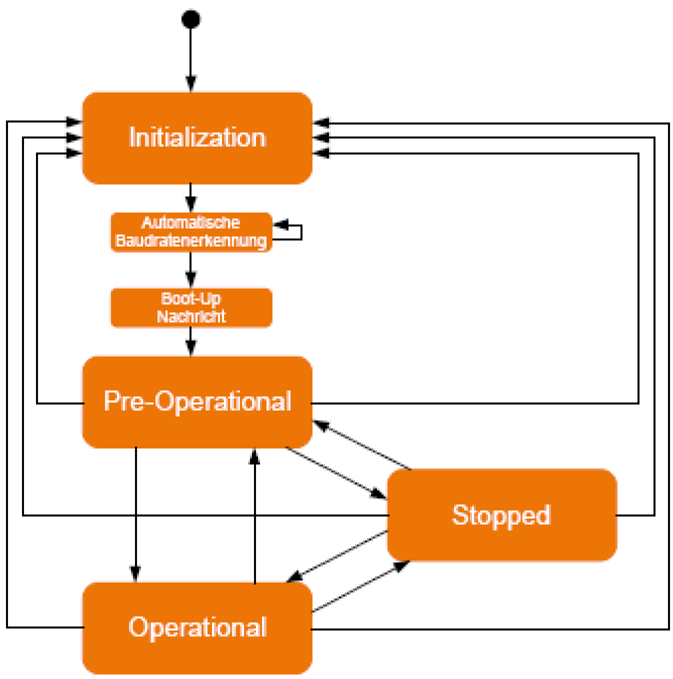


Fig. 2: NMT state diagram

7.5. Process data PDO (TPDO1)

Each channel of the redundant load cell MRW CAN has a transmit process data object (TPDO, 0x180 + node ID). This contains the current weight value + status information. PDO mapping of the measured values can be adjusted dynamically via the node ID. The default mapping is shown in table 2 and 3.

Data part of CAN telegram of TPD01							
Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Weight information				**Status Information**			

Table 2: TPDO1 default mapping

Weight information (byte 0 to 3): Format: signed long

Byte 0 = low
Byte 1 = middle low
Byte 2 = middle high
Byte 3 = high

Status information (byte 4):

Byte4	
bit 0	1: System error
bit 1	1: Motion
bit 3	1: Weight > 10kg

Table 3: Status information

7.5.1. PDO communication modes

7.5.1.1. Cyclic transmission

Cyclic transmission of TPDO1 is active if the entry 1800h/05h (interval time in milliseconds) contains a value greater than 0. Furthermore, the entry 1800h/02h (transmission type) must contain the value 254 (asynchronous, manufacturer-specific). In the OPERATIONAL state, the load cell then sends TPDO1 cyclically at the set cycle duration. The default setting is a cycle time of 1 sec.

7.6. Parameter data SDO

The parameters listed in the object directory are read and written using service data objects (SDOs). As can be seen in table 4, the object data has a 16-bit index via which a parameter can be directly addressed. In addition, each index has an 8-bit subindex which allows further selection within an index. The 8 bytes of the SDO are in the data area of the CAN message.

Byte 0:	Byte 1 to 3: Data addressing		Byte 4 to 7: 1 to 4 parameter data bytes			
Command specifier	**16-bit index**	**8-bit subindex**	**Data 0**	**Data 1**	**Data 2**	**Data 3**

	OBJECT DIRECTORY			
	Index	**Subindex**	**Description**	**Parameter**
	1000h	00h	Device type	
Upload	…	…	…	…
Download	1018h	00h	Identity Object	
Quantity		01h	Vendor ID	
Data bytes		02h	Product Code	
Request		03h	Revision number	00000001h
Response		04h	Serial number	12345678h
Abort	…	…	…	…
	6010h	00h	Weight value	512(kg)
	…	…	…	…

Table 4: SDO protocol access to object directory

7.7. Object directory

The object directory contains all data objects which are externally accessible and which influence the response of communication, the application and state machines. It is divided into three parts:

- Communication-specific part (index: 0x1000 – 0x1FFF)
- Manufacturer-specific part (index: 0x2000 – 0x5FFF)
- Profile-specific part (index: 0x6000 – 0x9FFF)

The contained parameters can be read and written by means of the default SDO using the index and subindex.
The following sections describe all of the parameters in the object directory of an MRW CAN load cell with index, subindex, data type, access right and default value (factory setting). The "Save" column indicates whether a parameter can be saved in the internal non-volatile memory (write "save" signature in OV index 1010h/01h).

7.7.1. Communication parameters

Index	Sub-index	Parameter	Data type	Access	Default value	Save
1000h	0	Device type	UNS32	const		
1001h	0	Error register	UNS8	ro	0	
1008h	0	Device name	VSTR	const	{depends on type}	
100Ah	0	Software version ("Vxx.yy")	VSTR	const	{depends on type}	
1010h	Saving parameter (Signatur: ,‘s‘,‘a‘,‘v‘,’e’ on Subindex 1)					
	0	Highest supported subindex	UNS32	ro	2	
	1	Saving all loadcell parameter	UNS32	rw	1	
1017h	0	Heartbeat interval time (multiple of 1ms, 0 deactivated)	UNS16	rw	2000ms	x
1018h	Identity object					
	0	Highest supported subindex	UNS8	ro	4	
	1	Vendor ID (manufacturer identification MOBA AG)	UNS31	ro		
	2	Product code	UNS32	ro	{depends on type}	
	3	Revision number	UNS32	ro	{depends on type}	
	4	Serial number	UNS32	ro	{depends on type}	
1200h	Server SDO1 parameter					
	0	Highest supported subindex	UNS8	ro	2	
	1	COB-ID Client -> Server	UNS32	ro	600h + Node-ID	
	2	COB-ID Server -> Client	UNS32	ro	580h + Node-ID	x
1800h	Transmit PDO1 communication parameter					
	0	Highest supported subindex	UNS8	ro	5	
	1	COB ID	UNS32	ro	180h + Node-ID	
	2	Transmission type (synchronous/asynchronous, manufacturer-specific)	UNS8	rw	1	x
	3	Lockout time between two TPDO messages (multiple of 100µs)	UNS16	rw	0	x
	4	Compatibility entry	UNS8	rw	0	x
	5	Interval time for cyc. transmission (multiple of 1ms, 0 deactivated)	UNS16	rw	100ms	x

Table 5/1: Communication parameters in object directory

Index	Sub-index	Parameter	Data type	Access	Default value	Save
1801h	Transmit PDO2 communication parameter					
	0	Highest supported subindex	UNS8	ro	5	
	1	COB ID	UNS32	ro	280h + Node-ID	
	2	Transmission type (synchronous/asynchronous, manufacturer-specific)	UNS8	rw	1	x
	3	Lockout time between two TPDO messages (multiple of 100µs)	UNS16	rw	0	x
	4	Compatibility entry	UNS8	rw	0	x
	5	Interval time for cyc. transmission (multiple of 1ms, 0 deactivated)	UNS16	rw	0	x
1A00h	Transmit PDO1 mapping parameter: Measured value					
	0	Highest supported subindex	UNS8	ro	1	
	1	Mapping entry 1, MRW CAN measured value	UNS32	rw	0x200E0120	x
	2	Mapping entry 2, MRW CAN measured value status	UNS32	rw	0x200E0220	x
1A01h	Transmit PDO2 mapping parameter: Command reply					
	0	Highest supported subindex	UNS8	ro	2	
	1	Mapping entry 1, command	UNS8	rw	0x20200108	x
	2	Mapping entry 2, error	UNS16	rw	0x20200208	x
1F80h	0	NMT startup	UNS32	rw	0x00000008	x

Table 5/2: Communication parameters in object directory

7.7.2. Manufacturer-specific part

Index	Sub-index	Parameter	Data type	Access	Default value	Save
200Eh	(TPDO1) measured value output					
	0	Highest supported subindex	UNS32	ro	21	
	1	Weight value	INT32	ro	0	
	2	Weight value status	INT32	ro	0	
2020h	(TPDO2) command reply					
	0	Highest supported subindex	UNS8	ro	2	
	1	Executed command	UNS8	rw	0	
	2	Error description	UNS8	rw	0	
2021h	Command evaluation					
	0	Highest supported subindex	UNS32	ro	2	
	1	Command code to activate a function	UNS32	rw	0	
	2	Parameter 1 for command	UNS32	rw	0	
3010h	Network setting (switch position: "F")					
	0	Highest supported subindex	UNS16	ro	2	
	1	ID	UNS16	rw	0	x
	2	Baud rate	UNS16	rw	0	x

Table 6: Manufacturer-specific part of object directory

7.7.2.1. Measured value output via TPO1 (200Eh)

The weight value is output as INT32 in increments of 1 kg (Byte 0 to Byte 3).

Byte 4 contains the status information for the weight value:

Bit 0 = System (1 = OK, 0 = system error)
Bit 1 = Motion (1)
Bit 3 = Weight > 10kg (1)

7.7.2.2. Measured value output via TPO1 (2020h)

In response to a command, the command itself is sent in Byte 1 of TPD02 and the error code in Byte 2.

The error code is defined as follows:

0 = No error, it was possible to execute command
1 = General error. It was not possible to execute command
2 = Parameter invalid
3 = It was not possible to execute command (motion or system alarm)

7.7.2.3. Command evaluation (2021h)

This object is used for external activation of a function of the load cell. A further parameter is accepted via subindex 2.
Note: Before data is written to the object 2021h in subindex 1 (command code), an optional parameter must have been written to subindex 2 (parameter).

The following commands are accepted in subindex 1:

Command	Function	Parameter	Description
01	Tare teach	-	The current weight is saved as the tare weight
02	Scaling	UNS16	Sets the weight value to the value in the parameter (1 to 1000kg)

Table 7: Command list

Example: Tare set via object 2021h, Subindex 1

No	DIR	ID (hex)	DLS	Data (hex)	Description
1	Tx	65A	8	23 21 20 01 01 00 00 00	SDO write, 2120h
2	Rx	5DA	8	60 21 20 01 00 00 00 00	SDO response, OK

Example: Error message in response via TPDO2

No	DIR	ID (hex)	DLS	Data (hex)	Description
2	Rx	2DA	2	01 00	Zero is accomplished

Example: Scaling with weight value input via object 2021h, Subindex 2

No	DIR	ID (hex)	DLS	Data (hex)	Description
1	Tx	65A	8	23 21 20 01 02 E8 03 00	SDO write, 2120h
2	Rx	5DA	8	60 21 20 02 00 00 00 00	SDO response, OK

Example: Perform scaling via object 2021h, Subindex 1

No	DIR	ID (hex)	DLS		Data (hex)	
1	Tx	65A	8		23 21 20 01 02 00 00 00	
2	Rx	5DA	8		60 21 20 01 00 00 00 00	

Example: Error message in response via TPDO2

No	DIR	ID (hex)	DLS	Data (hex)	Description
1	Rx	2DA	2	02 00	Scaling is accomplished

7.7.3. Automatic start

After power ON the status “OPERATIONAL“ is automatically active via command NMT.

No	DIR	ID (hex)	DLS	Data (hex)	Description
1	Tx	65A	8	23 80 1F 00 08 00 00 00	SDO write, 1F80h
2	Rx	5DA	8	60 80 1F 00 00 00 00 00	SDO response, OK

7.7.4. Save settings

After changing a parameter in the object directory, the objekt 1010h must be called for permanent saving.

No	DIR	ID (hex)	DLS	Data (hex)	Description
1	Tx	65A	8	23 10 10 01 73 61 76 65	SDO write, 1010h
2	Rx	5DA	8	60 10 10 01 00 00 00 00	SDO response, OK

8. Zero drift

Based on a long - terme monitoring of 103 MRW – load cells the frequency of occurrence of the zero drift has been identify.

From the experience gained may be made by a linear relationship between the zero drift and time will be expected.

The following chart shows the allocation of zero drift after 1 year:

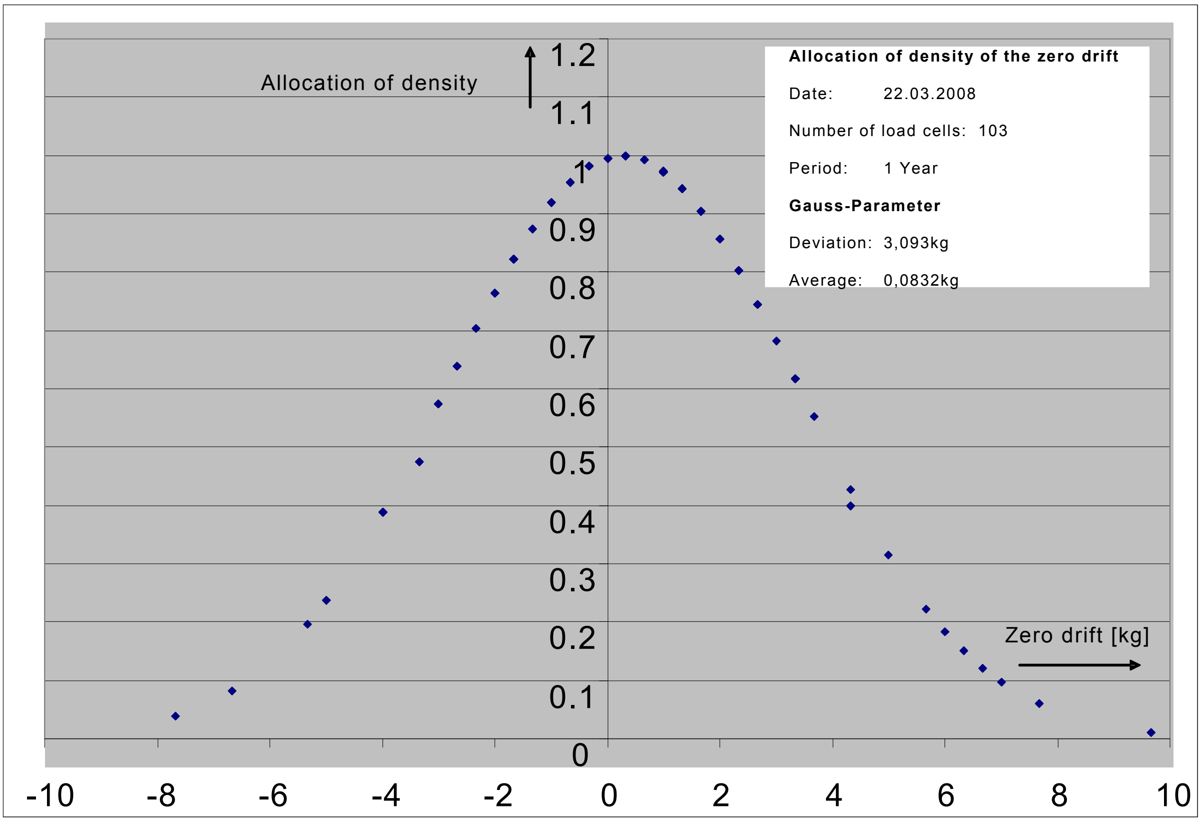


Fig.1.: Allocation of zero drift at 103 MRW load cells within 1 year

From the chart determine the following parameters:

Average = **0,0832kg** Deviation = **3,093kg**

The value **1** on the normalized Y-axis means that the zero drift most often occurred. Thus this value is zero drift averaged for all MRW – load cells (0.0832 kg) and with 100% rated. If over a larger period a larger zero drift can not be ruled out, the MRW - load cells must be at regular intervals (annually) be reviewed.

8.1. Probability of a zero drift

The following chart shows how likely a MRW - load cell within a year with more than + /- 3kg zero drift can be observed.

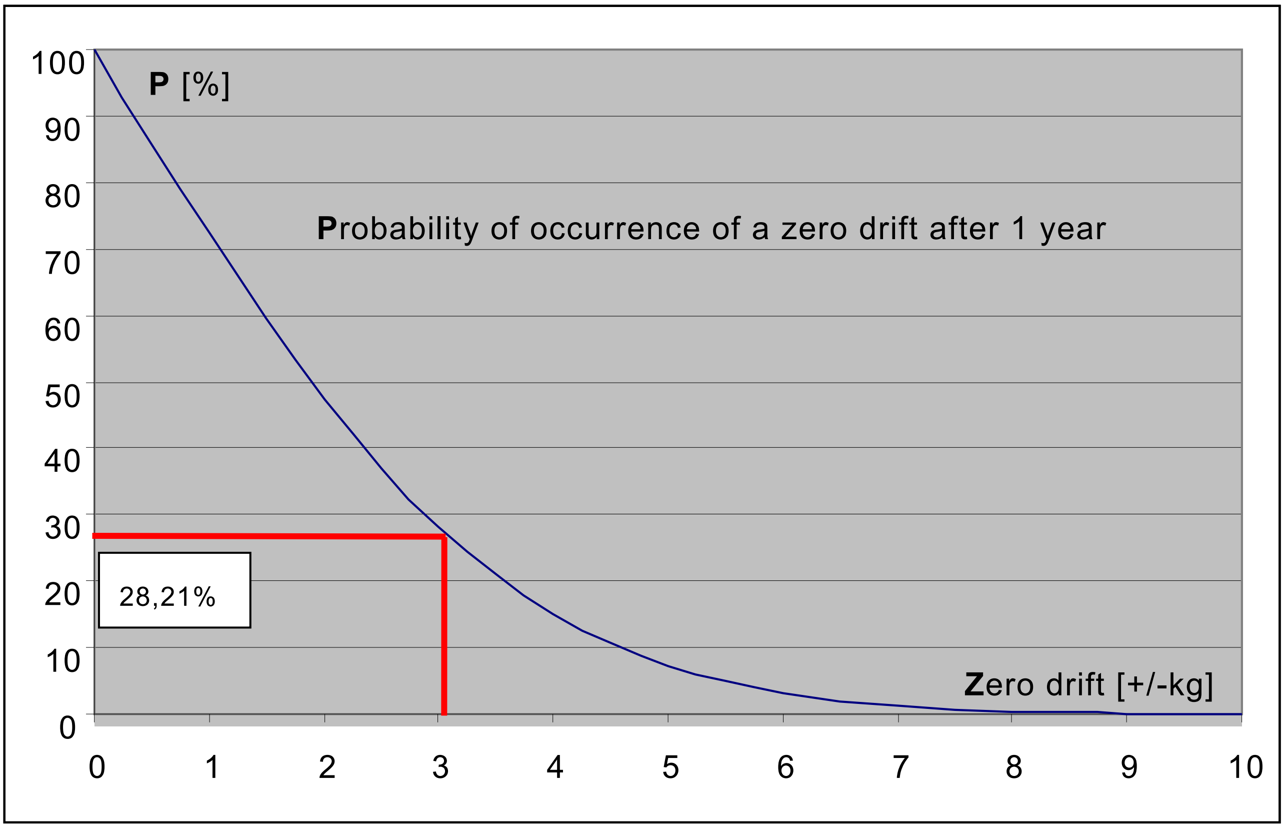


Fig.2.: Probability of a zero drift after 1 year

The probability that a MRW - load cell with more than + /-3kg zero drift in one year is observed to be approximately 28,21%.
A MRW - load cell with + /-5kg-zero drift occurs only with a probability of about 7%.

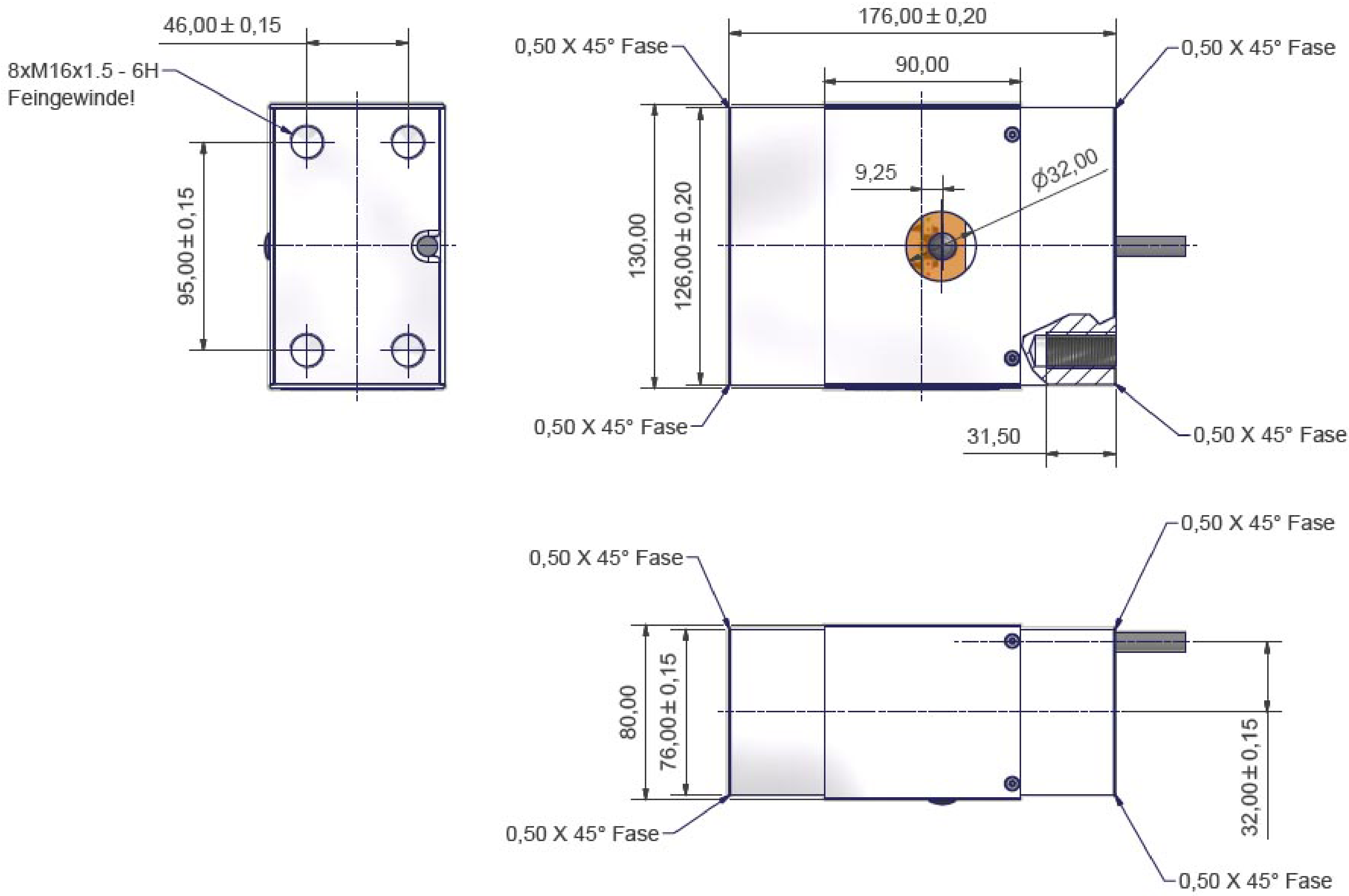
9. Inspection processes according to specific environment

The load cell is tested according the following inspection processes:

Climatical inspection process	IEC 68-2-14/33, DIN 40046
Mechanical inspection process	DIN 40046
Electromagnetic inspection process	EN 50140 100 V/m
Unit safety inspection process	EN 61010, DIN VDE 411
Insulation electric strength inspection process	DIN VDE 0682-742

10. Dimensions:

(tolerances according to) DIN ISO2768-1(2) f H



11. Connection cable

1x 5m; 8x0,22mm²; cable open:

Channel I :

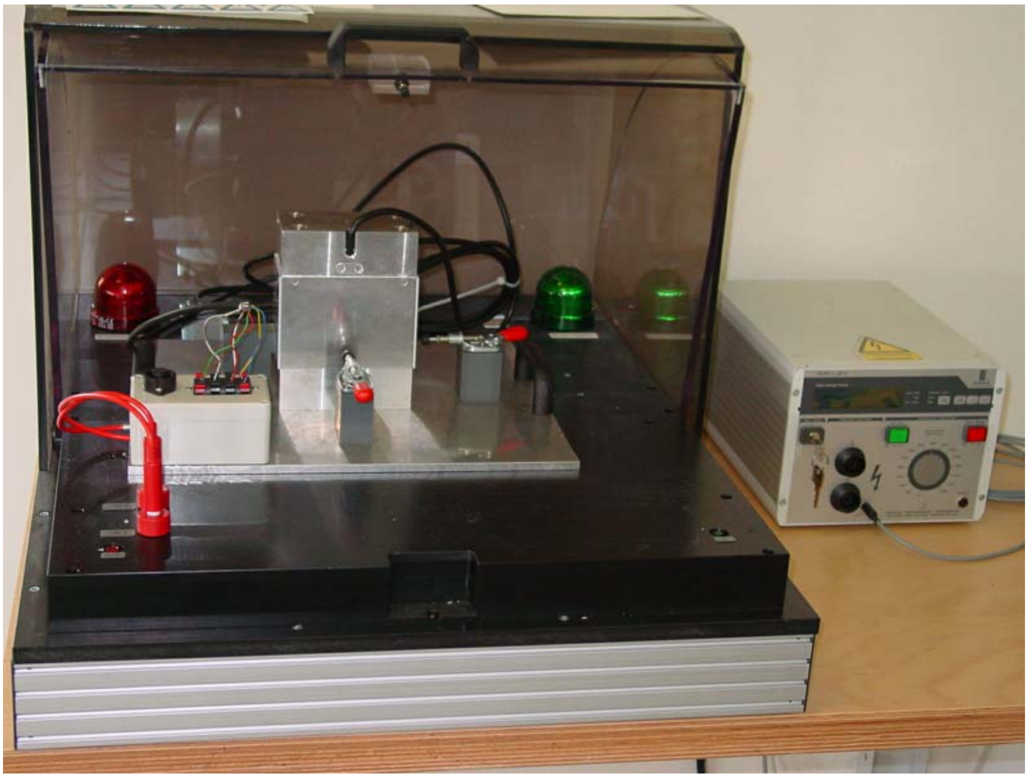
yellow	CAN1	UBatt
blue	CAN1	GND
violet	CAN1	CAN+
brown	CAN1	CAN-

Channel II :

red	CAN2	UBatt
black	CAN2	GND
white	CAN2	CAN+
green	CAN2	CAN-

12. Insulation voltage test

The cells of the MRW product line are optional available as insulated versions. Due to the insulted design of the electronic and by using special strain gauge elements this versions meets the requirements of the DIN/VDE norm 0682-742.



The test procedure can be described as follows: One pole will be connected with the housing of the cell. The second pole will be connected with the wires of the connecting cable. A alternating testing voltage of 3KV will be active for one minute (ramp 1kV/sec.). During this time no break down voltage is allowed. The leakage current of the ground wire is less than 0,3mA at an alternating voltage of 1KV and a cable length of 5 meters or less.

13. Temperature compensation

The zero point of the strain gauges full bridge circuits are depending on temperature.
This temperature effect will be compensated at the MRW CAN. Each MRW CAN will be heated up to +70°C in a climate cabinet during production. Afterwards the temperature will be cooling down slowly to -30°C. The temperature effect based to the zero point will be determined and saved for each channel of MRW CAN. The saved values provide the compensation of the temperature effect.

MRW 4-20 digital cells inside the climate cabinet

14. Limit value inspection

The application "load limitation of working platform" is a security relevant system. The norm EN 280 is referring to the norm EN954-1 class III.
The load cells of MOBA AG meets the requirements of these norms by using two channels technology.

The MRW must be checked against mechanical demages, cracks and stability of the limit values. MOBA AG is keen to describe the features of their products correctly and transparent. If further informations are needed, do not hesitate to contact us.

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Only the manufacturer of the platform lifter can determine how critical the assignment of the load control in reference to the stability of the machine might be. The manufacturer has the liability to minimise the risks by qualified maintenance in an appropriate time period.

The MRW CAN is a safety relevant product which can be used for the applications specified in the EN 280. After the installation of the safety product in aerial and working platforms according the applications of the EN280, the manufacturer must assure that the whole system is examined by an official notified approval body. Additionally the electromagnetic compatibility has to be proven. The results have to be examined by an official notified approval body as well.

With the MRW CAN, the application software is in your hands. We recommend activating a monitoring LED for the zero point. You can control this LED to have it activate in a range of +/- 15 kg (based on the tare weight of the working platform). A stable zero point is the characteristic, which shows that an entire system is functioning efficiently.

We also recommend that you schedule a simple opportunity to tare the zero point into your control concept. However, this procedure should only be performed by authorised service personnel. We recommend that the zero point be tared at each service interval.

15. Installation of the load cell

Based on the dimension data and material data the permissible leverages of the platform are to be determined. The load cell is the only friction-type connection between telescope arm and basket. During the mounting you have to take care that there is no “side-force effect”.

The load cell will be mounted with 4 bolts **M16 x 1,5** on each side. The bolts have to meet property class **8.8 at least.** The inside thread should be filled by the bolts up to a depth of 20mm to 25mm. Recommended is a length of 25mm to 30mm per bolt. For reason of stability and starting torque, **don’t use** bolts of **stainless** steel.
The bolts must be of **zinc-plated** or **chromated** material. MOBA AG recomments a positive locking mounting.

An additional mechanical breaking protection must be installed for safety relevant reasons by the manufacturer of the platform. The breaking protection is to be designed and mounted that it reliably carries the platform after a break of the load cell. Fixing the cable of the MRW a minimum radius of 50mm is required.

MOBA AG as manufacturer of electronic components is not able to estimate the application typically assembling of the MRW load cell. On this account the assignment of additional mechanical breaking protection is published.
The renouncement of the use of a breaking protection of own responsibility is released to the manufacturer of the platform.
The manufacturer of the platform bears the responsibility application-conditioned risks to estimate and by suitable arrangements to minimize!
For this purpose MOBA refers to the customer safety manual and in the special to the documentation of the company Dynatec.

16. Additional mounting remark to the fastening torques

The load cell will be screwed with 4 bolts M16×1.5 on each front. The maximum serviceable thread length of the load cell is 31mm. The bolts have to meet property class 8.8 at least. The required length of engagement of the internal thread must be least 20mm to 25mm, recommended is a length of 25mm to 30mm. Particularly in the occurrence of heavy bending loads the full capacity of the thread length should be used. In case of repeated assembling it must be assured that the state of the thread is absolutely faultless.
If a liquid locking feature is provided only semi-stiff products can be recommended (e.g. LOCTITE 243).

Unscrewing the bolted joint via heating may lead to a loss of resistance and can damage the load cell.
In case of heavy shearing or bending loads the bearing stress of the bolts is inferior to that of the load cell MRW 1000.

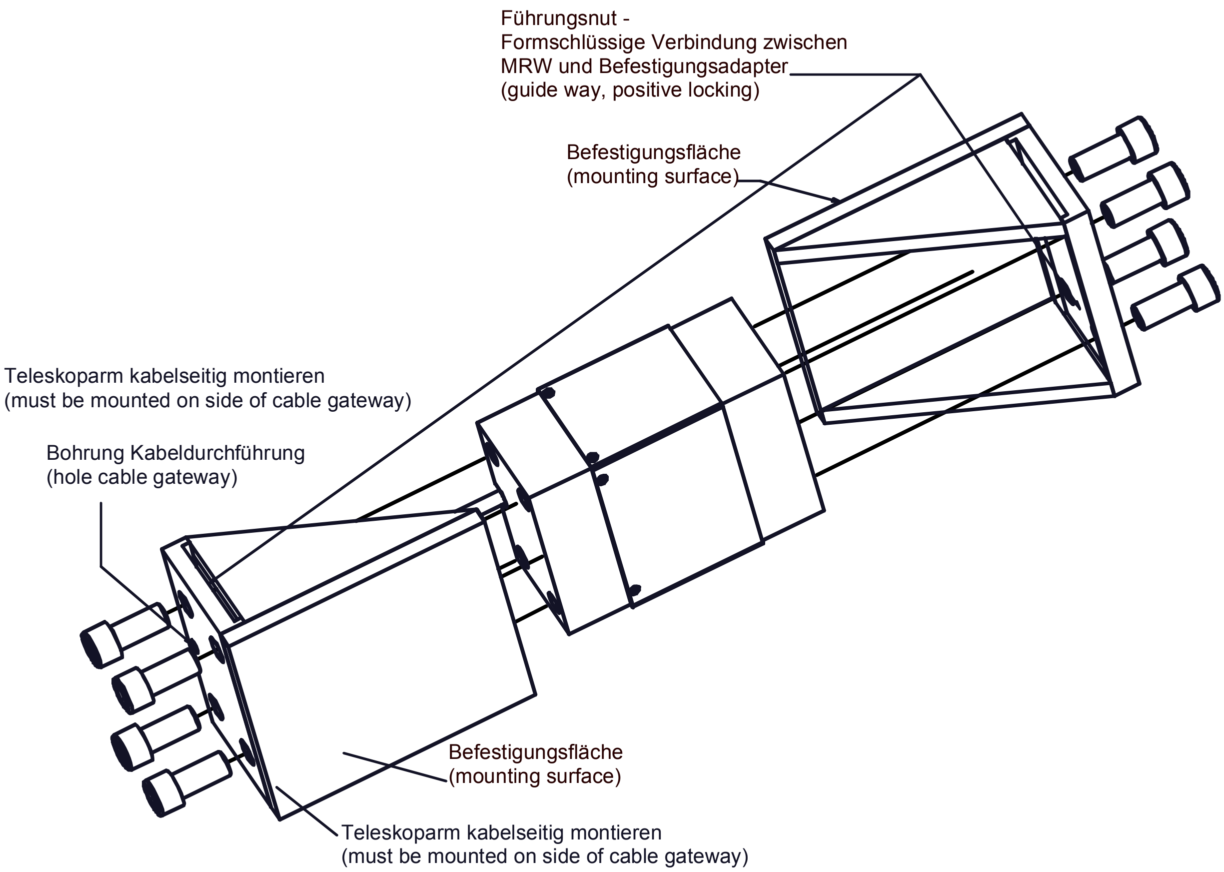
Therefore the constructive design of the connection and the bolted connection between MRW and Lifting arm is the determining point for the safety of the hole system, for this the user takes the full responsibility.
MOBA can't give general values of the fastening torques, because they are basically determined by the constructive design.

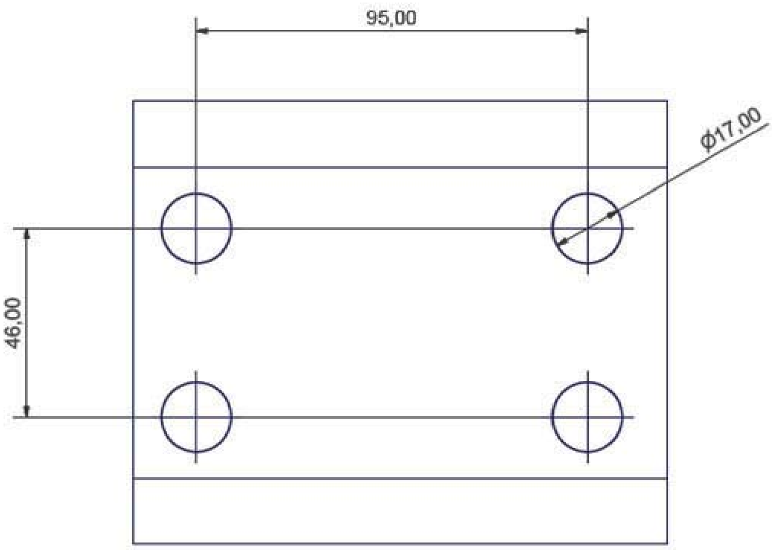
Heavy shear forces or torsional loads normally require a positive connection whereat relative movements between the inner interfaces must be avoided.
Not the resistance of the load cell but the verification of the counter flange construction can (in many cases will) limit the allowable load! The load cell in that case can be handled as a nut.

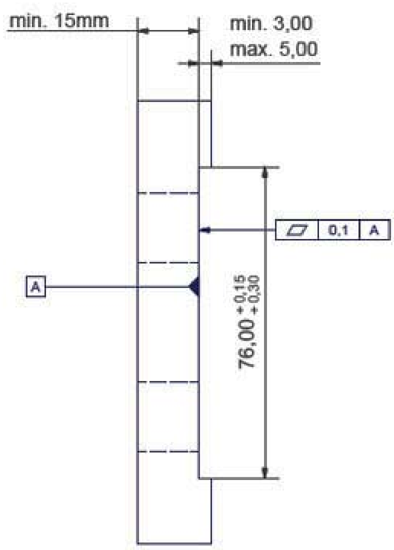
The counter flange should be designed as stiff as possible to avoid additional stresses in the connection due to large deflections. Particularly for heavy **dynamic loads** the use of a steel plate with a **sheet thickness of 15mm is recommended**. In case of thinner sheets additional bracing (e.g. ripping) is necessary to avoid bending moments on the bolts. Plane bearing areas (surface evenness under 0,2mm) and a sufficient preload of the bolts must be assured by the user.
The counter flange construction has to be verified by the user of the load cell.
This implies the verification of the bolted joints and therefore the choice of the required fastening torques!

17. Positive locking mounted

Recommendation of a positive locking connection of platform and load cell.

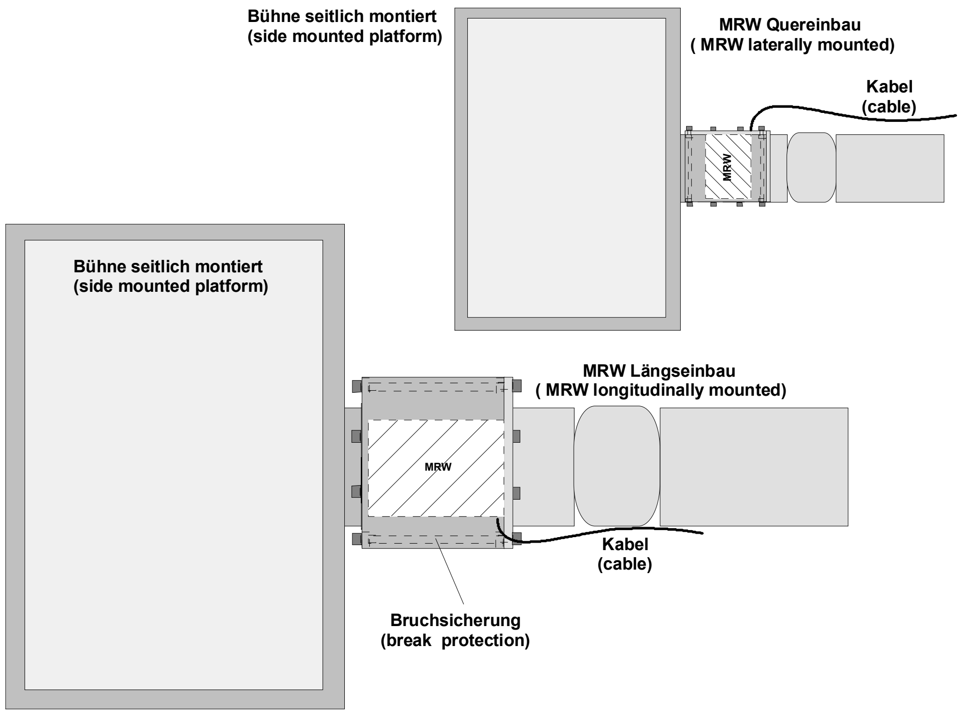


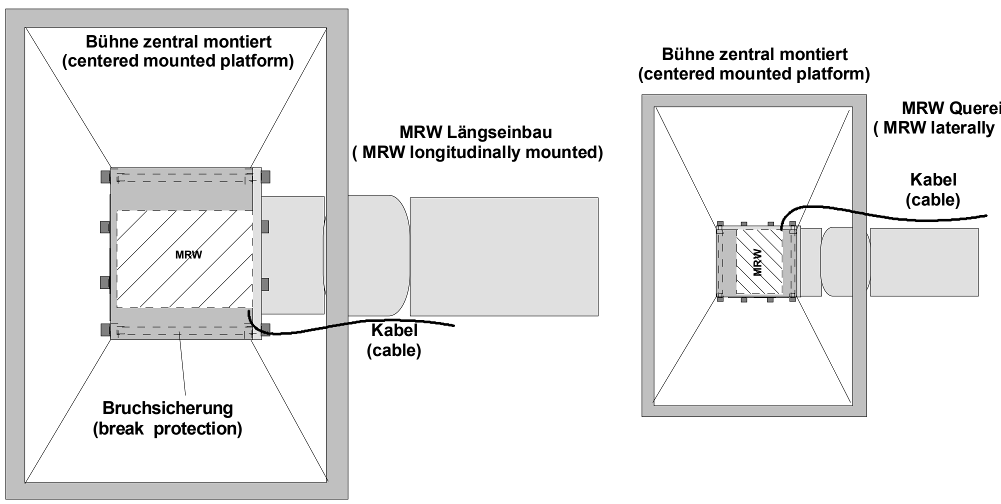




18. Installation suggestions

Suggestions of different MRW mountings





19. Instruction Sheet for Load Cell MRW CAN, Dimensioning and Load Limits Revision A

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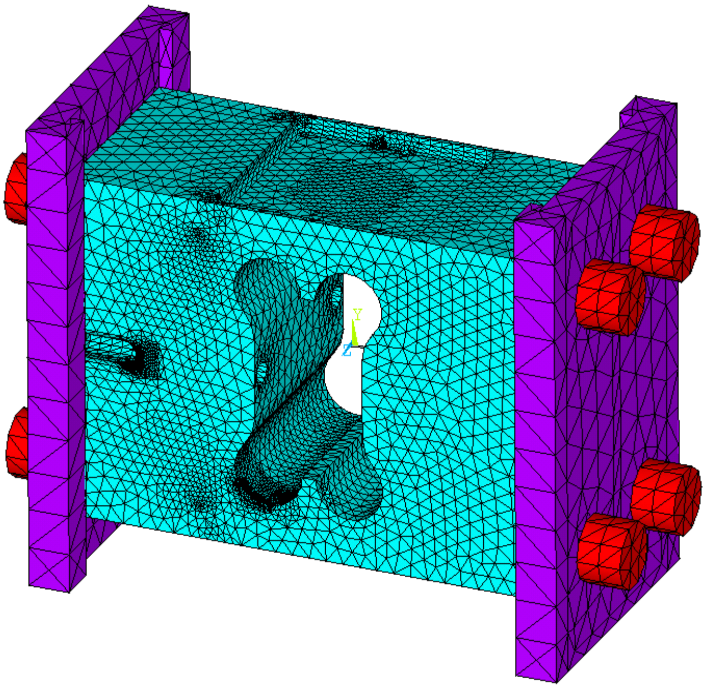

Client: MOBA Mobile Automation AG
Postfach 2161
D-65542 Limburg

Date: 29/03/2007

19.1. General

Most modern FEM simulation technology (software ANSYS Release 6.1) was used to optimise the load cell MRW 1000 (made of Aluminium AlZnMgCu1.5 status F53) and to determine the maximum allowed loads. Linear analyses as well as non-linear analyses including contact with separation and plastic material behaviour were carried out. Figure 1 on page 2 exemplifies one of the meshed models with particular fine discretisation of higher stressed areas. Simulation technology allows to determine deflection, stress and deformation for different load cases and to visualise the results via contour display (figure 2). Thereby weak points can be detected and the load cell can be optimised concerning strength and measuring behaviour.

19.2. Mounting

The load cell will be screwed with 4 bolts M16×1.5 on each front. The maximum serviceable thread length of the load cell is 31mm. The bolts have to meet property class 8.8 at least. The required length of engagement of the internal thread must be least 20mm to 25mm, recommended is a length of 25mm to 30mm. Particularly in the occurrence of heavy bending loads the full capacity of the thread length should be used. In case of repeated assembling it must be assured that the state of the thread is absolutely faultless. If a liquid locking feature is provided only semi-stiff products can be recommended (e.g. LOCTITE 243).

Unscrewing the bolted joint via heating may lead to a loss of resistance and can damage the load cell.

In case of heavy shearing or bending loads the bearing stress of the bolts is inferior to that of the load cell MRW 1000. Heavy shear forces or torsional loads normally require a positive connection whereat relative movements between the inner interfaces must be avoided.

Not the resistance of the load cell but the verification of the counterflange construction can (in many cases will) limit the allowable load!

The counterflange should be designed as stiff as possible to avoid additional stresses in the connection due to large deflections. Particularly for heavy **dynamic loads** the use of a steel plate with a **sheet thickness of 15mm...20mm is recommended.** In case of thinner sheets additional bracing (e.g. ripping) is necessary to avoid bending moments on the bolts. Plane bearing areas and a sufficient preload of the bolts must be assured by the user.

The counterflange construction has to be verified by the user of the load cell.

This implies the verification of the bolted joints!

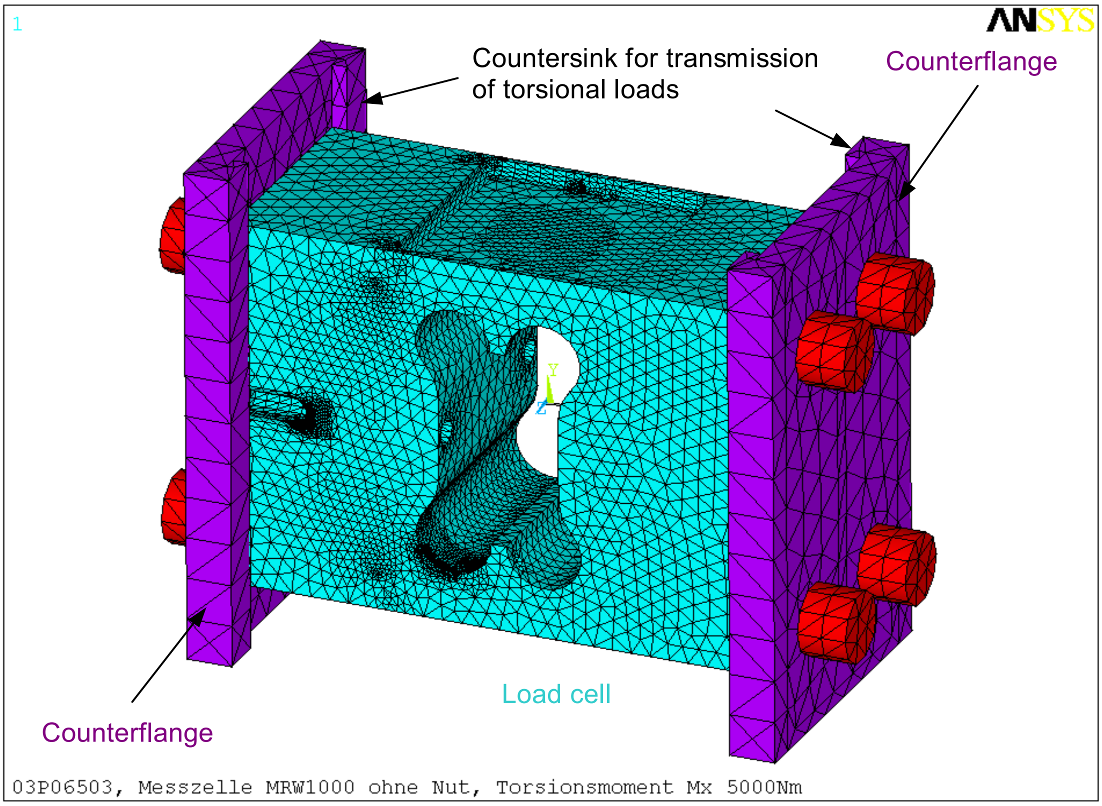

Figure 1: FEM-model of the load cell with counterflange construction.

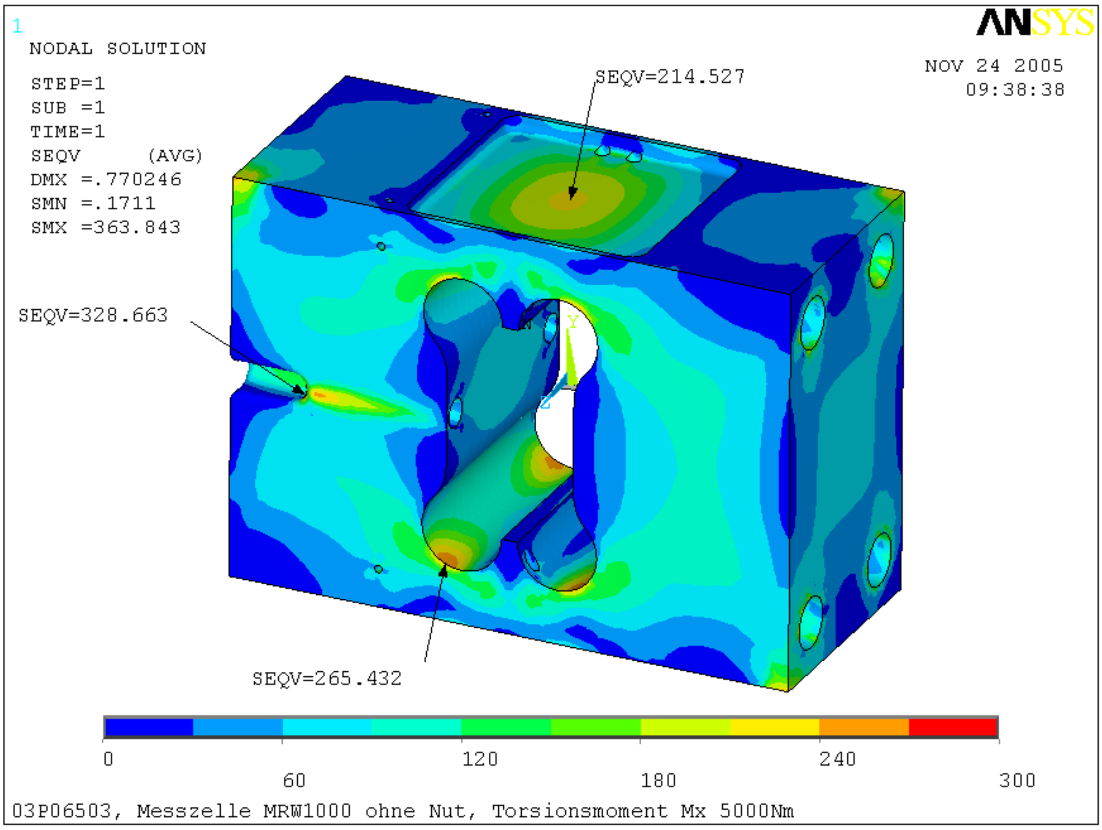

Figure 2: Graphical analysis on a contour display.

19.3. Allowed static loads

The measuring range of the load cell MRW 1000 is 1000kg. Depending on load position and additional loads, e.g. loads from operations outside the platform, wind loads etc., the measuring range can not always be fully utilised due to mechanical reasons.

According to figure 3 the user of the load cell has to determine value and point of application of the force components in three orthogonal directions for all relevant load cases. Factors of safety on the loads due to the according standards have to be taken into account. If necessary a dynamic factor has to be included.

For dimensioning according standards and dynamic factors (if necessary) have to be taken into account!

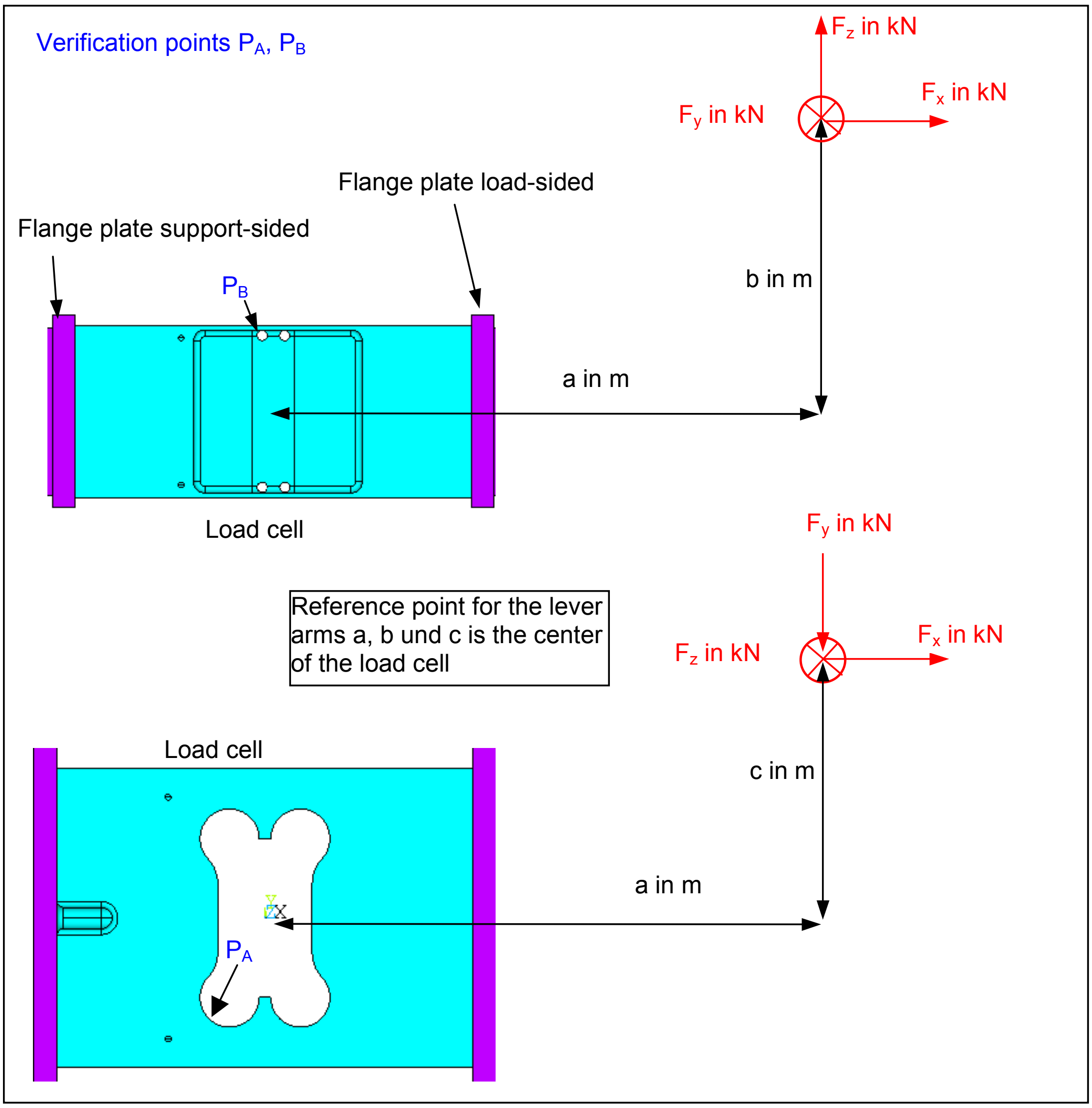

Figure 3: Definition of force direction and lever arms in case of excentric application of loads and naming of verification points.

The next step is to determine the stress at the 4 verification points P_A to P_D. Furthermore it has to be verified that the stresses are below the yield strength of $R_{p0,2}$=450N/mm² including a factor of safety of 1.25. Therefor the absolute values of the forces $|F_x|$, $|F_y|$ and |Fz| in kN and the lever arms |a|, |b| and |c| in m according to figure 3 have to be inserted in the formulas "verifications":

Verifications

$$\sigma_A = F_x \cdot (2 + 63 \cdot b + 10 \cdot c) + F_y \cdot (5.1 + 10 \cdot a + 53.5 \cdot b) + F_Z \cdot (2 + 63 \cdot a + 53.5 \cdot c) \leq 360\,\text{N/mm}^2$$

$$\sigma_B = F_x \cdot (1 + 105 \cdot b + 28.5 \cdot c) + F_y \cdot (3.7 + 28.5 \cdot a + 29 \cdot b) + F_Z \cdot (1 + 105 \cdot a + 29 \cdot c) \leq 360\,\text{N/mm}^2$$

$$\frac{R_{p0,2}}{\gamma_m} = \frac{450\text{N/mm}^2}{1,25} = 360\,\text{N/mm}^2$$

Attention: For lever arms less than 0.25m these proofs might be met as well for loads F_y>25kN (corresponding 2500kg).

In any case a maximum load of $F_y \leq 25$kN must not be exceeded!

A margin of safety >25% versus local yielding exists if the terms „verifications“ are all met and the maximum load does not exceed 25kN.

If loads exceed the terms above more than 25%, local plastic deformation will result. In case of minor overload this must not immediately affect the calibration of the load cell or lead to serious damage. Higher overloads should be avoided in any case (e.g. by means of bed stops).

In case of a single vertical force F_y with the distances (a) and (b) from the load cell centre, a simplified dimensioning using design table 1 on page 5 is allowed. Allowed loads are indicated in kg (1kg corresponds to 10N). The grey marked cells in the table indicate the load range where the mechanical load capacity exceeds the electric measuring range.

Important Information:

Table 1 contains the allowed loads solely for the load cell. A sufficient dimensioning of the counterflange construction including the bolts has to be verified separately!

DESIGN TABLE
for load cell
MRW CAN

		Cantilever a in m (→ bending stress)												
		0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Cantilever b in m (→ torsional stress)	0.00	2500	2500	2011	1440	1121	918	778	674	595	533	482	440	405
	0.25	1957	1725	1434	1118	916	776	673	594	532	481	440	404	375
	0.50	1136	1053	982	914	774	672	593	531	481	439	404	374	348
	0.75	800	758	721	687	656	592	530	480	438	404	374	348	326
	1.00	617	592	569	548	528	509	479	438	403	373	348	325	306
	1.25	503	486	470	456	442	429	416	403	373	347	325	306	288
	1.50	424	412	401	390	380	370	361	352	344	325	305	288	273
	1.75	367	358	349	341	333	326	318	312	305	299	288	272	258
	2.00	323	316	309	303	297	291	285	279	274	269	264	258	246

Table 1: Allowed loads for the load cell in vertical (y-)direction with different points of application, load in kg.

- Table 1 is only valid in case of exclusive action of a vertical force component F_y .(1kg excites a weigth F_y=10N)
- **Important:** The bolted joint must be verified seperatly.
- A factor of safety 1.25 versus local yielding of AlZnMgCu1.5 F53 is taken into account.
- Required factors of safety for the loads have to be taken into account additionally

A factor of safety about S>2 versus collapse of the load cell (disregarding the counterflange construction) exists if the allowed loads are determined according to table 1.
The counterflange construction has to be verified separately by the user of the load cell. This implies the verification of the bolted joints!

19.4. Dynamic strength

To verify the dynamic strength of the load cell, tests with a 2m lever arm have been carried out. Load has been applied with swelling (bending and torsional load) as well as with alternating Amplitude (torsional load). It was shown that a sufficient dimensioning of the counterflange is required to avoid a preterm collapse of the bolts (not the load cell!) due to bending load.
In all tests a damage of the cell (cracks) was signalised by an increasing difference between redundant measuring signals and the appearance of significant measuring errors. Due to an advanced crack (crack length > 10mm) the load cell signal was multiplied by factor 2 to 3 compared to the real torsional load. In this case the load did not fulfil the collapse-criteria due to Table 1. That means for the user:

In case of significant divergences higher than 100N (10kg) between the two measuring channels or in case of obvious divergences to the real load of both channels the load cell has to be examined for cracks immediately!

100.000 cycles with a dynamic (double) amplitude of 70% of the static amplitude did not lead to any visible damage of the cell. This applies as well for alternate load.
Despite the positive results of the dynamic testing and the perceptibility of damage due to measuring signals the typical fatigue behaviour of aluminium demands the following consideration:

In case of large dynamic load fractions, an antifall system for the platform is highly recommended!

20. Declaration of conformance

KONFORMITÄTSERKLÄRUNG

Declaration of Conformity

Declaration de Conformité

This corresponds to EN ISO/IEC 17050-1

Wir / We / Nous

MOBA Mobile Automation AG
Kapellenstraße 15
D-65555 Limburg (Germany)

erklären in alleiniger Verantwortung, dass das Produkt
declare under our sole responsibility that the product
déclarons sous notre seule responsabilité que le produit

04-04-00590 MRW CAN, isoliert
04-04-00595 MRW CAN, nicht isoliert

auf das sich diese Erklärung bezieht, mit den folgenden Normen übereinstimmt
to which this declaration relates is in conformity with the following standards
auquel se réfère cette déclaration est conforme aux normes

EN 13309 (2010)

verified standards

EN55022, Class B (2008-5)

EN61000-4-2 (2009-12)

EN61000-4-3 (2011-04)

EN61000-4-4 (2010-11)

EN61000-4-6 (2009-12)

ISO 7637-2 Puls 1, 2, 2b, 4, 5 (2011-03)

gemäß den Bestimmungen der Richtlinie
following the provisions of Directive
conformément aux dispositions de Directive

Electromagnetic compatibility 2004/108/EC

Limburg, den 12.03.2013

I.V. Matthias Weber
Leiter Qualitätsmanagement

21. Reliability of the load cell

Mean time to dangerous failure ($MTTF_d$) calculation

Project definition:

Manufacturer:	MOBA Mobile Automation AG Kapellenstraße 15 65555 Limburg (Germany)
Project:	MRW – CAN
Description:	Moment – Independent Redundant Load Cell Load cell MRW-CAN 2 x CAN OPEN output
Version:	V1.1.0
Note:	$MTTF_d$ relates to one of two redundant channels

Conditions:

Analysis method:	"Parts Count" method over all components assuming 50% dangerous failures
Data collection:	MIL-HDBK-217F-Notice 2 and manufacturer information
Conditions:	Normal operating conditions for environment and temperature
Environment:	Ground, Mobile
Temperature:	25 °C
Operating time:	Round the clock
Component stress:	Mean stress on components (not according to the circuit diagram)

$\lambda_d \rightarrow 1.0915$ FIT/10^{10} hrs

$MTTF_d \rightarrow 104.4$ years

Comment: If the $MTTF_d$ value is greater than 100 years, this value is limited to 100 years for further $MTTF_d$ calculations or performance level considerations in accordance to DIN EN ISO 13849-1.

22. Remark

Technical changes are subject to alteration!

Support:

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Engineering:	Norbert Lipowski	+49 6431 9577185