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MCE2035 PROFIBUS DP MODULE

Transfer the status and weight of digital loadcells

Applies for:

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2) INTRODUCTION

2.1 Introduction

This document describes the use of a MCE2035 Profibus-DP module from Eilersen Electric, when it is equipped with the program listed on the front page.

With the program specified on the front page, the MCE2035 Profibus-DP module is capable of transmitting weight and status for up to 4 load cells in a single telegram. Each load cell is connected to the Profibus-DP module through a load cell interface module.

It is possible to connect the MCE2035 Profibus-DP module to a Profibus-DP network, where it will act as a slave. It will then be possible from the Profibus-DP master to read status and weight for each of the connected load cells. Functions as zeroing, calibration and calculation of system weight(s) **must** be implemented on the Profibus-DP master.

By use of DIP-switches it is possible to:

- select measurement time.
- select scaling.
- include one of 3 different FIR filters.

Exchange of data between master and slave takes place as described in the following.

2.2 Profibus-DP specification

The MCE2035 Profibus-DP module confirms to the following Profibus-DP specifications:

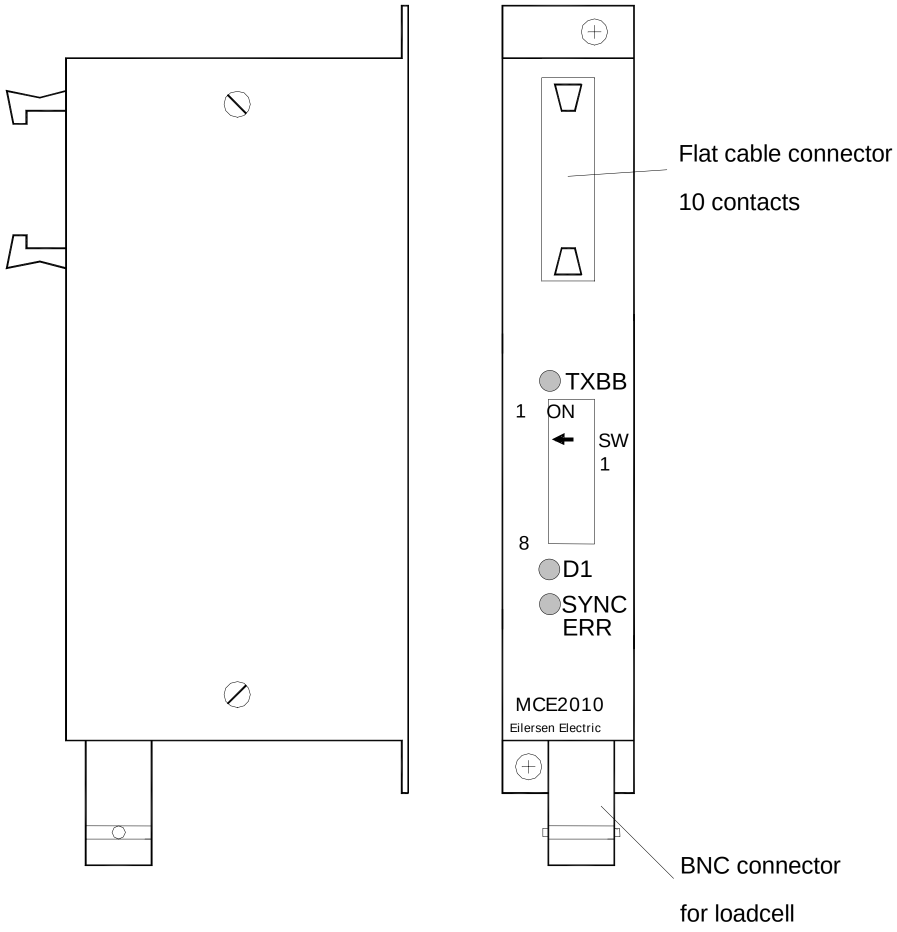
Protocol:	Profibus-DP
Communications form:	RS485
Module type:	Slave
Baud rates [kbit/sec]:	9.6, 19.2, 93.75, 187.5, 500, 1500, 3000, 6000, 12000
Profibus address:	0-127
Profibus connection:	9-pin sub-D (female) connector

IMPORTANT: Load cell modules and instrumentation <u>must be placed outside the hazardous zone</u> if the load cells are used in hazardous ATEX (Ex) area. Furthermore, only ATEX certified load cells and instrumentation can be used in ATEX applications.

3) MCE2010 DESCRIPTION

Below the layout of the MCE2010 load cell module is shown. Before using the system the load cells must be connected to the load cell modules.

*Please notice that the load cell and the load cell module **MUST** be marked with the same year/serial number. These are printed on the type-plate of the load cell and on a small sticker placed below the BNC plug on the load cell module. Load cells and load cell modules **MUST NOT** be intermixed because the program in each load cell module is **SPECIALLY** adapted to one load cell only (and only this load cell). The load cell module **MUST** be connected to exactly the load cell it is intended for and vice versa.*



The load cell modules are connected to each other using the supplied cable (10 pole ribbon cable). The MCE9601 terminal module (the one with connection terminals) and the MCE2035 Profibus-DP module are connected using the same cable.

All switches (SW1) in the load cell module must be at the correct position before use.

Please notice that the switches (SW1) are only read once during power-up. If a change in the switch setting is necessary the power has to be disconnected and then reconnected (after 10 seconds). Then the MCE2010 load cell module recognizes the new switch setting.

The switches SW1.1 to SW1.4 are used to select different modes of operation. The below table is valid for the normal standard software in the load cell module. Unless expressly specified, the default settings must normally be used.

MCE2010 SW1.1 to SW1.4		
SW1 No	**Default setting**	**Function**
1	OFF	Baud rate OFF: 115200 ON: 230400
2	ON	Filter, MSB
3	ON	Filter, LSB
4	OFF	Not used

Switch SW1.5 to SW1.8 are used for address selection. All load cell modules must have unique addresses ascending from 0 with no gaps unless expressly specified otherwise. No addresses may be skipped and no addresses may be used by more than one load cell module. In systems with 1-8 load cells switch SW1.5 must be set to OFF.

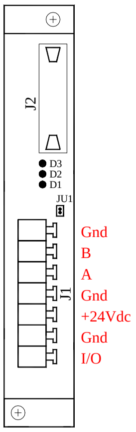
MCE2010 SW1.6 to SW1.8				
SW1.5	**SW1.6**	**SW 1.7**	**SW1.8**	**Address**
OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	ON	1
OFF	OFF	ON	OFF	2
OFF	OFF	ON	ON	3
OFF	ON	OFF	OFF	4
OFF	ON	OFF	ON	5
OFF	ON	ON	OFF	6
OFF	ON	ON	ON	7

The three LED's are used to indicate the following conditions:

MCE2010 LED'S		
TXBB	Green	Lit whenever the load cell module transmits data. Must be on/flashing rapidly whenever the system is started.
D1	Yellow	No synchronisation between load cell modules: One or more load cells not connected to load cell module or poor connection.
SYNC ERR	Red	No load cell synchronisation: No load cell connected to load cell module or poor connection.

4) MCE9601 DESCRIPTION

Below the layout of the MCE9601 terminal module is shown. The MCE9601 module is used for connection between the Eilersen Electric digital load cell bus at one side and power supply/equipment at the other side.



The J1 terminal block is used for connection of the following:

- Terminals **Gnd** and **B** (-) and **A** (+) gives access to the RS485 bus of all equipment connected to the load cell bus.
- Terminals **Gnd** and **+24Vdc** provides external power to the equipment connected to the load cell bus. These terminals have to be connected to an external +24VDC power supply.
- Terminals **Gnd** and **I/O** are the internal synchronization signal used by the load cell modules. Normally these terminals have no external connection and must be left open.

The **J2** connector is used for connecting equipment (load cell modules, communication modules etc.) on the digital load cell bus by using the supplied ribbon cable with mounted connectors.

The **JU1** jumper is used for hardware synchronisation. Normally this jumper should be left in the default factory setting which is **ON**.

The **light emitting diodes** on the MCE9601 module have the following function:

LED	Function
D1 (Green)	**RS485 Communication**. This LED should be **ON** during normal operation (Actually it is flashing quickly, but this can look like a steady light).
D2 (Yellow)	This LED should be **OFF** during normal operation. If this lamp is lit, the I/O pin is at reversed polarity.
D3 (Red)	**Hardware Synchronisation**. This LED should be **ON** during normal operation (Actually it is flashing quickly, but this can look like a steady light).

5) DATA EXCHANGE

5.1 Profibus-DP communication using PPO

Profibus-DP communication with the MCE2035 module uses a so called 'parameter-process data object' (PPO) consisting of 26 bytes. This telegram (object) is only used when transferring data from the slave to the master, since **no** data are transmitted from the master to the slave. The structure for this telegram is as follows:

Lc Register		**Lc Status(0)**		**Lc Signal(0)**					**Lc Status(3)**		**Lc Signal(3)**			
0	1	2	3	4	5	6	7		20	21	22	23	24	25

The byte order (MSB/LSB first?) for the individual parts of the telegram is determined by a jumper. Normally this jumper is set from the factory so that MSB comes first. In the following bit 0 will represent the least significant bit in a register.

LcRegister is a word (two bytes) that constitute a bit register for indication of connected load cells detected during power on. Hence bit 0-3 will be ON, if the corresponding load cell (address) was detected during power on. **LcRegister** is always transferred in **16 bit unsigned integer** format.

LcStatus(X) is a word (two bytes) that constitute a register containing the actual status for load cell **X**. **LcStatus(X)** is always transferred in **16 bit unsigned integer** format. During normal operation this register will be 0, but if an error occurs some bits in the register will be set resulting in an error code. The meaning of each individual bit in the status register can be found in the chapter *STATUS CODES*.

LcSignal(X) is a double word (four bytes) constituting a register containing the actual weight signal from load cell **X.** Depending on a jumper **LcSignal(X)** will be in either **32 bit signed integer** format or in **IEEE754 floating point** format. This jumper is default set so transfer of **LcSignal(X)** is done in **32 bit signed integer** format. Note that the value is only valid if the corresponding **LcStatus(X)** register is 0 indicating no error present. The scaling of the load cell signal is determined by a DIP-switch as described later.

Since only status and weight for the load cells are transmitted in the telegram, functions such as status handling, calculation of system weight(s), zeroing and calibration **must** be implemented on the Profibus-DP master. Please refer to the chapter *DATA PROCESSING* for an explanation on how this typically can be done.

5.2 Data formats

The Profibus-DP communication can transfer data in the following three data formats. If necessary please refer to other literature for further information on these formats.

5.2.1 Unsigned integer format (16 bit)

The following are examples of decimal numbers represented on 16 bit unsigned integer format:

Decimal	Hexadecimal	Binary (MSB first)
0	0x0000	00000000 00000000
1	0x0001	00000000 00000001
2	0x0002	00000000 00000010
200	0x00C8	00000000 11001000
2000	0x07D0	00000111 11010000
20000	0x4E20	01001110 00100000

5.2.2 Signed integer format (32 bit)

The following are examples of decimal numbers represented on 32 bit signed integer format:

Decimal	Hexadecimal	Binary (MSB first)
-20000000	0xFECED300	11111110 11001110 11010011 00000000
-2000000	0xFFE17B80	11111111 11100001 01111011 10000000
-200000	0xFFFCF2C0	11111111 11111100 11110010 11000000
-20000	0xFFFFB1E0	11111111 11111111 10110001 11100000
-2000	0xFFFFF830	11111111 11111111 11111000 00110000
-200	0xFFFFFF38	11111111 11111111 11111111 00111000
-2	0xFFFFFFFE	11111111 11111111 11111111 11111110
-1	0xFFFFFFFF	11111111 11111111 11111111 11111111
0	0x00000000	00000000 00000000 00000000 00000000
1	0x00000001	00000000 00000000 00000000 00000001
2	0x00000002	00000000 00000000 00000000 00000010
200	0x000000C8	00000000 00000000 00000000 11001000
2000	0x000007D0	00000000 00000000 00000111 11010000
20000	0x00004E20	00000000 00000000 01001110 00100000
200000	0x00030D40	00000000 00000011 00001101 01000000
2000000	0x001E8480	00000000 00011110 10000100 10000000
20000000	0x01312D00	00000001 00110001 00101101 00000000

5.2.3 IEEE754 floating point format (32 bit)

Representation of data on IEEE754 floating point format is done as follows:

Byte1		**Byte2**		**Byte3**	**Byte4**
bit7	bit6 bit0	bit7	bit6 bit0	bit7 bit0	bit7 bit0
S	2^7 …..…. 2^1	2^0	2^{-1} …….... 2^{-7}	2^{-8} ………….... 2^{-15}	2^{-16} ………..…. 2^{-23}
Sign	Exponent		Mantissa	Mantissa	Mantissa

<u>Formula</u>:

Value = $(-1)^S * 2^{(\text{exponent}-127)} * (\text{I}+\text{Mantissa})$

<u>Example</u>:

Byte1	Byte2	Byte3	Byte4
0100 0000	1111 0000	0000 0000	0000 0000

Value = $(-1)^0 * 2^{(129-127)} * (1 + 2^{-1} + 2^{-2} + 2^{-3}) = 7.5$

Please note that if transfer of MSB first has been selected (default setting), the byte with the “sign” will come first in the weight indications, and if LSB first has been selected the byte with the “sign” will come last in the weight indications.

5.3 Measurement time

By use of DIP-switches it is possible to choose between 4 different measurement times. All load cells are sampled/averaged over a measurement period determined by Sw1.1 and Sw1.2 as follows:

SW1.1	SW1.2	Measurement time
OFF	OFF	20 ms
OFF	ON	100 ms
ON	OFF	400 ms
ON	ON	2000 ms

NOTE: Upon default delivery SW1.1 is OFF and SW1.2 is ON, so that 100ms measuring time is achieved.

The hereby found load cell signals (possibly filtered) are used in the Profibus-DP communication until new signals are achieved when the next sample period expires.

5.4 Filtering

By use of DIP-switches it is possible to include one of 3 different FIR filters, which will be used to filter the load cell signals. Thus it is possible, to send the unfiltered load cell signals achieved over the selected measurement period through one of the following FIR filters, before the results are transmitted on the Profibus:

SW1.4	SW1.3	No.	Taps	Frequency				Damping
				Tavg 20ms	Tavg 100ms	Tavg 400ms	Tavg 2000ms	
OFF	OFF	0	-	-	-	-	-	-
ON	OFF	1	9	12.0 Hz	2.4 Hz	0.6 Hz	0.12 Hz	-80dB
OFF	ON	2	21	6.0 Hz	1.2 Hz	0.3 Hz	0.06 Hz	-80dB
ON	ON	3	85	1.5 Hz	0.3 Hz	0.075Hz	0.015Hz	-80dB

NOTE: With both switches OFF, which is default setting upon delivery, no filtering is performed.

5.5 Scaling

By use of a DIP-switch it is possible to select the desired scaling of the weight signals. The scaling of the weight signals on the Profibus is determined by Sw2.1 as follows, where the table shows how a given weight is represented on the Profibus depending on switch and jumper settings:

Weight [gram]	JU7 = OFF (32 bit signed integer) (normal default delivery)		JU7 = ON (IEEE754 floating point)	
	Sw2.1 = OFF (1 gram)	Sw2.1 = ON (1/10 gram)	Sw2.1 = OFF (1 gram)	Sw2.1 = ON (1/10 gram)
1,0	1	10	1,000	10,000
123,4	123	1234	123,000	1234,000

6) DATA PROCESSING

6.1 Zeroing, calibration and weight calculation

Calculation of system weight(s) is done by addition of the weight registers for the load cells belonging to the system. This is explained below. **Note** that the result is only valid if all status registers for the load cells in question indicate <u>no</u> errors. It should also be noted that it is up to the master to ensure the usage of consistent load cell data when calculating the system weight (the used data should come from the same telegram).

6.1.1 Zeroing of weighing system

Zeroing of a weighing system (all load cells in the specific system) should be performed as follows, taking into account that no load cell errors may be present during the zeroing procedure:

1) The weighing arrangement should be empty and clean.
2) The Profibus-DP master verifies that no load cell errors are present, after which it reads and stores the actual weight signals for the load cells of the actual system in corresponding zeroing registers.

```
LcZero[x]=LcSignal[x]
```

3) After this the uncalibrated gross weight for load cell **X** can be calculated as:

```
LcGross[X] = LcSignal[X] – LcZero[X]
```

6.1.2 Corner calibration of weighing system

In systems where the load is not always placed symmetrically the same place (for example a platform weight where the load can be placed randomly on the platform when a weighing is to take place), a fine calibration of a systems corners can be made, so that the weight indicates the same independent of the position of the load. This is done as follows:

1) Check that the weighing arrangement is empty. Zero the weighing system.
2) Place a known load (`CalLoad`) directly above the load cell that is to be corner calibrated.
3) Calculate the corner calibration factor that should be multiplied on the uncalibrated gross weight of the load cell in order to achieve correct showing as:

```
CornerCalFactor[x] = (CalLoad)/(LcGross[x])
```

After this the determined corner calibration factor is used to calculate the calibrated gross weight of the load cell as follows:

```
LcGrossCal[x] = CornerCalFactor[x] * LcGross[x]
```

6.1.3 Calculation of uncalibrated system weight

Based on the load cell gross values (`LcGross[x]` or `LcGrossCal[x]`), whether they are corner calibrated or not, a uncalibrated system weight can be calculated as either:

```
Gross = LcGross[X1] + LcGross[X2] + …
```

or:

```
Gross = LcGrossCal[X1] + LcGrossCal[X2] + …
```

6.1.4 System calibration of weighing system

Based on the uncalibrated system weight a system calibration can be made as follows:

1) Check that the weighing arrangement is empty. Zero the weighing system.
2) Place a known load (`CalLoad`) on the weighing arrangement. **NOTE:** In order to achieve a correct calibration of the system it is recommended, that the used calibration load is at least 50% of the system capacity.
3) Calculate the calibration factor that should be multiplied on the uncalibrated system weight in order to achieve correct showing as:

   ```
   CalFactor = (CalLoad)/(Actual Gross)
   ```

   After this the determined calibration factor is used to calculate the calibrated system weight as follows:

   ```
   GrossCal = CalFactor * Gross
   ```

   If the determined calibration factor falls outside the interval 0.9 to 1.1 it is very likely that there is something wrong with the mechanical part of the system. This does not however apply to systems, which do not have a load cell under each supporting point. For example on a three legged tank with only one load cell, you should get a calibration factor of approximately 3 because of the two “dummy” legs.

7) INSTALATION OF SYSTEM

7.1 Checklist during installation

During installation of the system the following should be checked:

1) The Profibus-DP master should be configured to communicate with the MCE2035 Profibus-DP module using the supplied GSD file. When configuring with the GSD file a MCE2035 station type is selected.

2) All hardware connections are made as described below.

3) The load cells are mounted mechanically and connected to the Profibus-DP module using their corresponding load cell interface module. The load cell addresses are set using the DIP-switches on the load cell interface modules, so that they forth running from address 0 (0-3).

4) Using DIP-switches the desired measurement time, filter and scaling is selected.

5) The Profibus-DP module is connected to the Profibus-DP network, and possibly a termination is made at this Profibus-DP slave.

6) The address of the Profibus-DP module is set using Sw2.2-Sw2.8. Power is applied and the Profibus-DP communication is started.

7) Verify that the red LED (PBE) on the Profibus-DP module is NOT lit, and that the yellow LEDs (DES and RTS) are lit/flashing. Verify that the TXBB LED on the Profibus-DP module is lit and that the TXBB LED’s on the load cell interface modules are also lit (can flash slightly).

8) Verify that the Profibus-DP module has found the correct load cells (**LcRegister**), and that no load cell errors are indicated (**LcStatus(x)**).

9) Verify that every load cell gives a signal (**LcSignal(x)**) by placing a load directly above each load cell one after the other (possibly with a known load).

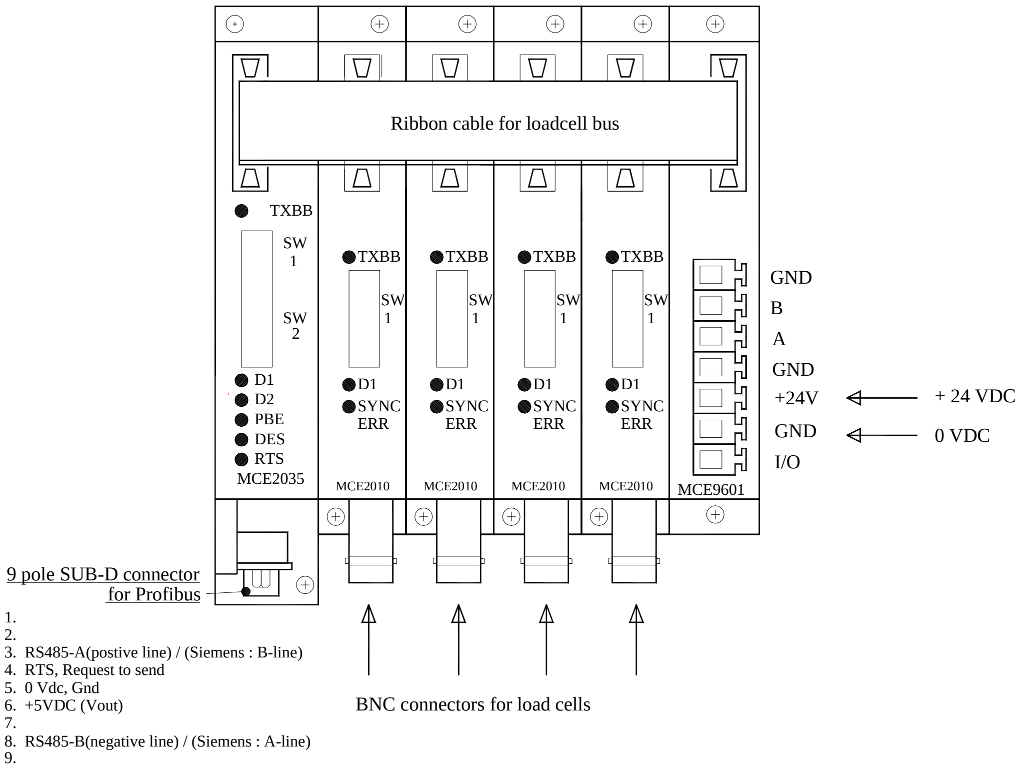
The system is now installed and a zero and fine calibration is made as described earlier. Finally verify that the weighing system(s) returns a value corresponding to a known actual load.

Note that in the above checklist no consideration has been made on which functions are implemented on the Profibus DP master.

8) HARDWARE DESCRIPTION

8.1 MCE2035 overview

The following figure is an overview of how a MCE2035 Profibus-DP system is made using four MCE2010 load cell modules and a MCE9601 connection module:



8.2 Connection of power and load cells

This chapter describes the connection of power supply and load cells to the MCE2035 module.

IMPORTANT: The used power supply must be stable and free of transients. It may therefore be necessary to use a separate power supply dedicated to the weighing system, and not connected to any other equipment.

The 10 pole connector (J2) on the MCE2035 module is connected to the 10 pole connectors on the load cell interface modules (MCE2010) and to the 10 pole connector on the MCE9601 connection module using the supplied ribbon cable with mounted connectors. Through this bus cable connection of power supply to the individual modules is achieved and data can be transferred from the load cell modules to the MCE2035 module.

The MCE9601 module has the following connections in the blue connector (J1):

MCE9601 CONNECTOR	CONNECTION
GND	-
B (DATA-)	-
A (DATA+)	-
GND	-
+24V	+24VDC (Vin)
GND	0 VDC (GNDin)
I/O	-

The 10 pole connector (J2) on the MCE2035 Profibus-DP module has these connections:

MCE2035 J2 CONNECTER	FUNCTION
J2.1 - J2.2	RS485-B (DATA-)
J2.3 - J2.4	RS485-A (DATA+)
J2.5 - J2.6	0 VDC (GNDin)
J2.7 - J2.8	+24VDC (Vin)
J2.9 - J2.10	I/O line

8.3 DIP-switch settings

The Profibus-DP module is equipped with a 4 pole DIP-switch block that has the following function:

SWITCH	FUNCTION
Sw1.1-Sw1.2	**Measurement time** Used to select the desired measurement time as described in an earlier chapter. Note that these switches are only read during power on.
Sw1.3-Sw1.4	**Filtering** Used to select the desired filter as described in an earlier chapter. Note that these switches are only read during power on.

and a 8 pole DIP-switch block that has the following function:

SWITCH	FUNCTION
Sw2.1	**Scaling** Used to select the desired scaling as described in an earlier chapter. Note that these switches are only read during power on.
Sw2.2-Sw2.8	**Selection of Profibus-DP communication address** The address is selected as the DIP-switches are binary coded, so Sw2.2 is MSB and Sw2.8 is LSB. Note that these switches are only read during power on.

8.4 Light Emitting Diodes

The Profibus-DP module is equipped with 6 light emitting diodes (LED). These LED’s have the following function:

LED	FUNCTION
TXBB (Green)	**Communication with load cells** Profibus-DP module is communicating with load cells.
D1 *(Green)*	*Reserved for future use*
D2 *(Green)*	*Reserved for future use*
PBE (Red)	**Profibus Error (when initializing the SPC3)** The SPC3 Profibus-DP controller was not initialized correctly.
DES (Yellow)	**Data Exchange State** Exchange of data between Profibus-DP slave and master.
RTS (Yellow)	**RtS signal (SPC3)** The Profibus-DP module sends to the master.

8.5 Jumpers

The Profibus-DP module is equipped with 7 jumpers. These jumpers have these functions:

JUMPER	**FUNCTION**
JU1	*Reserved for future use* *(normal default factory setting is OFF)*
JU2-JU4	*Reserved for future use (termination)* *(normal default factory setting is OFF)*
JU6	*Reserved for future use* *(normal default factory setting is OFF)*
JU7	**Selection of (32 Bit Signed Integer) / (IEEE754) data format** The jumper determines if the weight indications in the telegram are in *32 bit signed integer* or in *IEEE754 floating point* format. OFF: *32 bit signed integer* format (normal setting from factory) ON: *IEEE754 floating point* format
JU8	**Selection of LSB/MSB data format** The jumper determines the byte order in which data are transmitted/received. OFF: LSB first ON: MSB first (normal setting from factory)

8.6 Profibus-DP connector

The Profibus-DP module is equipped with a nine pole female sub-D connector (J1) for connection to the Profibus-DP network. The connector is a standard Profibus-DP connector. Termination of the Profibus should take place in the sub-D connector (male) of the cable. The specific terminals in the connector have the following function:

J1 TERMINALS	FUNCTION
J1.1	Not used
J1.2	Not used
J1.3	RS485-A (**positive** line) (Siemens designation: B line)
J1.4	Request to Send (RTS)
J1.5	0 VDC (Gnd)
J1.6	+5VDC (Vout)
J1.7	Not used
J1.8	RS485-B (**negative** line) (Siemens designation: A line)
J1.9	Not used

Note that some companies use different designations for the RS485-A and the RS485-B lines. Therefore the polarity of the lines has been listed.

8.7 Hardware Selftest

During power-on the Profibus-DP module will perform a hardware selftest. The test will cause the light emitting diodes D1, D2 and PBE to turn on and off shortly, one at a time.

8.8 Update times

Please note that update times across the Profibus-DP communication depends on the specific Profibus-DP configuration (selected baudrate, number of slaves, scan times etc.).

9) STATUS CODES

Status codes are shown as a 4 digit hex number. If more than one error condition is present the error codes are OR’ed together.

CODE (Hex)	CAUSE
0001	**Invalid/missing ’sample’ ID** Bad connection between communication module and load cell module.
0002	**Load cell timeout** Check that the load cell is connected to the load cell module.
0004	**Load cell not synchronized** Bad connection between load cell and load cell module.
0008	**Hardware synchronization error** Cable between load cell modules shorted or disconnected.
0010	**Power failure** Supply voltage to load cells is to low.
0020	**Overflow in weight calculation** Internal error in load cell module.
0040	**Invalid/missing ’latch’ ID** Bad connection between communication module and load cell module.
0080	**No answer from load cell module** No data is received from this load cell module. This can be caused by the removal of the load cell module, no power to the module or that the connection between load cell module and communication module is broken.
0100	*Reserved for future use*
0200	*Reserved for future use*
0400	*Reserved for future use*
0800	**No load cell modules answer** Bad connection between communication module and load cell module. Not all telegrams from communication module are received in load cell module.
1000	*Reserved for future use*
2000	*Reserved for future use*
4000	*Reserved for future use*
8000	*Reserved for future use*