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4X37 DEVICE NET SYSTEM

Status and weight transfer using DeviceNet

Applies for:

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1) CONTENTS

2) INTRODUCTION

2.1 Introduction

This document describes the use of a 4X37 DeviceNet system unit from Eilersen Electric. The 4X37 system unit consists internally of a 4037 DeviceNet module (with the program listed on the front page) and a 4040 communication module.

The 4X37 system unit is connected to X loadcells (1-4). With the program specified on the front page, the 4X37 DeviceNet unit is capable of transmitting weight and status for up to 4 loadcells in a single telegram.

It is possible to connect the 4X37 DeviceNet unit to a DeviceNet network, where it will act as a slave. It will then be possible from the DeviceNet master to read status and weight for each of the connected loadcells. Functions as zeroing, calibration and calculation of system weight(s) **must** be implemented on the DeviceNet master.

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

2.2 ATEX (Ex) specification

IMPORTANT: Instrumentation (the 4x37) <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.

2.3 DeviceNet specification

The DeviceNet unit confirms to the following DeviceNet specifications:

Protocol:	DeviceNet
Communications form:	CAN
Module type:	Slave
Baud rates [kbit/sec]:	125, 250, 500
DeviceNet address:	0-63
DeviceNet connection:	Standard 5-pin DeviceNet connector

3) DATA EXCHANGE

3.1 DeviceNet communication using PPO

DeviceNet communication with the 4X37 DeviceNet unit 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 LSB 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 loadcells detected during power on. Hence bit 0-3 will be ON, if the corresponding loadcell address (LC1-LC4) 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 loadcell **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. A description of the different error codes 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 loadcell **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 resolution of the loadcell signal is 1 gram, so that 12345 gram is represented by the number 12345.

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

3.2 Data formats

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

3.2.1 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

3.2.2 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

3.2.3 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

Formula:

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

Example:

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

4) DATA PROCESSING

4.1 Zeroing, calibration and weight calculation

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

4.1.1 Zeroing of weighing system

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

1) The weighing arrangement should be empty and clean.
2) The DeviceNet master verifies that no loadcell errors are present, after which it reads and stores the actual weight signals for the loadcells of the actual system in corresponding zeroing registers:

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

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

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

4.1.2 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 loadcell that is to be corner calibrated.
3) Calculate the corner calibration factor that should be multiplied on the uncalibrated gross weight of the loadcell 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 loadcell as follows:

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

4.1.3 Calculation of uncalibrated system weight

Based on the loadcell 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] + …
```

4.1.4 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.
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 that do not have a loadcell under each supporting point. For example on a three legged tank with only one loadcell, you should get a calibration factor of approximately 3 because of the two “dummy” legs.

5) INSTALATION OF SYSTEM

5.1 Checklist during installation

During installation of the system the following should be checked:

1) If necessary the DeviceNet master should be configured to communicate with the 4X37 DeviceNet system unit using the supplied EDS file.

2) The loadcells are mounted mechanically and connected to BNC connectors in the front panel of the 4X37 system unit.

3) The 4X37 DeviceNet system unit is connected to the DeviceNet network using the DeviceNet connector in the front panel of the 4X37 system unit. If necessary a possible termination of the DeviceNet network is made at this DeviceNet slave.

4) Use SW1 in the front panel of the 4X37 system unit to select any features associated with SW1 on the 4040 communication module.

5) Use SWD.1-SWD.6 in the front panel of the 4X37 system unit to select the communication address of the 4X37 DeviceNet system unit.

6) Use SWD.7-SWD.8 in the front panel of the 4X37 system unit to select the communication speed (baudrate) of the 4X37 DeviceNet system unit.

7) Power (24VDC) is applied at the 2 pole power connectors in the front panel of the 4X37 system unit as described in the hardware section, and the DeviceNet communication is started.

8) Verify that the **MS** lamp and the **NS** lamp both end up green.

9) Verify that the **TxDN** lamp is lit/flashes vague green.

10) Verify that the **TxLC** lamp (yellow) is lit (turns on after approx. 5 seconds).

11) Verify that the two **TxBB** lamps (green) are lit (both lit after 10 seconds).

12) Verify that NONE of the **1**, **2**, **3** or **4** lamps (red) are lit.

13) Verify that the 4X37 DeviceNet system unit has found the correct loadcells (**LcRegister**), and that no loadcell errors are indicated (**LcStatus(x)**).

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

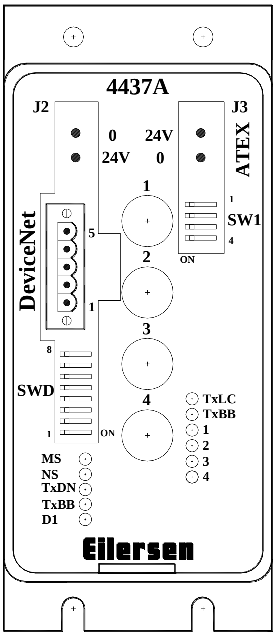
The system is now installed and a zero and fine calibration is made as described earlier. Finally verify that the weighing system(s) returns a value corresponding to a known actual load.

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

6) HARDWARE DESCRIPTION

6.1 4X37 overview

The following figure is an overview of a 4X37 DeviceNet system unit with 4 loadcell connections (i.e. a 4437 system unit):



6.2 4X37 front panel description

This chapter describes the connections, DIP-switch settings and lamp indications that are available on the front panel of the 4X37 system unit.

6.2.1 Connection of power

The 4X37 system unit is powered by applying +24VDC on the green two pole connectors (J2 and J3) as specified on the front panel of the 4X37 system unit. This powers the entire 4X37 system unit including the loadcells.

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.

NOTE: If the loadcells are to be placed inside an EX area, then the 4X37 system unit itself <u>**MUST**</u> be placed outside the EX area, and the 4X37 system unit <u>**MUST**</u> be supplied as follows:

1) The 2 pole connector (J3), located to the right above the 4 pole DIP-switch block, <u>**MUST**</u> be powered by a 4051A power supply (+24VDC ATEX approved) from Eilersen Electric.
2) The 2 pole connector (J2), located to the left above the 5 pole connector (DEVICENET), <u>**MUST**</u> be powered by a separate +24VDC, that has <u>**NO**</u> connection to the ATEX approved +24VDC from the above mentioned 4051A power supply.

NOTE: In ***7) APPENDIX – CONNECTION OF POWER*** figures are showing how power supply is connected to Non-ATEX and ATEX applications respectively.

6.2.2 Connection of loadcells

The loadcells must be connected to the available BNC connectors in the front panel of the 4X37 system unit. The loadcells are connected starting with the connector marked 1 and continuing onwards in rising order. Thus if three loadcells are to be connected, they should be connected to the BNC connectors marked 1, 2 and 3.

6.2.3 DeviceNet connector

The front panel of the 4X37 system unit is equipped with a five pole connector with a <u>standard</u> DeviceNet interface. This allows for direct connection to a DeviceNet network using <u>standard</u> DeviceNet connectors. The specific terminals in the connector have the following function as described in the DeviceNet Specification:

Connection	Function	Color
DEVICENET.1	V-	(Black)(0VDC input)
DEVICENET.2	CAN_L	(Blue)
DEVICENET.3	SHIELD	(Grey)
DEVICENET.4	CAN_H	(White)
DEVICENET.5	V+	(Red)(24VDC input)

6.2.4 SW1 settings

The front panel of the 4X37 system unit is equipped with a 4 pole DIP switch block named SW1. These switches are mounted on the 4040 communication module, and they are **ONLY** read during power-on. When the 4040 communication module is equipped with standard program, their functionality is as follows:

Sw1.1	FIR Filter
OFF	No filter
ON	30 taps

SWITCH	FUNCTION
Sw1.2-Sw1.4	*Reserved for future use*

6.2.5 SWD settings

The front panel of the 4X37 system unit is equipped with a 8 pole DIP switch block named SWD. These switches allow setting of the DeviceNet communication address and DeviceNet communication speed (baudrate) of the 4X37 DeviceNet system unit. This DIP switch block has the following function:

SWITCH	FUNCTION
SWD.1-SWD.6	**Selection of DeviceNet Node Address (NA)** The address (0-63) is selected as the DIP-switches are binary coded, so SWD.6 is MSB and SWD.1 is LSB. Note that these switches are only read during power on.
SWD.7-SWD.8	**Selection of DeviceNet Data Rate (DR)** The desired baudrate is set according to the table below. Note that these switches are only read during power on.

SWD.8	SWD.7	4X37 DeviceNet Data Rate (DR)
OFF	OFF	125 kbps
OFF	ON	250 kbps
ON	OFF	500 kbps
ON	ON	Not allowed

6.2.6 Light Emitting Diodes (LEDs)

The front panel of the 4X37 system unit is equipped with a number of status lamps (light emitting diodes). These have the following functionality:

LED	FUNCTION
MS (Green/Red)	**Module Status LED** The 4037 Module Status LED, that can be lit/flashing in different colors depending on the status of the module. The function of the MS LED is given in the table below.
NS (Green/Red)	**Network Status LED** The 4037 Network Status LED, that can be lit/flashing in different colors depending on the status of the network. The function of the NS LED is given in the table below.
TxDN (Green)	**Transmit DeviceNet** The 4037 module transmits on DeviceNet (CAN bus).
TxBB (Left) (Green)	**4037 communication with 4040 module (internal)** 4037 DeviceNet module is transmitting to 4040 module.
D1 *(Green)*	*Reserved for future use*
TxLC (Yellow)	**4040 communication with loadcells** 4040 communication module is communicating with loadcells.
TxBB (Right) (Green)	**4040 communication with 4037 DeviceNet module (internal)** 4040 communication module is transmitting to 4037 DeviceNet module.
1 (Red)	**Status for loadcell 1** Bad connection, loadcell not ready or other error detected.
2 (Red)	**Status for loadcell 2** Bad connection, loadcell not ready or other error detected.
3 (Red)	**Status for loadcell 3** Bad connection, loadcell not ready or other error detected.
4 (Red)	**Status for loadcell 4** Bad connection, loadcell not ready or other error detected.

The MS and NS LED's can in conjunction with the table below be used for error finding.

Light emitting diode	Color	Status	Description
MS	Green	ON	**Normal Operation.** Communication performed normally.
		Flashing	**Standby State.** The unit needs supervision.
	Red	ON	**Unrecoverable fault.** A timer error, memory error or other system error. The unit may need replacing.
		Flashing	**Recoverable fault.** Configuration error, DIP-switch not set correct or similar error. Correct error and restart unit.
	---	OFF	**No power.** The power is disconnected or the unit is being restarted.
NS	Green	ON	**On-Line, Connection OK.** The unit is On-Line and a connection with the master has been established.
		Flashing	**On-Line, No Connection.** The unit is On-Line but no connection to the master has been established.
	Red	ON	**Critical Communication Error.** The unit has detected an error that makes it impossible to communicate on the network (duplicate MAC Id or Bus-Off error).
		Flashing	**Communication Time-Out.** One or more I/O connections are in the Time-Out state.
	---	OFF	**No power/Off-line.** The device may not be powered.

6.3 Hardware Selftest

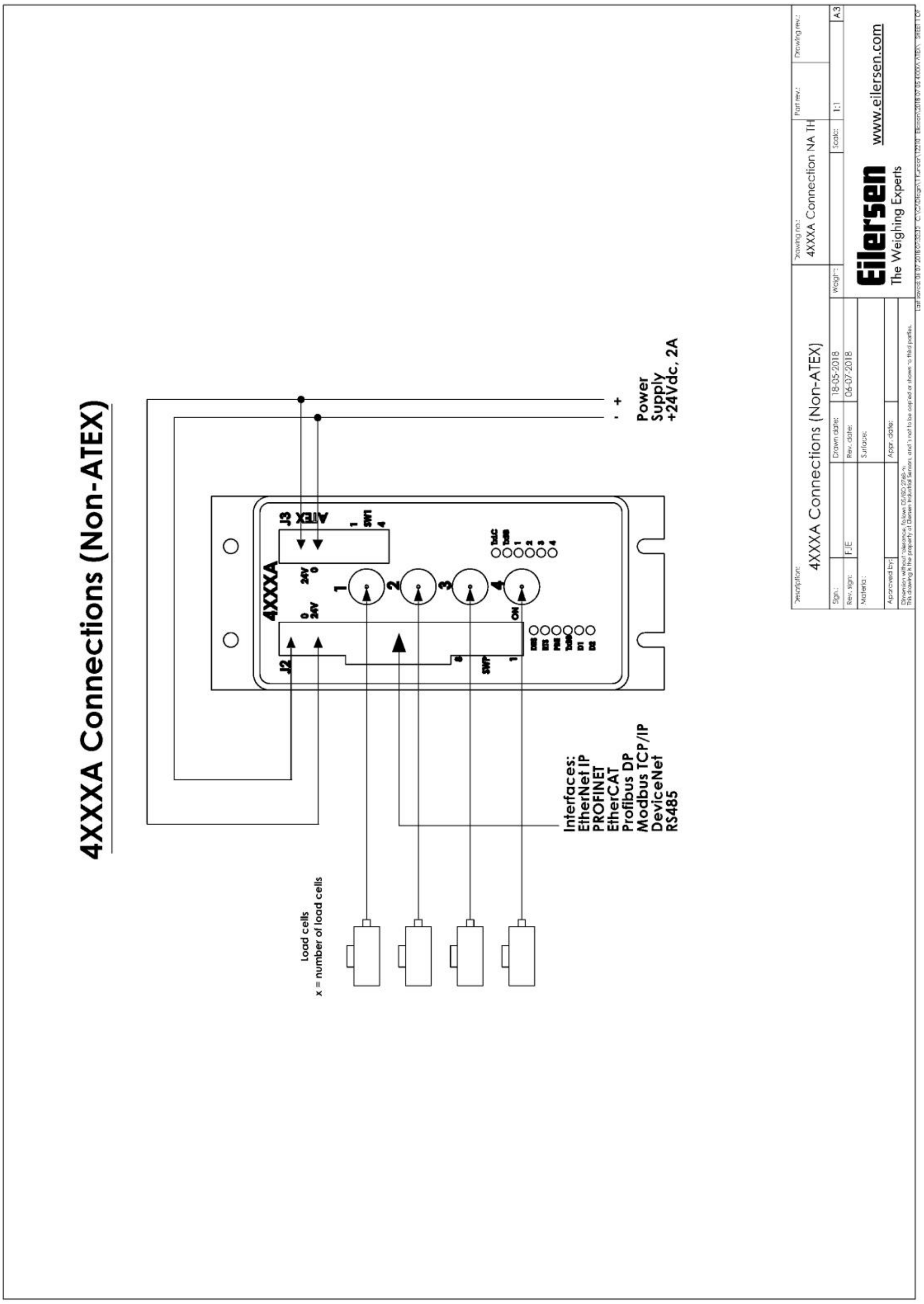
During power-on the 4X37 DeviceNet system unit will perform a hardware selftest. The test will cause the light emitting diodes D1, MS and NS to flash shortly one at a time.

6.4 Update times

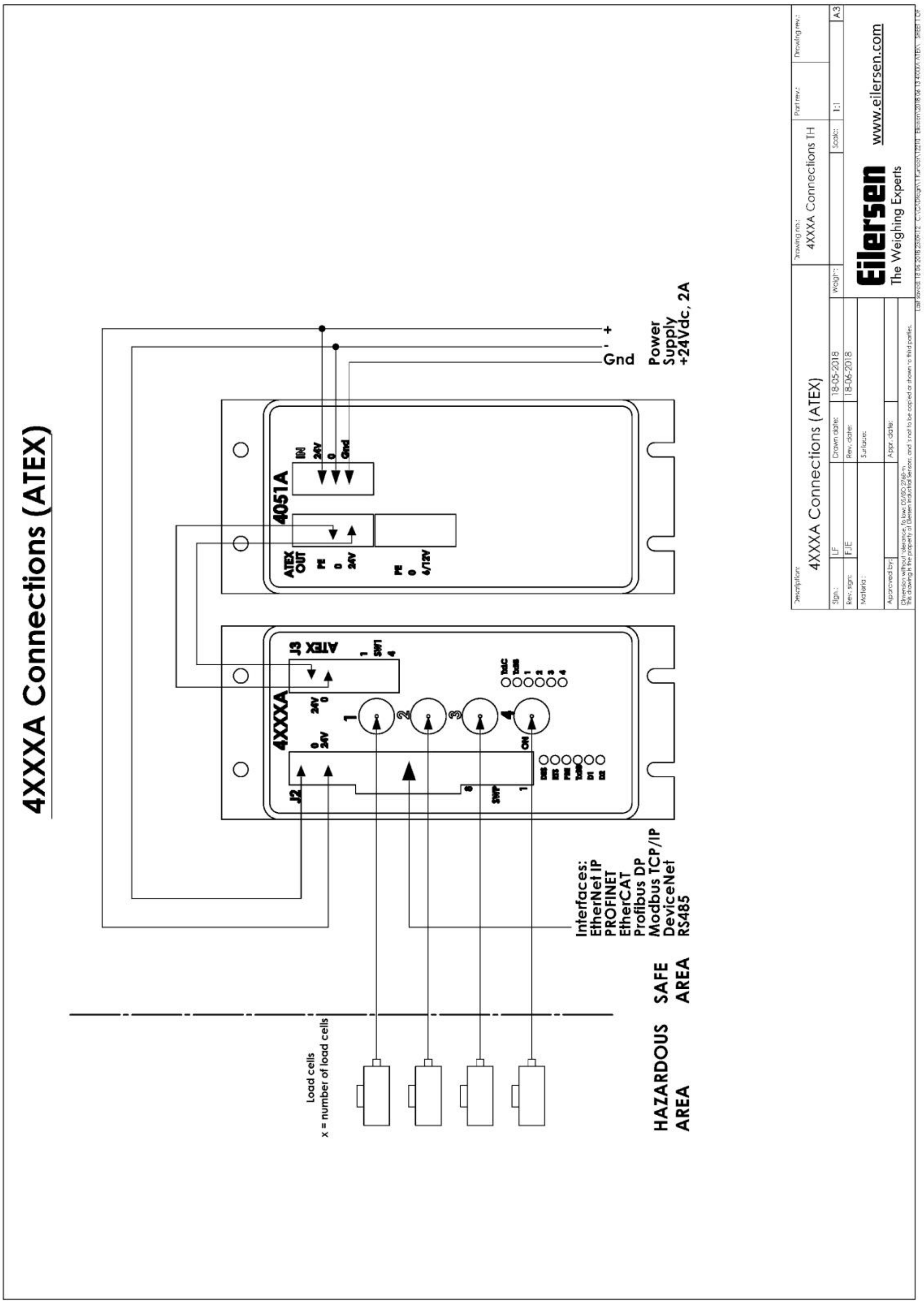
The 4X37 DeviceNet system unit samples the loadcell signals over a period of 200 mS. The hereby found loadcell signals are used in the DeviceNet communication until new signals are achieved when the next sample period expires. Update times across the DeviceNet communication depends on the specific DeviceNet configuration (selected baudrate, number of slaves, scan times etc.).

7) APPENDIX – CONNECTION OF POWER

7.1 Non-ATEX applications



7.2 ATEX applications



8) APPENDIX – INTERNAL FEATURES

8.1 4037 DeviceNet module

This chapter describes possible connections, DIP-switch settings and jumper settings that are available internally on the 4037 DeviceNet module. These will normally be set from Eilersen Electric and should only be changed in special situations.

8.1.1 SW3 settings

The 4037 DeviceNet module is internally equipped with a 4 pole DIP switch block named SW3. This DIP switch block has the following function:

SWITCH	**FUNCTION**
Sw3.1-Sw3.4	*Reserved for future use*

8.1.2 Jumper settings

The 4037 DeviceNet module is internally equipped with 5 jumpers. These jumpers have these functions:

JUMPER	**FUNCTION**
JU1	Reserved for future use (normal default factory setting is OFF)
JU2	**Test mode** JU2 OFF: Normal mode (default at delivery and should not be changed) JU2 ON: Test mode The jumper must be OFF during normal operation.
JU6	**Test mode** JU6 OFF: Normal mode (default at delivery and should not be changed) JU6 ON: Test mode The jumper must be OFF during normal operation.
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 (normal setting from factory) ON: MSB first

8.2 4040 communication module

For information on jumper settings, DIP-switch settings, LED status lamps etc. on the 4040 communication module that is not covered in the above, please refer to the separate documentation that describes the 4040 communication module and its specific software.

8.2.1 SW2 settings

The 4040 communication module is internally equipped with a 8 pole DIP switch block named SW2. Please note that these switches are **ONLY** read during power-on. This DIP switch block has the following function when the 4040 communication module is equipped with standard program:

Sw2.1	Sw2.2	Sw2.3	Number of loadcells
OFF	OFF	OFF	1
ON	OFF	OFF	1
OFF	ON	OFF	2
ON	ON	OFF	3
OFF	OFF	ON	4
ON	OFF	ON	5
OFF	ON	ON	6
ON	ON	ON	6

SWITCH	**FUNCTION**
Sw2.4-Sw2.8	*Reserved for future use*

8.2.2 Jumper settings

The 4040 communication module is internally equipped with 4 jumpers named P2, P3, P4 and P5. In this system these jumpers must be set as follows:

JUMPER	**POSITION**
P2	OFF (Loadcell connected to 4040 **NOT** accessible using SEL1)
P3	OFF (Loadcell connected to 4040 **NOT** accessible using SEL6)
P4	OFF (Loadcell connected to 4040 **NOT** accessible using SEL1)
P5	OFF (Loadcell connected to 4040 **NOT** accessible using SEL6)

8.2.3 Light Emitting Diodes (LEDs)

The 4040 communication module is internally equipped with a number of status lamps (light emitting diodes). The lamps have the following functionality when the 4040 communication module is equipped with standard program:

LED	**FUNCTION**
D11 *(Red)*	*Reserved for future use*
D12 *(Red)*	*Reserved for future use*
D13 *(Red)*	*Reserved for future use*
D14 *(Red)*	*Reserved for future use*

9) APPENDIX - STATUS CODES

Status codes for the connected loadcells 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	*Reserved for future use*
0002	*Reserved for future use*
0004	*Reserved for future use*
0008	*Reserved for future use*
0010	**Power failure** Supply voltage to loadcells is to low.
0020	**New loadcell detected or loadcells swapped** Power the system off and back on. Then verify that all parameters are acceptable.
0040	**No answer from loadcell** Bad connection between loadcell and loadcell module? Bad connection between loadcell module and communication module?
0080	**No answer from loadcell** Bad connection between communication module and master module?
0100	*Reserved for future use*
0200	*Reserved for future use*
0400	*Reserved for future use*
0800	**No loadcell answer** Bad connection between loadcell and loadcell module? Bad connection between loadcell module and communication module? Bad connection between communication module and master module? Bad setting of DIP switches on loadcell or communication module?
1000	*Reserved for future use*
2000	*Reserved for future use*
4000	*Reserved for future use*
8000	*Reserved for future use*

Please note that the above listed status codes are valid when the 4040 communication module is equipped with standard program.