



# **DeLaval positioning module AFC\_SENS**

## Instruction Book

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## Safety precautions

### DeLaval positioning module AFC\_SENS

#### 1. Note to operator

It is the operator's responsibility to see that any person involved with the use or operation of this equipment follows all safety and operational instructions. Under no circumstances should this equipment be used if the equipment is faulty or the operator does not completely understand the operation of the equipment.

#### 2. Disclaimer

The information, instructions and parts listed are applicable and current on the date when issued. DeLaval reserves the right to make changes without notice.

#### 3. Definitions of admonishments

Admonishments are safety related warning messages. Admonishments provide important information intended to prevent incorrect or hazardous use of equipment, machinery or software, and support risk assessment. The following list defines the different types of admonishments used in DeLaval documentation:

**Danger:** Refers to imminent and severe risk. Failure to comply with instruction will result in serious injury or death.

**Warning:** Refers to a potential but severe risk. Failure to comply with instruction could result in injury or death.

**Caution:** Refers to a limited risk. Failure to comply with instruction could result in minor injury.

**Mandatory:** Refers to an action or behaviour which is essential to safe and successful use of the equipment.

**Prohibited:** Refers to an action or behaviour which is incompatible to safe and successful use of the equipment.

**Note!** Is intended to draw attention to specific points of importance in the text and advice to prevent equipment damage.

#### 4. Safety regulations

**Warning!****Intended use**

Do not use the equipment for any other purposes than the intended use.

**Warning!****Risk of injury!**

The system must only be operated by trained personnel. Make sure that children and unauthorised people do not come into contact with the system.

**Mandatory!**

Read the instructions carefully before using the equipment. Contact the local DeLaval dealer if there are parts of these instructions that are not understood. Compliance with the instructions ensures a correct and safe use of the equipment. Save the instructions for future reference.

**Prohibited!****Do not use inadequate parts or consumables.**

Using products which do not meet specified requirements, for example spare parts or consumables, or not appropriately trained personnel for the DeLaval product may lead to risks or damage. Consequently it may also void or limit the warranty.

**Mandatory!**

Disconnect the electrical supply before removing shields, covers or guards.

**Caution!**

Never clean the equipment with a high pressure cleaner or any other jet of water. The equipment is sensitive and can be destroyed by the high pressure.

## 5. Safety labels on the equipment

**Warning!****Keep safety signs legible!**

Read all the safety signs on the machine and in this manual. Replace any lost or damaged signs. Keep safety signs clean and legible at all times.

## Regulatory

### FCC part 15

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**NOTE:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense

**NOTE:** The user is cautioned that any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## ISED part

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

## Limitation

**NOTE 1:** The module is always operate at a distance of more than 10 cm from the human body what according to Nerve Stimulant compliance distance.

**NOTE 2:** The positioning module AFC\_SENS must not be used in other products then the DeLaval OptiDuo (The host). The module must not be installed in host with other transmitters or antennas.

## Host Marking

After installation of the positioning module AFC\_SENS in the Delaval OptiDuo it must be marked to indicate that includes FCC/ISED register radio module.

The Type Plate must be replaced with new one has following information:

Contains FCC ID: UCS-OPTIDUOV1

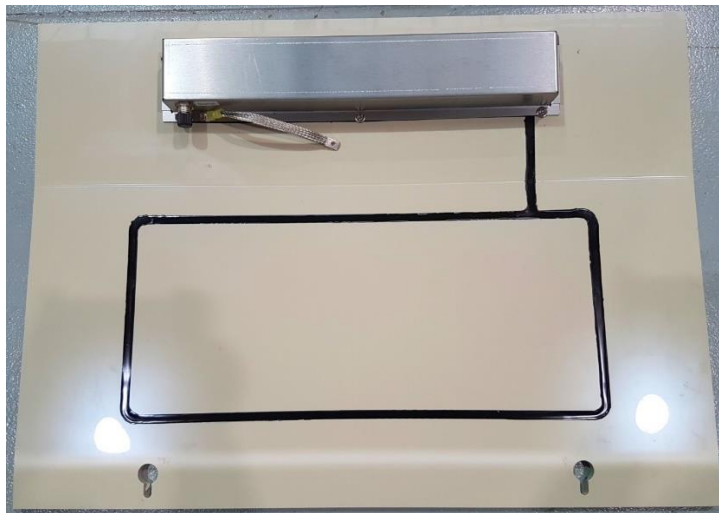
Contains IC: 6576A-OPTIDUOV1

## General

The positioning module AFC\_SENS board is used for navigating an autonomous vehicle (HOST) along an inductive guidance wire embedded within concrete floor. AFC\_SENS board integrates two functions:

- detection of the guidance wire – vehicle guiding function
- detection of FDX type RFID tags – coding of special action for vehicle along path

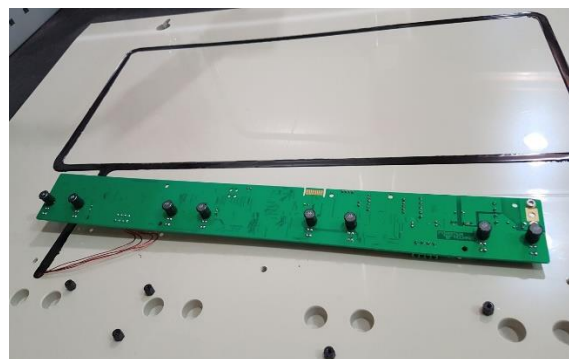
### Product overview



**Picture 1.** Product overview

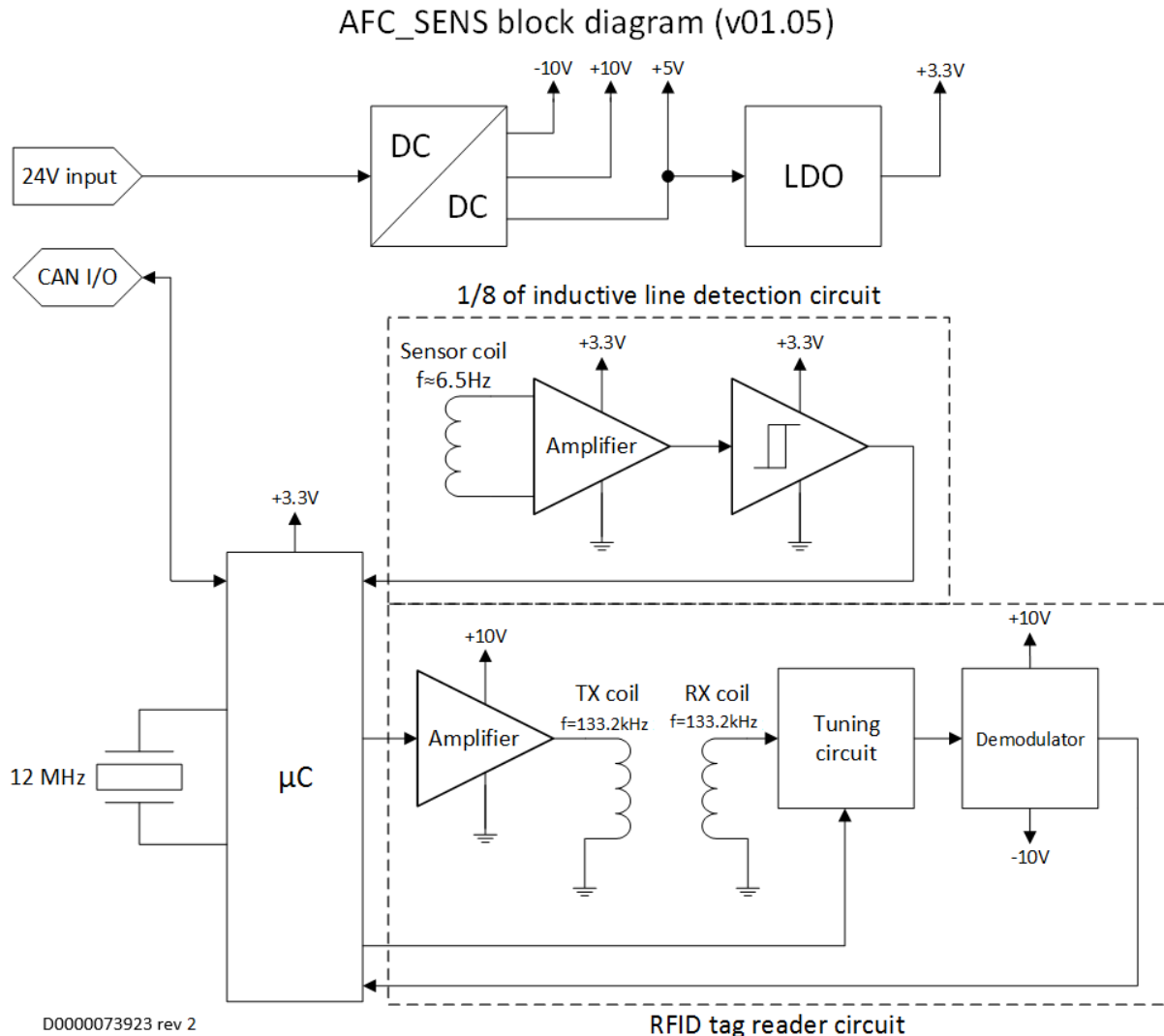


**Picture 2.** PCB and shielding overview



**Picture 3.** PCB and antenna overview

## Block diagram



### Inductive line detection circuit

The inductive line detection circuit consists of four sensors, each using two ferrite coils, which are detecting the magnetic field generated by the wire. The four separate sensors allow HOST to determine its transverse displacement in relation to the wire.

### RFID tag reader circuit

The RFID reader uses two rectangular air coils (measuring 19.88" × 8.46"), one for transmitting and one for receiving, embedded in the bottom plate of HOST. The RFID reader operates simultaneously with the guidance wire detection circuit, allowing HOST to determine its longitudinal position along the guidance wire.

Only the FDX-B (ISO 11784/5) type tags are used.

The 133.2kHz carrier wave is generated by the microcontroller and amplified by class-AB amplifier, which drives the transmit coil (TX coil).



The tuning circuit on the receiving side ensures the receiving coil (RX coil) is always in resonance with the carrier frequency. The signal picked up by the RX coil is demodulated and then goes back to the microcontroller.

## Microcontroller

AFC\_SENS is based on NXP LPC4078 microcontroller (using 12 MHz crystal resonator), which performs several functions including:

- generation of the 133.2kHz carrier wave for TX section of the RFID tag reader,
- processing the demodulated signal received from RFID tag to extract the tag ID,
- reading and interpreting the output from each inductive line detectors,
- communicating with the mainboard over CAN bus (bitrate: 100 kbps).

## Power

AFC\_SENS is powered by 24V DC and uses CAN interface for communication (details regarding CAN commands and frame structure can be found in the “CAN communication” paragraph.

24V input power is converted by a switching regulator to -10V, +10V and +5V. The +5V rail is fed to a linear regulator (LDO), which subsequently converts it to 3.3V used for powering the microcontroller.

Switching frequency is 450kHz -100/+60kHz (500 ±50kHz for the alternative switcher IC).

## CAN communication

### Identifier

The identifier consists of 11 bits. Bit 1 is used as direction bit. Bits 2-8 contain the node’s address in reversed order. Bits 9 and 10 contain the priority of message.

Bit	Meaning	Remarks
10	Priority	Priority: 0x00 – Alarm, 0x01 – Standard, 0x02 – Service, 0x03 – FT-MC-Net Protocol
9		
8	Node address	LSB
⋮		⋮
1		MSB
0	Direction bit	Direction bit: 0x00 – Slave -> Master, 0x01 – Master -> Slave

The following node addresses are reserved:

**0x00:** Cannot be used due to a bug in CAN controller in NXP LPC2000 series

**0xFD:** fixed address of Ethernet <-> CAN gateway. Note: only one gateway is allowed on a CAN-bus!

**0xFE:** Factory setting of peripheral devices.

**0xFF:** Broadcast address.

### Data bytes 0-7

The byte 0 is used as a 'Command byte'. The data bytes 1-7 are associated with parameters specific for given command.

## Commands

### 0x01 (Handing over identifier)

- Priority: 0x02
- Direction bit: 0x00 (Slave -> Master)
- Expected response: None
- Description: Sent cyclically by each node. Cycle time for initialization status = 0 is about 30 seconds, for initialization status != 0 about 5 seconds. Can be used to detect new participants on the bus.

Data byte	Meaning	Value	Comment
0	Identifier	0x01	
1	Node type	0x##	Values presented in table below
2	Number of output devices/channels or services		
3	Software version		
4	Software revision		
5	Initialisation status		Values presented in table below
6	Software release		Optional, master must evaluate length

### Data byte 1 (Node type)

0x1D – AFC (Automatic Feed Conditioner) sensor and antenna unit

### Data byte 2 (Service) with type 0x15 (TA)

Value	Meaning
LSB	SM
LSB+1	DU
LSB+2	Print

### Data byte 5 (Initialization status)

Value	Meaning
0x00	Initialization
0x01	HW reset
0x02	SW reset
0x03	CAN Störung
0x04	CAN Overrun
0x05	Search mode
0x06	Addressing

**0x01 (Requesting identifier)**

- Priority: 0x01
- Direction bit: 0x01 (Master -> Slave)
- Expected response: 0x01
- Description: Master can request Identify to check if all registered subscribers are on the bus. Every approx. 30 sec the cyclic transmission is reset.

Data byte	Meaning	Value	Remark
0	Identifier	0x01	

**0x39 (AFC\_Sens request/setting)**

- Priority: 0x01
- Direction bit: 0x01 (Master -> Slave)
- Expected response: 0x39
- Description: Requests for data or configures Slave

Data byte	Meaning	Value	Comment
0	AFC_Sens	0x39	
1	Mode	0x##	Values presented in the table
2	DB 2	0x##	
⋮	⋮	⋮	
7	DB 7	0x##	

**Data byte 1 (Mode)**

Value	Meaning	Remark
0x00	Set cyclic transmission for loop position and tranponder number	DB 2: Status 0 : sleep 1 : active
0x01	Set reading cycle time for Multireader	Cycle time [ms] DB 2-4: MSB-LSB
0x02	Read inductive line / tag	The slave will automatically send cyclic events in active mode. Max. total time 50ms.
0x03	Alive?	Asks if AFC_Sens board is active. Numbers in the request (?): DB 2-5: MSB-LSB

**0x39 (AFC\_Sens handover [responses])**

- Priority: 0x01
- Direction bit: 0x00 (Slave -> Master)
- Expected response: none
- Description: Hands over requested data or confirms receiving CAN settings

Data byte	Meaning	Value	Comment
0	AFC_Sens	0x39	
1	Mode	0x##	Values presented in the table
2	DB 2	0x##	
⋮	⋮	⋮	
7	DB 7	0x##	

**Data byte 1 (Mode)**

Value	Meaning	Remark
0x00	Response with Status	DB 2: Status 0 : sleep 1 : active
0x01	Response with cycle time	Cycle in milliseconds DB 2-4: MSB-LSB DB 5: MSB-LSB LSB 0 : response for a request 1 : software restart LSB+1 0 : normal start 1 : restart by watchdog DB 6 (bottom half): Tuning circuit inputs FRES4, FRES3, FRES2 (MSB-LSB) DB 6 (upper half): Upper 4 bit of ADC value (not used) DB 7: Lower 8 bit of ADC value (not used)
0x02	Response with inductive line lateral position / tag ID	DB 2-5: tag ID (MSB-LSB) DB 6: line position
0x03	Alive response	DB 2-4: Cycle [ms] (MSB-LSB) DB 5: Version DB 6: Revision DB 7: Release

**Abbreviations:**

- LSB – least significant bit
- MSB – most significant bit
- DB – data byte