MOS-200

USER MANUAL

Ref : **MU-MOS-200-1.4-EN**

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1 FOREWORD

1.1 Aim of this manual

This manual explains how to install and use the MOS200 reader.
Performance and other characteristics are shown in the relevant data-sheet.

1.2 Versions

Version	Index	Date	Modifications
1	4	14/07/2010	First English edition, translated from 1.4-FR

1.3 Disclaimer

BALOGH reserves the right to make changes to this manual without further notice.

BALOGH does not assume any liability arising out of errors, oversight, or misunderstanding of any information contained in this manual.

2 GENERAL INFORMATION

2.1 Description of BRS localisation system

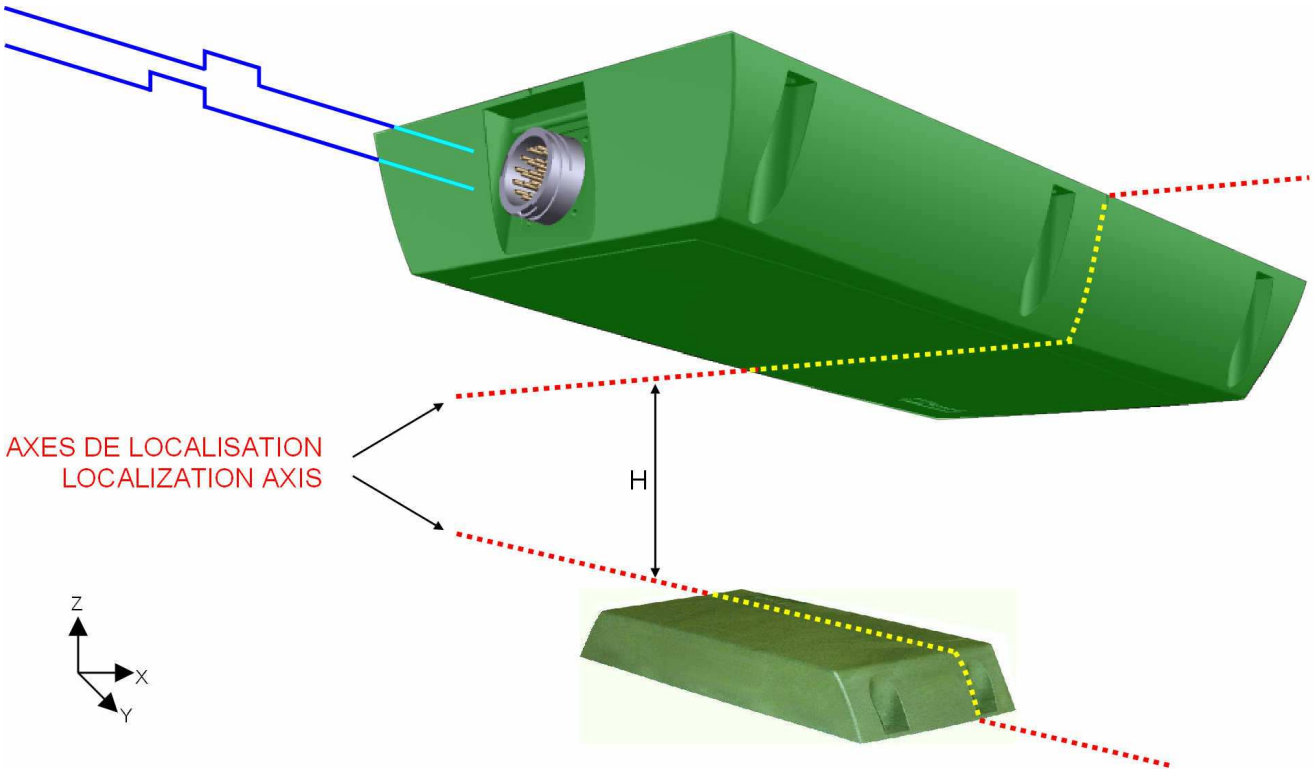
The Beacon Localisation system consists of:

- an on-board reader mounted under the train (product code MOS-200)
- a beacon secured on the ground (product code OMS-201).

The reader is composed of a single monolithic unit equipped with a connector (19 pin bayonet lock).

The beacon is composed of a single monolithic unit. It communicates by radio-frequency with the reader and has no electrical connection to any ground equipment.

On passing over the beacon, the reader transmits different data via its connector, including a localisation signal when the markings of both casings are vertically aligned



Notes:
X is the longitudinal track axis (direction of train movement)
Y is transversal track axis
Z is vertical axis
H is the vertical separation between the top of the beacon and the bottom of the reader

2.2 System operation

The reader is powered from the train, typically 110VDC.
The beacon is remotely powered by the reader's 125 KHz unmodulated transmitter.

Once powered, the beacon transmits at 6.78MHz enabling the reader to generate the localisation signal when the two are vertically aligned. These signals (S1 and S2) are sent to an on-board controller.

The beacon also transmits identification data by modulating the 6.78MHz carrier. This identification information is sent on the "Data-TX" interface.

The other signals shown on the diagram below are used for reader control.
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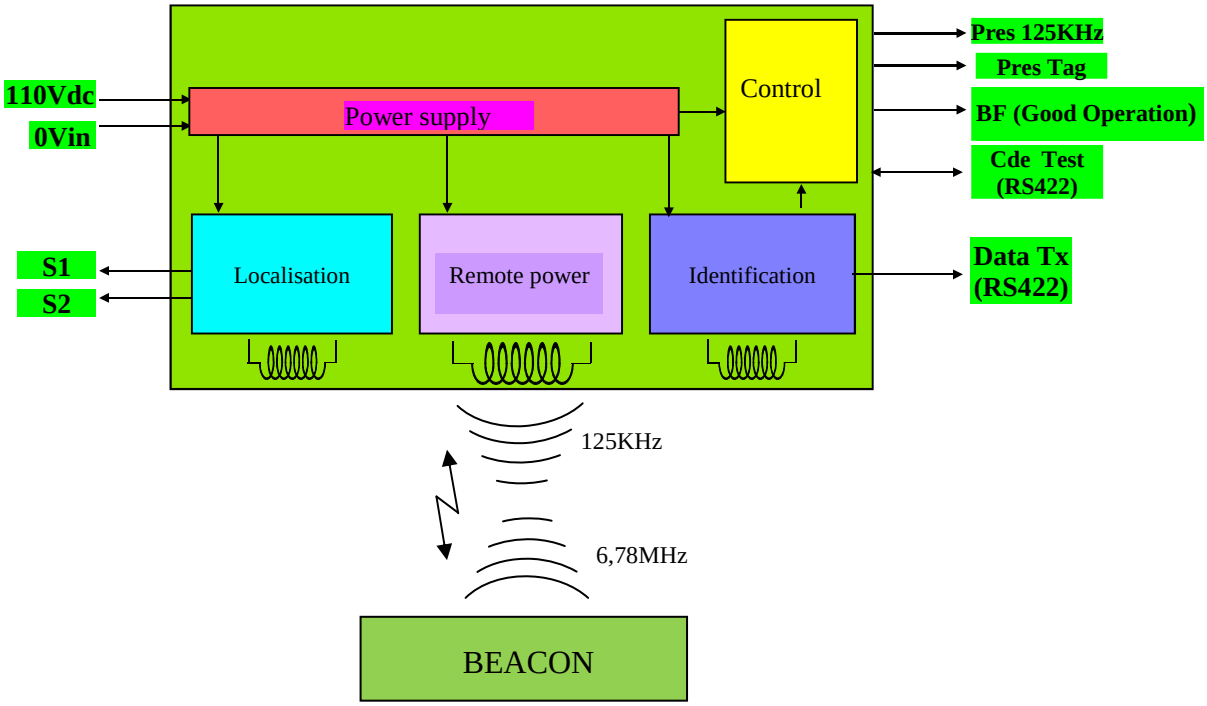


2.3 Simplified description

As soon as the beacon receives remote power from the reader it starts transmitting its identifier and continues doing so until leaving the reader's field. This identifier is in turn transmitted by the reader on its "Data-TX" interface without interruption until the beacon leaves the reader's field.

Either S1 (or S2, depending on the direction of train travel) becomes active on entering the localisation zone and the two signals switch polarities simultaneously when reader and beacon are vertically aligned. On leaving the zone S2 (or S1) becomes inactive. The order (S1 then S2 or S2 then S1) depends on the train's direction of travel.

The reader includes a diagnostic function allowing monitoring of the 125 KHz transmitter and data reception. The on-board controller can also communicate with the reader using setup and control commands.
.

3 SAFETY RECOMMANDATIONS

The safety studies performed on the BRS system (consisting of an on-board reader MOS200 and a ground beacon OMS201), whose main function is to "provide the on-board controller with data allowing localisation of the train", are compliant with the safety requirements SIL 4.

The safety manual refers to requirements whose application is the user's responsibility. These requirements are explicitly mentioned in each relevant paragraph below.

All the recommendations are summarised in the table below showing the correspondence between the safety manual and the user manual.

3.1 Mechanical

Requirements for user	Reason	References in documents	
		MU-MOS-200.EN (reader MOS-200)	MU-OMS-201.EN (beacon OMS-201)
The metallic environment of the sub-systems must comply with BALOGH SA requirements.	A reduced reader-beacon communication range could cause loss of localisation precision.	§4.4 Environmental constraints for reader.	§4.4 Environmental constraints for beacon.
The cable-side connector must comply with BALOGH SA requirements.	Compatibility (mechanical and electrical) non-compliant with standards and expected requirements.	§10.2 Connector for cable	na
The cable must comply with BALOGH SA requirements.	Compatibility (mechanical and electrical) non-compliant with standards and expected requirements.	§10.3 Type of cable to use.	na
Connections must be carried out and checked by the user according to BALOGH SA instructions.	System operation in non-optimal conditions (protection loss or absence for inputs/outputs against external damage)	§10 Connections	na
Fastening of sub-systems must be carried out and checked by the user according to BALOGH SA instructions.	A reduced reader-beacon communication range could cause loss of localisation precision. Data transmission to controller at the wrong moment.	§4.1 Mechanical specifications §4.2 Installation drawings.	§4.1 Mechanical specifications §4.2 Installation drawings.
Positioning of sub-systems in axes X, Y & Z must be carried out and checked by the user according to BALOGH SA instructions.	A reduced reader-beacon communication range could cause loss of localisation precision. Data transmission to controller at the wrong moment.	§4.3 Positioning constraints for reader.	§4.3 Positioning constraints for beacon.
Instructions for operation provided by BALOGH SA guaranteeing radio communication must be carried out by the user.	A reduced reader-beacon communication range could cause loss of localisation precision.	§4.3 Positioning constraint for reader "distance H".	§4.3 Positioning constraint for reader "distance H".

Note: na = not applicable

3.2 Electrical

Requirements for user	Reason	References in documents	
		MU-MOS-200.EN (reader MOS-200)	MU-MOS-200.EN (reader MOS-200)
110VDC power provided by train must comply with requirements specified by BALOGH SA.	*Non-safety recommendation.* No system operation	§2.2 System operation "Power supply"	na
User must take necessary precautions in order to avoid incorrect encoding of ground beacon.	A wrong ground beacon identifier will be transmitted "as is" to the on-board controller	na	§5 Encoding of beacon identifier.
At the controller, the user must provide a means of extracting the beacon identifier from a continuous data stream transmitted from the BRS system through the Data-TX interface and a means of checking data transmission integrity for this identifier.	The BRS system performs no checking of data transmission integrity (signals: RS422_Data Tx+ & RS422_Data Tx-).	§7 IDENTIFICATION INTERFACE "Data-TX".	na
At the controller, the user must provide a means of checking coherence for signals S1 & S2 by examining their change of state and a means of determining the localisation instant	The BRS system performs no checking of localisation information (signals: TOR_S1 & TOR_S2)	§6 LOCALISATION SIGNALS	na
The user must use all the safety data (Data-TX, S1 & S2) provided by the BRS system in order to perform the train localisation function.	Necessary operating conditions providing a guaranteed Safety Integrity Level SIL4 for the BRS system.	§6 POSITIONING SIGNALS. §7 IDENTIFICATION INTERFACE "Data-TX".	na

Note: na = not applicable

4 MECHANICAL SPECIFICATION

4.1 Dimensions

SAFETY RECOMMENDATION – SIL4

Fastening of sub-systems must be carried out and checked by the user according to BALOGH SA instructions.

Dimensions of bare casing:

- Length = 385mm
- Width = 256mm
- Height = 68mm

- The length is augmented by the connector and the incoming cable.
- Reader must be secured on metallic plate whose width exceeds casing by at least 20mm.

Overall dimensions:

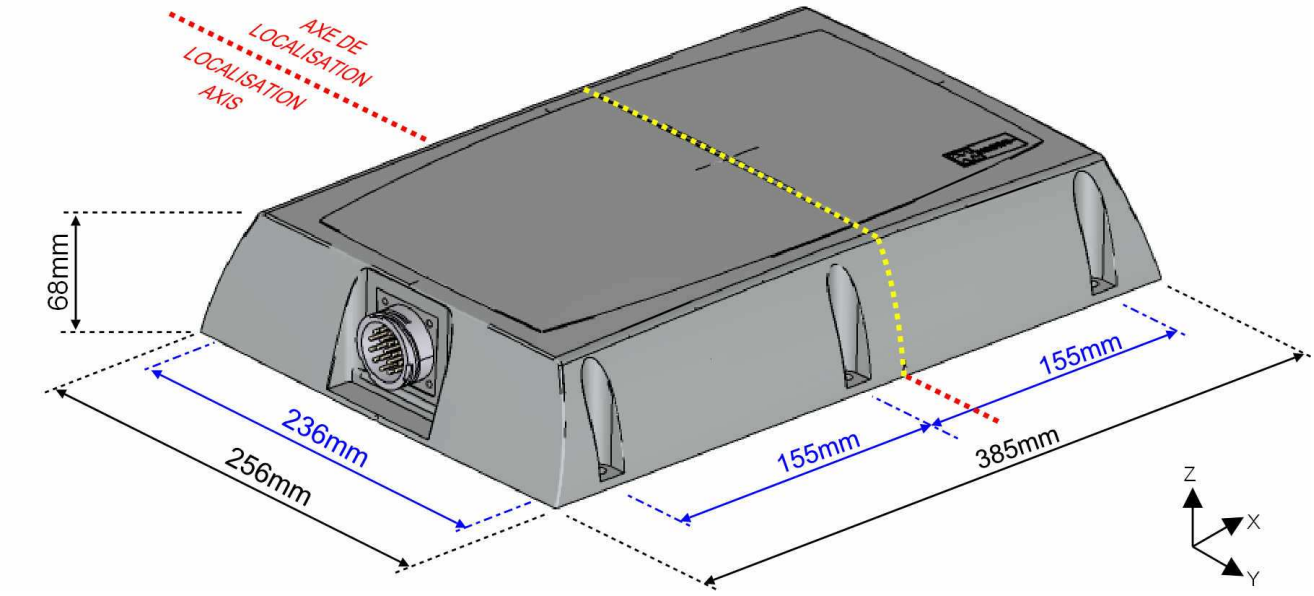
- Length including connector = 470mm approx.
- Overall length = 600mm approx depending on cable type
- Overall width including metallic plate = 296mm minimum

The reader is fastened using 6 screws Ø 6mm.

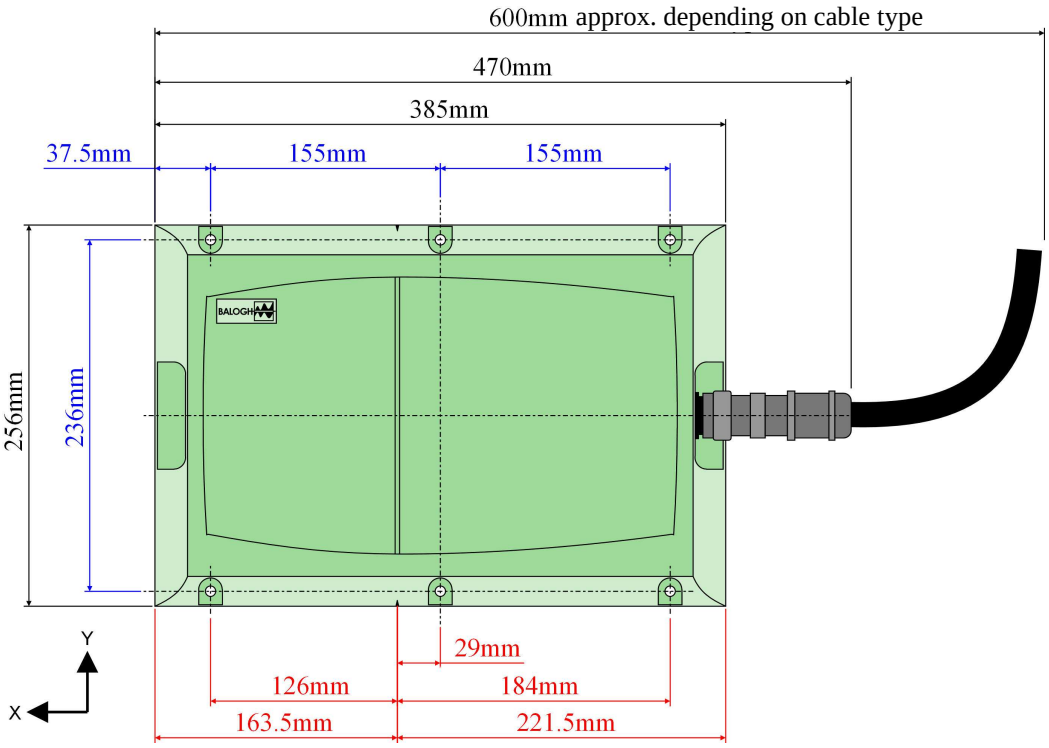
Recommended tightening torque is 5Nm.

4.2 Installation diagrams

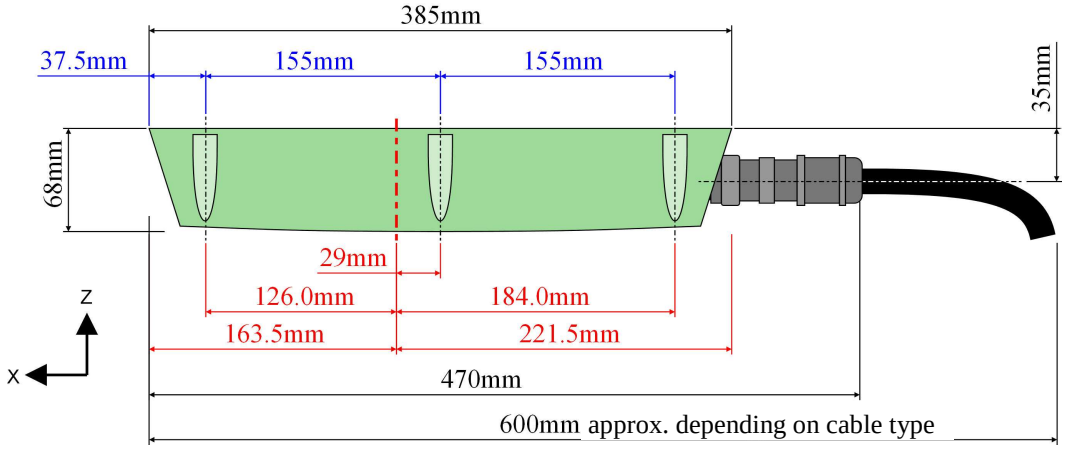
4.2.1 Perspective



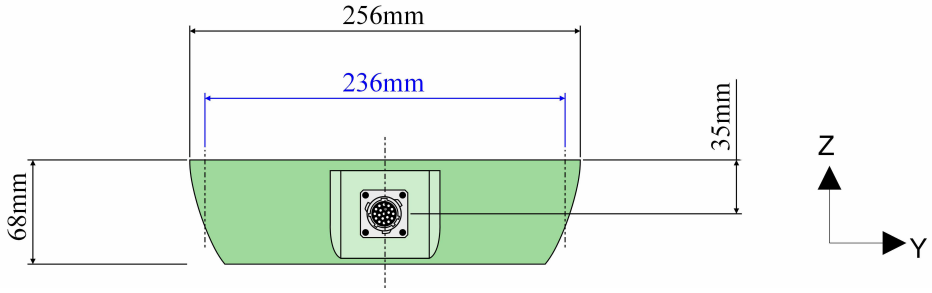
4.2.2 Bottom view



4.2.3 Side view



4.2.4 End view

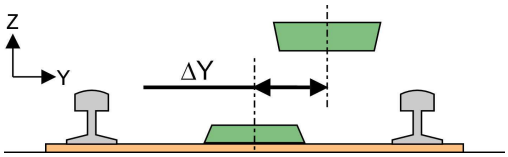
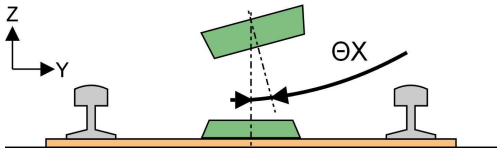
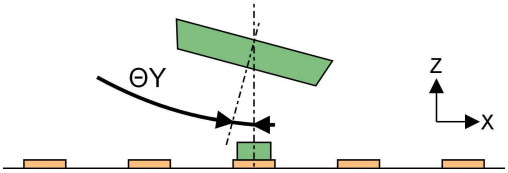
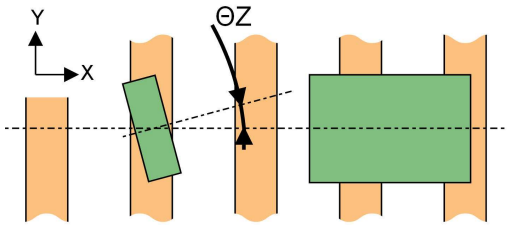


4.3 Positioning constraints for reader

SAFETY REQUIREMENT – SIL4

Positioning of sub-systems in axes X, Y & Z must be carried out and checked by the user according to BALOGH SA instructions.

- The reader must be installed longitudinally (long side of reader parallel to track)
- The reference axis for localisation is engraved on the casing and is 29 mm off-centre (opposite side to connector).
- By taking this offset into account, the reader can be installed with the connector end pointed either to the front or the back of the train.
- The vertical separation H between the bottom of the reader and the top of the beacon must be between 60mm and 200mm.
- Tolerances on position to be taken into account for installation (see note 1):
  Lateral and angular tolerances are defined for a reader-beacon pair. The indications in the table below concerning the reader's position on the train and the beacon position on the track are only suggestions.

			Reader to beacon	Reader to train	Beacon to track
ΔY	Lateral offset (see note 2)		**+/- 10mm**	+/- 2mm	+/- 8mm
ΘX	Tilt in vertical (lateral) plane		**+/- 10°**	+/- 2°	+/- 8°
ΘY	Tilt in vertical (longitudinal) plane		**+/- 15°**	+/- 3°	+/- 12°
ΘZ	Rotation in horizontal plane (top view)		**+/- 5°**	+/- 1°	+/- 4°

Note 1:

- The position and angular tolerances for each reader-beacon pair must be met. In order to achieve this end, the tolerances for an individual reader (or beacon) can be relaxed.
- These tolerances are additive: a reader-beacon pair with all tolerances at their maximum values will operate correctly.

Note 2:

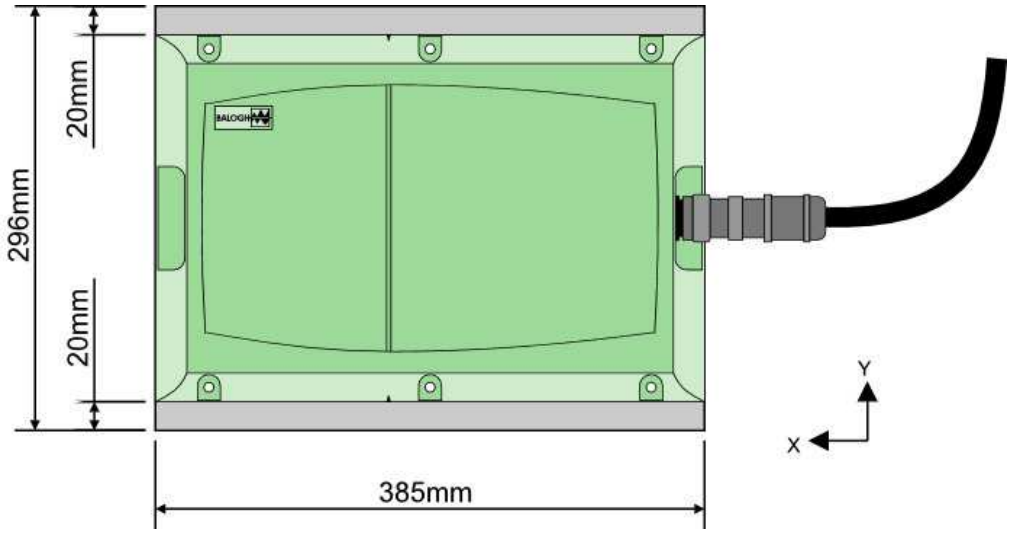
- The maximum lateral offset for correct operation is +/- 50mm. Within this interval product performance is guaranteed.
- The maximum lateral offset for functional operation is +/- 80mm. At this offset, communication and localisation are possible, however without guaranteed performance (in particular for precision).
- Tolerances shown in the table must be adhered to during installation so that performance is maintained during movement given that small deviations (vibrations…) occur.

4.4 Environmental constraints for reader

SAFETY REQUIREMENT – SIL4

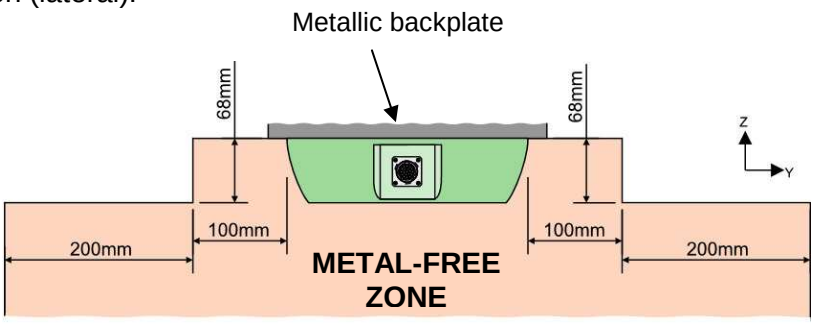
The metallic environment of the sub-systems must comply with BALOGH SA requirements.

- The distance between two readers on the same train must be greater than 5 metres (500 cm).
- The reader must be secured on a metallic plate of dimensions 385mm x 296mm (width exceeds casing by at least 20mm on each of the longer sides)

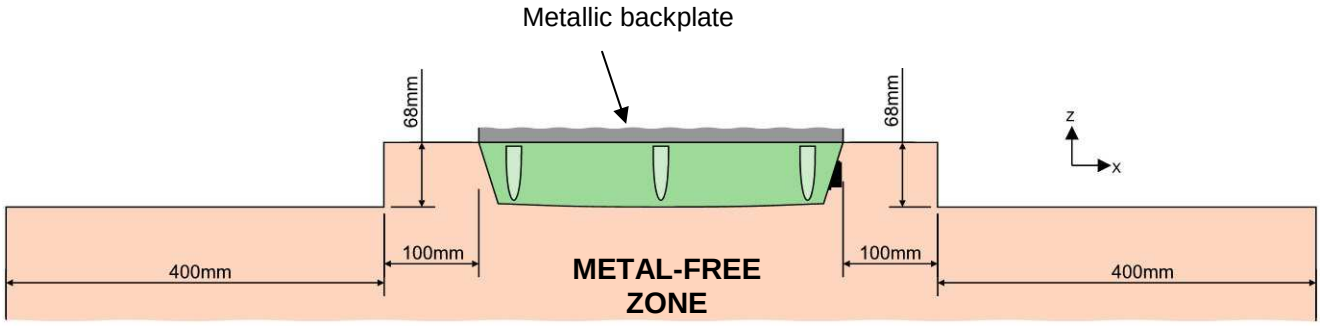


- There must be a metal-free zone around the reader as indicated in the diagram below (colour = zone without metal) :

Cross section (lateral):



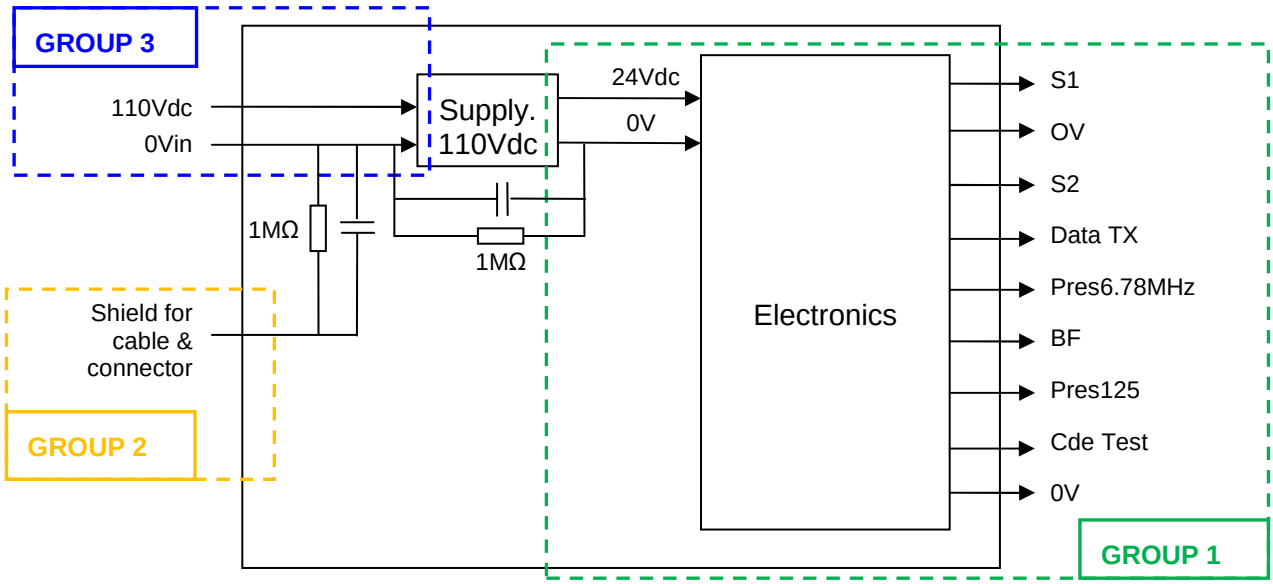
Cross section (longitudinal):



5 ELECTRICAL SPECIFICATION FOR INTERFACES

5.1 Isolated power circuits

There are three isolated power circuits as shown in the diagram below:



5.2 Power supply

Power supply voltage to reader: 110VDC as specified in EN50155.
Operation is guaranteed for voltages in the range: 77VDC to 137.5VDC.
Power supply current: 250mA (typical, rated, not starting) at 110VDC

5.3 Digital Outputs

Reader's internal power supply produces 24VDC regulated.

Name	Type	Voltage min high state	@ Current max	Rated voltage for high state
S1 & S2	Digital output	19V	40mA	24V
Pres125KHz (S3)	Digital output	15V	40mA	24V
Pres6.78MHz (S4)	Digital output	19V	40mA	24V
BF (S5)	Digital output	19V	40mA	24V

5.4 Cde-Test and Data-Tx : RS 422 interfaces

The interfaces "Cde-Test" et "Data-Tx" are RS422 differential pairs compliant with TIA/EIA-422-B.
The output stage has an impedance of 120Ω. It may be necessary to adapt the lines at the controller end with a 120Ω resistor.

6 LOCALISATION SIGNALS

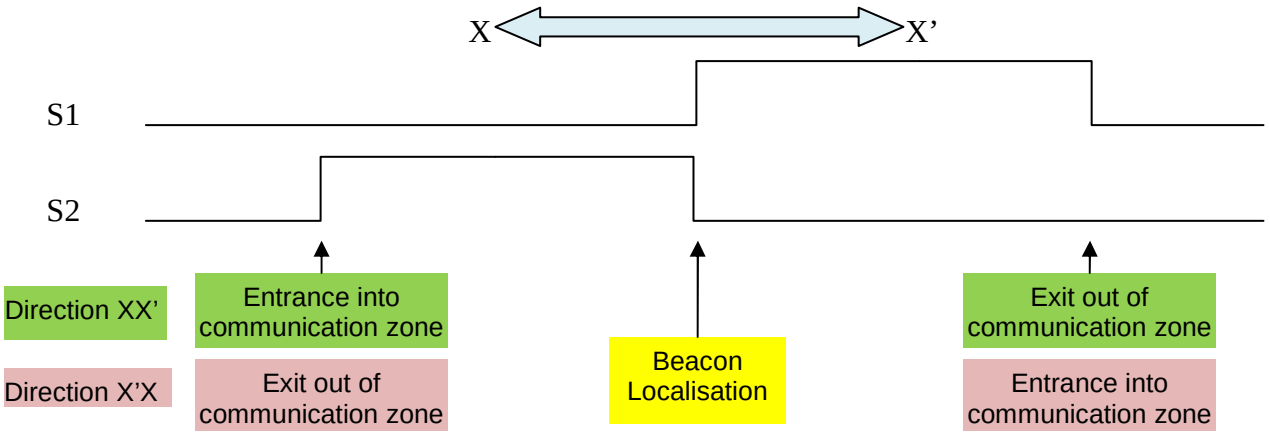
SAFETY REQUIREMENT – SIL4

The user must use all the safety data (Data-TX, S1 & S2) provided by the BRS system in order to perform the train positioning function.

The signals S1 and S2 provide information about localisation and the communication zone

These signals allow:

- beacon detection with an indication of entrance into and exit out of the communication zone
- beacon localisation



For the direction XX', beacon detection is provided by the rising edge of signal S2 from '0' to '1'.

Beacon localisation information is provided by the simultaneous rising of S1 and the falling of S2. Beacon disappearance information is given by the falling edge of S1.

For the direction X'X, beacon detection is provided by the rising edge of signal S1 from '0' to '1'.

Beacon localisation information is provided by the simultaneous rising of S2 and the falling of S1. Beacon disappearance information is given by the falling edge of S2.

The two signals S1 and S2 are generated by two independent circuits (safety requirement). The simultaneous switching of S1 and S2 may not happen at exactly the same time. This represents the measurement precision and corresponds to a distance of less than 5cm.

SAFETY REQUIREMENT – SIL4

At the controller, the user must provide a means of checking coherence for signals S1 & S2 by examining their change of state and a means of determining the localisation instant

The controller must verify

- the coherence of signals S1 and S2
- that the "simultaneous" switching of S1 and S2 occur at a maximum separation of +/-5cm

It is the responsibility of the controller to process the special cases of the reader at rest just above the beacon and incoherent signals S1 and S2 (e.g. S1 without S2 or vice versa).

The outputs S1 are S2 are digital: binary '0' = 0V and '1' = 24VDC (19V @ 40mA max)

7 IDENTIFICATION INTERFACE Data-TX

SAFETY REQUIREMENT – SIL4

At the controller, the user must provide a means of extracting the beacon identifier from a continuous data stream transmitted from the BRS system through the Data-TX interface and a means of checking data transmission integrity for this identifier.

'Data-TX' carries the identifier received from the beacon.
The signal sent to the controller is a binary signal, encoded either NRZ or FM0 depending on the type of reader MOS-200:
- MOS-200-FM0 for Data Tx in FM0 coding
- MOS-200-NRZ for Data Tx in NRZ coding

For both types, the date transmission rate is 62.5kbits/s, i.e. a bit duration of 16µs.
When the reader goes over the beacon, Data_Tx carries the beacon identifier data, unless the signal BF is low ('0') in which case, no message is sent.

When the reader is **not** above the beacon, Data Tx is determined by state of the BF signal:
When BF is high ('1'), the reader is considered to be working correctly, and the RS422 levels are at rest: Tx+ at '1', Tx- at '0'.
When BF is low ('0'), the reader is considered to be faulty, and the RS422 levels are active: Tx+ at '0', Tx- at '1'.

The RS422 link for the transmission of the Data-Tx signal is simplex (one-way). The reader sends either the beacon identifier or the BF information, no reply or command sent by the controller reaches the reader.

The reader does not format the data received from the beacon – no start or stop or other bits are added. If such formatting is required, it must be included in the encoded beacon data.

Note: If the reader is not powered, both RS422 levels for Data-Tx are at 0V.

7.1 Example for NRZ output

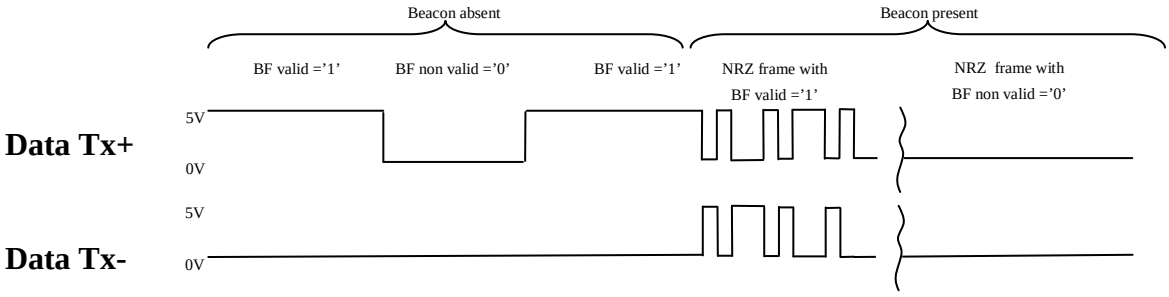
While passing over a beacon, Data-TX will typically show the following behaviour:
- Indication of BF state (before encountering beacon)
- Start of message - preamble of 72bits NRZ at '1'.
- Separator 2 bits NRZ at '1'.
- message as frame of 144bits NRZ.
- Separator 2 bits NRZ at '1'.
- message as frame of 144bits NRZ.
- Separator 2 bits NRZ at '1'.
- message as frame of 144bits NRZ
- Separator 2 bits NRZ at '1'.
- Start of message - preamble of 72bits NRZ at '1'.
- Separator 2 bits NRZ at '1'.
- message as frame of 144bits NRZ.
- Etc…
- Incomplete frame due to beacon exiting the communication zone.
- Indication of BF state (after encountering beacon)

Due to beacon start-up time, the first frame received by the reader will be incomplete, i.e. the first bits received will be somewhere in the middle of the frame.
As long as the beacon remains within the communication zone, the reader receives data from the beacon and transmits this continuously to the controller. If the reader comes to rest above the beacon, the controller will receive frames continuously until the reader moves past the beacon and leaves the communication zone.

The beacon transmits continuously. At the end of a frame, it immediately begins retransmitting the same frame from the beginning again.

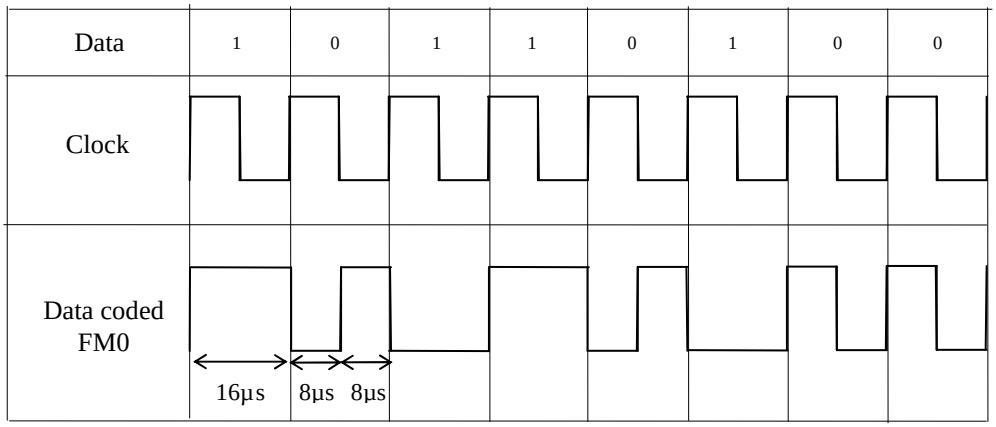
The number of frames transmitted depends on the time the reader and beacon remain within the communication zone.

Example of RS422 levels for signal Data Tx:



7.2 Example for FM0 output

Data sequence showing FM0 coding:



While passing over a beacon, Data-TX will typically show the following behaviour:

- Indication of BF state (before encountering beacon)
- Start of message - preamble of 72bits at '1' encoded FM0 (1152µs)
- Separator 2 bits FM0 (32µs)
- message as frame of 144bits FM0 (2304µs).
- Separator 2 bits FM0 (32µs)
- message as frame of 144bits FM0 (2304µs).
- Separator 2 bits FM0 (32µs)
- message as frame of 144bits FM0 (2304µs).
- Separator 2 bits FM0 (32µs)
- Start of message - preamble of 72bits at '1' encoded FM0 (1152µs)
- Separator 2 bits FM0 (32µs)
- message as frame of 144bits FM0 (2304µs).
- etc…
- Incomplete frame due to beacon exiting the communication zone.
- Indication of BF state (after encountering beacon)

Due to beacon start-up time, the first frame received by the reader will be incomplete, i.e. the first bits received will be somewhere in the middle of the frame.

As long as the beacon remains within the communication zone, the reader receives data from the beacon and transmits this continuously to the controller. If the reader comes to rest above the beacon, the controller will receive frames continuously until the reader moves past the beacon and leaves the communication zone.

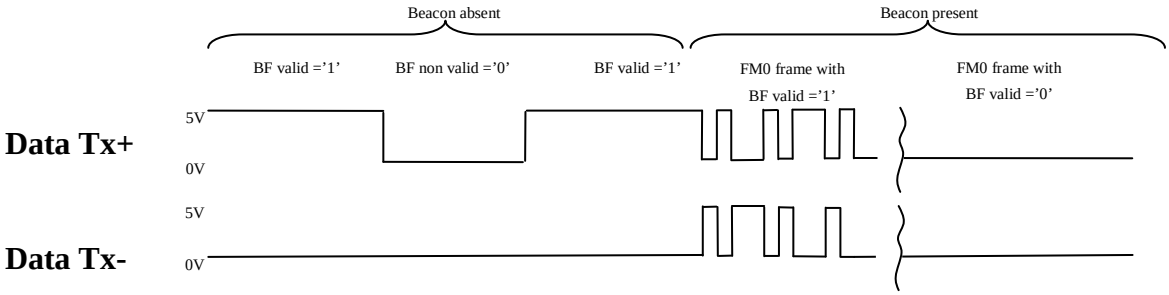
The beacon transmits continuously. At the end of a frame, it immediately begins retransmitting the same frame from the beginning again.

A complete frame consists of 512 bits (8192µs):

- 72 bits FM0 at '1' : 1152µs
- 4 separators consisting of 2 bits each :4x 32µs = 128µs
- 3 identifiers 144bits FM0 :3x2304µs = 6912µs
- Total time : 8192µs

These frames repeat endlessly and are all identical. The number of frames transmitted depends on the time the reader and beacon remain within the communication zone.

Example of RS422 levels for signal Data Tx:



8 READER STATUS SIGNAL

8.1 Output "Pres125KHz"

The output '*Pres125KHz' (S3)* indicates correct operation of the reader's 125 KHz transmitter.

'Pres125KHz' is at '1' for correct operation, at '0' otherwise. The principle of operation is as follows: a small antenna connected to a 125 KHz receiver detects a small part of the transmitted power and generates a binary signal which is sent via the reader's control section to the digital output. (Pres125KHz)

The output Pres125KHz is digital: binary '0' = 0V, '1' = 24Vdc (15V @ 40mA max)

8.2 Output "Pres6.78MHz"

The output '*Pres6.78MHz' (S4)* indicates that the reader's 6.78 KHz receiver has detected a signal. This means that a beacon is close and will soon start to transmit its identifier data. This signal is active whether or not correct beacon data is received. As soon as the 6.78 MHz is no longer detected, this signal is deactivated. This means that if two beacons are close together, this signal could remain active, whereas the identifier data will be coming from the other beacon. The detection threshold for the 6.78 MHz receiver is fixed.

The output Pres6.78MHz is digital: binary '0' = 0V (inactive), '1' = 24Vdc (19V @ 40mA max)

8.3 Output "BF"

The output *'BF' (S5)* indicates correct operation of the reader ("Good operation"); it comprises the results of tests on the different reader parts; localisation, reception and emission. This signal also incorporates the results of the following tests:

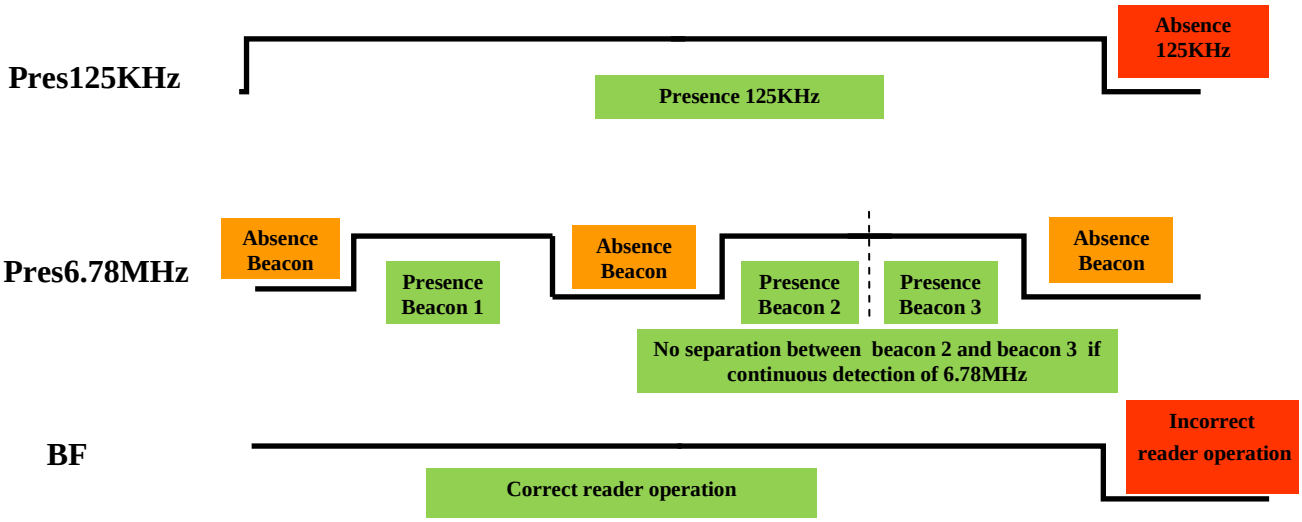
- antenna continuity
- 125 KHz transmitter operation (Pres125KHz)

This signal is at '1' when the reader is operating correctly, at '0' otherwise.

The output BF is digital: binary '0' = 0V (inactive), '1' = 24Vdc (19V @ 40mA max)

Note: the Data-TX signal also carries this "Good operation" information – see previous chapter.

8.4 Summary of reader states



9 SERVICE PORT "Cde-Test"

This is a standard half-duplex serial link on a RS422 differential pair. A 0V reference is available on several pins of the connector (pins F-H-K-S-T and U, see §10.1).

Although this interface is always available, it is recommended not to send commands to the reader if a beacon is present.

The data-rate is fixed at 19200bps.

9.1 Character format

1 character 10 bits = 1 start bit + 8 data bits + 1 stop bit

For the data byte, least significant bit is sent first

Start	Data : 1 byte	Stop

9.2 Messages sent to and received from reader

9.2.1 Format of commands (status requests)

The format of the messages sent by the controller to the reader is as follows:

STX	Fn	CS

- <STX> : Start character, 1 byte, value 02H
- <Fn> : Function code, 1 byte. The different values that this byte can take on are shown in the table below
- <CS> : Checksum, 1 byte, value = exclusive OR of preceding bytes. The CS is the third and last byte in message.

Name	Fn hexa	Description
F1	20h	Not used
F2	21h	Diagnostic (auto-test) request
F3	22h	Not used
F4	23h	Stop 125KHz transmitter
F5	24h	Start 125KHz transmitter
F6	25h	Read firmware version
F7	26h	Not used
F8	28h	"Good operation" request

9.2.2 Format of replies (status messages)

The format of the replies sent by the reader to the controller is shown below. If the reader receives a request Fn, then it responds with the message Fn.

STX	Fn	DATA : D1	DATA : D2	CS

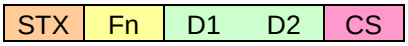
- <STX> : Start character, 1 byte, value 02H
- <Fn> : Function code, 1 byte. The different values that this byte can take on are shown in the table below.
- <DATA>: Supplied by reader as in table below.
- <CS> : Checksum, 1 byte, value = exclusive OR of preceding bytes. The CS is the last byte.

Request	Fn hexa	D1	D2	Description
F1	20h			Not used
F2	21h	00	DEF	Diagnostic (auto-test) : DEF (active 1) : • bit 0 = transmitter error • bit 1 = receiver error • bit 2 = processor error • all other bits 0
F3	22h			Not used
F4	23h	00	00	
F5	24h	00	00	
F6	25h	V1	V2	Firmware version : • V1 = major index • V2 = minor index
F7	26h			Not used
F8	28h	BF1	BF2	Good operation status bits: BF1 (active 1): • bit 0 = continuity error for receiving antenna (A-B)1 • bit 1 = continuity error for receiving antenna A • bit 2 = continuity error for receiving antenna (A-B)2 • bit 3 = continuity error for receiving antenna B • bit 4 = symmetry fault between antenna A and antenna B. • bit 5 = reduced power for 125kHz transmitter due to current. • bit 6 = reduced power for 125kHz transmitter due to voltage. BF2 (active 1): • bit 0 = signal present on receiver A • bit 1 = signal present on receiver B • bit 2 = reserved • bit 3 = 125KHz transmitter error
	0Fh	00	00	NAK

Important notes :
The diagnostic command F2 briefly turns off the 125 KHz transmitter and briefly turns on a 6.78 MHz transmitter which consequently prevents detection of any beacon that is present.
The F8 command allows monitoring of all important functions without affecting reader.

9.2.3 Messages sent automatically by the reader

The following message is automatically sent at reader start-up. No reply should be sent by the controller:



- <STX> : Start character, 1 byte, value 02H
- <Fn> : Function code, 1 byte. The different values that this byte can take on are shown in the table below.
- <CS> : Checksum, 1 byte, value = exclusive OR of preceding bytes. The CS is the last byte.

Request	Fn hexa	D1	D2	Description
R2	21h	00	DEF	Diagnostic (auto-test) : DEF (active 1) : • bit 0 = transmitter error • bit 1 = receiver error • bit 2 = processor error • all other bits 0

This message is automatically sent when the reader is powered up, after performing the diagnostic tests.

9.2.4 Transmission of beacon identifier

Transmission of the beacon identifier is possible using this service port. This transmission is not guaranteed.

The frame data to be encoded into the beacon can be defined according to customer requirements.

10 CONNECTORS

The connectors used belong to the UTO series from SOURIAU, size 16, 19 pins, protection index IP67, with shielding capability compatible with EMI requirements.
The connectors are circular with a bayonet locking ring.

10.1 Connector on reader

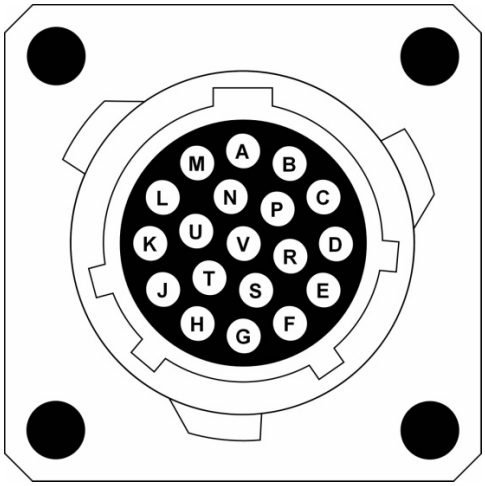
The connector on the reader is a 19-pin male socket on a square base (wall mounting).
Part numbers:

- Shell : UTO01619PH
- Pins : RM20M12E8K

The male contacts have a diameter of 1.6mm.

Pin	Assignment
A	110VDC
B	0VDC
C	CdeTest_RS422_RX-
D	Data_TX_422-
E	Data_TX_422+
F	0V
G	S2
H	0V
J	S1
K	0V
L	Pres125KHz
M	Pres6.78MHz
N	BF (Good Operation)
P	CdeTest_RS422_TX+
R	CdeTest_RS422_RX+
S	0V
T	0V
U	0V
V	CdeTest_RS422_TX-

External front view of socket
(rear view of plug on cable side)



10.2 Connector to mount on cable

SAFETY REQUIREMENT – SIL4

The cable-side connector must comply with BALOGH SA requirements.

The cable-side connector is a female plug with part numbers:

- Shell: UTO61619SH
- Pin sockets: RC16M23K - for wire gauges 0.5mm^2 to 1,5mm^2 (AWG16 to AWG20).
- Backshell and clamp: UTOS16JCSL (long model for cables ∅13.5 to 18mm).

These are typical references. See SOURIAU product documentation for exact available references.

The pin sockets of the plug should be chosen according to the conductor gauges used in the cable. The above part number is suitable for gauges from 0.5mm^2 to 1.5mm^2 (AWG16 to AWG20). See SOURIAU product documentation for other possible references.

The backshell for the plug should be chosen according to the outer cable diameter. The above part number is suitable for cable diameters from 13.5mm to 18mm. See SOURIAU product documentation for other possible references.

10.3 Cable type

SAFETY REQUIREMENT – SIL4

The cable must comply with BALOGH SA requirements

The cable to be used must have the following characteristics:

- 19 conductors
- common shield with 360° contact to connector.
- twisted pairs preferred for serial links.
- conductor cross-section between 0.5 mm^2 and 1.5 mm^2.
- outer cable diameter between 13.5mm and 18mm.
- cable linear capacity less than 100pF/m.
- maximum length: 200m.

Individual conductors must be connected to contacts using a crimping tool.

The shield must be correctly connected to the backshell: the clamp must make 360° contact with the shield. See SOURIAU documentation for the correct procedure.

SAFETY REQUIREMENT – SIL4

Connections must be carried out and checked by the user according to BALOGH SA instructions.

11 VERIFYING READER OPERATION

Reader verification can be done in two cases:

- In the workshop, for example on delivery or before installation. In this case measurements can be made using several different apparatus, a test cable can be used to connect to the reader in order to monitor the signals and a PC can be used to emulate the on-board controller.
- Reader installed under train, for regular checks

The MOS-200 reader is entirely immersed in resin. It can neither be disassembled nor repaired. Any permanent fault or defect found during the verification process will require the reader to be replaced.

The technical procedures described in this chapter need to be carried out by personnel adequately trained in electronics measurements.

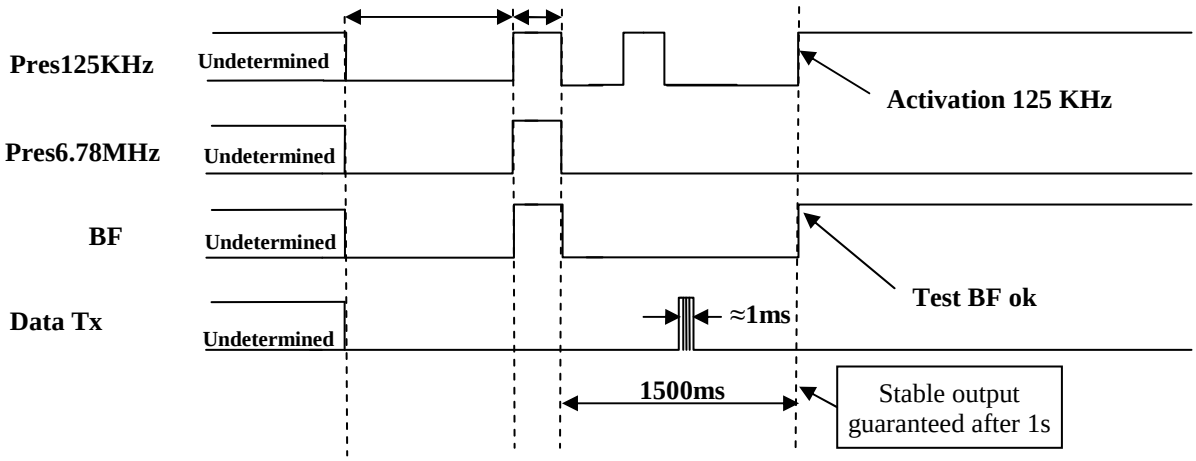
11.1 Testing in workshop

11.1.1 Apparatus required

- A test cable with 19-pin female plug and individual access to all 19 wires
- Power supply 110V / 1A.
- An ammeter measuring the current drawn from the power supply, if the power supply has no current display.
- A 2-channel oscilloscope. If not available, either two voltmeters or a circuit with LEDS for visualising the digital outputs can be used.
- An OMS-201 reference beacon centrally mounted on a metallic plate of dimensions 260mm x 180mm.
- A metallic plate of dimensions 385mm x 296mm on which the reader under test is to be fixed.

11.1.2 Tests to be performed

- The MOS-200 reader is connected to the 110VDC power supply. When powered up, the outputs are as follows :

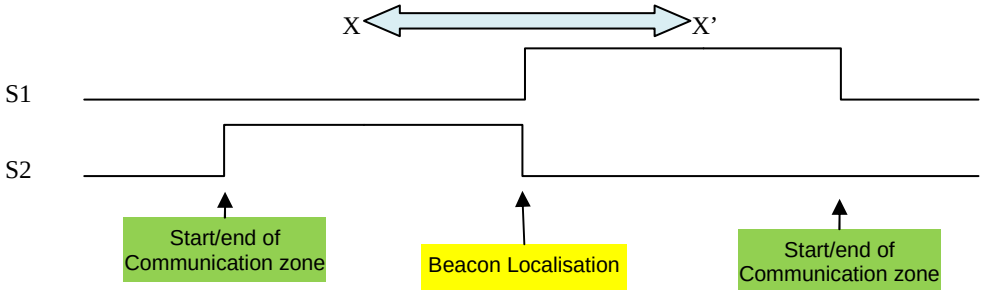


- o A 100ms pulse is generated on the 3 digital outputs "*BF*", "*Pres6.78MHz*" and "*Pres125 kHz*".
- o Automatic emission of a test pattern that appears on the "Data-Tx" output. This test pattern is in fact a 62.5 KHz square-wave of duration 1 ms sent by the microcontroller to the 6.78 MHz transmitter which is then detected by the 6.78 MHz receiver and sent to this output. During this time the 125 KHz transmitter is turned off, so as not to receive and data from a beacon that may be present.
- o Emission of a status message on the output "cde test" (see §9.2.3).

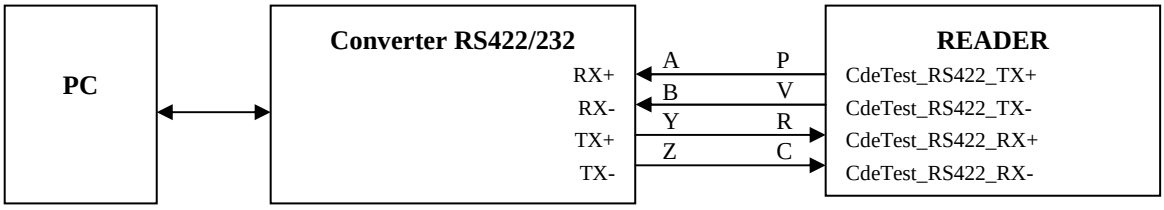
- With the reader powered up and no beacon:
  - current drawn must be between 170mA and 300mA.
  - signal BF must be at 1
  - signal Pres125KHz must be at 1

- The beacon is placed before the reader
  - signal Pres6.78KHz becomes active (1)

- Move the beacon past the reader simulating the train movement
  - signals S1 and S2 must behave as follows :



- By connecting the serial link "CDE-TEST" to a PC using an RS422-RS232 converter (see connection diagram below), the "COM-MOS" program can be used to read the beacon identifier.



- Signal "DATA-TX" can be checked with an oscilloscope: signal is present and data rate is 62.5 kbits/s (bit duration of 16µs).

11.2 Verifying the operation of an installed reader

If the connector can be removed, the use of a long test cable will allow the tests described in the preceding section to be performed. Similarly if individual access to certain wires is possible between the reader and the controller, signals can be checked.

If the connector cannot be removed or if wires cannot be accessed individually, then it is the user's responsibility to implement the necessary test functions in the controller.

12 MAINTENANCE

12.1 Regular maintenance

The MOS-200 reader requires no regular operational maintenance.

The MOS-200 reader should be regularly cleaned to avoid accumulation of dirt on casing.

The MOS-200 reader should be regularly examined for:

- cracks in casing
- broken mounting plates
- missing mounting screws
- correctly tightened mounting screws
- connector properly locked in place

The MOS-200 reader operation should be checked regularly according to procedure in the previous chapter.

12.2 Replacement

To replace a MOS-200 reader, proceed as follows:

- turn the knurled ring of connector 1/3 turn anti-clockwise to disengage plug from socket
- remove the 6 mounting screws and lift out the reader, remembering the localisation axis
- Put the new MOS-200 reader in the same position, replace 6 mounting screws and tighten to recommended torque.
- Plug in connector and turn knurled ring 1/3 turn clockwise until locked.

Check for correct operation according to above procedure in the previous chapter.

12.3 Recycling

Decommissioned MOS-200 readers should be returned to BALOGH for recycling in accordance with guideline D3E.