



KONGSBERG

Instruction Manual

MST

Mini SSBL Transponder



(Cd6424b)

MST Mini SSBL Transponder

Instruction Manual

This is the Instruction manual for the Kongsberg Maritime Mini SSBL Transponder.

If the transponder includes a lithium battery:

Warning

Due to safety rules, the safety information for transponder and transponder battery must be read before handling transponders or separate transponder batteries. Refer to:
- Safety information for transponder and transponder battery chapter on page 9.

About this document

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Updated Spare Parts chapter with P/N 499-215473 for Chassis w/rechargeable battery MST.				

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INTRODUCTION

Manual contents

This manual describes all the MST transponders.

It provides technical specifications, operating instructions, maintenance procedures and battery charges instructions. It also includes spare parts lists, and outline dimension drawings for each of the transponder units.

List of abbreviations

HiPAP	High Precision Acoustic Positioning
HPR	Hydroacoustic Position Reference
LED	Light Emitting Diode
MF	Medium Frequency
MST	Mini SSBL Transponder
N/A	Not Applicable
ROV	Remotely Operated Vehicle
SSBL	Super-Short Base Line

How to handle a transponder

Note *The MST must always be switched off when not used.*

Important information

Warning *Do not point the transducer / end cap towards you self or others when you turn the MST on.*

Transponder with a NiMH battery:

Warning *Charging of battery is connected with some risk.*

→ *Follow the procedure on page 27.*

Transponder with lithium battery:

Warning

***Due to safety rules, the transponder must be handle with care. Refer to:
- Safety information for transponder and
transponder battery chapter on page 9.***

Operation

- *Refer to sections:*
- *Operation on page 19.*
 - *Transponder configuration on page 20.*
 - *Transponder External power / Responder function on page 21.*

Maintenance

- *Refer to Maintenance on page 37.*

Pressure relief valves

- *Refer to pressure relief valves on page 23.*

General description

The MST transponder is designed primarily for use with the Kongsberg Maritime HiPAP / HPR system.

Figure 1 MST transponders



The MST transponder can work from its own internal battery pack, or an external power supply, and it can be interrogated acoustically through water or via a cable (responder function).

The transponder housing is an aluminium cylinder which is anodised and polyurethane coated to protect against corrosion and abrasion.

The unit is designed with a modular construction. The electronics, battery pack, transducer and end cap can easily be replaced individually.

MST features:

- External channel selection:
 - 56 channels for HiPAP / HPR 400
 - 14 channels for HPR 300.
- Operator selectable source level to optimise battery life.
- Operator selectable sensitivity.
- Both transponder and responder function.
- Fast battery charging (requires rechargeable battery).

Available transponders

This manual covers the following transponders:

Transponder series	Model	Battery
MST 319		
	MST 319/N depth 1000 m, transducer $\pm 90^\circ$	Rechargeable
	MST 319/L depth 1000 m, transducer $\pm 90^\circ$	Lithium
MST 324		
	MST 324/N depth 2000 m, transducer $\pm 45^\circ$	Rechargeable
	MST 324/L depth 2000 m, transducer $\pm 45^\circ$	Lithium
MST 342		
	MST 342/N depth 4000 m, transducer $\pm 20^\circ$	Rechargeable
	MST 342/L depth 4000 m, transducer $\pm 20^\circ$	Lithium

Transducers

There are three transducer beamwidths available:

- A 180° hemispherical transducer
- A 90° cone transducer
- A 40° cone transducer.

Beam patterns

The figure below presents examples of beam patterns. A beam pattern shows the transmit/receive sensibility in the different directions.

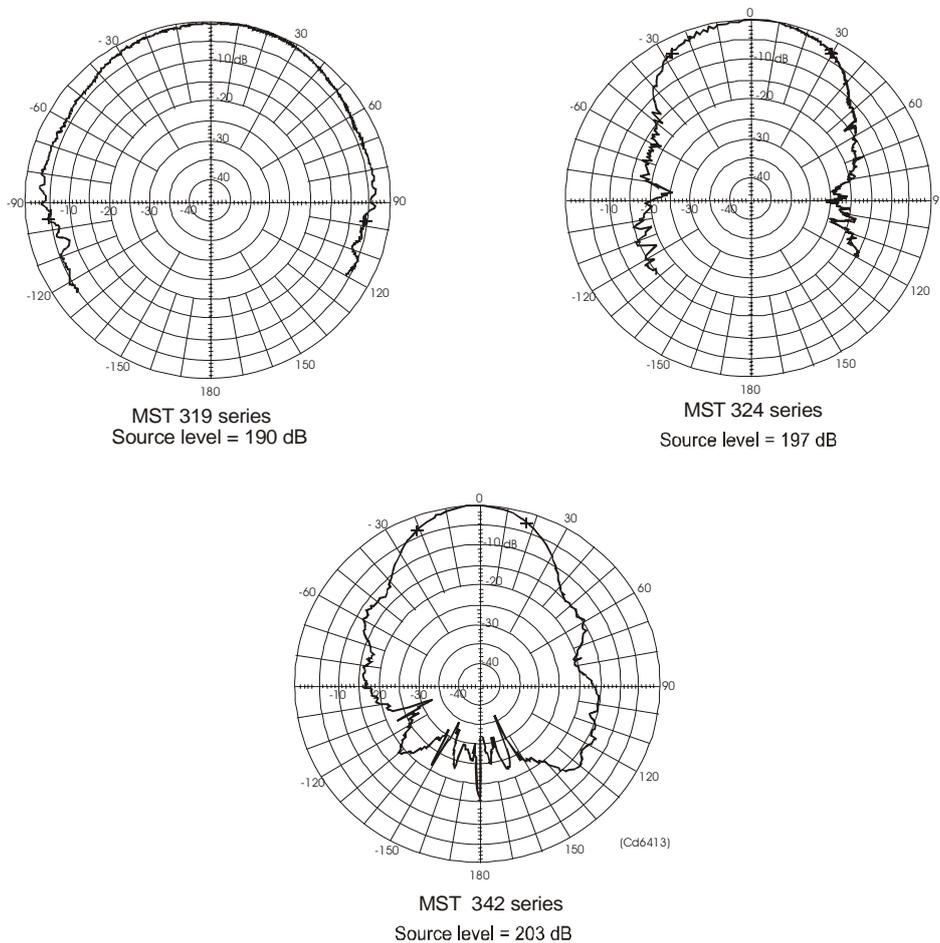


Figure 2 Examples of beam patterns

Accessories

A floating collar is available to fit around the transponder.

Transponder model identification principles

The transponder name consists of the model name, the model number and any options included.

The name contains three letters followed by three numbers. The letters after the numbers describe the options (see example below).

Model name

MST = Mini SSBL Transponder

Model number

The three digits number describe:

Digit 1: frequency band

Digit 2: depth rating

Digit 3: beamwidth

The following are available:

1st number	2nd number	3rd number
Frequency band	Depth rating	Transducer beamwidth
3 = 30 kHz	1 = 1000 m 2 = 2000 m 4 = 4000 m	2 = $\pm 20^\circ$ 4 = $\pm 45^\circ$ 9 = $\pm 90^\circ$

Options

N = NiMH Rechargeable battery pack

L = Primary Lithium battery pack

Example: **MST 319/N**

The example given (MST 319/N) therefore indicates that the transponder unit is a mini SSBL transponder, operating in the 30 kHz band, rated to 1000 meters depth, with a $\pm 90^\circ$ beamwidth and a NiMH rechargeable battery.

TECHNICAL SPECIFICATION

Common specifications

General

The technical details given in this paragraph are general for all the MST transponder types.

Housing material	Anodised aluminium
Housing coating	Polyurethane
Operating temperature	0°C to +30°C

Connectors

Transponder connector type	Subconn MCBH5M (5 pin)
Pigtail connector type	Subconn MCIL5F (5 pin)

Power supply

The following power supply options are available:

- Internal battery
- External 22 - 26 Vdc (40 W)

Transmitter

Power	maximum 100 W
Frequency	27 kHz to 32.5 kHz
Transmitter pulse length	10 ms

Receiver

Receiver bandwidth (-3dB)	20 kHz to 26.5 kHz
---------------------------	--------------------

Responder operation

- Responder trigger connection:
 - Via the external connector.
- Responder trigger signal:
 - Positive logic pulse
 - amplitude 5 V to 25 V
 - 2 ms to 6 ms duration
 - input impedance 10 k Ω - 30 k Ω (non resistive).

Source level and receiver sensitivity

Model	Source level - max (2 steps) 24 V ext. power / battery	Receiver sensitivity (2 steps)
MST 319	190 dB* 184 dB	100 dB* 110 dB
MST 324	197 dB* 191 dB	100 dB* 110 dB
MST 342	203 dB* 197 dB	100 dB* 110 dB

* Factory pre-set.

MST 319

Weight in air / water	2.4 kg / 1 kg
Operating depth	maximum 1000 m
Transducer beam	±90°

→ *Outline dimension, refer to page 56.*

MST 324

Weight in air / water	2.7 kg / 1.2 kg
Operating depth	maximum 2000 m
Transducer beam	±45°

→ *Outline dimension, refer to page 56.*

MST 342

Weight in air / water	4.1 kg / 2.0 kg
Operating depth	maximum 4000 m
Transducer beam	±20°

→ *Outline dimension, refer to page 56.*

Floating collars

1000 / 2000 m floating collar

Type no	119-217081
Deep rating	2000 m
Buoyancy with 319 TP	4.5 kg
Buoyancy with 324 TP	4 kg
Overall height with cage	549 mm
Diameter	275 mm
Colour	orange

→ *More information, refer to page 56.*

4000 m floating collar

Type no	119-217083
Deep rating	4000 m
Buoyancy with 342 TP	3.5 kg
Overall height with cage	597 mm
Diameter	290 mm
Colour	orange

→ *More information, refer to page 56.*

Battery charger

→ *Outline dimension, refer to page 56.*

SAFETY INFORMATION FOR TRANSPONDER AND TRANSPONDER BATTERY

Introduction

This section includes transponder safety information for the Kongsberg transponders with lithium battery and separate Kongsberg transponder lithium batteries. It also includes emergency procedures.

Product identification

Product name

All Kongsberg Maritime transponders with a lithium battery, and separate Kongsberg Maritime transponder lithium batteries.

→ *Refer to Kongsberg Maritime transponder instruction manuals for the actual model.*

Battery design

A transponder lithium battery consists of several battery cells that are electrical connected, both in serial and parallel.

A transponder lithium battery consists of two separate parts:

- Receiver part (Rx)
- Transmitter part (Tx)

There are transponder batteries with different number of cells, voltages and capacity.

→ *Refer to Kongsberg Maritime transponder instruction manuals for the actual model.*

All transponder batteries include protection against short-circuits (re-settable fuses) and reverse current (diodes).

Battery chemistry

A transponder lithium battery consists of cells with chemistry:

Lithium Thionyl Chloride - Li/SOCl₂

- Negative electrode: Lithium metal (Li)
- Positive electrode: Thionyl chloride (SOCl₂)
- Electrolyte: Solution of lithium tetrachloroaluminate (LiAlCl₄) in thionyl chloride

Battery cell manufacturers/types

A transponder lithium battery consists of cells from one or two of the following types:

- Tadiran TL-2300
- Sonnenschein SL-780
- Saft LS 33600
- Saft LSH 20
- Sonnenschein SL-760

Hazards identification

General

Short-circuits, overheating, mechanical damage and exposure to water can start chemical reactions and high currents inside the transponder lithium battery. This can generate noxious gases and/or danger of explosions. The chemical reactions will continue without additional supply of oxygen, as the battery cells contain the necessary ingredients for maintaining the chemical reactions.

During operation, the battery is placed inside the transponder. Water ingress into the transponder can cause dangerous situations.

Danger of explosions

- If the cells that form the battery reach the critical temperature of 180° C, they will explode.
- **Water ingress** - The battery temperature will increase, caused by the high internal currents. The temperature can reach the critical point of 180° C.
- **Water ingress** - Electrolysis gives hydrogen. Together with oxygen, hydrogen can create oxyhydrogen gas inside the transponder (depends on the concentration). This gas is very inflammable/explosive.
- **Water ingress** - Chemical reactions in the battery will cause a pressure build-up inside the transponder. The transponder can explode if the inside pressure is high enough.
- If the transponder explodes, either the transducer or the bottom end cap will blow out, or the transponder becomes fragmented. This can cause serious damages on personnel and/or equipment.

- Some transponders have a relief valve that will prevent over-pressure. Noxious gases will then leak out of the transponder until the chemical reactions have stopped.
-

Note

The relief valve can be plugged, caused by products from the chemical reactions during an emergency as described above.

Noxious gases

- Thionyl chloride (SOCl₂)
- Sulphur dioxide (SO₂)
- Hydrogen chloride (HCl)
- Chlorine (Cl₂)

Signs and symptoms:

- Corrosive fumes with pungent odour, is very irritating to skin, eyes and mucous membranes. Over-exposure can cause symptoms of non-fibrotic lung injury and membrane irritation.

Inhalation:

- Lung irritant.

Skin contact:

- Skin irritant.

Eye contac:

- Eye irritant.

Ingestion:

- Tissue damage to throat and gastro/respiratory tract if swallowed.

Medical conditions:

- Eczema, skin allergies, lung injuries, asthma and other respiratory disorders may occur.

First-aid measures

All personnel that have been exposed to the noxious gases should immediately be seen by a doctor.

Inhalation:

- Remove from exposure, rest and keep warm.

Skin contact:

- Wash off skin thoroughly with water. Remove contaminated clothing and wash it before reuse.

Eye contact:

- Irrigate thoroughly with water for at least 15 minutes.

Ingestion:

- Wash out mouth thoroughly with water and give plenty of water to drink.

Fire-fighting measures

- **Cool down the battery with copious amounts of cold water.**
 - Transponder with lithium battery:
 - * Immerse the transponder in the sea for 12 hours or permanent.
 - * If this method is impossible, the transponder can be cooled down by use of a fire hose.
 - Separate transponder lithium battery:
 - * Immerse the battery in the sea for 12 hours or permanent.
 - * If this method is impossible, the battery can be cooled down by use of a fire hose.

Cooling down the battery with copious amount of cold water is the only way to reduce/stop the internal chemical reactions, or to limit the fire/explosions to as few battery cells as possible. The chemical reactions/fire will continue without additional supply of oxygen, so extinguisher like Lith-X will not work properly.

Applying water directly onto a battery, may develop oxyhydrogen gas, due to the possible electrolysis if the battery terminals are exposed to water. This gas is very inflammable/explosive. However, if the water cooling takes place out on deck, or in a storeroom with good ventilation, there will never be enough hydrogen gas to give oxyhydrogen gas (any gas will evaporate).

Personals protection

Fire/explosion:

- Use smoke-diving equipment.

Relief valve opens and noxious gasses come out:

- Use self-contained full-face respiratory equipment, and protective equipment of rubber or plastic.

Opening transponder with defect/possible defect battery:

- Use self-contained full-face respiratory equipment, and protective equipment of rubber or plastic.

Opening a *functioning* transponder:

- Use protective goggles.

Handling

Introduction

All personnel that handle transponders must know the transponder's status:

'*Functioning*' - '*Failing*' - '*Unknown*'

A Transponder with unknown status, must be handled as a transponder that is failing.

Recovering a '*functioning*' transponder

- All transponders recovered from the sea, should be placed in a safe place out on deck and controlled for minimum 2 hours:
 - Look for outer damages that could involve a water leakage.
 - The transponder housing temperature must be checked to verify a possible temperature increase in the lithium battery.

Recovering a '*failing*' transponder

- Handle as possible water ingression.
- Evacuate all unnecessary people.
- Recover the transponder with great precaution. Use a crane.
- No people should be near the transponder when it is lifted up on deck.
- Place the transponder in a safe place out on deck, shielded from people and vital equipment.

- Fasten the transponder in a crane, ready to lower it into the sea again.
- Control the transponder for minimum 2 hours:
 - Look for outer damages that could involve a water leakage.
 - The transponder housing temperature must be checked to verify a possible temperature increase in the lithium battery.

Failing and normal temperature:

- Take out the battery, see *”Opening a transponder with defect/possible defect battery”*.

→ Refer to page 15.

Failing and increasing temperature:

- See *”Handling a heated or self-heated transponder”*.

→ Refer to page 14.

Handling a heated or self-heated transponder

- Evacuate all unnecessary people.
- Fasten the transponder to a rope and immerse it in the sea for 12 hours or permanent.
 - If this method is impossible, the transponder can be cooled down with copious amount of cold water. Use a fire hose.
- Recover the transponder and control the temperature.
- Repeat this until the temperature is low and stable.
- The transponder can now be opened, see *“Opening a transponder with defect/possible defect battery”*.

→ Refer to page 15.

Handling a transponder if the relief valve opens

- Evacuate all unnecessary people.
- Use necessary protection equipment.
- Fasten the transponder to a rope and immerse it in the sea for 12 hours or permanent.
 - If this method is impossible, the transponder can be cooled down with copious amount of cold water. Use a fire hose.
- Repeat this until no gases come out the check valve and the temperature is low and stable.

- The transponder can now be opened, see “*Opening a transponder with defect/possible defect battery*”.
- *Refer to page 15.*
- Wash out chemical reaction products with water.

Opening a transponder with defect/possible defect battery

- The transponder is reported failing. There could have been water ingress in the transponder.
- Open the transponder in a safe place out on deck, shielded from people and vital equipment.
- Use necessary protection equipment.

Caution

Do not stand in front of transducer or bottom end cap, when opening the transponder.

- If there has been water ingress, and the battery is still heated:
 - Disconnect the battery from the transponder electronics, and then see “*Handling heated or self-heated separate battery*”
 - *Refer to page 15.*
- Wash out chemical reaction products with water.

Opening a ‘functioning’ transponder

- The transponder is reported functioning.
- Open the transponder in a safe place out on deck, shielded from people and vital equipment.

Caution

Do not stand in front of transducer or bottom end cap, when opening the transponder.

Handling heated or self-heated separate battery

- Evacuate all unnecessary people.
- Fasten the battery to a rope and immerse it in the sea for 12 hours or permanent.
 - If this method is impossible, the battery can be cooled down with copious amount of cold water. Use a fire hose.
- Wash out chemical reaction products with water.

Storage

Caution

A transponder that is failing, must be stored in a safe place out on deck, shielded from people and vital equipment.

A transponders that is functioning, and separate batteries can be stored indoors.

- Storage temperature:
 - Recommended storage temperature lies between 0° C and +25° C (max +50° C, min -55° C).
 - Storage relative air humidity:
 - Recommended relative air humidity is 40 to 70%.
 - A transponder/separate battery must not be stored directly in the sunlight.
 - A battery must not be exposed to water.
 - For long term storage, the battery must be disconnected from the transponder electronics.
 - Storeroom:
 - A solid room with study racks for transponders/separate batteries.
 - A room where no people are staying, or no vital equipment is placed.
 - Good ventilation.
 - Clearly identified.
-

Caution

A fire station, with fire hose (water), must be placed outside the storeroom.

Ecological information

A lithium thionyl chloride battery does not present environmental hazard.

Disposal considerations

- A lithium thionyl chloride battery does not contain any heavy metals, and is therefore not regarded as special waste (contains only biodegradable parts).
- A used transponder lithium battery often contains a significant amount of residual energy. It is the danger of explosion that presents a problem when disposing a battery.
 - Used batteries must therefore be handled with the same care as new ones.

Caution

For safe disposal, contact a company that has been approved to collect and dispose lithium batteries.

Transport information

All transponders with a lithium battery and separate transponder lithium batteries must be shipped in accordance with the prevailing regulations:

Transponder with lithium battery:

UN no. 3091, Class 9 Miscellaneous
(Lithium batteries contained in equipment)

Separate transponder lithium battery:

UN no. 3090, Class 9 Miscellaneous (Lithium batteries)

Transport:

Aircraft:	IATA DGR
Sea Transport:	IMDG Code
Railway:	RID
Road transport:	ADR

- Aircraft - Only new transponder lithium batteries can be transported by air.
- Aircraft - Transport of all transponders with new lithium battery and new separate transponder lithium batteries by air is only permitted onboard cargo aircraft. The goods must be clearly labelled:

CARGO AIRCRAFT ONLY

Caution

Transponder with lithium battery - During transport the lithium battery must always be disconnected from the electronics.

- Original transponder/battery cages must be used.

OPERATION

General

The transponder is designed for operation in water only. However, the transponder may be operated in air for test purposes over a short period of time.

Activate the transponder

- 1 Switch the unit ON.

When used as a transponder:

- This is done by inserting the on / off plug into the end cap connector.

When used as a responder / connected to external power:

- If external power supply / responder trig are to be used:
- Refer to page 21 for details.

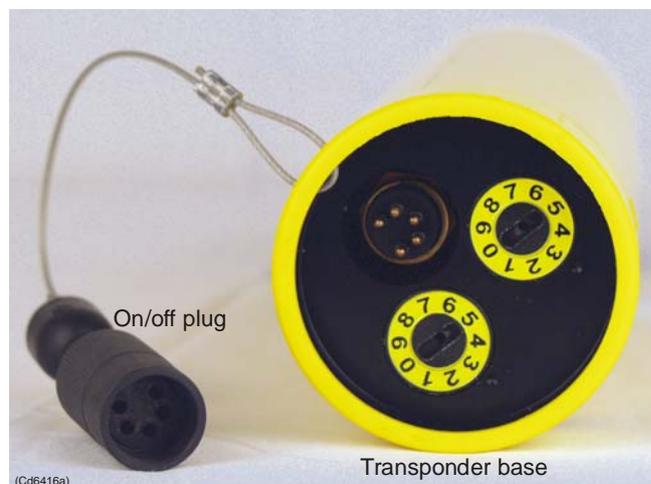


Figure 3 MST transponder base with on/off plug

- The unit will ping twice to indicate that it is activated.
- If:
- **The unit does not ping**, switch the unit OFF and leave it for approximately 5 minutes. Switch the unit back ON and listen for the pings.
 - **The unit emits a triple ping**, this indicates the channel switches are set to an illegal channel (for example 30). The triple ping will be emitted every 10 seconds until a legal channel is set.

Note

The triple ping will also be emitted if a switch is slightly off its position.

- 2 Check that the unit replies in air as follows:
 - For HiPAP / HPR 400 channels - use the HiPAP / HPR 400 and the test transducer.
 - For HPR 300 channels - use the TTS 286 Transponder Test Set.
 - Alternatively, lower the unit into the water alongside the ship, and test with the topside system.

Deactivate the transponder/responder

Note

The MST must always be switched off when not in use.

- 1 Switch the unit OFF.

When used as a transponder:

- This is done by disconnecting the on / off plug.

When used as a responder / connected to external power:

- This is done by disconnect the power / responder cable.

Changing the transponder channel

Principles

Channel selection is done via the two switches on the end cap.

→ *Refer to the figure on page 47.*

Before you deploy the transponder, the required channel must be selected.

Caution

The channel switches must be set accurately - if not, the MST will not operate correctly.

- 1 Switch OFF the MST.
 - 2 Set the channel switches to the required channel.
- *Refer to figure on page 47.*

- 3 Wait 5 minutes to ensure the MST has re-set correctly.
- 4 Switch ON the MST.
- 5 Listen for two (2) transmission pulses.
- 6 If no transmission pulses are heard, repeat steps 1 to 5.

Caution

If three (3) pulses are transmitted and repeated every 10 seconds, an illegal channel has been selected.

External power supply and / or responder trig

If the external power supply and / or responder trig are to be used, carry out the following additional checks:

- 1 Check the external power / responder cable.
 - Connect wire 2 and 5 in the pigtail (the ON / OFF function).

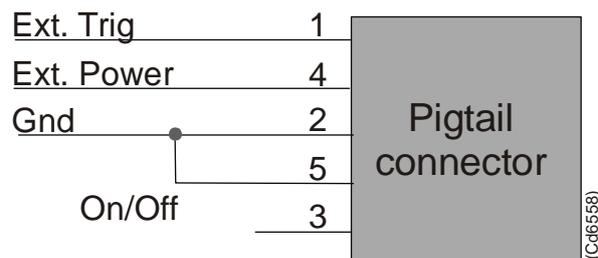


Figure 4 Pigtail wire connection

- 2 Ensure that the external supply is between 22 and 26 Vdc.

Note

The voltage supplied must not be below 22 Vdc. If below, the MST will take its power from the internal battery.

- 3 Check the responder trigger signal. The signal values are:
 - Positive logic pulse
 - Amplitude 5 V to 25 V
 - 2 ms to 6 ms duration.
- 4 Set the channel switches to the required channel.
- 5 Switch ON the MST by inserting the external power/responder cable.
- Refer to page 19 for details.
- 6 If the responder function is to be used, the unit must be checked in air on deck, using the topside system.

Pre-deployment checks

Prior to deployment of the transponder, it is important that the following checks are made to ensure correct operation.

- 1** Ensure that both retaining cords are in place.
→ *Refer to figure on page 38.*
- 2** If the unit has been altered from the factory pre-sets, check that the unit is configured according to your requirements.
→ *Refer to Source level / Sensitivity settings, on page 36.*
- 3** if the unit has a rechargeable battery, ensure the unit has been recently charged.
→ *Refer to page 27 for for details.*
- 4** Ensure that the pressure relief valves (channel switches) are in closed position.
→ *Refer to page 23.*
- 5** Select the channel required via the end cap switches.
→ *Refer to page 20 for for details.*
- 6** Switch the unit ON.
→ *Refer to page 19 for for details.*

Deployment

When you fit the transponder onto a vehicle / structure, the unit must be positioned with the transducer upright and there must be a clear line of sight between the transponder's head and the ship's transducer. To secure the transponder, use a hose clamp with rubber protection.

Recovery checks

- 1** After recovery, **switch the unit OFF.**
- 2** Wash the unit thoroughly in warm fresh water to dissolve any salt deposits and clean off any sand or silt.
- 3** As an extra precaution, it is recommended that the unit is left to soak in fresh water to allow salt to dissolve and diffuse from hard-to-reach areas, such as crevices around O-rings, and between mating parts.
 - Leave the unit to soak for 24 hours, or as long as practical conditions allow.

If a rechargeable unit is to be re-deployed imminently, put the unit on charge.

Pressure relief valves

The two channel selector switches, have dual O-rings, and they work as follows:

- One will seal only when the switch is pressed fully into its seat.
- The other one will seal, even with the switch pushed approx. 2 mm outwards.
 - If one or both switches rest in a not fully home position, or they feel springy when pushed in place, it means there is some degree of overpressure inside the MST.

→ Refer to page 27.

If the pressure becomes too big, one or both valves will vent. When the pressure has been relieved, both the switches can be pushed back into position.

Operation of pressure relief valves

Manual venting

Insert the dedicated tool (or any standard M3 screw) into the centre of both channel selector switches, and pull out (approx. 5 mm) until it feels loose and an O-ring is just visible. (See figure below.)

This operation will immediately release any overpressure inside the MST, and it will also ensure that the O-rings and valve is moving freely.



Figure 5 Manual venting

Trip point for pressure release

Gently let the spring pull the selector switch back. The switch will now rest approx. 3 mm above the surface of the end cap. In this position the valve is at the trip point to venting, and will do so without resistance. This position is ideal during charging.

Closing the valve

Simply push the switch until it is flush with the end cap.

Floating collar

General

A floating collar consists of two halves. These halves are placed around the transponder housing and bolted together. The collar is equipped with cages to protect the transducer and end cap. Reflective bands are placed on all sides and bottom, to aid visual location in dark conditions.

Floating collar for MST 319 / MST 324



Figure 6 MST 324 with floating collar

Floating collar for MST 342

The MST 342 floating collar has a support ring for extra transponder support. The support ring consists of two halves and must be mounted on the transponder, before the floating collar is bolted together. This is illustrated in the figure below.

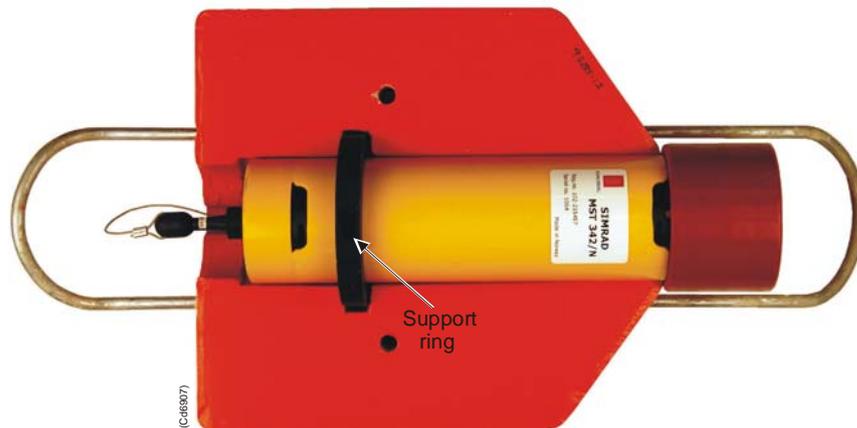


Figure 7 MST 342 with support ring, placed in the floating collar



Figure 8 MST 342 with floating collar

BATTERIES

A MST transponder is delivered with the following types of batteries:

- NiMH rechargeable battery.
- Lithium battery (not rechargeable).

Battery lifetime

Note

Always allow a safety margin of error in any operation calculations.

NiMH

Max source level	Rechargeable battery pack (fully charged)	
	Quiescent	1 ping per sec
MST 319	480 hours	18 hours/ 64.800 no. of replies
MST 324	480 hours	18 hours/ 64.800 no. of repliess
MST 342	480 hours	9 hours/ 32.400 no. of replies

Lithium

Max source level	Lithium battery pack (fully charged)	
	Quiescent	1 ping per sec
MST 319	960 hours	36 hours/ 129.600 no. of replies
MST 324	960 hours	36 hours/ 129.600 no. of repliess
MST 342	960 hours	18 hours/ 64.800 no. of replies

Battery charger

- Charge method: Constant current.
- Charge rate: 0,5 C (Fast charge).
- Permit fast charge between 10°C and 40°C.
- Detection of fully charged battery: Temperature rise (dT/dt), maximum temperature, maximum time (180 min).
- Trickle charge by pulse current.

Charging the battery

The battery is charged inside the MST. This is connected with some risk, so please follow the charge procedure carefully.

Warning

When you are charging the battery ensure:

- ***Good ventilation and stable temperature.***
 - ***The transponder is not covered.***
 - ***No open fire, sparks or smoking in the area.***
-

Safety

Safety has been a main criteria when designing the battery, the charger, the transponder electronics and the housing.

- Battery
 - *Refer to safety information section on page 9.*
 - Charger (see section *Battery charger* above)
 - Transponder electronics:
 - Includes battery undervoltage control that disconnects the battery from the electronics when the battery voltage is too low. Reduces the possibility of reverse polarity.
 - Transponder housing:
 - The channel selector switches also act as safety pressure relief valves.
- *Refer to page 23.*
-

Note

If the inside pressure becomes too high, the valves will vent. This can be caused by several factors.

- *High ambient temperature.*
 - *Heat generated during charging.*
 - *Batteries may leak some hydrogen gas and/or oxygen when charging.*
-

Charge procedure

- 1 Switch OFF the transponder.
- 2 Acclimatise the transponder.
 - The battery must have a temperature between 10°C and 40°C. Recommended charge temperature is 25°C.
- 3 Manually vent the two pressure relief valves.
→ *Refer to pressure relief valves on page 23.*
- 4 Connect the charger plug to the MST.
- 5 Connect Power supply to mains (110 Vac or 220 Vac). The Green light on the charger will illuminate.
- 6 The charging will start:

Stage 1 - Charger measures the battery status:

Charger Status LED - flashing red light

- The charger checks that the battery temperature is between 10°C and 40 °C and that the battery voltage is between 15 V and 25 V.
- The charger will trickle charge the battery during this mode. The charger will stay in this mode until the battery satisfies the temperature and voltage requirements.

Stage 2 - Fast charge

Charger Status LED - constant red light

- Fast charge, constant current. The charger will measure temperature, voltage and time during this mode.
- **If the battery voltage exceed the maximum limit (25 V)**, the charger will stop fast charge until the battery voltage is within the voltage requirements (15 V - 25 V). During this mode the charger will trickle charge the battery.
The Battery Status LED will turn OFF.

Stage 3 - Detection of fully charged battery

Methods for detection of fully charged battery:

- Temperature rise (dT/dt)
- maximum temperature
- maximum time.

When one of these criteria occur the charger will stop the fast charge mode.

Stage 4 - Completely charged battery and trickle charge

Charger Status LED - constant green light

When the battery is fully charged, the charger will start trickle charge mode.

The transponder is now ready for operation!

Note

It is not recommended that the battery is trickle charged for a long time. It is better to start fast charge again to top the battery just before operation.

- 7** Disconnect Power supply from the mains (110 Vac or 220 Vac).
 - 8** Disconnect charger plug from the MST transponder (external connector).
 - 9** Ensure that the pressure relief valves (channel switches) are in closed position.
- *Refer to page 23.*



Figure 9 Battery charger

Replacement of the battery pack

The battery is build into the chassis. To replace it, follow the procedure below:

- 1 Open the transponder.
→ *Refer to page 37 for details.*
- 2 Disconnect the battery connector.
→ *For connector location - refer to the figure on page 40.*
- 3 Remove the battery.
- 4 Assembly is the reverse of dismantling.

Battery storage

If the unit is not to be re-deployed in the near future, store it in a suitable environment.

The recommended temperature range for long-term storage of the rechargeable battery cells is -20°C to $+35^{\circ}\text{C}^*$. Stored capacity decreases over time due to the self-discharge of the rechargeable battery cells.

Self-discharge is dependent on temperature. The higher the temperature the greater the self-discharge over time. Long-term storage has no permanent effect on capacity. Loss in capacity due to self-discharge are reversible.

*The relative humidity should be $< 50\%$.

CONFIGURATION

HPR 400 channels

Note

The following channel numbers are not allowed:

- “Twin-figured” B(11, 22, 33 ...99)
- B(01, 02, 03 ...09)

Refer to table 1, HPR 400 channel numbers and operation frequencies.

The HiPAP / HPR 400 system interrogates the transponders by transmitting two pulses with frequencies according to the protocol. The transponder reply is determined by the second interrogation pulse.

Note

A HiPAP system uses the same channel working principle as a HPR 400 system. The following paragraphs, therefore describe only the principles for an HPR 400 system.

A total of 56 positioning frequency channels are available. Refer to table 1 for frequencies.

When the first interrogation pulse is an odd number, the reply is 250 Hz higher than it is when the pulse is an even number.

- Switch A is set to the first digit of the desired channel number - Rx1.
- Switch B is set to the second digit of the desired channel number - Rx2.

→ *Refer to the timing diagram on page 32.*

- **Example:**

If channel B12 is to be selected, switch A must be set to position 1 and B to position 2. Referring to table 1, the first transmission frequency will then be 21,000 Hz and the second transmission frequency will be 21,500 Hz.

To find the reply frequency: The second frequency number is 2 so go to rows Be2/Bo2, and the first frequency number is odd (1) therefore the Bo2 row is used. The reply frequency is therefore 29,250 Hz.

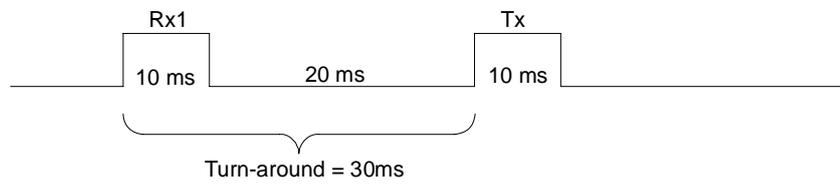
HPR 300 channels

The HPR 300 system interrogates the transponders by transmitting one pulse with frequency according to the protocol.

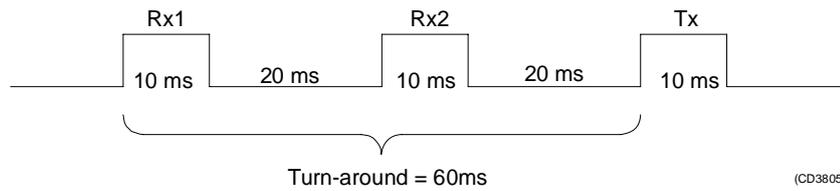
For the HPR 300 a total of 14 channel numbers (frequency combinations) are available.

Refer to table 2 for frequencies, and set switch A and switch B to the required interrogation frequency to achieve the desired transponder beacon transmission frequency.

HPR 300 (SSBL)



HPR 400 (SSBL)



(CD3805)

Figure 10 Transponder reception and transmission signal timing diagram

HPR 400 channels and positioning frequencies table

Transponder channel number	Operating frequencies	
	Interrogation	Reply
Be1	21000	28500
Bo1	21000	28750
Be2	21500	29000
Bo2	21500	29250
Be3	22000	29500
Bo3	22000	29750
Be4	22500	30000
Bo4	22500	30250
Be5	23000	30500
Bo5	23000	30750
Be6	23500	27000
Bo6	23500	27250
Be7	24000	27500
Bo7	24000	27750
Be8	24500	28000
Bo8	24500	28250

Table 1 HPR 400 channel numbers and operating frequencies

Where:

B = Frequency band (30 KHz)

e = Even numbers (2, 4, 6, 8)

o = Odd numbers (1, 3, 5, 7)

HPR 300 channels and positioning frequencies table

Switch A setting	Switch B setting	Transponder channel number	Operating frequencies	
			Interrogation	Reply
0	1	1	20492	29762
0	2	2	21552	30488
0	3	3	22124	31250
0	4	4	22727	31847
0	5	5	23364	32468
0	6	6	24038	27173
0	7	7	24510	27777
0	8	8	25000	28409
0	9	9	26042	29070
1	1	11	21552	27173
2	2	22	22727	28409
3	3	33	23923	29762
4	4	44	25126	31250
5	5	55	26455	32468

Table 2 HPR 300 switch settings, channel numbers and operating frequencies

Functions

The Transponder includes the following functions:

- Transponder
- Responder
- External power

The Transponder function is default. To activate the responder or the external power functions, external connection is required.

Transponder function

The transponder function enables the unit to respond to a hydroacoustic interrogation signal from a compatible surface / underwater unit. The transponder function requires:

- 1 An allowable transponder channels must be selected.
 - 2 The unit must be switched on.
 - Once selected, the transponder will reply only to the corresponding interrogation channel.
- If no valid interrogations are received after 65 seconds, the transponder unit will enter 'sleep' state whereby the drain on the battery pack will be at a minimum.
 - On receipt of a valid interrogation the unit will 'wake up' and reply to subsequent interrogations. The topside unit decodes the reply to give just the range, or the range and bearing, dependent on the type of surface unit used.

Responder function

The responder function enables the unit to reply to a "Trigger" pulse via the external connector on the end cap.

→ *See also page 21.*

Proceed as follows:

- 1 Select the desired channel.
 - 2 Switched ON the MST.
 - This is done by inserting the external power / responder cable.
 - 3 Give a valid trigger pulse from the topside system, and the transponder will reply at the previously selected channel.
- If the responder trigger signal is lost, the transponder will automatically revert to the transponder function after 65 seconds. The responder function is automatically initiated by the presence of a valid "Trigger" pulse.

External power function

When the transponder is set to the external power function, it requires a dc supply of between 22 Vdc and 26 Vdc.

→ *See also page 21.*

Proceed in the following order:

- 1** Select the desired channel.
- 2** Switched ON the MST.
 - This is done by inserting the external power / responder cable.
- The transponder will be powered from the external supply as long as the external supply voltage remains above 22 V. If the external voltage falls below this level, or is lost (for example umbilical failure), the transponder will automatically revert to its internal battery pack (transponder function).

Source level (Tx power) and sensitivity (Rx gain) adjustment

General

For certain applications, you may need to adjust the source level (Tx power) and sensitivity (Rx gain) settings. This is done on the main board.

Note

If these are adjusted from their factory pre-sets, make a note to ensure units are not deployed with the wrong configuration at a later date.

To reduce the factory pre-set Tx power

When working at short ranges in a quiet acoustic environment, you may require to reduce the factory pre-set source level. Reduced source level will increase battery life.

To reduce the factory pre-set source level:

- 1 Open the transponder.
→ *Refer to page 37 for details.*
- 2 Locate the main board.
- 3 Move the jumper to the required position.
→ *Refer to the figures on page 45.*
- 4 Close the transponder.
→ *Refer to page 41 for details.*

To reduce the factory pre-set Rx gain

This can be performed when working at short ranges where there is a high degree of low frequency acoustic or electrical noise at the transponder. To reduce these problems, you may reduce the factory pre-set sensitivity setting as follows:

- 1 Open the transponder.
→ *Refer to page 37 for details.*
- 2 Locate the main board.
- 3 Move the jumper to the required position.
→ *Refer to the figures on page 45.*
- 4 Close the transponder.
→ *Refer to page 41 for details.*

MAINTENANCE

General

The following maintenance is normally required:

- Charging the battery (if rechargeable battery is used).
- Lubrication of the external connector - refer to *page 42* for more information.
- Washing the unit.

To select the source level and sensitivity, and to change the battery pack, the unit must be opened.

Caution

Electronic devices can be destroyed by static electricity. It is therefore essential that full protection against static is practised by service engineers. Although the unit is resistant to mechanical vibration and shock, every effort must be made to avoid careless handling when the unit is in use or being transported.

O-rings

Whenever the transponder is opened and the O-rings are exposed, precautions must be taken. This includes keeping the O-rings and mating surfaces free of dust and debris. If any of the mentioned surfaces is to be cleaned, it is important to use lint-free objects. Q-tips must never be used to clean areas anywhere near an o-ring.

When inserting an O-ring, make sure the surface is clean, and that it is covered with a thin film of silicone grease.

Dismantling the transponder

→ *Transponder assembly refer to the figure on page 50.*

To dismantle the transponder unit, follow the procedure below:

Before you open the unit:

- 1** Switch **OFF** the unit.
- 2** Before opening the unit;
 - Wash the unit thoroughly in fresh water, and dry off any moisture on the outside.
 - Any work must be carried out in a clean, dry area.
 - Ensure full anti-static precautions have been taken.

Opening the unit:

The unit is held together by a retaining cord inserted in a groove between the tube and the end cap / transducer. Access to the cord is via two clearly visible slots at either end of the transponder tube. The cord is inserted by hand, and it is removed by picking up the free end visible in one slot, and pushing the other end (visible in the other slot).



Figure 11 Indicating retaining cord inserting/removing

Caution

Take care not to use sharp objects that can damage the anodized surface of the aluminium.

- 1** Disconnect any external cables, or remove the on / off plug.
- 2** Remove the retaining cord between the end cap and the tube, as described above.
- 3** Carefully pull the end cap from the unit. Do this by two people pulling it apart, or gently secure either part in a makeshift cradle, while pulling the other part. In most cases however, it is also possible for one man to separate the two parts by hand.

Caution

Observe the 5 mm orientation peg at either end of the tube. When pulling apart, make sure to keep this orientation until parts are completely free from each other. Forceful twisting of the parts relative to each other while the internal parts are still mated, will damage the unit.

- 4** Remove the retaining cord between the transducer and the tube, as described above.
- 5** Pull the tube from the transducer.
 - All internal parts are now clearly visible and accessible.

Replacement of the transducer

The transducer is a sealed unit and can not be opened. If it is not working, the whole unit must be replaced. To replace the transducer, follow the procedure below:

- 1** Open the transponder.
 - *Refer to page 37 for details.*
- 2** Remove the soldering at the connections TD+ and TD-.
 - *The wires location, see the figure on page 50.*
- 3** You can now remove the transducer.
- 4** Assembly is the reverse of disassembly.

Replacement of the main board

To replace the main board, follow the procedure below:

- 1 Open the transponder.
→ Refer to page 37 for details.
- 2 Disconnect the battery pack and the transducer.
→ Refer to the figure on page 50.
- 3 De-solder the obvious wires from the solder posts on the board. Ensure adequate labelling for reassembling.
- 4 Unscrew the six fixing screws (see figure below).
- 5 You can now remove the main board.
- 6 Assembly is the reverse of disassembly.

Caution

If you force the end cap into the housing, the edge connector may be destroyed.

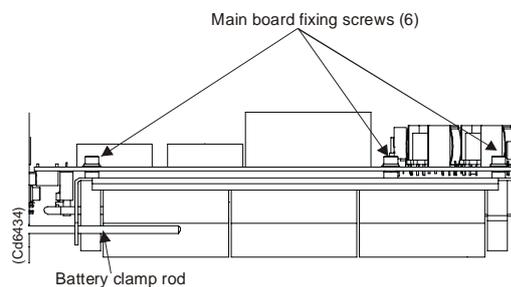


Figure 12 Position of the main board fixing screws

Replacement of the interface board

To replace the interface board, follow the procedure below:

- 1 Open the transponder.
→ Refer to page 37 for details.
- 2 Unscrew the screws holding the interface board (see figure below).
- 3 De-solder the obvious wires from the solder-posts on the board. Ensure adequate labelling for reassembling.
- 4 You can now remove the interface board.
- 5 Assembly is the reverse of disassembly.

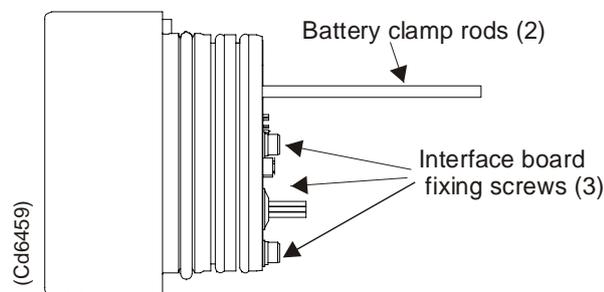


Figure 13 Position of the interface board fixing screws

Replacement of the battery pack

→ Refer to page 30.

Transponder assembly

Assembly is the reverse of disassembly, but note the following:

-
- Note** *The condition of the O-rings must be checked. If there is any doubt as to their condition, or if they have been in use for more than 1 year, they should be replaced.*
-
- Caution** *Ignoring these recommendations may result in flooding of the MST unit.*
-
- Note** *Backup rings are used on all seals on all MST 324 transponders.*
-

Procedure for handling the O-rings:

- 1 Check the condition of the rings and carry out any necessary replacements.
- 2 Ensure the O-ring surfaces are clean and free from any dust, debris or old grease.
- 3 Lightly grease the rings prior to assembly using Molykote 33 grease or similar.
- 4 Re-fit the O-rings (see figure below).

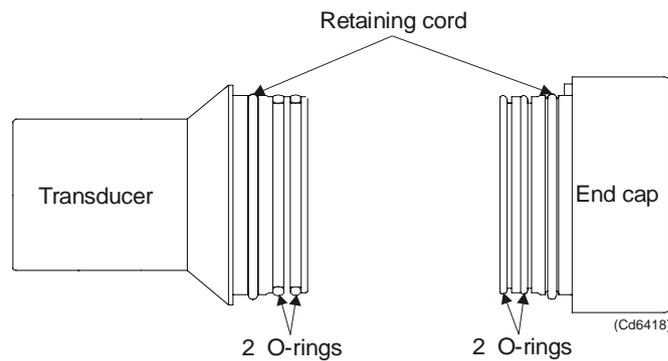


Figure 14 O-rings and retaining cord

- 5 Check that the ring is fitted correctly as follows:
 - a Carefully slide the transducer assembly into the housing till the housing meets the first O-ring.
 - b Press the transducer fully into the housing.

Transducer handling

At transportation and storage, the transducer face and the O-ring grooves must be protected. Do not leave the transducer resting on the face, because even a small roughness on the support may cause a permanent distortion in the polyurethane face.

As a precaution at storage, short-circuit the electrical wires. This prevents potential voltage build-up, which otherwise may appear from temperature variations.

Lubrication of the external connector

The external connector must be lubricated. The recommended lubricant is:

- Molykote 44 Medium.

Note

Use it sparingly, half a match-head dose per contact is adequate.

MAIN PARTS

Overview

A MST transponder unit consists of the following main parts:

- Circuit boards
- Battery pack
- Transducer
- End cap
- Housing

→ *Refer to figure on page 50.*

Circuit boards

Overview

The MST transponder electronics includes two circuit boards:

- Main board
- Interface board

The transponder schematic and interconnections:

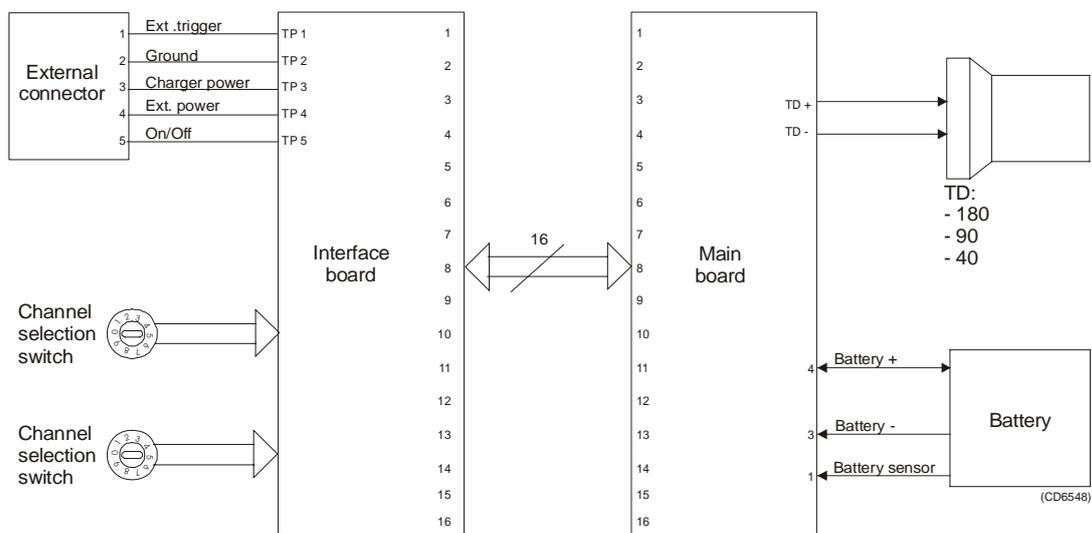


Figure 15 MST transponder schematic

Main board

The main board is mounted on the chassis, and it is controlled by the processor (Philips P87C552).

Note

Some components may vary, depending on the transponder model.

- Both the receiver and the transmitter are integrated in the main board.

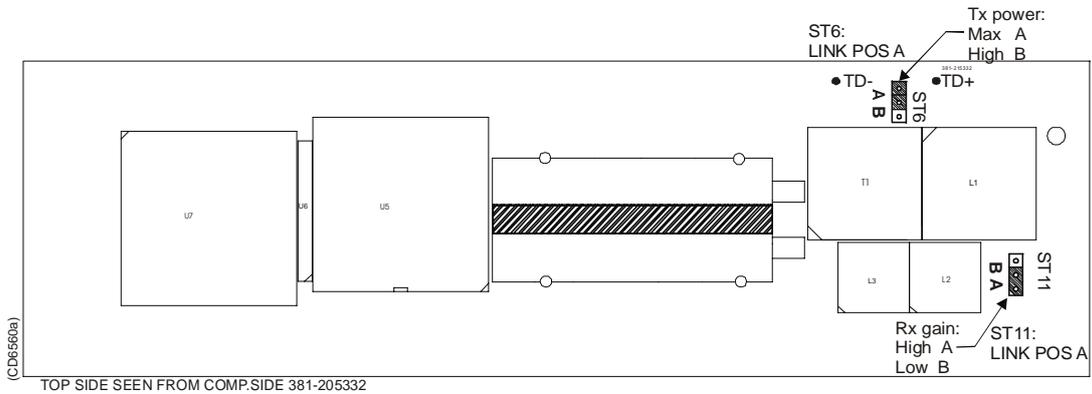


Figure 16 Jumper configuration on the main board

Interface board

The interface board is mounted on the end cap. This board contains:

- all the input and output interfaces for the transponder
- the battery charger.

Note

Some components may vary, depending on the transponder model.

Battery

Battery information:

→ *Refer to page 26.*

The battery pack is connected directly to the main board.

→ *Refer to the figure on page 44.*

Transducers

Overview

As a standard, two O-rings for water sealing between the transducer and the housing are provided.

The transducer is connected directly to the main board.

→ *Refer to page 50.*

Transducer 180

The transducer has a beam pattern covering one hemisphere. The two wires for electrical connection, emerge from the bottom.

Transducer 90

The transducer has a 90 degrees conical beam. The transducer is oil-filled to withstand the high pressure. The two wires for electrical connection emerge from the bottom.

Transducer 40

The transducer has a 40 degrees conical beam. The transducer is oil-filled to withstand the high pressure. The two wires for electrical connection emerge from the bottom.

End cap

The end cap holds the following:

→ *Refer to figure on page 19.*

- ON / OFF plug (strapped onto the end cap)
- Switches for channel selection / Pressure relief valves
- External connector

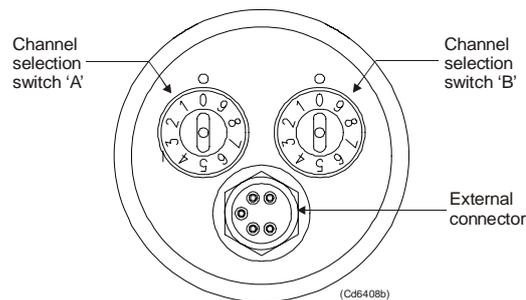


Figure 17 End cap

ON / OFF plug

The attached plug will act as ON switch when inserted into the external connector.

→ *See the figure on page 19.*

Pressure relief valves

The two channel selector switches, also have an additional function. They are both spring loaded, to act as safety pressure relief valves.

→ *How it works - see page 47.*

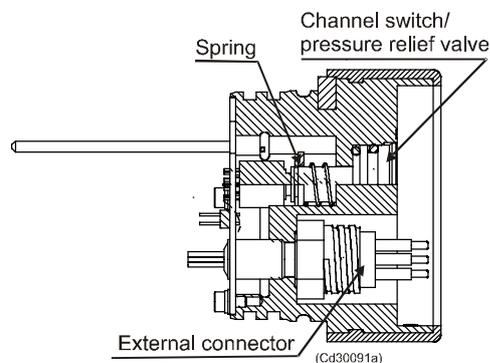


Figure 18 External connector -internal

External connector

The transponder external connector is recessed within the transponder end cap.

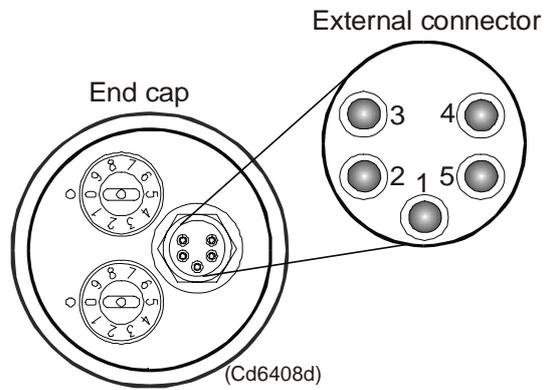


Figure 19 External connector

Function	If an equivalent connector is used, wires may be numbered as below
External trigger/ charger LED 1	1
Ground	2
Charger power	3
External power/charger LED 2	4
On /Off	5

Table 3 Transponder external connector pin-out diagram

Housing

→ Refer to technical specifications on page 6.

SPARE PARTS

Introduction

This chapter lists the parts and modules defined by Kongsberg Maritime as *Line Replaceable Units (LRUs)* for the MST transponder series. These LRUs are the individual parts and items which the manufacturers considered are replaceable by the local maintenance engineer. Exploded figures are included to assist you with part identification.

The required mounting components (such as nuts, bolts etc.) are not identified on the figures, and the order numbers are not allocated, as we regard these items as standard commercial parts available from retail outlets around the world.

Codes used

The following codes are used in the parts lists:

Part no. - Kongsberg Maritime's part number.

Item name - The name of the item.

Technical data - Technical specifications and any other relevant information.

Drw. ref. - Reference number of the production or illustration drawing where the item is included. If a number is given here, the drawing will be included in the manual's/document's drawing file.

Drw. pos. - The item's position number on the drawing referenced above.

No. in sys. - The quantity of the item used in the system. *Note that this information is not provided for standard components such as nuts, bolts and washers.*

Rec. spares - The quantity of the item recommended to be carried as spares onboard the vessel. *Note that this information is not provided for standard components such as nuts, bolts and washers.*

MST transponder - exploded view

This paragraph displays an exploded view of a MST transponder. The parts lists are presented on the following pages.

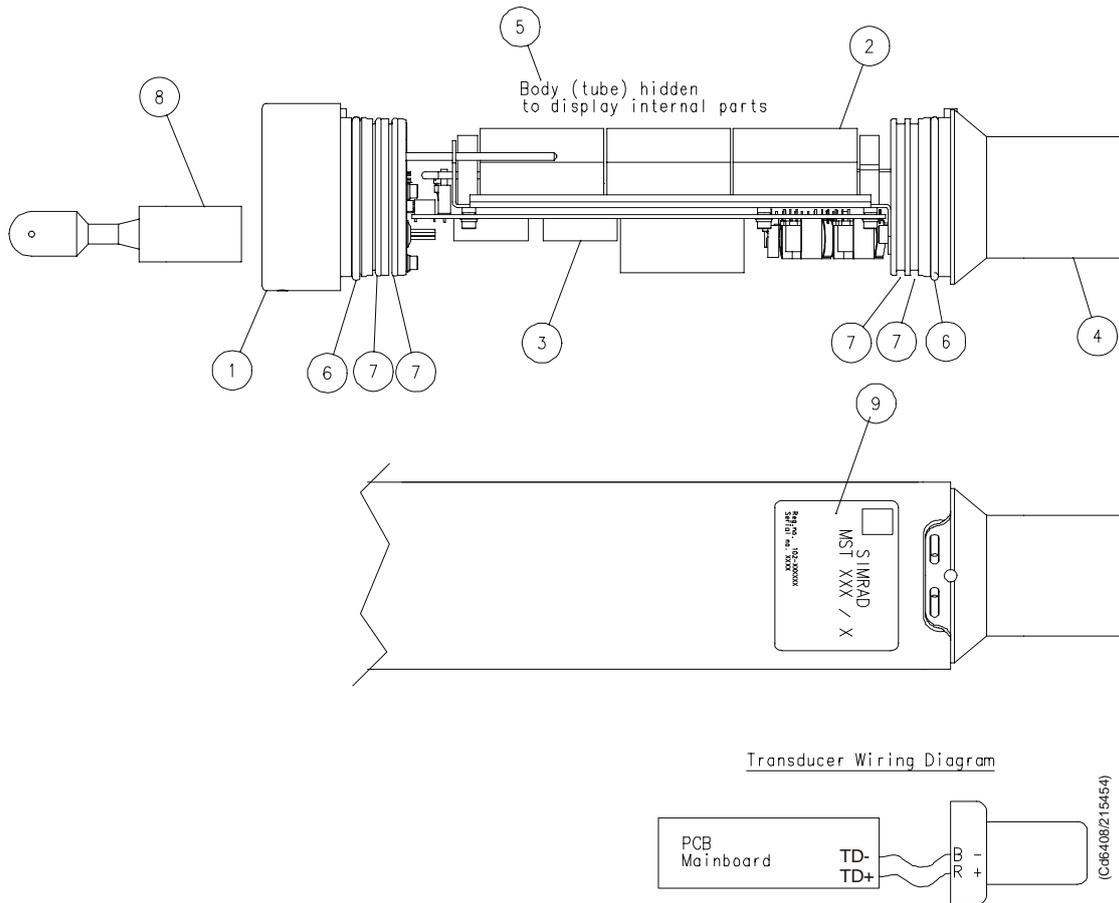


Figure 20 MST transponder - exploded view

Common parts

General

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
382-215340	Interface board (1)	Figure page 50	1
-	-	N/A	-
540-085075	O-rings	Figure page 50	4
-	58.42 x 2.62	7	4
599-215481	Retaining cord	Figure page 50	2
-	-	6	1
599-216333	ON / OFF plug	Figure page 50	1
-	-	8	1
370-097274	Dummy plug for transportation	N/A	1
-	UV-plug MCDC5F 5p	-	1

Responder pigtail

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
599-219046	MST responder pigtail	-	-
-	Connector type: Subcom MCIL5F (5 pin)	-	-

Charger

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
LAD-219045	MST Charger adapter	-	-
-	The power supply and the charger adapter plug are included (1)	-	-

1 Charger adapter plug, part. no: 380-216343

Power supply, part. no: 290-098059

Batteries

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
499-219504	Lithium battery pack	Figure page 50	-
-	Primary (not rechargeable)	2	-
499 -215473	Chassis w/rechargeable battery MST	Figure page 50	-
-	-	2	-

Floating collar

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
119-217081	MST 319 / MST 324 floating collar	-	-
-	-	-	-
119-217083	MST 342 floating collar	-	-
-	-	-	-

MST 319/N transponder

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
102-215453	MST 319/N Transponder unit	-	-
-	-	N/A	-

Main modules

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
312-215523	Transducer	Figure page 50	1
-	-	4	-
382-215415	Main board	Figure page 50	1
-	-	3	-
499-215461	End cap	Figure page 50	1
-	Interface board is included (1) part no, see page 51	1	-
599-215459	Housing	Figure page 50	1
-	-	5	-

→ Common spare parts and battery, refer to page 51

MST 319/L transponder

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
102-219655	MST 319/L Transponder unit	-	-
-	-	N/A	-

Main modules

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
312-215523	Transducer	Figure page 50	1
-	-	4	-
382-215415	Main board	Figure page 50	1
-	-	3	-
499-215461	End cap	Figure page 50	1
-	Interface board is included (1) part no, see page 51	1	-
599-215459	Housing	Figure page 50	1
-	-	5	-

→ Common spare parts and battery, refer to page 51.

MST 324/N transponder

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
102-215455	MST 324/N Transponder unit	-	-
-	-	N/A	-

Main modules

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
312-215477	Transducer	Figure page 50	1
-	-	4	-
382-215333	Main board	Figure page 50	1
-	-	3	-
499-215461	End cap	Figure page 50	1
-	Interface board is included (1) part no, see page 51	1	-
599-215459	Housing	Figure page 50	1
-	-	5	-

→ *Common spare parts and battery, refer to page 51*

MST 324/L transponder

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
102-219657	MST 324/L Transponder unit	-	-
-	-	N/A	-

Main modules

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
312-215477	Transducer	Figure page 50	1
-	-	4	-
382-215333	Main board	Figure page 50	1
-	-	3	-
499-215461	End cap	Figure page 50	1
-	Interface board is included (1) part no, see page 51	1	-
599-215459	Housing	Figure page 50	1
-	-	5	-

→ *Common spare parts and battery, refer to page 51*

MST 342/N transponder

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
102-215457	MST 342/N Transponder unit	-	-
-	-	N/A	-

Main modules

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
312-215505	Transducer	Figure page 50	1
-	-	4	-
382-216262	Main board	Figure page 50	1
-	-	3	-
499-216010	End cap	Figure page 50	1
-	Interface board is included (1) part no, see page 51	1	-
599-215531	Housing	Figure page 50	1
-	-	5	-

→ Common spare parts and battery, refer to page 51

MST 342/L transponder

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
102-219659	MST 342/L Transponder unit	-	-
-	-	N/A	-

Main modules

Part no.	Item name	Drw. ref.	No. in sys.
-	Technical data	Drw. pos.	Rec. spares
312-215505	Transducer	Figure page 50	1
-	-	4	-
382-216262	Main board	Figure page 50	1
-	-	3	-
499-216010	End cap	Figure page 50	1
-	Interface board is included (1) part no, see page 51	1	-
599-215531	Housing	Figure page 50	1
-	-	5	-

→ Common spare parts and battery, refer to page 51

DRAWING FILE

Overview

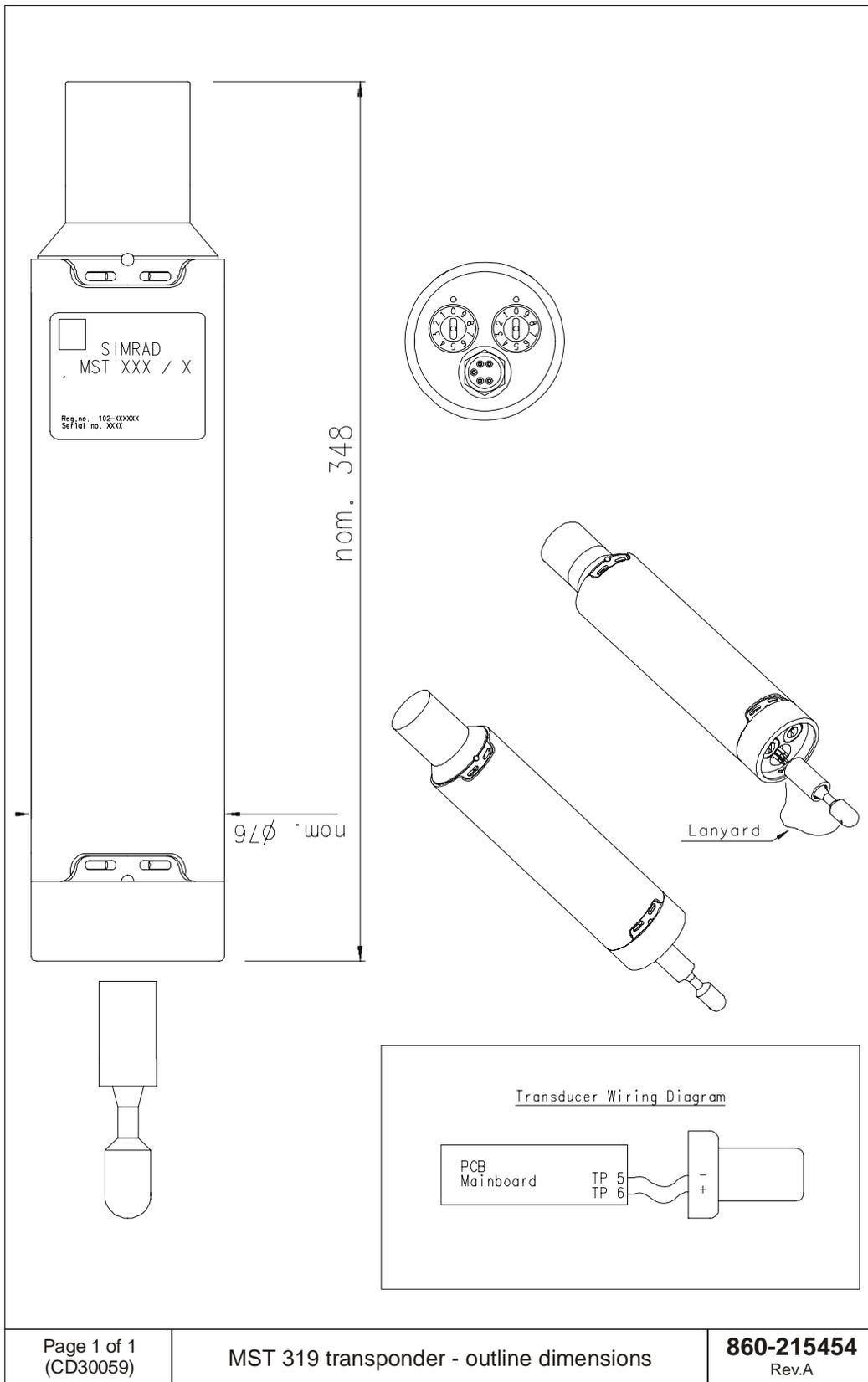
This section contains outline dimensions drawings. The illustrations are based on the original system drawings.

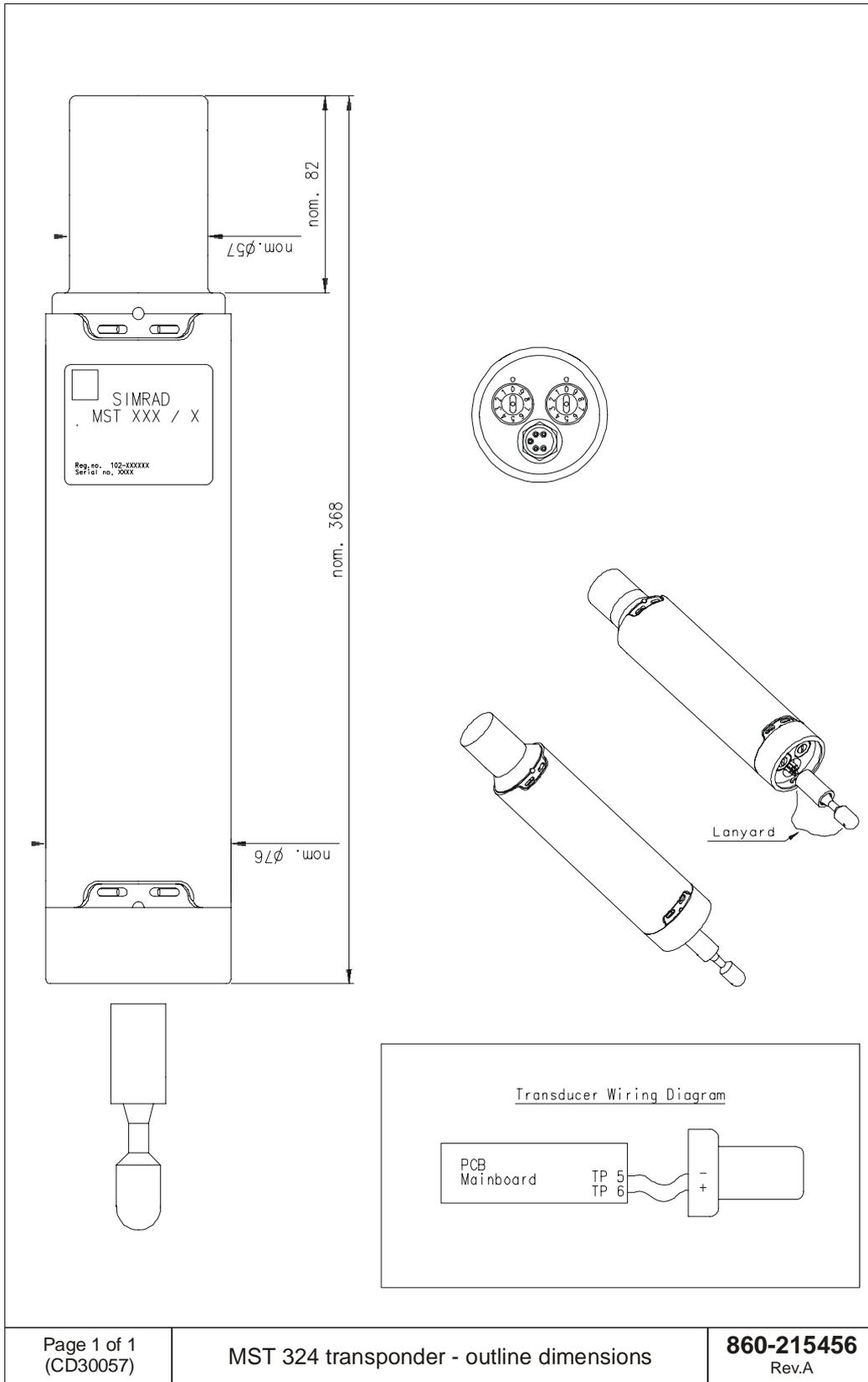
- All measurements are in mm.
- The illustrations are not in scale.
- The original drawings are available in electronic format upon request.

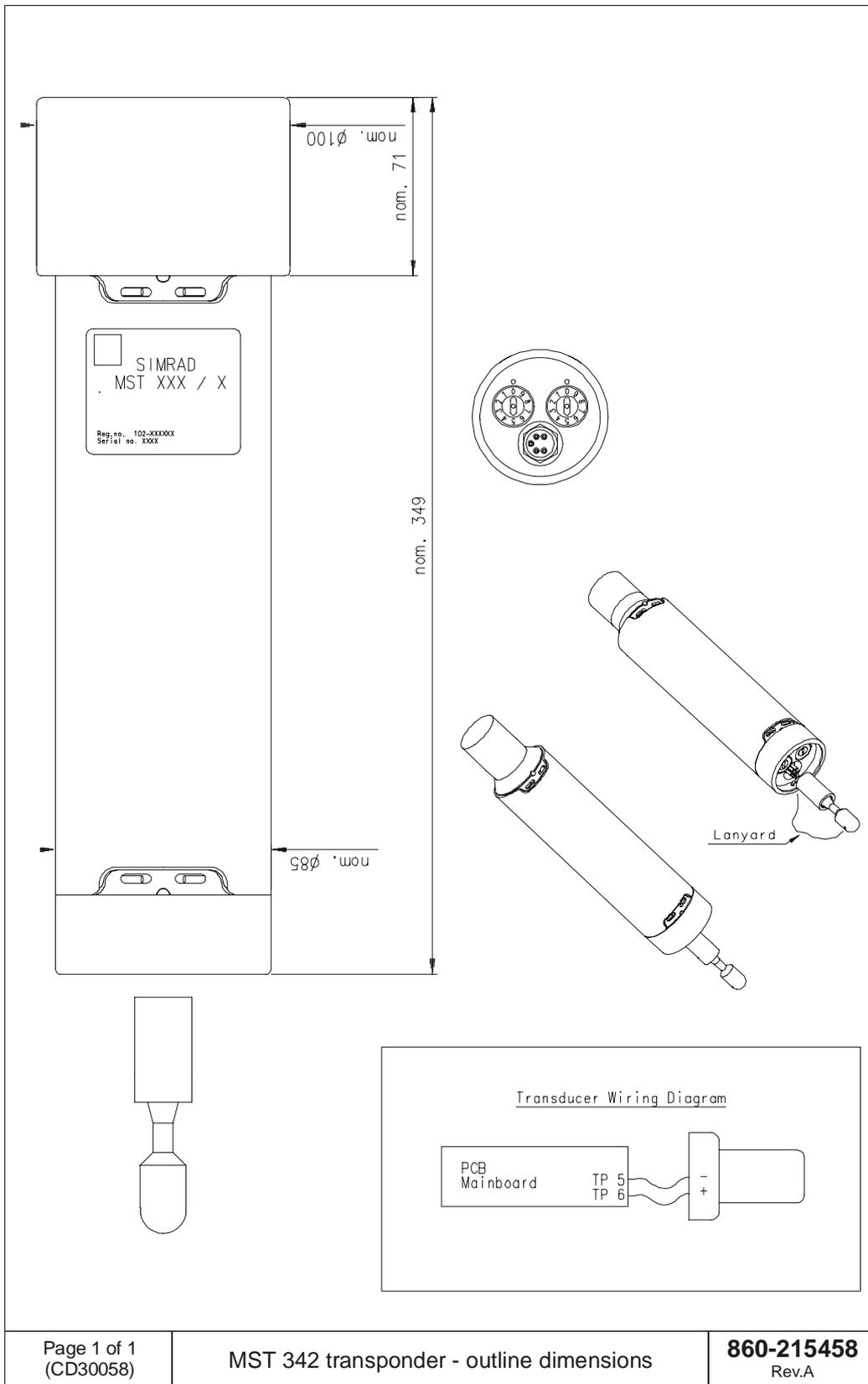
Drawings

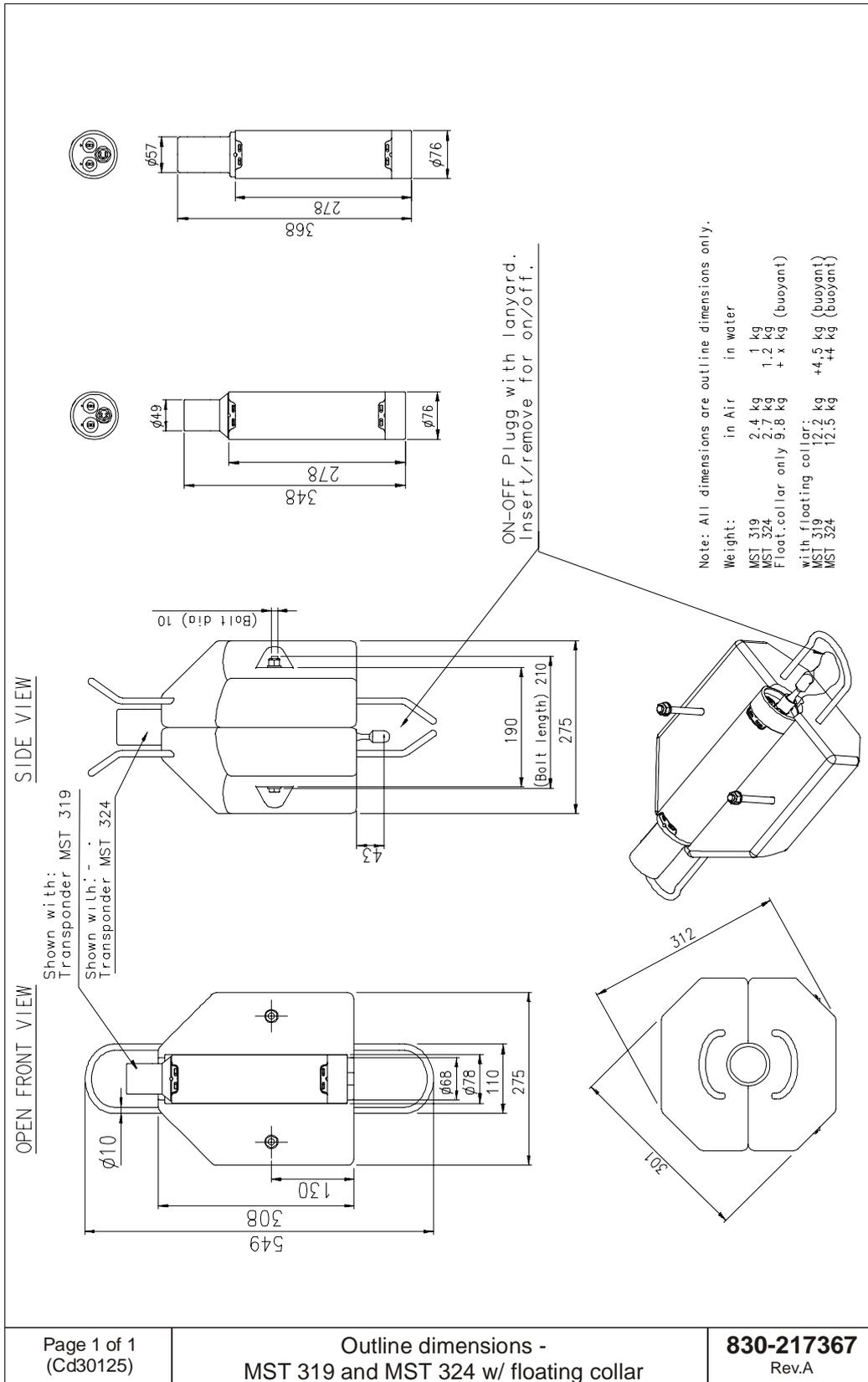
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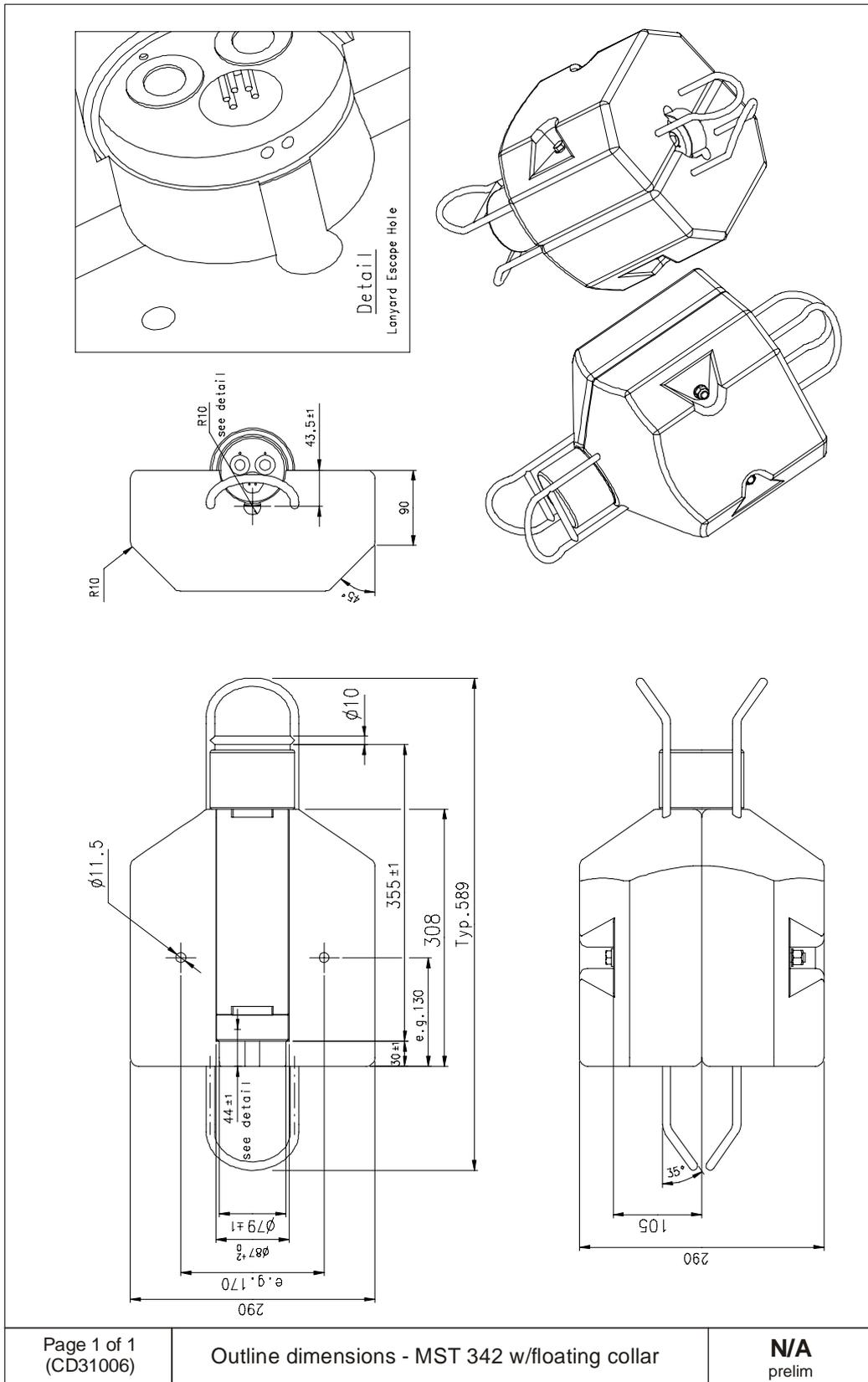
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- MST 324 transponder, page 58.
- MST 342 transponder, page 59.
- MST 319 and MST 324 transponder with floating collar, page 60.
- MST 342 transponder with floating collar, page 61.
- MST battery charger, page 62.







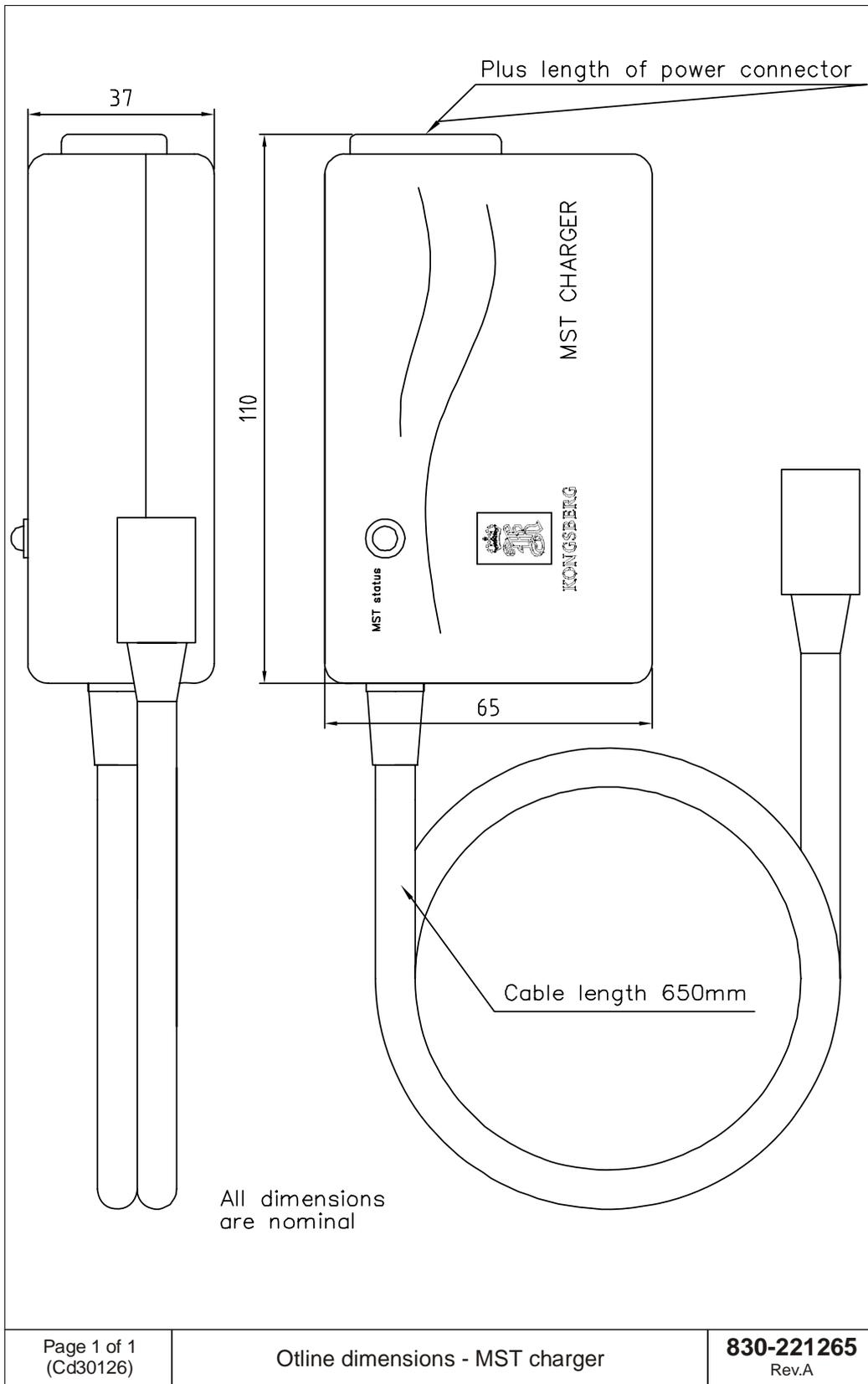




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Outline dimensions - MST 342 w/floating collar

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