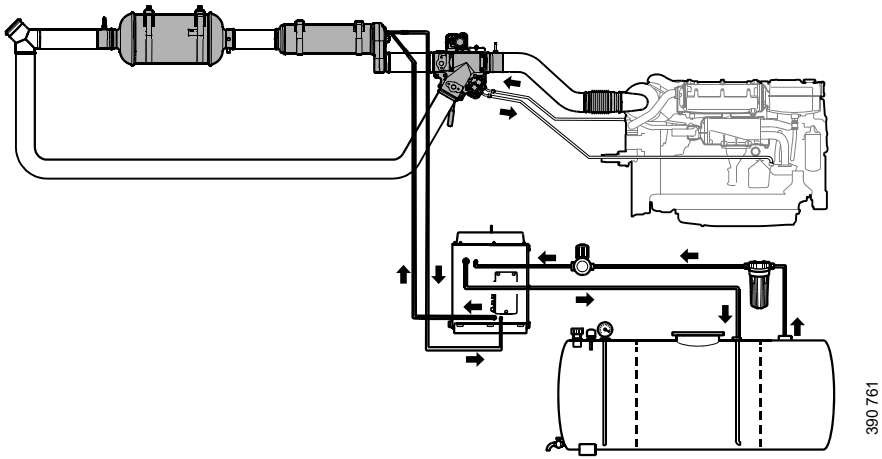
SCR system

Marine engines
DI13, DI16



Changes from the previous issue

The changes made in this document compared with the previous issue are marked with a black line in the left-hand margin. The changes are also described below.

- The highest permitted temperature by the exhaust routing valve actuator has been added to the Exhaust routing valve section.
- The information in the NOx sensor section has been made clearer.
- Section Important data has been added.

SCR and reductant

SCR (Selective Catalytic Reduction) is a system in which reductant is added to the exhaust gases in order to reduce the nitrogen oxide (NOx) content. This document describes SCR system components and how they should be connected.

Reductant is a solution consisting of urea and water, and is usually called AdBlue®, DEF, ARLA 32 eller AUS 32/AUS 40, depending on the market. If the engine is equipped with an SCR system, the reductant is added to the exhaust gases upstream of the catalytic converter. This reduces nitrogen oxide emissions. The SCR system can be used with either 32.5% or 40% by weight of urea.

Reductant with 32.5% by weight of urea freezes at approx. -11°C (12°F). With 40% by weight of urea freezes at 0°C (32°F). When the solution freezes, ice and urea always maintain the same concentration. Always store the reductant at a temperature of between 0°C and 30°C (32 to 86°F).

IMPORTANT!

Cleanliness is very important when working on the reductant circuit. Clean thoroughly around all parts to prevent dirt from entering the system.

When working on the SCR system, the reductant connections may only be lubricated with soapy water or with distilled water with a 3% urea mixture. Any other types of lubricants may block and damage the components in the SCR system.

Reductant is highly corrosive. For this reason, only pipes and couplings resistant to urea may be used in the SCR system. The reductant prefilter and the reductant pump between the main tank and the buffer tank must also be urea-resistant. Always rinse away reductant spillage on connections and other parts with lukewarm water to prevent corrosion. If reductant seeps into electrical connections or electrical cables, these must be renewed.

32.5% by weight of urea

IMPORTANT!

If 32.5% by weight of urea is used, the reductant should be specified in accordance with ISO 22241 in order to comply with the emission requirements set by the public authorities.

Rec. % by weight of urea	Limit values according to ISO 22241
32.5%	31.8-33.2%

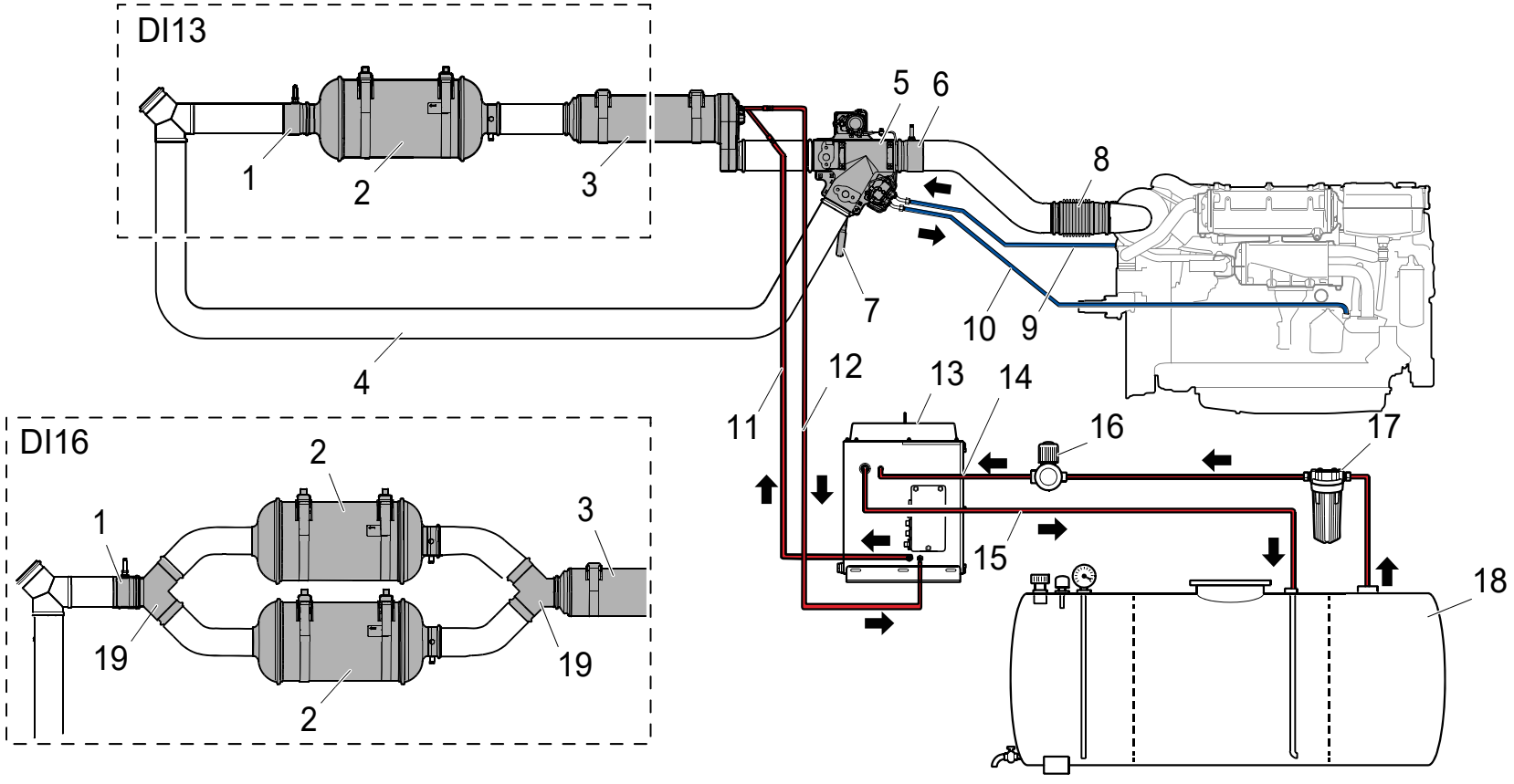
40% by weight of urea

IMPORTANT!

If 40% by weight of urea is used, the reductant should be specified in accordance with ISO 18611 in order to comply with the emission requirements set by the public authorities.

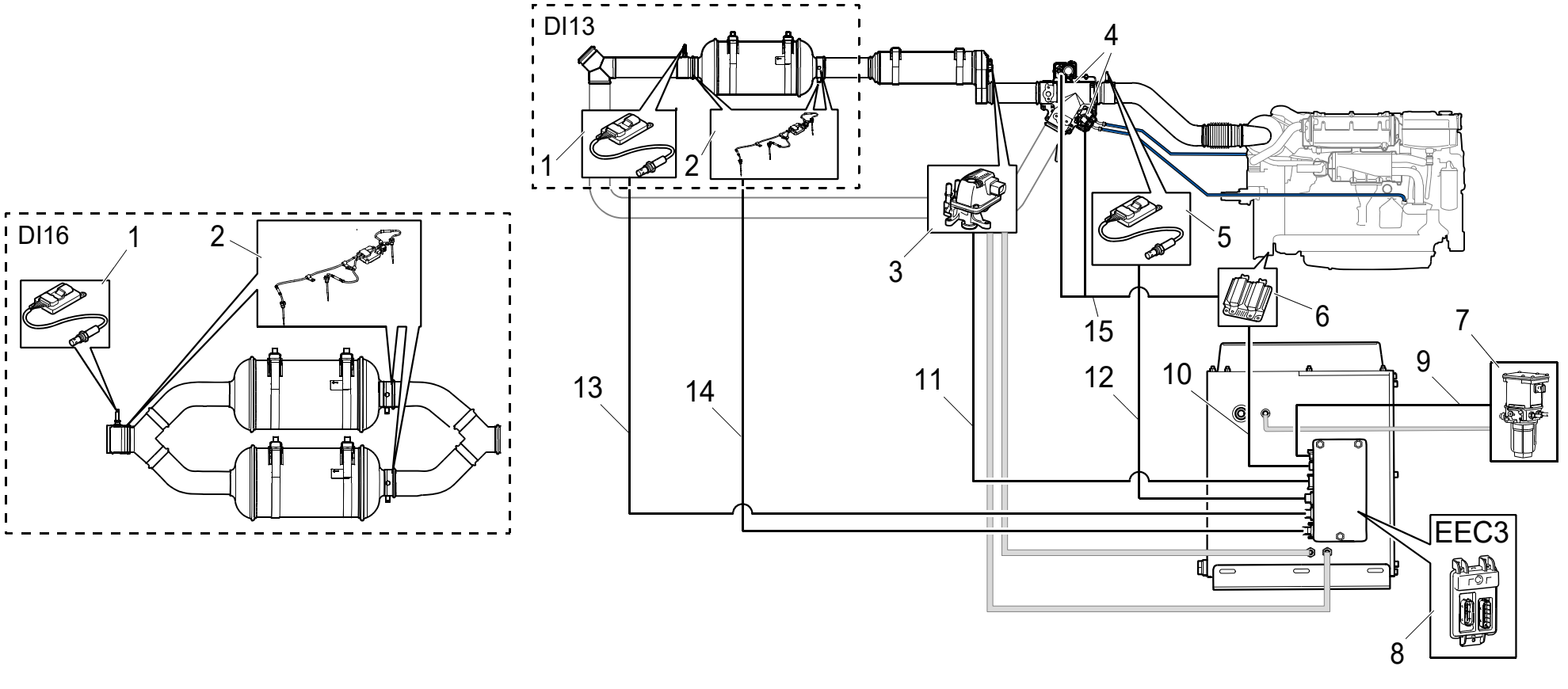
Rec. % by weight of urea	Limit values according to ISO 18611
40%	39-41%

System overview of mechanics



	Component	Standard	Option	Fitted by fitter
1.	Flange with outlet for NOx sensor T115 and 1 exhaust gas temperature sensor.	x	-	x
2.	SCR catalytic converter with outlets for 2 exhaust gas temperature sensors.	x	-	x
3.	Evaporator.	x	-	x
4.	Bypass pipe.	-	-	x
5.	Exhaust routing valve with 2 actuators.	x	-	x
6.	Flange with outlet for NOx sensor T131.	x	-	x
7.	Handle to bypass the SCR system.	x	-	-
8.	Exhaust bellows.	-	x	x
9.	Coolant line from the engine to the exhaust control valve actuator.	-	-	x
10.	Coolant return.	-	-	x
11.	Pressure pipe for reductant from the buffer tank.	-	-	x
12.	Return pipe for reductant to buffer tank.	-	-	x
13.	Reductant tank (buffer tank).	x	-	x
14.	Pressure pipe for reductant from the main tank.	-	-	x
15.	Return pipe for reductant to main tank.	-	-	x
16.	Pump for reductant supply from the main tank.	-	-	x
17.	Prefilter for reductant.	-	-	x
18.	Main tank for reductant.	-	-	x
19.	Branch pipe (DI16 only).	x	-	x

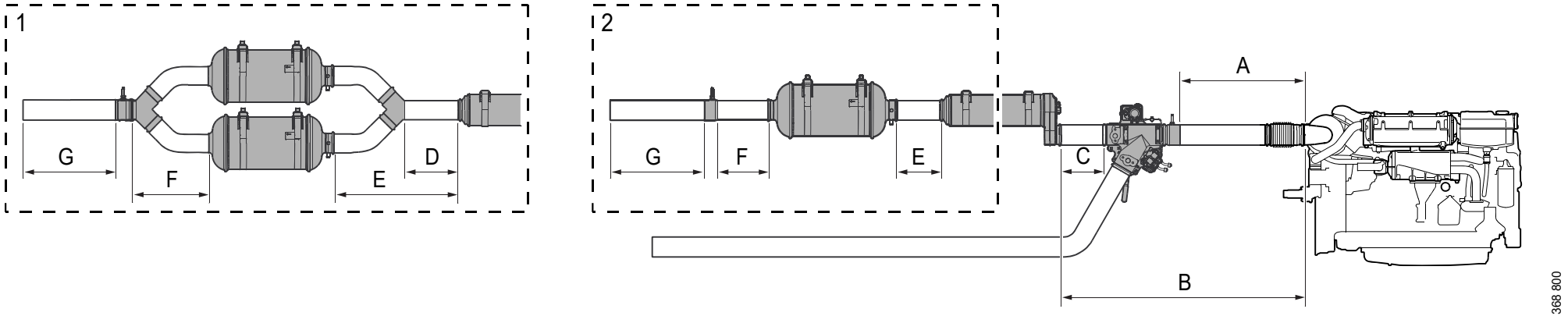
System overview of electrics



	Component	Standard	Option	Fitted by fitter
1.	NOx sensor T115.	x	-	x
2.	Exhaust temperature sensor T158 (x 3).	x	-	x
3.	Reductant doser.	x	-	-
4.	Exhaust routing valve actuator.	x	-	-
5.	NOx sensor T131.	x	-	x
6.	Engine control unit.	x	-	-
7.	Pump for reductant supply from the main tank.	-	-	x
8.	SCR control unit EEC3.	x	-	-
9.	Electric cable to pump for reductant supply from the main tank.	-	-	x
10.	Electrical cable to reductant tank (buffer tank).	x	-	x
11.	Electrical cable for reductant doser.	x	-	x
12.	Electric cable to NOx sensor T131.	x	-	x
13.	Electric cable to NOx sensor T115.	x	-	x
14.	Electrical cable for exhaust gas temperature sensor T158.	x	-	x
15.	Electrical cable to the 2 actuators of the exhaust routing valve.	x	-	x

Exhaust pipe

Pipe lengths



1. *DI16.*
2. *DI13.*

	From	To	Max/min pipe length (mm)
A	Turbocharger	Flange for NOx sensor	Max 1,500
B	Turbocharger	Evaporator intake	Max 2,000
C	Exhaust routing valve outlet	Evaporator intake	Max 500
D[1]	Evaporator outlet	Branch pipe	Min 300
E	Evaporator outlet	SCR catalytic converter inlet	Max 1,500
F	SCR catalytic converter outlet	Flange for NOx sensor and exhaust temperature sensor	Max 400
G	Flange for NOx sensor and exhaust temperature sensor	Exhaust outlet	Min 500

1. DI16 only.

Exhaust pipe bends

The sum of the exhaust pipe bends between the turbocharger outlet and NOx sensor upstream of the exhaust routing valve must not exceed 270°.

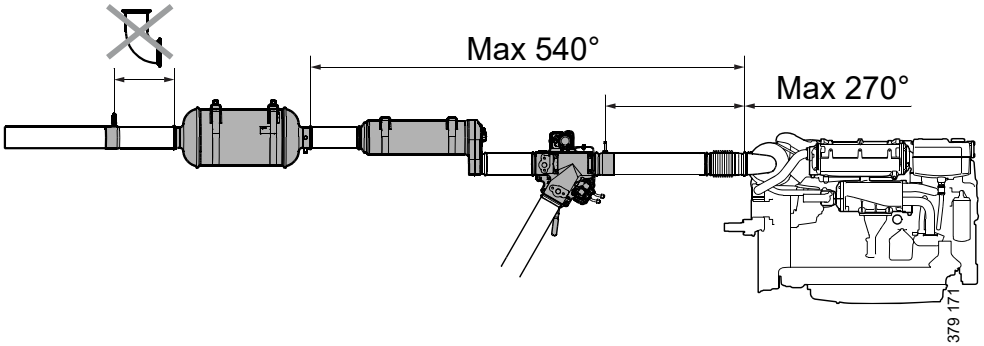
The sum of the exhaust pipe bends between the turbocharger outlet and SCR catalytic converter inlet must not exceed 540°. Example:

Max. angle before SCR catalytic converter	Number of 90° exhaust pipe bends	Number of 45° exhaust pipe bends
540°	4 off	4 off
540°	6 off	0 off

The radius of the exhaust pipe bends must be at least 1.5 x pipe diameter, based on a pipe diameter of 127 mm (5 inches).

IMPORTANT!

No exhaust pipe bends may be installed between the SCR catalytic converter outlet and the NOx sensor downstream of the SCR catalytic converter.



Maximum angle upstream of the exhaust routing valve and downstream of the SCR catalytic converter.

Pipe material

The exhaust pipe between the evaporator and the SCR catalytic converter must be made from stainless metal type 1.4301 or 1.4509, US grade 316L or equivalent. Scania also recommends that this material is used for other exhaust pipes downstream of the SCR catalytic converter. Other instructions on exhaust system shape and fitting are available in *02:04 Exhaust system*.

Other requirements

IMPORTANT!

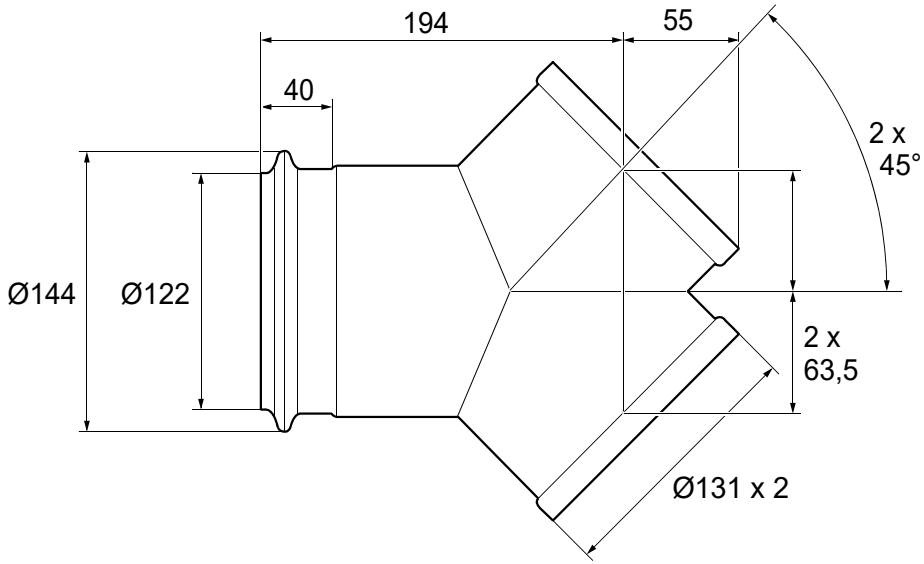
There should always be a flexible connection between the exhaust system and the engine which absorbs the movement of the engine and changes in length in the exhaust system due to temperature changes. Also see *02:04 Exhaust system*.

The brackets for exhaust routing valve, bypass pipe, evaporator and SCR catalytic converter must be able to bear the weight of the component. The weight of the components must not load the exhaust bellows or turbocharger.

Tighten the V-clamps in the SCR system after the engine has warmed up to working temperature for the first time. Carry out the retightening when the engine has cooled down again. Tightening torque 20 Nm.

Branch pipe

The image shows the dimensions of the branch pipes used to connect the SCR catalytic converters for DI16.

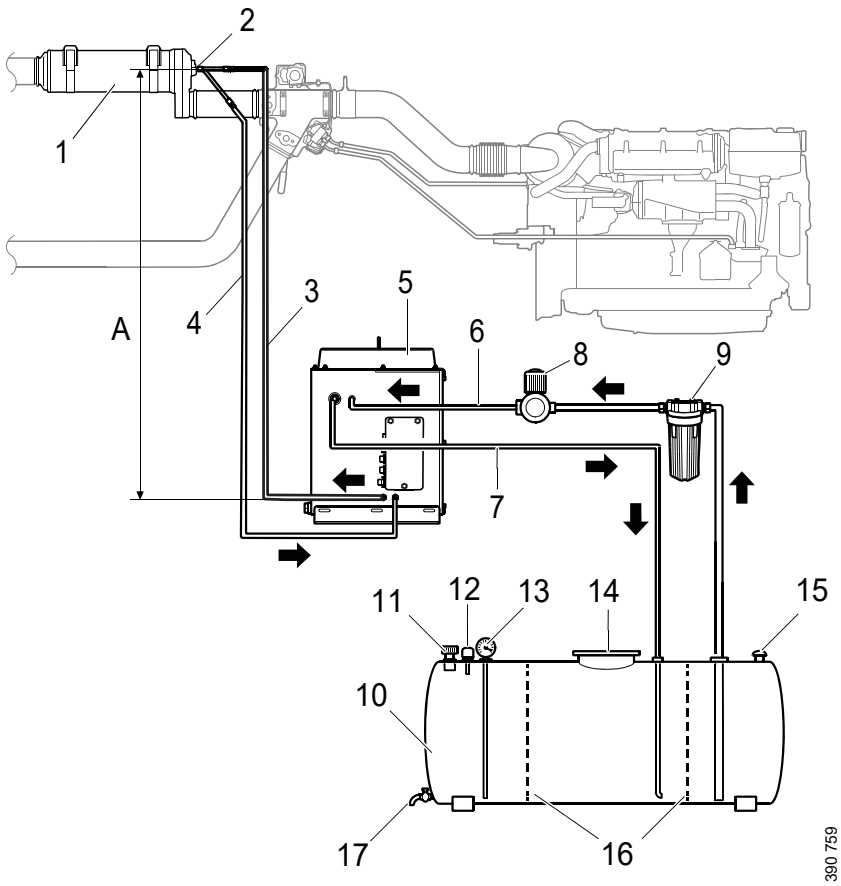


Main tank for reductant and reductant pipes

Example of installation

1. Evaporator.
2. Reductant doser.
3. Pressure pipe for reductant from the buffer tank.
4. Return pipe for reductant to buffer tank.
5. Buffer tank.
6. Pressure pipe for reductant from the main tank.
7. Return pipe for reductant to main tank.
8. Pump for reductant supply from the main tank.
9. Prefilter for reductant.
10. Main tank for reductant.
11. Filling.
12. Overfill protection.
13. Level gauge.
14. Inspection hatch.
15. Ventilating valve.
16. Baffle plate.
17. Draining tap.

A = Max. height 2 metres from the pressure pipe connection on the buffer tank to the reductant doser, max. length 16 metres.



Example of installation of the main tank for reductant and reductant pipes

Materials for pipes and main tank

The main reductant tank, the reductant pipes and all couplings must be made of urea-resistant material, such as stainless steel X5CrNi 18-10 in accordance with SS-EN 10088-2 or similar. Follow classification society requirements. If the material is welded, its anti-corrosive qualities must be retained.

Dimension the reductant pipes according to the dimensions of the connections on the buffer tank, as indicated in the Connecting the reductant tank section.

Main tank

- Dimension the main tank so that there is sufficient reductant for the specific use and area. Reductant consumption is approx. 9% of fuel consumption.
- The tank must be fitted with internal baffle plate to prevent the reductant from being thrown about at sea.
- The tank must have a drain tap.
- There must be a ventilation line from the upper part of the tank to the outside of the hull. It should be designed so that water cannot enter and so that reductant cannot run out when the ship is leaning heavily.
- The tank must be fitted with inspection hatches so that it can be inspected and cleaned inside.
- The pipe fitting should be at a sufficient distance from the bottom of the tank, so as not to suck up deposits gathered at the bottom.

Main tank to buffer tank

- The pipes to the buffer tank should be as short as possible and should be mounted in such a way that they cannot be exposed to mechanical damage.
- There must be a return pipe from the buffer tank to the main tank so that any surplus fluid can run back to the main tank.

  However, if the reductant pump between the main tank and the buffer tank is controlled by Scania software, no return line is required. The reductant pump is then switched off when the level sensor identifies that the buffer tank is full.

  In these cases, one ventilation line and one filter must be connected to the return line connection. The ventilation line must be pulled out on deck, alternatively to a well-ventilated area. Position the filter as high as possible, but at least 500 mm above the buffer tank, so that the reductant cannot come into contact with the filter. Position the filter so that it is protected against moisture.

  The ventilation line can also be routed to the top of the main tank.
- There must be a prefilter for reductant with a filtration rating of 30-50 micrometres.
- There must be a reductant pump with a flow capacity of between 0.4 and 5 litres/minute.

Buffer tank to the evaporator

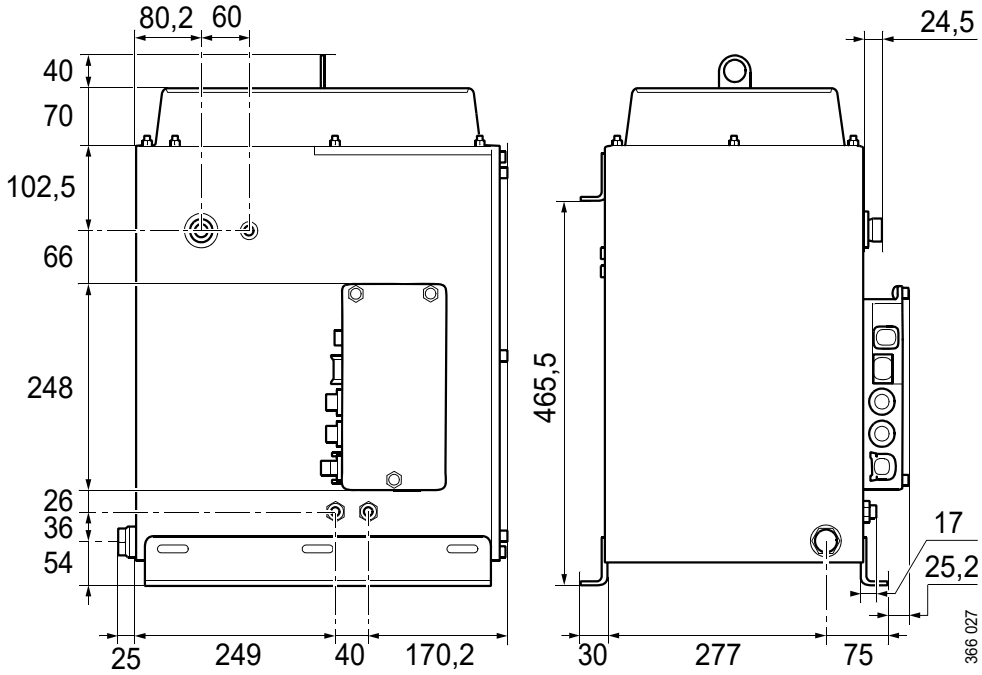
- The maximum length of the pipes between the buffer tank and evaporator reductant doser is 16 metres.
- The reductant doser should be installed level with or higher than the top of the buffer tank. Otherwise there is a risk of a siphoning effect when the system is switched off, leading to components breaking.
- The reductant doser can be installed a maximum of 2 metres above the pressure pipe connection on the buffer tank.

Reductant tank (buffer tank)

In the reductant tank, the reductant pump and SCR control unit are in front of an inspection hatch on the right-hand side of the tank.

Empty, the reductant tank weighs approx. 25 kg.

- Total volume: 30 litres.
- Filling volume: 16 litres.



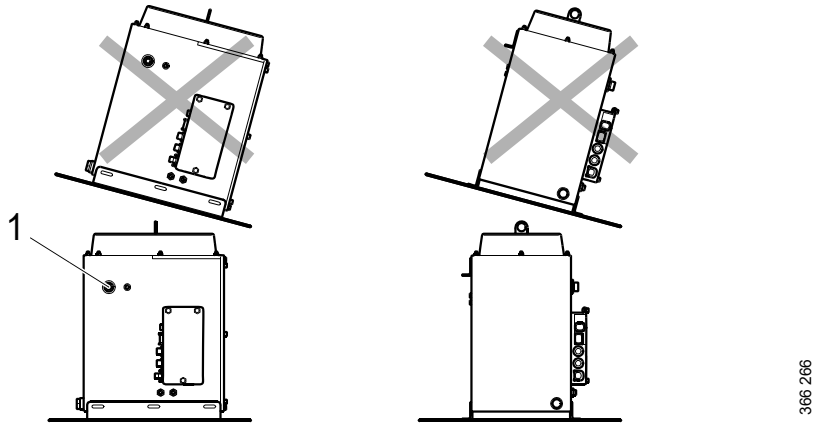
Position

Position the reductant tank so that the reductant cannot freeze. If the reductant freezes, the tank must be drained and cleaned. See the Workshop Manual.

REQUIREMENT!

The reductant tank must not be positioned close to the exhaust system or any sources of heat which may cause the reductant to be heated to more than 55 °C. Measure the temperature in the reductant tank space when the installation has finished. Refer to *02:08 Measuring instructions for installation inspection*.

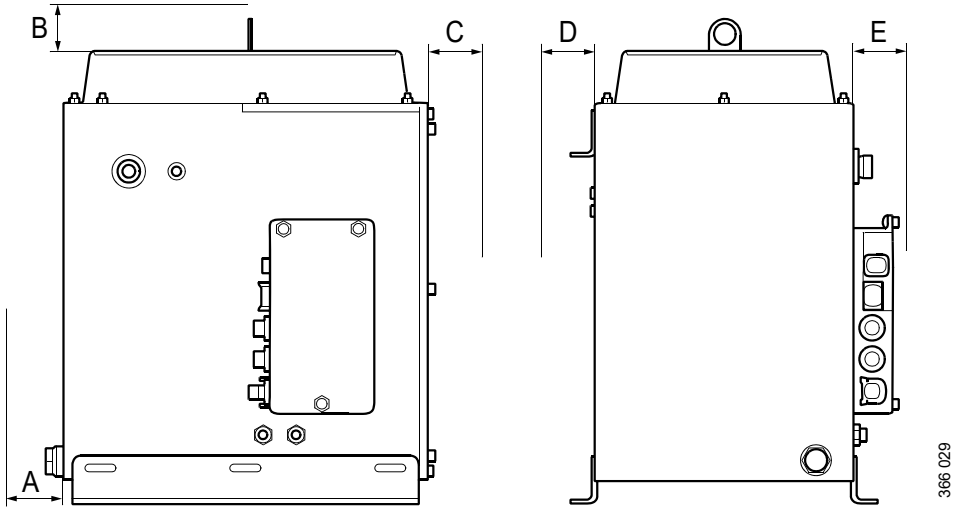
Do not position the reductant tank in a twisted or non-vertical position. Place the reductant tank so that the return pipe connection (1) is above the main tank, so that the reductant can run back into the main tank. It does not matter how the reductant tank is fitted in relation to the level of the engine.



Clearances

When the reductant tank is installed, the clearances below should be observed so that the reductant tank can be maintained and repaired in a simple way.

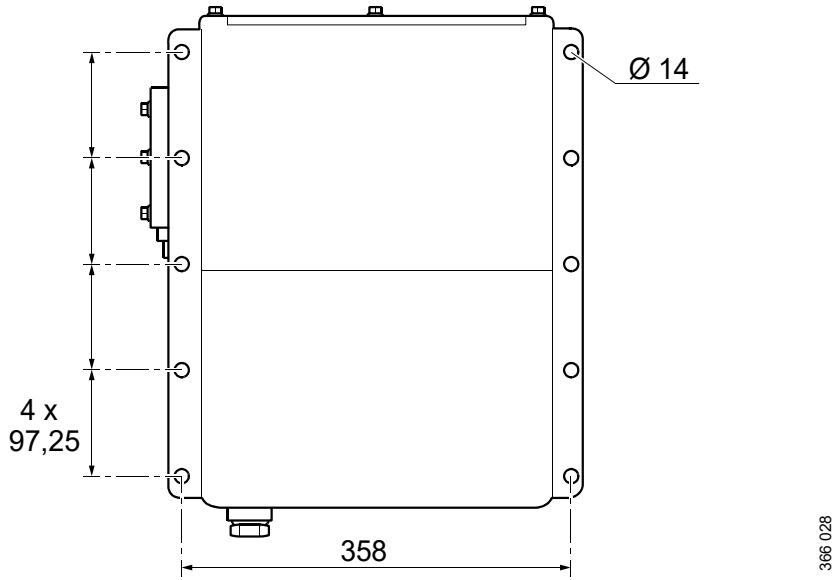
	mm	Purpose
A	235	To access the drain plug.
B	555	To lift out the reductant pick-up unit.
C	560	To open the inspection hatch to renew the reductant filter and access the reductant pump and SCR control unit.
D	220	To undo the reductant pump screws.
E	225	To connect the reductant pipes and harness-to-harness connectors.



Mounting

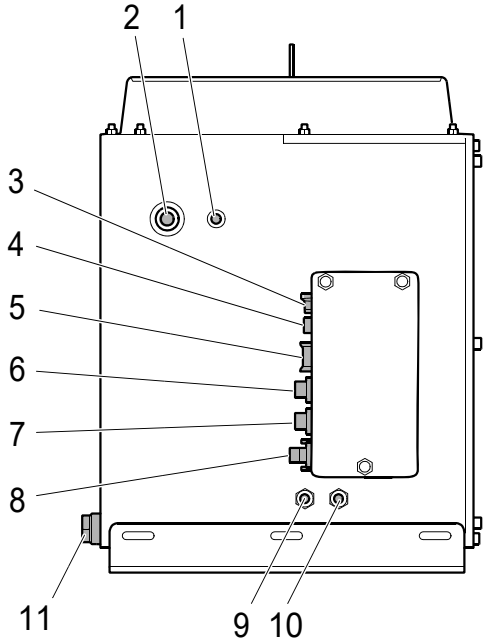
The reductant tank should be fitted with 3 brackets with 5 x 14 mm holes in each bracket. The bottom brackets are shown in the picture to the right. The upper rear bracket has the same dimensions and is shown under the heading Reductant tank (buffer tank).

Use at least 2 of the brackets and 2 of the holes in each bracket when mounting. In order to be able to remove the reductant tank for maintenance and repair, the brackets must not be welded.



Connecting the reductant tank

	Description	Connection
1.	Pressure pipe for reductant from the main tank	Nipple, Ø 8 mm, 24° internal conical thread in accordance with DIN 3861
2.	Return pipe for reductant to the main tank	Nipple, Ø 22 mm, 24° internal conical thread in accordance with DIN 3861
3.	Reductant pump for main tank.	C4109. For connection, see *03:01 Electrical system*
4.	Voltage supply from engine. CAN connection	C7
5.	Reductant doser	C316
6.	NOx sensor T131 upstream of the exhaust routing valve	C4051
7.	NOx sensor T115 downstream of the SCR catalytic converter	C4011
8.	Exhaust gas temperature sensor	C4092
9.	Pressure pipe for reductant from the buffer tank	Pipe with ferrule, Ø 8 mm
10.	Return pipe for reductant to buffer tank	Pipe with ferrule, Ø 10 mm
11.	Drain plug	3/4" BSP



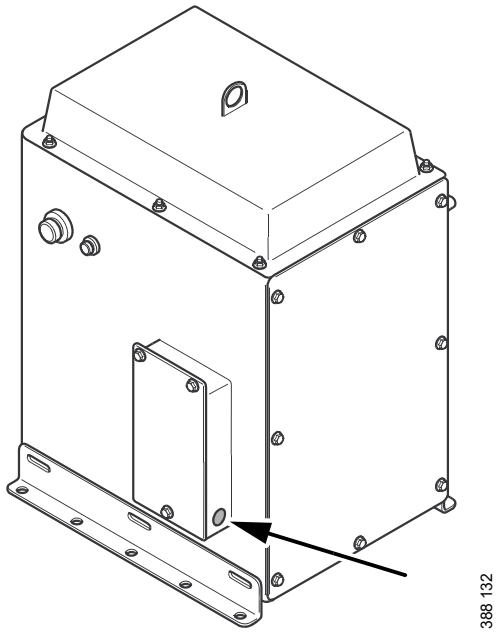
First filling of reductant tank

The first time you fill the reductant tank, you must keep the reset button (see illustration) pressed in for at least five seconds. A short press of the button will result in the level sensor not registering any level increase in the tank, and a fault code is generated after a few minutes.

Keeping the button pressed for five seconds will keep the reductant pump operating for 30 minutes regardless of the level sensor. In normal cases, the pump runs until 80% of the reductant level has been attained. If the reductant level has not increased after 30 minutes, a fault code is generated and you will have to press the button in for a further five seconds. This can happen when using it for the first time as there are then large quantities of air in the system.

The reset button also has the following functions:

- If the reductant pump is operating and you briefly press the button, the pump switches itself off.
- If the reductant pump has been switched off due to a fault code and you briefly press the button, the pump restarts.



Reset button.

Exhaust routing valve

Position

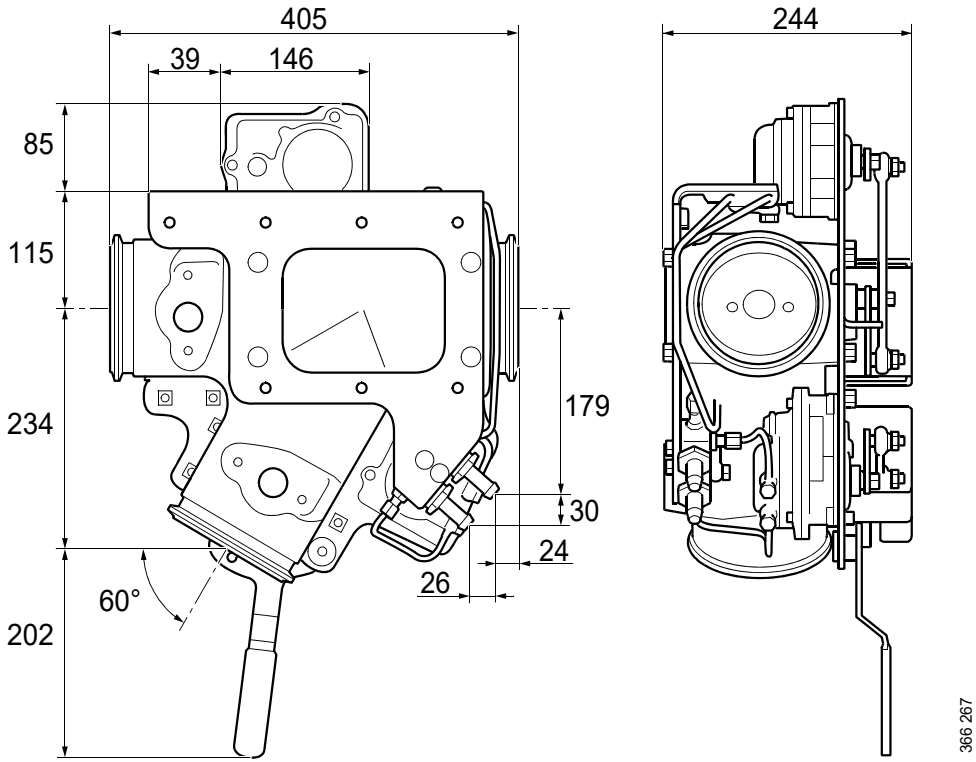
The exhaust routing valve may be installed horizontally or vertically. However, it must not be mounted on the engine.

As the exhaust routing valve actuator may be damaged if the temperature is too high, the space around the exhaust routing valve must be well-ventilated, and the accompanying insulation must be used. In addition, the actuators must be cooled by connecting a coolant circuit. See Connection of coolant.

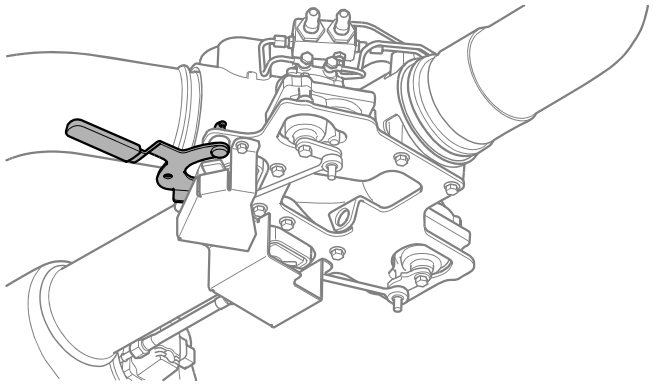
REQUIREMENT!

The highest permitted temperature at the exhaust routing valve actuator is 90°C. Measure the temperature when the installation is complete. Refer to *02:08 Measuring instructions for installation inspection*.

The exhaust routing valve weighs approximately 24 kg.

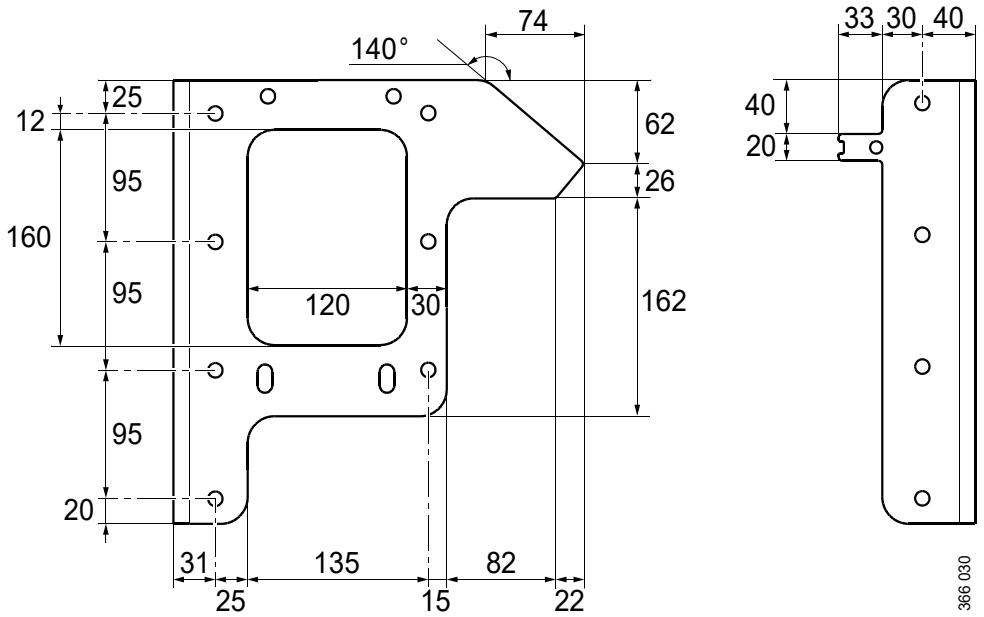


It must be possible to access the handle of the exhaust routing valve and the lock pin of the handle without removing insulation or other components. See illustration.



Mounting

The exhaust routing valve is fitted with a bracket with 11 M10 holes. Use at least 4 of the holes when mounting. The bracket must not be welded because the two actuators may get damaged. In addition, it must be possible to remove the exhaust routing valve in order to carry out repairs to it.



Exhaust routing valve bracket.

Connection of coolant

This section shows how to connect a circulating coolant circuit between the engine and the exhaust routing valve. However, it is also possible to connect an external coolant circuit.

Note:

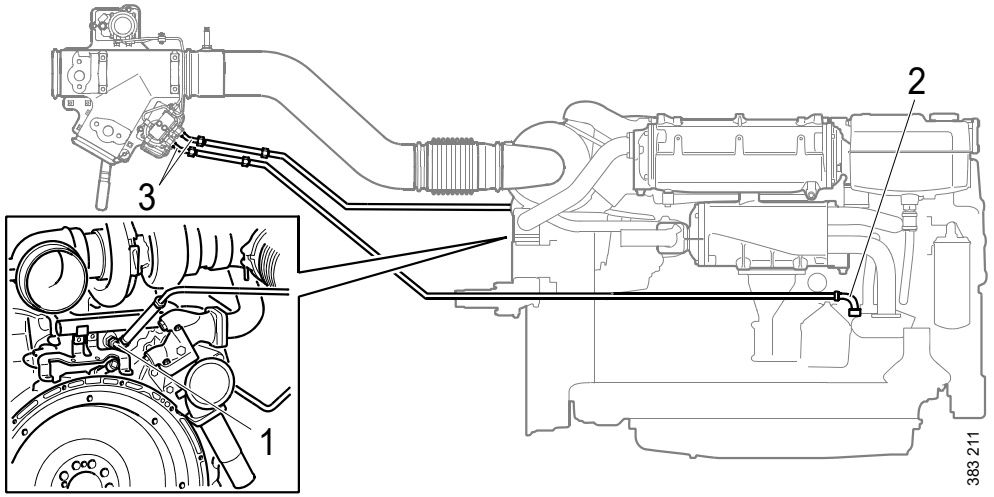
Do not use sea water to cool the exhaust routing valve.

Scania recommends using pipes, but it is also possible to use hose.

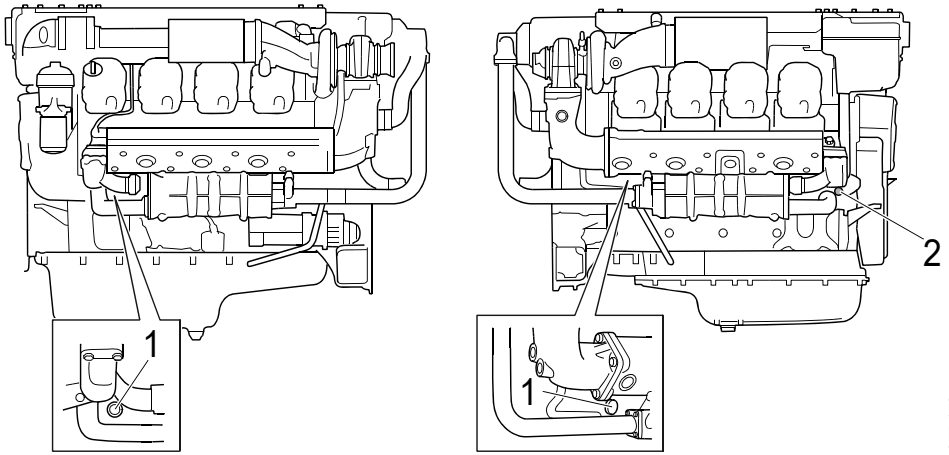
It does not matter which of the connections of the exhaust routing valve (3) are used for coolant intake or coolant return.

The images show the coolant connections on DI13 and DI16:

1. Coolant out of the engine. M22x1.5.
2. Coolant return to the engine. DI13: M22x1.5. DI16: M26x1.5.
3. Coolant connection to exhaust routing valve. M22x1.5.



DI13.



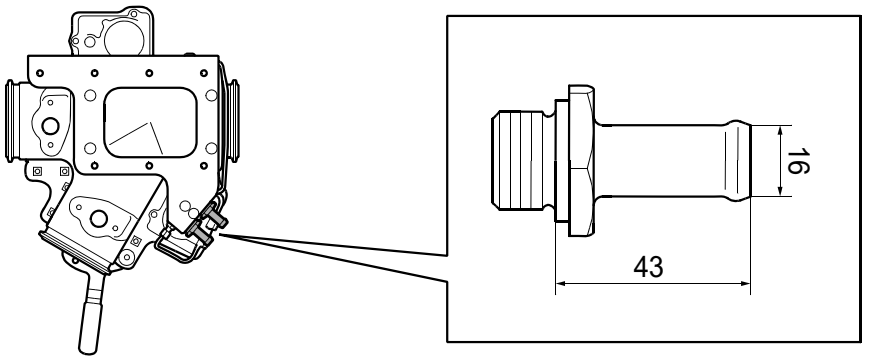
DI16.

Coolant hose connection

Use hose with an internal diameter of 16 mm to connect to the pre-assembled nipples on the exhaust routing valve. The material must be EPDM-type or similar, and must be able to withstand a working pressure of 2.4 bar. The material must be refrigerant-resistant.

Note:

To ensure sufficient flow, hoses must not have any sharp bends and there must be no spots where they are at risk of being pinched.



Nipples to connect the coolant hose to the exhaust routing valve.

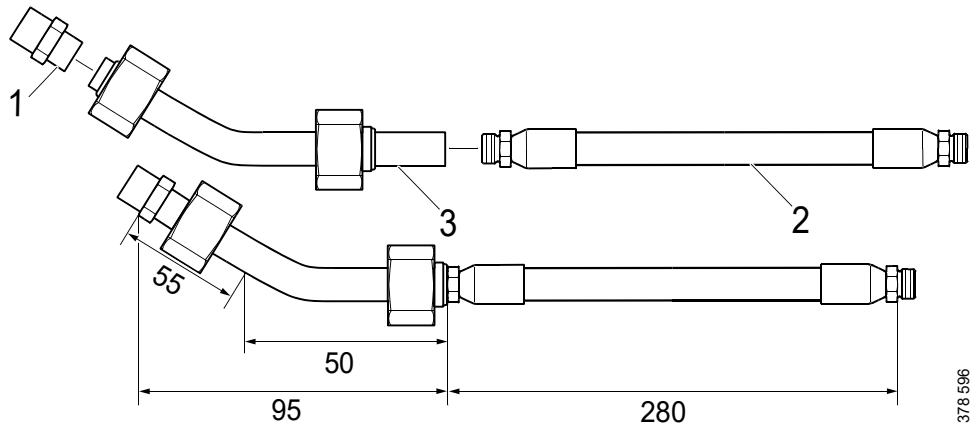
Connecting the coolant pipe

If pipes are to be used, the pre-assembled unions on the exhaust routing valve must be removed and the accompanying parts shown in the illustrations fitted. It is important to use at least one hose connection on each pipe to and from the engine, to absorb vibrations from the engine.

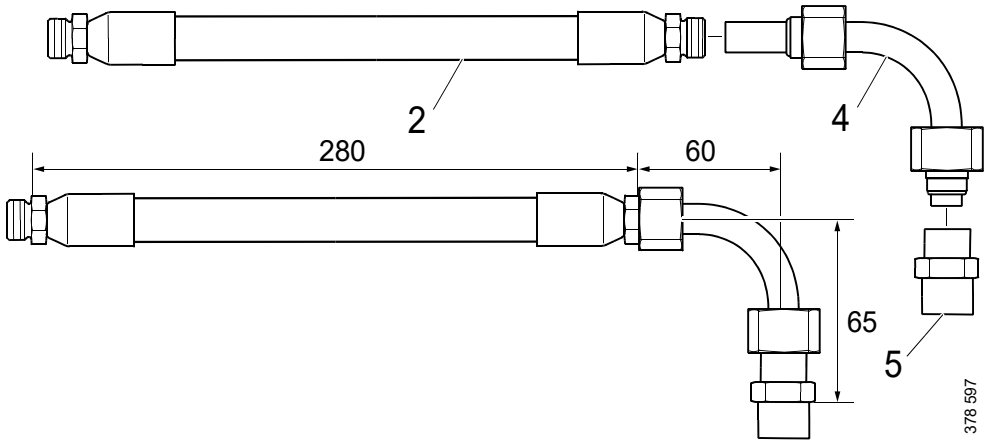
The pipe material must be refrigerant-resistant.

Tightening torque for union nuts: 30 Nm.

Item	Description	Qty	Dimensions
1	Connection union to exhaust routing valve or engine.	2	M22
2	Hose for coolant pipe connection.	4	Ø 12 mm, M18x1.5
3	Tube with ferrule and union nuts.	3	Ø 12 mm
4	Tube with ferrule and union nuts.	1	Ø 12 mm
5	Union for engine connection.	2	DI13: M22 DI16: M26



Connection of the exhaust routing valve and coolant from the engine.



Connection of coolant filter return to engine.

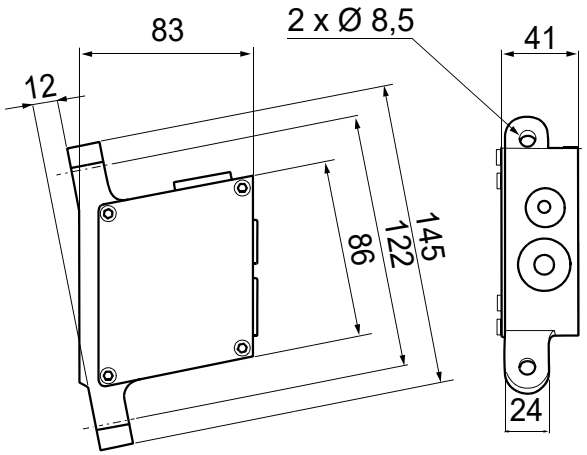
Surge voltage protection for classified engines

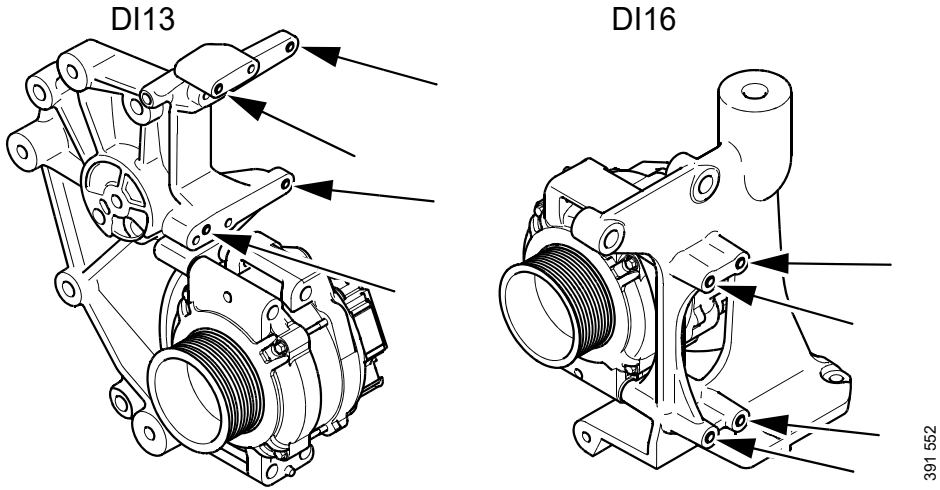
The additional surge voltage protection is a requirement for classified installations. It protects SCR control unit EEC3 and the exhaust routing valve against power surges in the event of lightning, for example.

The surge voltage protection must be machined if a level attachment surface is required to fit it. Fit the bracket with two M8 screws.

The surge voltage protection bracket is grounded through the retaining screws. The surge voltage protection attachment point must therefore be connected to ground. A good attachment point which provides a ground connection is the alternator bracket. However, there is only room on the alternator bracket for the surge voltage protection bracket if the engine does not have dual alternators or an A/C compressor. The bracket must be machined somewhat to fit on the alternator bracket.

The surge voltage protection is connected to harness-to-harness connector C4089 on the engine. The length of the electrical cable going to C4089 is 390 mm. The length of the electrical cable going to C4089X is 380 mm. The electrical cables must not be spliced. The connection of C4089 is described in *03:01 Electrical system*.





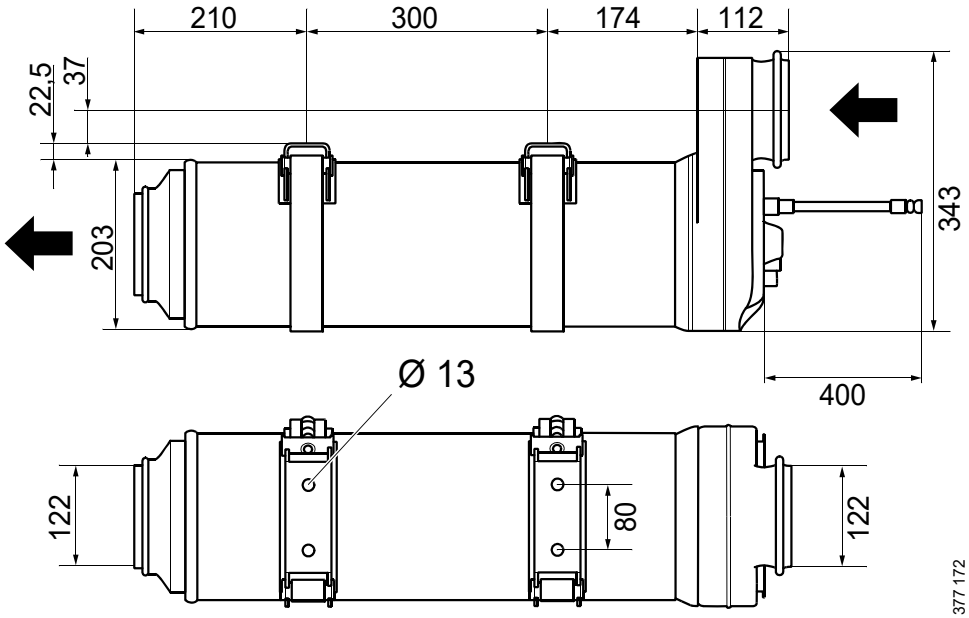
Possible attachment points for surge voltage protection on alternator bracket.

Evaporator

Position

The evaporator must be fitted in the direction of the exhaust gases as illustrated. It may be installed horizontally or with the outlet pointing downwards. The intake can be rotated 360°.

The space around the evaporator must be well-ventilated. The maximum permissible temperature is 115°C. The accompanying insulation must be used. The evaporator weighs approx. 17 kg.



Mounting

The evaporator is supplied with two retaining straps with brackets. Attach the brackets with flange screw M12 or a common screw of a suitable length. Use an M12 flange nut if necessary.

Tightening torques

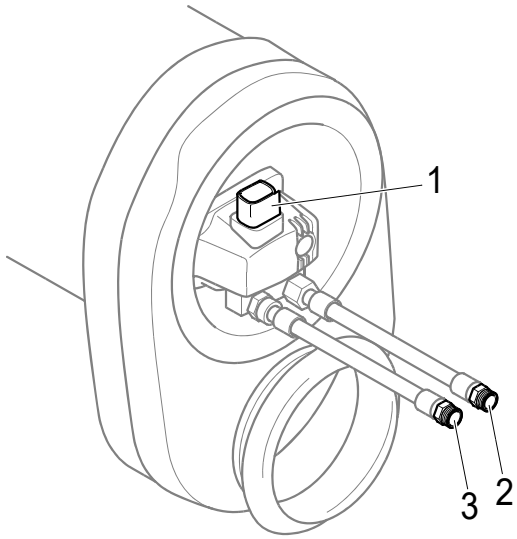
Flange bolt M12: 77 Nm. Regular screw M12: 70 Nm.

Retaining strap: 40 Nm.

Connection of reductant doser

The evaporator is supplied with two hoses which are connected to the reductant doser. The hoses must be used as they absorb vibrations from the pipes to and from the reductant tank. The maximum bend radius for the hoses is 50 mm.

	Connection	Note
1.	Electrical cable to reductant tank.	V117
2.	Reductant return pipe.	Ø 10 mm
3.	Reductant pressure pipe.	Ø 8 mm



377 173

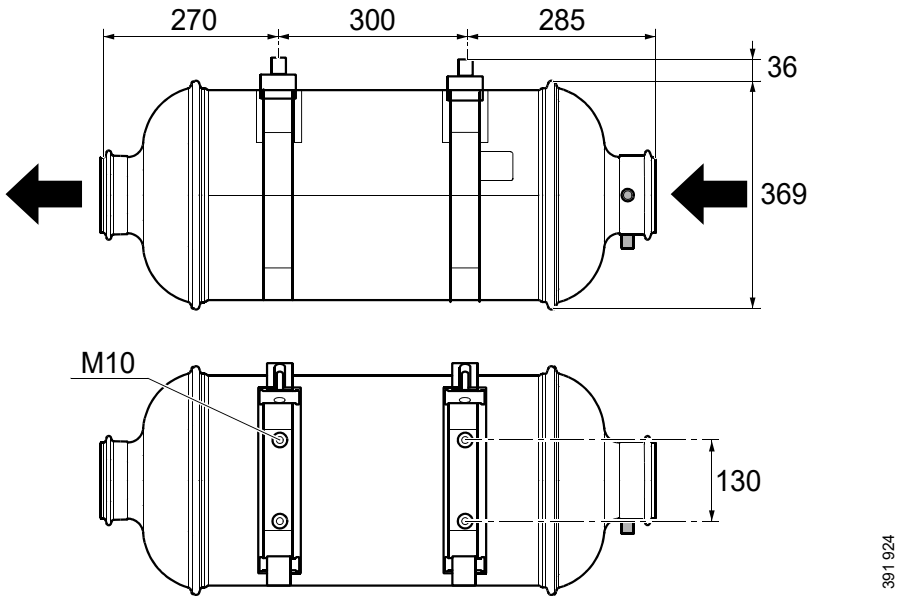
SCR catalytic converter

Position

The SCR catalytic converter must be fitted in the direction of the exhaust gases as illustrated. There are two sensor outputs on the input side. The SCR catalytic converter may be installed horizontally or with the outlet pointing upwards.

For DI16, two SCR catalytic converters are used. They may be longitudinally displaced. Longitudinal displacement is limited by the length of the electrical cables of the exhaust gas temperature sensors. See the Exhaust gas temperature sensor section.

The SCR catalytic converter weighs approx. 30 kg. It can be ordered with or without insulation.



Mounting

The SCR catalytic converter is supplied with two retaining straps with brackets. Attach the brackets with M10 flange screws.

Tightening torques

M10	42 Nm
Retaining strap	39 Nm

NOx sensor

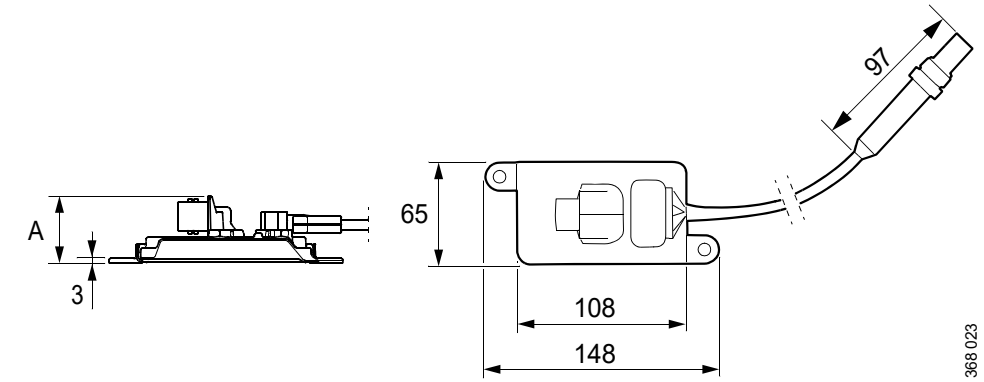
The SCR system comes with two NOx sensors, which have their own control unit. The sensor control units are connected to the SCR control unit in the reductant tank. See Connecting the reductant tank. The control unit should be shielded from radiated heat and knocks. The electrical cables between the sensors and the control units must not be spliced. The NOx sensors and control units must not be painted.

Electrical cable length (mm)	Tightening torque (Nm)
910	50 ±10

If the temperature by the NOx sensor control units is too high, this may damage the control units.

REQUIREMENT!

The highest permitted temperature at the NOx sensor control units is 90°. Measure the temperature when the installation is complete. Refer to *02:08 Measuring instructions for installation inspection*.

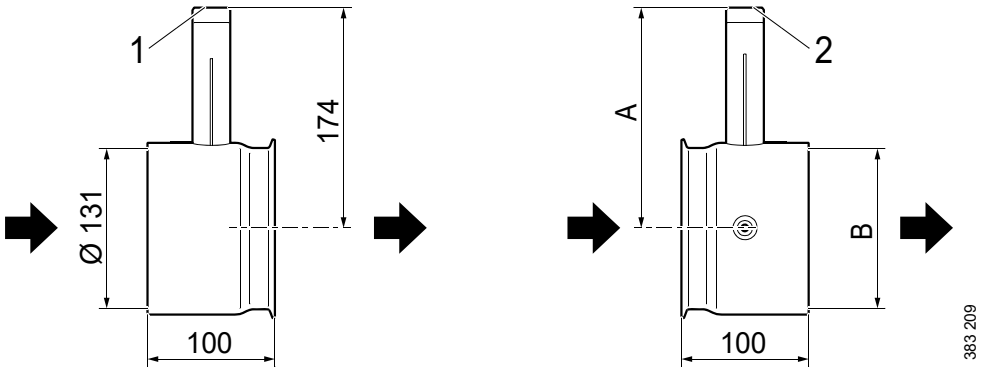


NOx sensor (x 2).
T131 (grey electrical cable): A = 42 mm.
T115 (black electrical cable): A = 38 mm.

Fitting

Fit NOx sensor T131 (grey electrical cable) to one of the accompanying flanges, which should be positioned upstream of the exhaust routing valve. The flange has only one outlet for this NOx sensor.

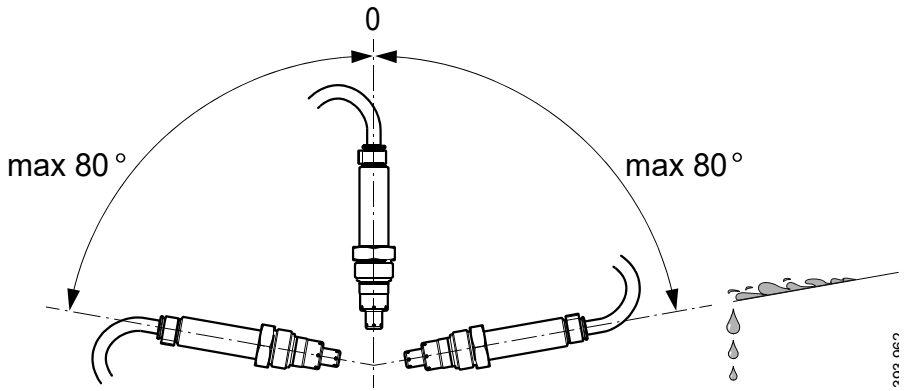
The other flange must be fitted on the outlet side of the SCR catalytic converter. The flange has an outlet for NOx sensor T115 (black electrical cable) and also an outlet for an exhaust gas temperature sensor. See the following section. The flange can be selected with inner diameters of 131 or 156 mm for the connection of 130 or 155 mm pipes downstream of the SCR system.



1. *Outlet for NOx sensor T131 (grey electrical cable) in flange upstream of exhaust routing valve.*
2. *Outlet for NOx sensor T115 (black electrical cable) in flange downstream of SCR catalytic converter.*
   - *For pipes Ø 130 mm: A = 174 mm, B = Ø 131 mm.*
   - *For pipes Ø 155 mm: A = 170 mm, B = Ø 156 mm.*

IMPORTANT!

The NOx sensors must be fitted so that there is no risk of them coming into contact with water, as moisture damages them. The NOx sensors must be slightly inclined, so that the condensed water can run out of them. The maximum installation angle is 80° to the vertical plane. This applies regardless of whether the exhaust pipe is installed horizontally or vertically.

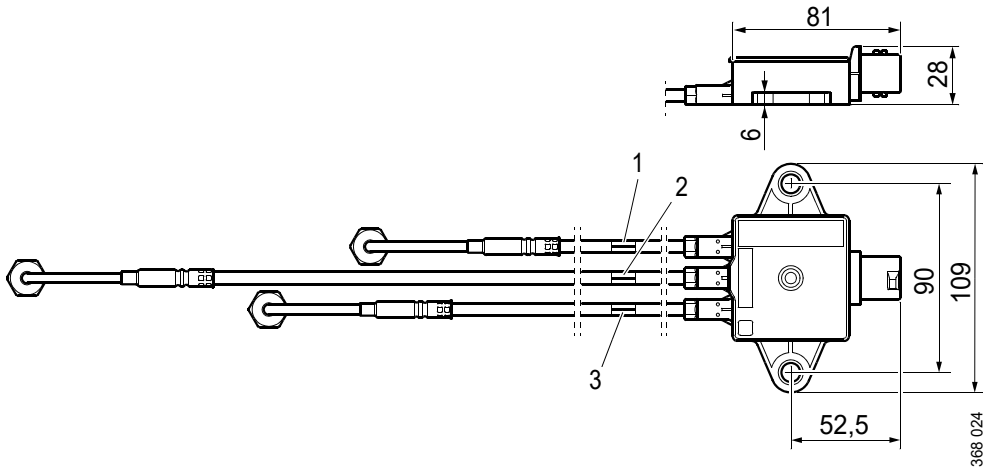


Exhaust gas temperature sensor

The SCR system comes with three exhaust gas temperature sensors, which share a control unit. The sensor control unit is connected to the SCR control unit in the reductant tank. See Connecting the reductant tank. The control units should be shielded from radiated heat and knocks. The electrical cables between the sensors and the control unit must not be spliced. The connection between the sensor and the electrical cables must not be insulated, as it may be damaged if it is exposed to temperatures above 200°C.

	Colour code	Electrical cable length (mm)	Max. rotation (°)[1]	Tightening torque (Nm)
1	Blue	980	180	35-40
2	Yellow	1,570	270	
3	White	1,220	270	

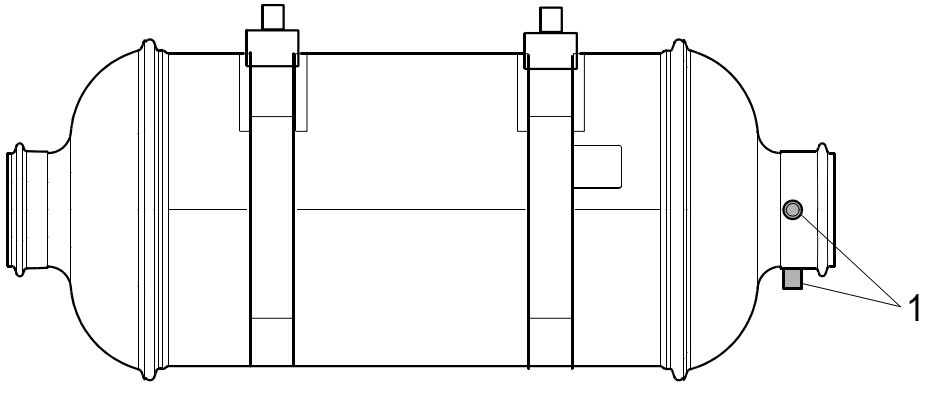
1. Max. rotation means how much the electrical cable can be twisted around its own axis.



Exhaust gas temperature sensor.

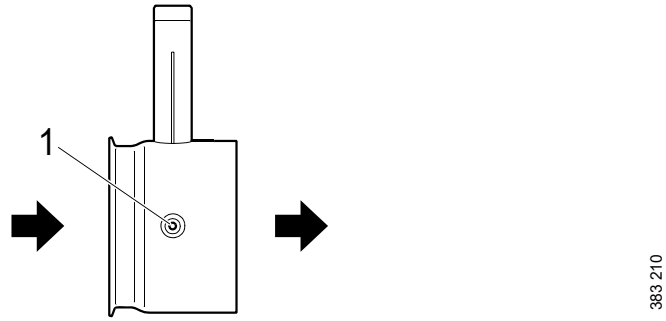
Fitting

The two shorter exhaust temperature sensors (blue and white in colour) should be fitted to the outlets of the inlet side of the SCR catalytic converter (1). On DI16, one temperature sensor should be fitted to each SCR catalytic converter and the other outlet plugged.



1. *Outlet for exhaust temperature sensor (blue and white) on the inlet side of the SCR catalytic converter.*

The longer exhaust temperature sensor (yellow in colour) should be fitted to the flange on the outlet side of the SCR catalytic converter (1).



1. *Outlet for exhaust temperature sensor (yellow) in the flange downstream of the SCR catalytic converter.*

Important data

Highest permitted temperature for reductant	55°C
Highest permitted temperature by the evaporator	115°C
Highest permitted temperature by the exhaust routing valve actuator	90°
Highest permitted temperature by the NOx sensor control units	90°