

1 **Specimens**

- 1 *Ultrasonic wind sensor* (ident-no. 00.16470.000000; serial-no. 85095.0001, incl. connector; specimen No. 50-18-0403-1)
- 1 *ARCO-SERIAL combined-wind sensor NMEA* (ident-no. 00.14581.010010; serial-no. 850983.0003, incl. connector; specimen No. 50-18-0403-2)
- 1 *PRO-WEA WG-SENSOR 4-20 mA* (wind speed, 0-60 m/s, ident-no. 00.14524.100040; serial-no. 851107.0010, incl. connector; specimen No. 50-18-0403-3)
- 1 *PRO-WEA WR-SENSOR 4-20 mA* (wind direction, ident-no. 00.14523.130040; serial-no.850889.0010, incl. connector; specimen No. 50-18-0403-4)
- 1 *PROFESSIONAL sensor ice free IX 3.0 WR* (wind direction, ident-no. 00.14601.300004; serial-no. 821207.0003, incl. connector; specimen No. 50-18-0403-5)
- 1 *PROFESSIONAL Sensor ice free IX 2.0 WG* (wind speed, ident-no. 00.14602.900008; serial-no. 791261.0010, incl. connector; specimen No. 50-18-0403-6)
- 1 *INDUSRTY wind direction sensor* (ident-no.00.14567.100040; serial-no. 850215.0007, incl. connector, specimen No. 50-18-0403-7)
- 1 *THP-NAV temp.-humidity-pressure-sensor* (ident-no. 00.08095.001000; serial-no. 850772.0010 incl. connector installed in a sensor-protection housing (ident-no. 00.08141.620000; serial-no. 851223.0014 specimen No. 50-18-0403-8a and -8b)



fig. 1 specimen no. 50-18-0403-1



fig. 2 specimen no. 50-18-0403-2



fig. 3 specimen no. 50-18-0403-3



fig. 4 specimen no. 50-18-0403-4



fig. 5 specimen no. 50-18-0403-5



fig. 6 specimen no. 50-18-0403-6



fig. 7 specimen no. 50-18-0403-7

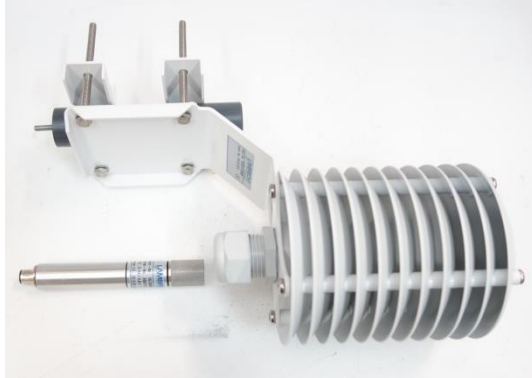


fig. 8 specimen no. 50-18-0403-8a and -8b

2 Relevant Specification

2.1 Exposures

2.1.1 Cold test

Test Ad: Cold for non-heat-dissipating specimen with gradual change of temperature according to DIN EN 60068-2-1 (01/2008)

Temperature: $(-40 \pm 3) ^\circ\text{C}$

Test duration: 16 hours

2.1.2 Condensation test

Test CH: Paints and varnishes – Determination of resistance to humidity according to ISO 6270-2 (09/2005) and based on DIN EN ISO 12944-6 (07/1998)

Temperature: $(40 \pm 3) ^\circ\text{C}$

Relative humidity: $\approx 100\%$

Test duration: 480 hours

2.1.3 Salt mist test

Salt mist test based on DIN EN ISO 7253 (09/2005) and based on DIN EN ISO 12944-6 (07/1998), Category C4, high

Temperature: $(35 \pm 2) ^\circ\text{C}$

Test solution: $5 \pm 1\%$ sodium chloride solution (NaCl-solution)

pH-value: 6.5..7.2

Test duration: 720 h

2.2 Evaluations

2.2.1 Visual inspection

Examination of changes related to the initial state of the specimens.

Inspection times: after each exposure

2.2.2 Operability test

Each specimen is individually connected to a data logger (provided by the customer, "Ser[LOG]Plus + power [cube] 24 VDC 480 W") and checked for operability.

Test times: Initial test and during the cold test (after 8 hours at cold)

Acceptance conditions: The data logger must display plausible values (no error messages)

3 Test procedure

3.1 Test equipment

The test and measuring instruments as well as the calibration status were checked before using.

Test and measuring equipment	Inv. No.
Climate test chamber type C-70/1000, Manufacturer CTS GmbH	M574355
Salt mist test chamber type HSA 400, Manufacturer Vötsch	M566579
Refractometer type HI-96821 Manufacturer ATP Messtechnik	M563459
Precision balance type MB200	M564827

3.2 Test sequence

The tests were carried out in the following sequence:

Pos.	Exposure
1.	Operability test (initial test)
2.	Cold test, 16 hours (operability test after the first 8 h)
3.	Condensation test, CH 480 h
4.	Salt mist test 720 h

3.3 Test setup

The test setups of the climate and corrosion tests are shown in the following figures.



fig. 9

test setup:
specimens in the climate test chamber
(cold test)



fig. 10

test setup:
specimens in the salt mist test chamber
(condensation test)



fig. 11

test setup:
specimens in the salt mist test chamber
(salt mist test)

3.4 Exposure diagrams

The stress sequences of the climate and corrosion tests are shown in the following diagrams.

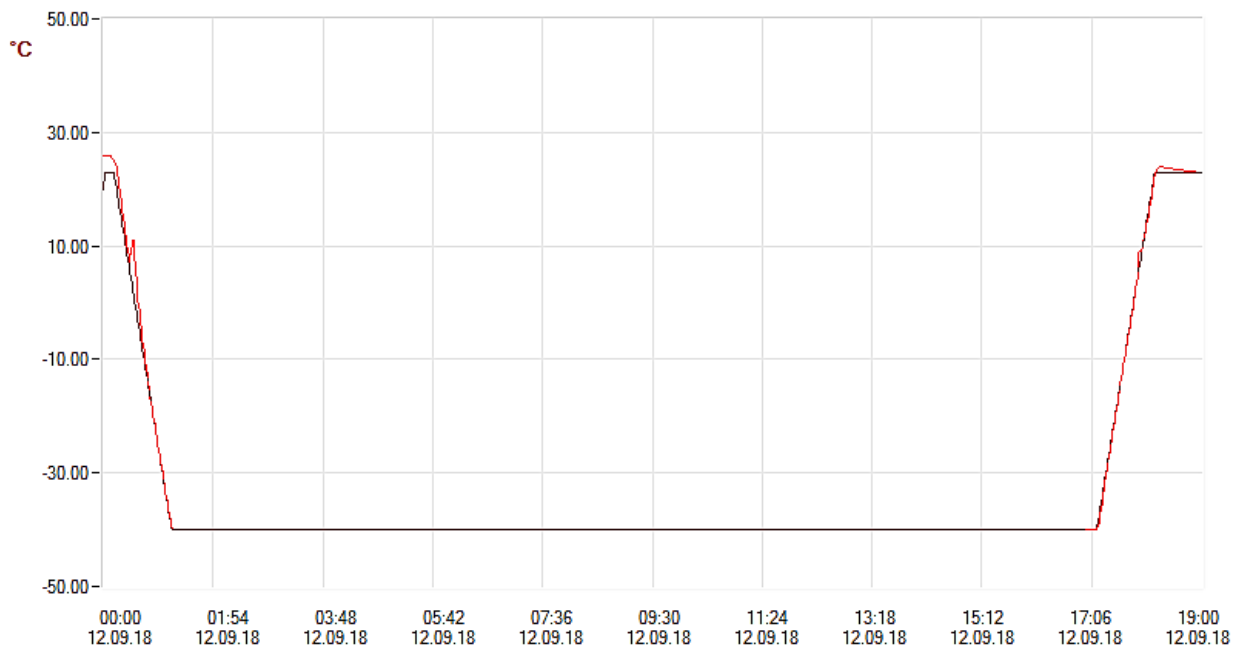


Diagram 1: Test Ab: Cold (temperature)

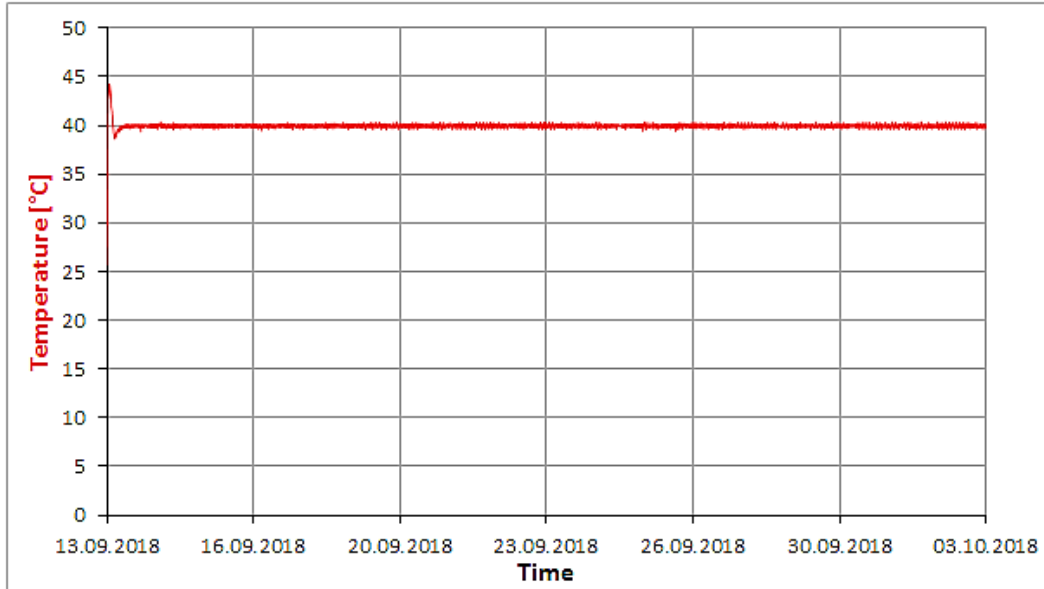


Diagram 2: Condensation test (temperature curve)

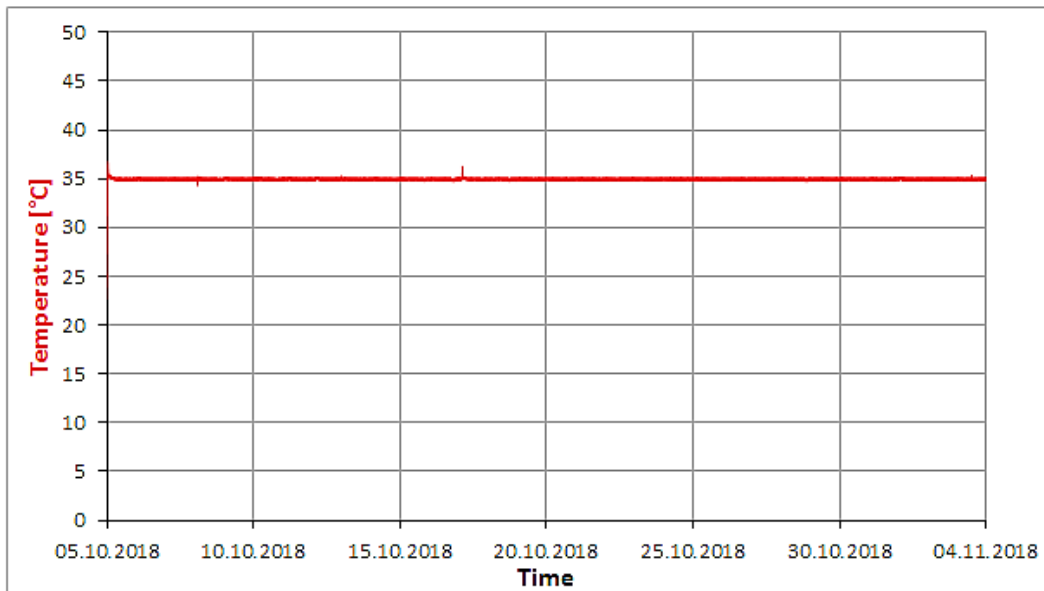


Diagram 3: Salt mist test (temperature curve)

4 Results

4.1 Operability test

The operability of the tested specimens was ensured before and during (after 8 h at cold) the cold test according to clause 2.1.1 (see table below).

Channel no.	Initial state (11/09/2018)	During cold (12/09/2018)
1	23 16470 WG 0,0 m/s	23 16470 WG OV-Range (0,3 m/s)
2	30 14581 WG 0,0 m/s	30 14581 WG 0,6 m/s
3	34 08095 TA 26,1 Grad C	34 08095 TA -38,1 Grad C
4	03 14524 WG 0,0 m/s	03 14524 WG 0,0 m/s
5	04 14523 WR 271,4 Grad	04 14523 WR 274,6 Grad
6	05 14567 WR 269,9 Grad	05 14567 WR 209,0 Grad
7	06 14602 WG 0,0 m/s	06 14602 WG 0,0 m/s
8	07 14601 WR 74,3 Grad	07 14601 WR 294,9 Grad

4.2 Operability test after all exposures, carried out by the customer

Values of the operability test (table below) after all exposures (carried out by the customer), see fig. 12

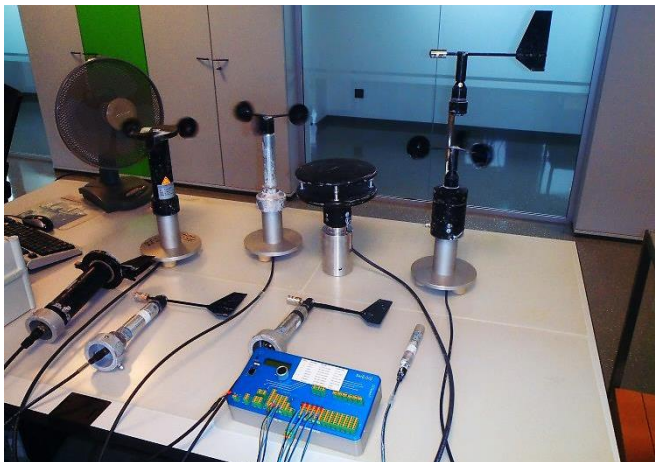


fig. 12

Specimen no. 50-18-0403-1..-8(a/b)
test setup after all exposures

operability test, carried out by the
customer

Channel no.	without airflow	with airflow
1	23 16470 WG 0,0 m/s	23 16470 WG 2,5 m/s
2	30 14581 WG 0,0 m/s	30 14581 WG 1,8 m/s
3	34 08095 TA 22,4 Grad C	34 08095 TA 22,2 Grad C
4	03 14524 WG 0,0 m/s	03 14524 WG 2,1 m/s
5	04 14523 WR 140,0 Grad	04 14523 WR 140,0 Grad
6	05 14567 WR 342,1 Grad	05 14567 WR 342,1 Grad
7	06 14602 WG 0,0 m/s	06 14602 WG 1,6 m/s
8	07 14601 WR 24,9 Grad	07 14601 WR 24,6 Grad

4.3 Visual inspection

Test time	Result
16 h Cold	No changes compared to the initial state of the specimens were visually detected
480 h Condensation	<ul style="list-style-type: none"> - Stains at the surfaces - Surface defects at the black anodized layer - White deposits / signs of corrosion - Swollen seal <p><i>See fig. 13 to fig. 41</i></p>
720 h Salt mist	<ul style="list-style-type: none"> - Stains at the surfaces - Surface defects at the black anodized layer - White deposits / signs of corrosion - Swollen seal - Red rust <p><i>See fig. 42..fig. 71</i></p>

4.4 Photographic representation of the results

4.4.1 After the condensation test

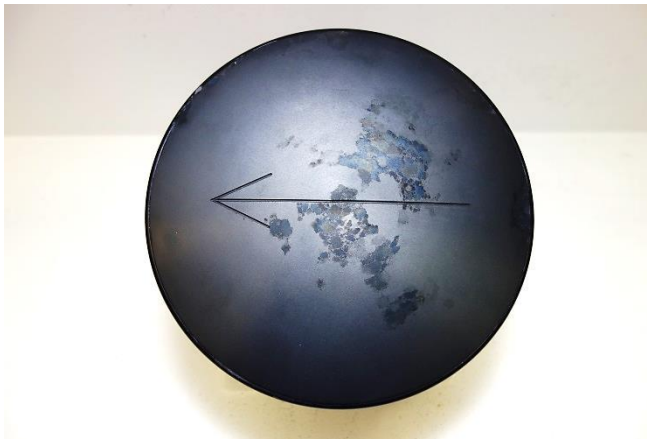


fig. 13

Specimen no. 50-18-0403-1
after the condensation test

Stains on the surface and surface defects
at the black anodized layer



fig. 14

Specimen no. 50-18-0403-1
after the condensation test

Stains on the surface and surface defects
at the black anodized layer



fig. 15

Specimen no. 50-18-0403-1
after the condensation test

Stains on the surface and surface defects
at the black anodized layer



fig. 16

Specimen no. 50-18-0403-2
after the condensation test

Overview



fig. 17

Specimen no. 50-18-0403-2
after the condensation test

Surface defects at the black anodized
layer (wind direction vane, crossbar and
holder cup)

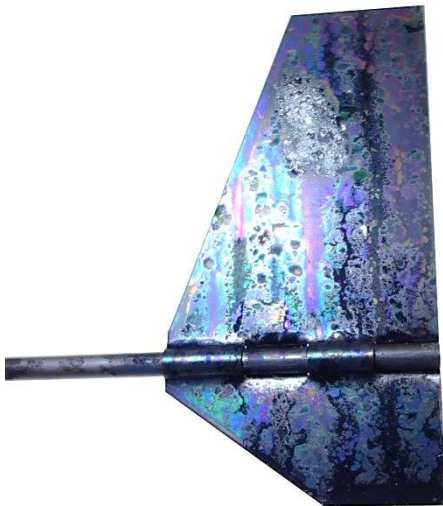


fig. 18

Specimen no. 50-18-0403-2
after the condensation test

Detailed: wind direction vane;
surface defects at the black anodized
layer



fig. 19

Specimen no. 50-18-0403-2
after the condensation test

Surface defects at the black anodized
layer (rotor cups)



fig. 20

Specimen no. 50-18-0403-2
after the condensation test

Verdigris between housing and bow
connection



fig. 21

Specimen no. 50-18-0403-2
after the condensation test

Verdigris between housing and a screw



fig. 22

Specimen no. 50-18-0403-2
after the condensation test

White corrosion products around the cup
rotor screws



fig. 23

Specimen no. 50-18-0403-3
after the condensation test

Overview



fig. 24

Specimen no. 50-18-0403-3
after the condensation test

Stains on the surface and surface defects
at the black anodized layer (rotor cups)



fig. 25

Specimen no. 50-18-0403-4
after the condensation test

Overview



fig. 26

Specimen no. 50-18-0403-4
after the condensation test

Stains on the surfaces and corrosion
phenomena (aluminum)

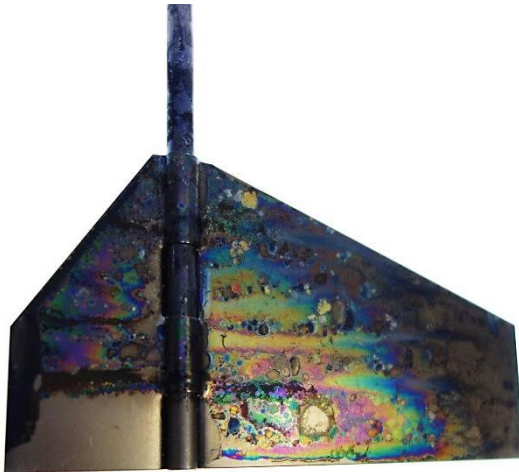


fig. 27

Specimen no. 50-18-0403-4
after the condensation test

Stains on the surface and surface defects
at the black anodized layer



fig. 28

Specimen no. 50-18-0403-5
after the condensation test

Overview



fig. 29

Specimen no. 50-18-0403-5
after the condensation test

Stains on the surface and surface defects
at the black anodized layer



fig. 30

Specimen no. 50-18-0403-5
after the condensation test

White corrosion products around the
screw



fig. 31

Specimen no. 50-18-0403-6
after the condensation test

Overview



fig. 32

Specimen no. 50-18-0403-6
after the condensation test

Stains on the surface



fig. 33

Specimen no. 50-18-0403-6
after the condensation test

Stains on the surface and surface defects
in the black anodized layer

Swollen seal between housing and cup
rotor



fig. 34

Specimen no. 50-18-0403-6
after the condensation test

White corrosion products around the cup
screws



fig. 35

Specimen no. 50-18-0403-6
after the condensation test

Stains on the surface and surface defects
at the black anodized layer (bottom)



fig. 36

Specimen no. 50-18-0403-7
after the condensation test

Overview



fig. 37

Specimen no. 50-18-0403-7
after the condensation test

White deposits at the nut



fig. 38

Specimen no. 50-18-0403-8a
after the condensation test

Overview



fig. 39

Specimen no. 50-18-0403-8a
after the condensation test

White corrosion products around the
connector



fig. 40

Specimen no. 50-18-0403-8a installed in
Specimen no. 50-18-0403-8b
after the condensation test

Overview

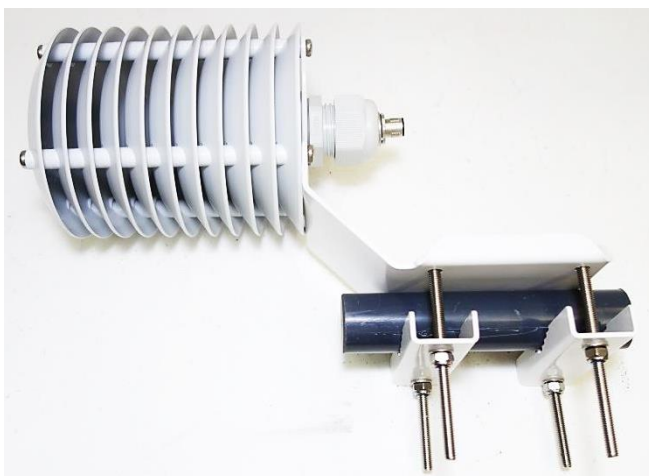


fig. 41

Specimen no. 50-18-0403-8a installed in
Specimen no. 50-18-0403-8b
after the condensation test

Overview

4.4.2 After the salt mist test



fig. 42

Specimen no. 50-18-0403-1
after the salt mist test

Overview



fig. 43

Specimen no. 50-18-0403-1
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer



fig. 44

Specimen no. 50-18-0403-2
after the salt mist test

Overview

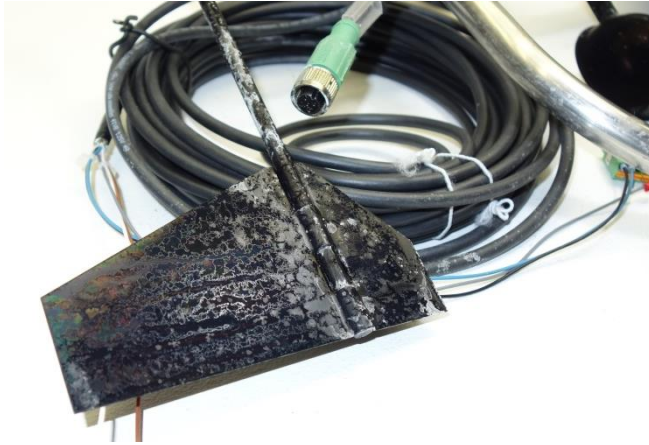


fig. 45

Specimen no. 50-18-0403-2
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer



fig. 46

Specimen no. 50-18-0403-2
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer

Corrosion at the screw



fig. 47

Specimen no. 50-18-0403-2
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer (rotor
cup)



fig. 48

Specimen no. 50-18-0403-2
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer

White deposits on the cup rotor and cup



fig. 49

Specimen no. 50-18-0403-3
after the salt mist test

Overview



fig. 50

Specimen no. 50-18-0403-3
after the salt mist test

Aluminium corrosion of the housing



fig. 51

Specimen no. 50-18-0403-3
after the salt mist test

Aluminium corrosion of the housing



fig. 52

Specimen no. 50-18-0403-4
after the salt mist test

Overview



fig. 53

Specimen no. 50-18-0403-4
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer



fig. 54

Specimen no. 50-18-0403-4
after the salt mist test

Signs of corrosion of the housing
White and grey deposits between nut and
sensor housing (no evaluation of the foot)



fig. 55

Specimen no. 50-18-0403-4
after the salt mist test

Corrosion products (red rust and white
deposits between the front mass and
cross beam)



fig. 56

Specimen no. 50-18-0403-5
after the salt mist test

Overview



fig. 57

Specimen no. 50-18-0403-5
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer



fig. 58

Specimen no. 50-18-0403-5
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer



fig. 59

Specimen no. 50-18-0403-5
after the salt mist test

Red rust at the connector housing



fig. 60

Specimen no. 50-18-0403-6
after the salt mist test

Overview



fig. 61

Specimen no. 50-18-0403-6
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer



fig. 62

Specimen no. 50-18-0403-6
after the salt mist test

Stains on the surfaces and surface
defects at the black anodized layer

Defect seal



fig. 63

Specimen no. 50-18-0403-6
after the salt mist test

Red rust at the connector housing



fig. 64

Specimen no. 50-18-0403-7
after the salt mist test

Overview



fig. 65

Specimen no. 50-18-0403-7
after the salt mist test

White deposits at the nut
(no evaluation of the foot)



fig. 66

Specimen no. 50-18-0403-8a installed in
specimen no. 50-18-0403-8b, incl.
connection wire after the salt mist test

Overview



fig. 67

Specimen no. 50-18-0403-8a
after the salt mist test

Overview



fig. 68

Specimen no. 50-18-0403-8a
after the salt mist test

White deposits and corrosion traces at the
sensor



fig. 69

Specimen no. 50-18-0403-8a removed
from Specimen no. 50-18-0403-8b
after the salt mist test

White deposits at the surface
plug not removable (normal force)



fig. 70

Specimen no. 50-18-0403-8b
after the salt mist test

Red rust under the connection screws
(coating defects)

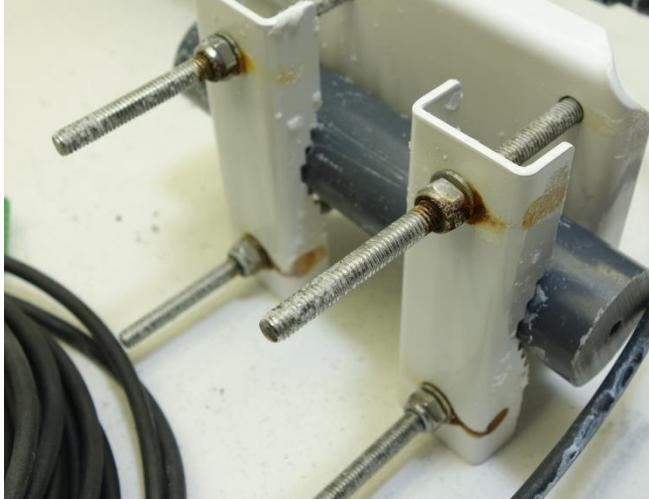


fig. 71

Specimen no. 50-18-0403-8b
after the salt mist test

Red rust under the connection
screws/nuts (coating defects)