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Bundesnetzagentur

BNetzA-CAB-02/21-102

## TEST REPORT

Test Report No.: 1-7488/18-01-11\_A



Deutsche  
Akkreditierungsstelle  
D-PL-12076-01-01

### Testing Laboratory

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#### Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)  
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-01

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### Manufacturer

same as applicant

### Test Standard/s

FCC - Title 47 CFR Part 15	2018-12	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
ICES-003, Issue 6	2017-04	Interference-Causing Equipment Standard Digital Apparatus

### Test Item

**Kind of test item:** Telematic Unit  
**Model name:** MCG TQ377  
**FCC ID:** RI7ME910C1WW and XF6-M15SB  
and 2AS7RTQ377MCG  
**IC:** 5131A-ME910C1WW and 8407A-M15SB  
**S/N serial number:** 1850-0048  
**HW hardware status:** H1164-0101-001  
**SW software status:** 368  
**Power Supply:** DC 9-36V



This test report is electronically signed and valid without handwritten signature. The public keys can be requested at the test laboratory to verify the electronic signatures.

**Test Report authorised:**

**Test performed:**

Hans-Joachim Wolsdorfer  
Radio Communications & EMC

Uli Kraus  
Radio Communications & EMC

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## 2 General information

### 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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**This test report replaces the test report with the number 1-7488\_18-01-11 and dated 2019-03-20**

## 2.2 Application details

Date of receipt of order: 2019-01-15  
Date of receipt of test item: 2019-01-15  
Start of test: 2019-01-18  
End of test: 2019-01-18  
Person(s) present during the test: Jonas Antoni

## 3 Test standard/s:

Test Standard	Version	Test Standard Description
FCC - Title 47 CFR Part 15	2018-12	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
ICES-003, Issue 6	2017-04	Interference-Causing Equipment Standard Digital Apparatus
ANSI C63.4	2014-01	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

## 4 Test Environment

Temperature: 20°C – 25°C  
Relative humidity content: 30 % - 50 %  
Air pressure: 1020 hPa  
Power supply: 230 V / 50 Hz

## 5 Test Laboratories sub-contracted

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## 6 Information about Test Conditions

### 6.1 Test Item

<b>Kind of test item</b> :	Telematic Unit		
<b>Type identification</b> :	MCG TQ377		
<b>Equipment classification:</b>	Equipment for vehicular use		
<b>Environment classification:</b>	Automotive environment		
<b>Supply voltage</b> :	DC 24V		
<b>Ports</b> :	<b>Description</b>	<b>Direction</b>	<b>Length</b>
(maximum cable lengths declared by manufacturer)	DC power port	Input	> 3m
	Signal/control port CAN	In / output	> 3m
	Telecommunication port ETHERNET	In / output	> 3m
<b>Is mounting position / usual operating position defined?</b>	No		
<b>Additional information:</b>	<ul style="list-style-type: none"> <li>- The built in radio parts are already tested and not part of this test report.</li> <li>- This is a class B digital device.</li> <li>- The instructions furnished the user shall include a statement according to §15.105 of the used FCC rules.</li> </ul>		

### 6.2 EUT: Type, S/N etc. and Short Descriptions Used in this Test Report

short description*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	Telematic Unit	MCG TQ377	1850-0048	H1164-0101-001	368

\*) EUT short description is used to simplify the identification of the EUT in this test report.

### 6.3 Auxiliary Equipment (AE): Type, S/N etc. and Short Descriptions

AE description*)	Auxiliary equipment	Type	S/N serial number	HW hardware status	SW software status
AE A	Notebook	Dell Latitude E5520 P15F001	36974941957	- / -	Microsoft Windows 7 pro

\*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.

### 6.4 EUT Set-up(s)

EUT set-up no.*)	Combination of EUT and AE	Remarks
set. 1	EUT-A + AE A	---

\*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

### 6.5 EUT Operating Modes

EUT operating mode no.*)	Description of operating modes	Additional information
op. 1	data traffic on ETH and CAN	Radio modules idle

\*) EUT operating mode no. is used to simplify the test report.

## 7 Summary of Test Results

No deviations from the technical specifications were ascertained  
 There were deviations from the technical specifications ascertained

### 7.1 Emission

#### 7.1.1 Enclosure

EMI Phenomenon	Frequency range	Basic standard	Result
Radiated Interference Field Strength	30 - 1000 MHz	FCC Part 15 Class B	passed
Radiated Interference Field Strength	> 1 GHz	FCC Part 15 Class B	passed

#### 7.1.2 AC Mains Power Input/Output Ports

EMI Phenomenon	Frequency range	Basic standard	Result
Conducted interference voltage	0,15– 30 MHz	FCC Part 15 Class B	NA7

#### Remarks:

NA1	Not tested because not required by used standard
NA2	Test not applicable because port does not exists
NA3	Test not applicable because port only for services
NA4	Test not applicable because port lengths not longer than 3m
NA5	Not tested because not required by customer
NA6	Not tested because used frequency < 108 MHz
NA7	Not tested because the device is for vehicular use

## 7.2 Measurement and Test Set-up

Note: The test configuration is in accordance with the requirements given in the standards in point 3

## 7.3 Measurement uncertainty

The uncertainty of the measurement equipment fulfils CISPR 16 and the related European and national standards.

The semi anechoic chamber fulfils the requirements of CISPR 16-1 (ANSI C63.4) for a test volume of 4m Ø.

The table below shows the measurement uncertainties for each measurement method. The expended uncertainty (k=2 or 95%) was calculated with worst case values.

Measurement Method	Frequency area Impulse duration time	Description	Expanded uncertainty (k=2 or 95%)
<b>Radiated Emission</b> <b>FCC part 15 B, ANSI C63.4</b>	30 MHz – 18 GHz	- / -	± 4.28 dB
<b>Conducted Emission</b> <b>FCC part 15 B, ANSI C63.4</b>	9 kHz – 30 MHz	- / -	± 3.49 dB

## 8 Detailed test results - Emission

### 8.1 Electromagnetic Radiated Emissions (Distance 10 m)

#### 8.1.1 Instrumentation for Test (see equipment list)

F 1	F 2	F 4b	F 5	F 6	F 7	F 8	F 28				
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#### 8.1.2 Test Plan

EUT set-up	set 1		
Operating mode	Application	Limit	Result
op 1	Enclosure	FCC part 15 B Class B	passed

**Remarks:** Powered by external power supply DC 24V

#### 8.1.3 Radiated Limits

Frequency- range	FCC part 15 B Class B	FCC part 15 B Class A
30 MHz – 88 MHz	30 dB $\mu$ V/m	39,1 dB $\mu$ V/m
88 MHz – 216 MHz	33,5 dB $\mu$ V/m	43,5 dB $\mu$ V/m
216 MHz – 960 MHz	36 dB $\mu$ V/m	46,4 dB $\mu$ V/m
above 960 MHz	44 dB $\mu$ V/m	49,5 dB $\mu$ V/m
	* This values are recalculated from the class B limits at 3 m antenna distance in §15.109 (g 2) of the FCC rules	.

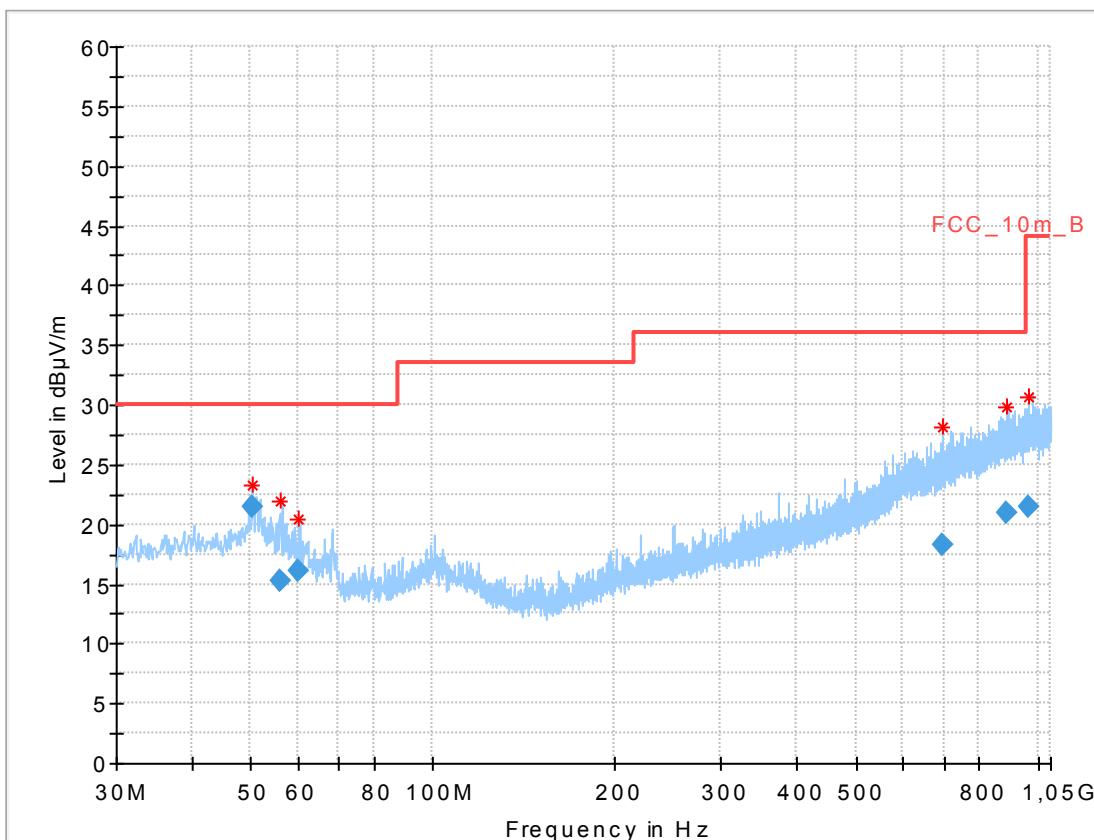
#### 8.1.4 Calibration Information

Device	Serial number	Internal Number	Calibration valid until	Calibration interval
ESCI 3 Receiver	100083/003	300003312	12/2019	12 month
Trilog Antenna	9163-371	300003854	11/2019	24 month
Remarks:				System check of all relevant devices and the chamber (weekly)

## 8.1.5 Test Results

### Common Information

EUT: TQ377  
 Serial number: 1850-0048  
 Test description: FCC part 15 class B @10m  
 Operating condition: data traffic on ETH and CAN, Radio modules switched off  
 Operator name: Kraus  
 Comment: 24V DC powered



### Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
50.434	21.41	30.0	8.59	1000	120	100.0	V	180.0
55.963	15.25	30.0	14.75	1000	120	200.0	V	296.0
60.206	16.12	30.0	13.88	1000	120	203.0	V	160.0
694.657	18.33	36.0	17.67	1000	120	203.0	V	250.0
891.147	20.95	36.0	15.05	1000	120	400.0	H	315.0
967.442	21.40	44.0	22.60	1000	120	400.0	H	308.0

## 8.1.6 Hardware Set-up

### Subrange 1

#### Frequency Range:

30 MHz - 2 GHz

#### Receiver:

Receiver [ESCI 3]  
@ GPIB0 (ADR 20), SN 100083/003, FW 4.42

#### Signal Path:

without Notch

FW 1.0

#### Antenna:

VULB 9163  
SN 9163-295, FW ---  
Correction Table (vertical): VULP6113  
Correction Table (horizontal): VULP6113  
Correction Table (vertical): Cable\_EN\_1GHz (1005)  
Correction Table (horizontal): Cable\_EN\_1GHz (1005)

#### Antenna Tower:

Tower [EMCO 2090 Antenna Tower]  
@ GPIB0 (ADR 8), FW REV 3.12

#### Turntable:

Turntable [EMCO Turntable]  
@ GPIB0 (ADR 9), FW REV 3.12

#### Software version

EMC32 V10.40.10

## 8.1.7 Sequence of testing

### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a nonconducting table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

### Premereasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position  $\pm 45^\circ$  and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 8.1.8 Signal strength calculation

Calculation formula:

$$SS = U_R + CL + AF$$

List of abbreviations:

SS	►	signal strength
$U_R$	►	voltage at the receiver
CL	►	loss of the cable
AF	►	antenna factor

List with correction factors:

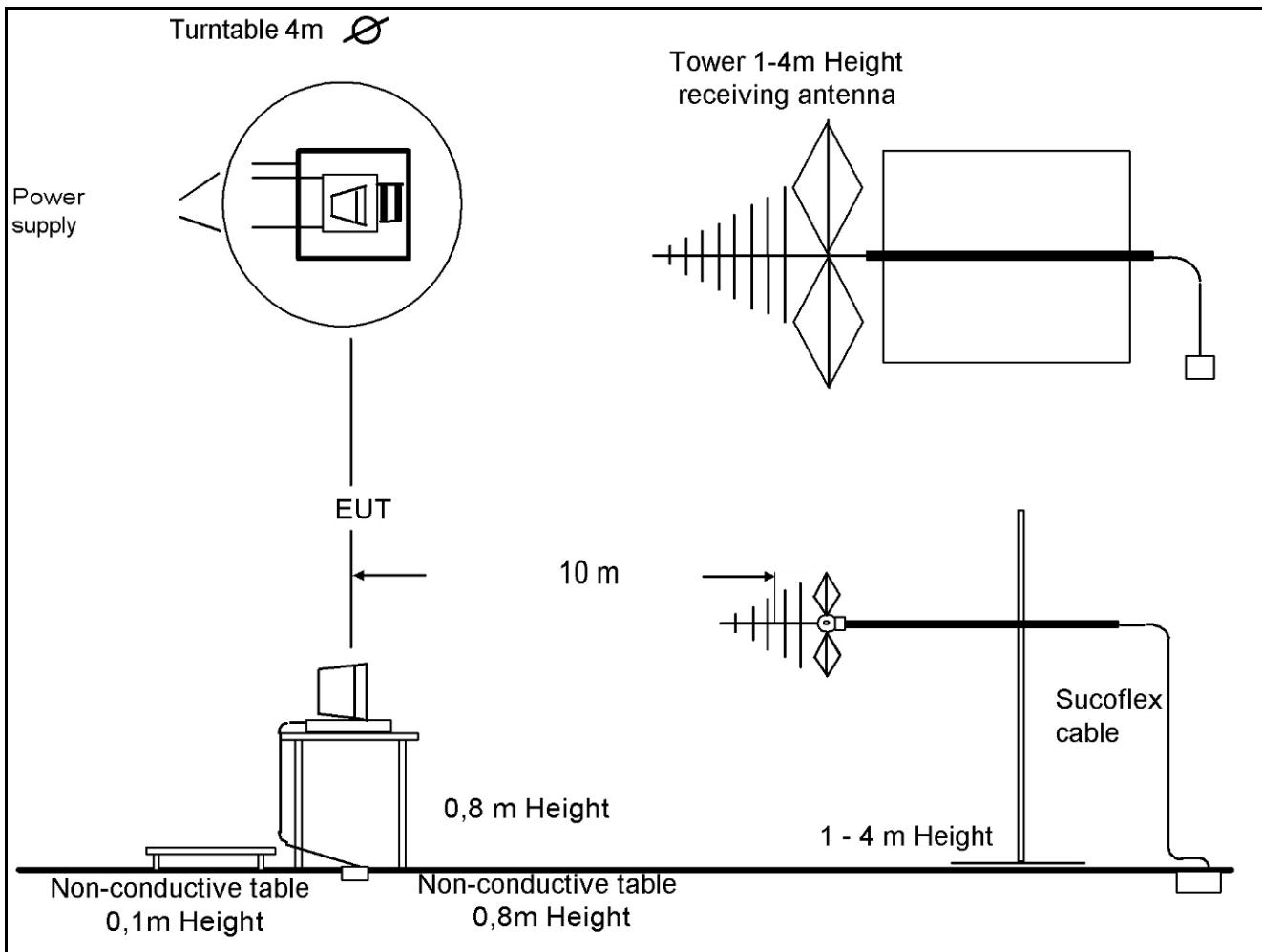
Frequency [MHz]	CL [dB]	AF [1/m]
30,000	0,20	12,30
100,000	0,60	11,30
200,000	1,10	10,60
300,000	1,30	13,20
400,000	1,60	15,30
500,000	1,90	16,80
600,000	2,00	18,80
700,000	2,20	20,30
800,000	2,30	21,50
900,000	2,40	22,80
1000,000	2,50	23,30

Example calculation:

For example at 500,000 000 MHz the measured Voltage ( $U_R$ ) is 12,35 dB $\mu$ V, the loss of the cable (CL) is 1,90 dB and the antenna factor (AF) is 16,80 dB (m $^{-1}$ ) the final result will be calculated:

$$SS \text{ [dB}\mu\text{V/m]} = 12,35 \text{ [dB}\mu\text{V]} + 1,90 \text{ [dB]} + 16,80 \text{ [dB (m}^{-1}\text{)]} = 31,05 \text{ [dB}\mu\text{V/m]} (35,69 \mu\text{V/m})$$

### 8.1.9 Test Set-up



## 8.2 Electromagnetic Radiated Emissions (Distance 5 m)

### 8.2.1 Instrumentation for Test (see equipment list)

F 1	F 6	F 28	F 29	F 30	F 33						
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### 8.2.2 Test Plan

<b>EUT set-up</b>	set 1		
<b>Operating mode</b>	<b>Application</b>	<b>Limit</b>	<b>Result</b>
op 1	Enclosure	FCC part 15 class B	passed

<b>Remarks:</b>	The measured values are recalculated from 5m to 3m distance Powered by external power supply DC 24V
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### 8.2.3 Radiated Limits

Frequency- range above 1GHz	47CFR15: (FCC part 15 B) Class B	47CFR15: (FCC part 15 B) Class A *
	54 dB $\mu$ V/m	59,5 dB $\mu$ V/m
	* This values are recalculated from the class A limits at 10 m antenna distance in §15.109 (g 2) of the FCC rules.	

### 8.2.4 Calibration Information

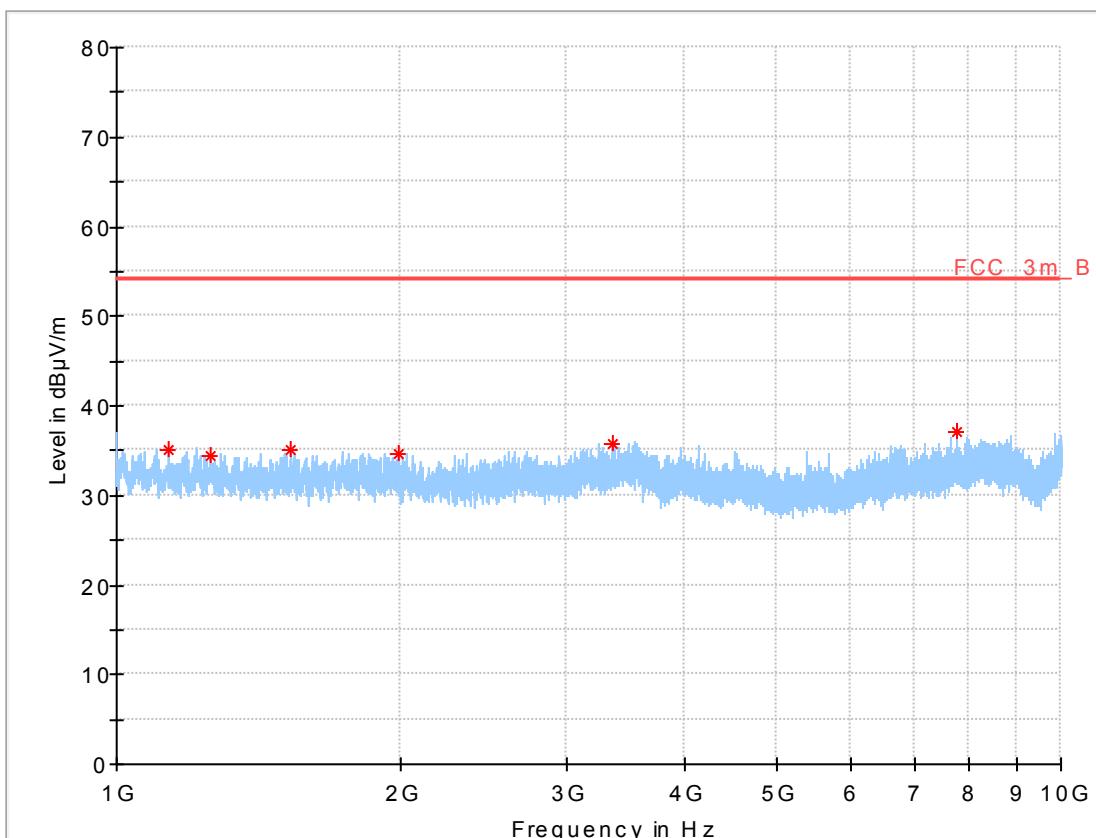
Device	Serial number	Internal Number	Calibration valid until	Calibration interval
FSU 26	200809	300003874	12/2019	12 month
Horn Antenna	9120B188	300003896	04/2020	24 month

Remarks:  
System check of all relevant devices and the chamber (weekly)

## 8.2.5 Test Results

### Common Information

EUT: TQ377  
 Serial number: 1850-0048  
 Test description: FCC part 15 class B  
 Operating condition: data traffic on ETH and CAN, Radio modules switched off  
 Operator name: Kraus  
 Comment: 24V DC powered



### Critical\_Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1135.900	35.02	54.0	18.98	---	---	100.0	V	267.0	-5
1255.600	34.51	54.0	19.49	---	---	100.0	H	105.0	-5
1532.350	35.11	54.0	18.89	---	---	100.0	H	136.0	-5
1988.650	34.67	54.0	19.33	---	---	100.0	V	133.0	-4
3356.650	35.78	54.0	18.22	---	---	100.0	H	248.0	-2
7761.700	37.04	54.0	16.96	---	---	100.0	V	137.0	4

## 8.2.6 Hardware Set-up

Subrange 1

Frequency Range: 1 GHz - 10 GHz

Receiver: FSU 26 [FSU 26]

@ GPIB0 (ADR 17), SN 200809/026, FW 4.71

Signal Path: 1\_6\_EN

FW 1.0

Correction Table: 3\_5m

Correction Table: LNA\_EN (matix)

Antenna: BBHA 9120 B

Correction Table (vertical): BBHA9120

Correction Table (horizontal): BBHA9120

Correction Table (vertical): Cable\_Horn\_EN (1103)

Correction Table (horizontal): Cable\_Horn\_EN (1103)

Antenna Tower: Manual [--]

Turntable: Turntable [EMCO Turntable]

@ GPIB0 (ADR 9), FW REV 3.12

Software version: EMC32 V10.40.10

## 8.2.7 Sequence of testing

### Setup

- The Equipment was setup to simulate a typical usage like described in the user manual / or described by manufacturer.
- If the EUT is a tabletop system, a nonconducting table with 0,8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is: (see ANSI C 63.4)  
< 18 GHz = 3 m  
18-26 GHz = 1,5 m  
26-40 GHz = 0,75 m
- The EUT was set into operation.

### Premasurement

- The turntable rotates continuous from 0° to 360°
- The antenna is polarized vertical and horizontal.
- In accordance to the antenna beam and the size of the EUT the antenna height changes in 30 cm steps, start at 1 meter. If it is not possible to tilt the emissions will be checked with a manually tilted antenna from top side.
- The analyzer scans quickly to find the maximum emissions of the EUT

### Final measurement

- The final measurement will be performed with minimum the six highest peaks (depends on emissions and number of measured points below 1 GHz)
- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position ( $\pm 45^\circ$ ) and antenna movement between 1 and 4 meter.
- The final measurement will be done with AV (Average / see ANSI C 63.4) detector
- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit, and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

## 8.2.8 Signal strength calculation

### Calculation formula:

$$SS = U_R + CL + AF + PA + DC$$

### List of abbreviations:

SS	►	signal strength
U <sub>R</sub>	►	voltage at the receiver
CL	►	loss of the cable and gain of the preamp
AF	►	antenna factor
DC	►	distance correction (results measured on 5 m calculated to 3 m)

*List with correction factors: column CL in table contains cable factor and preamplifier correction*

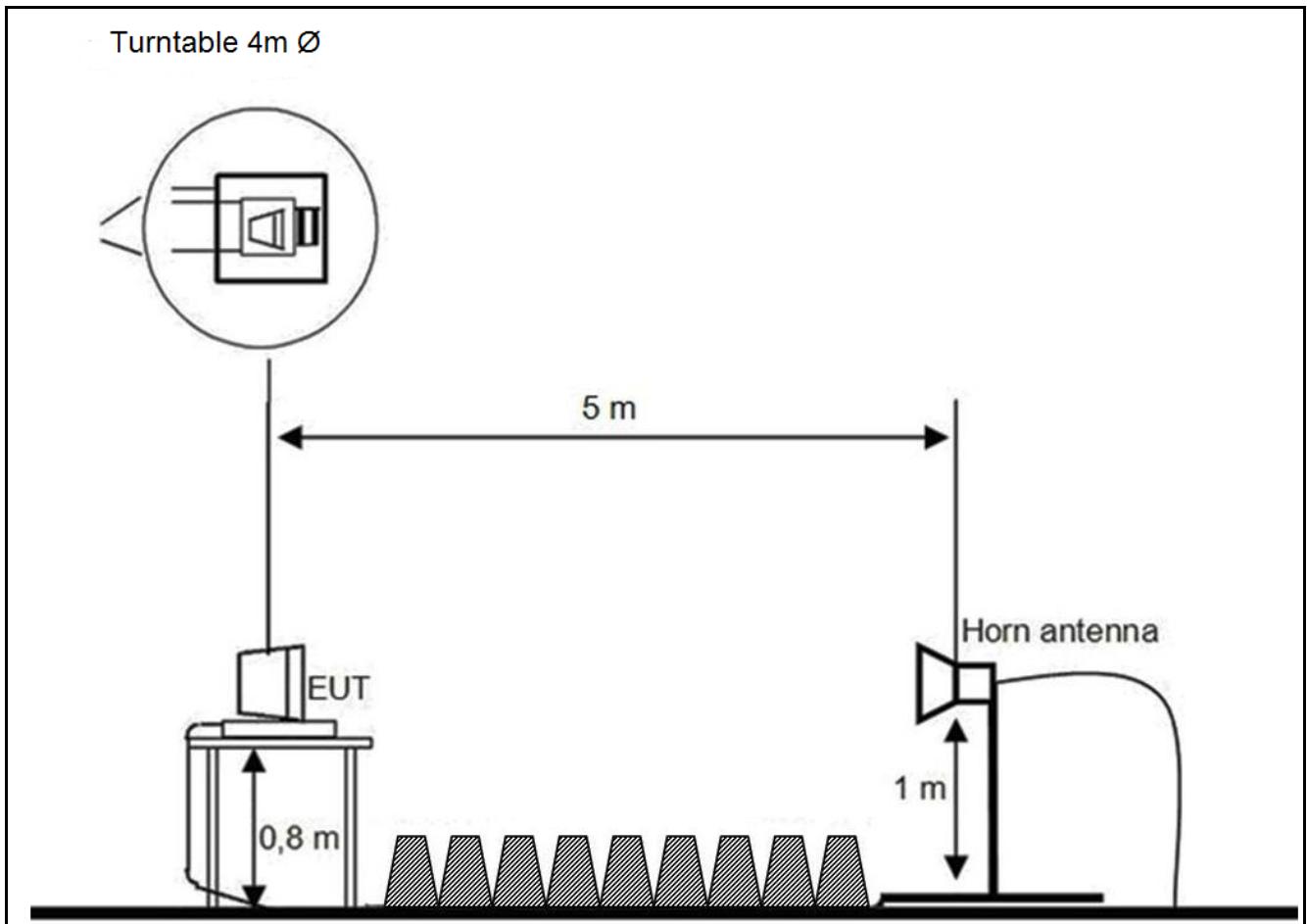
Frequency [GHz]	CL [dB]	AF [dB1/m]	DC [dB]
1,000	-35,50	26,20	4,40
1,500	-35,20	26,10	4,40
2,000	-35,10	26,70	4,40
2,500	-35,00	26,50	4,40
3,000	-34,70	27,60	4,40
3,500	-34,80	28,40	4,40
4,000	-35,00	28,60	4,40
4,500	-34,90	28,90	4,40
5,000	-34,80	29,30	4,40
5,500	-34,35	29,80	4,40
6,000	-34,00	30,30	4,40
6,500	-33,50	31,20	4,40
7,000	-33,10	31,20	4,40
7,500	-33,40	31,70	4,40
8,000	-33,80	32,10	4,40
8,500	-33,75	32,30	4,40
9,000	-33,70	31,70	4,40
9,500	-33,50	29,40	4,40
10,000	-33,40	33,00	4,40

### Example calculation:

For example at 4,000 000 000 GHz the measured Voltage (U<sub>R</sub>) is 46,13 dB<sub>µ</sub>V, the loss of the cable (CL) is -35,00 dB, the antenna factor (AF) is 28,60 dB(m<sup>-1</sup>) and the distance correction (DC) is 4,40 dB the final result will be calculated:

$$SS \text{ [dB} \mu\text{V/m]} = 46,13 \text{ [dB} \mu\text{V]} + (-35,00) \text{ [dB]} + 28,60 \text{ [dB} (\text{m}^{-1})] + 4,4 \text{ [dB]} = 44,13 \text{ [dB} \mu\text{V/m]} (160,88 \mu\text{V/m})$$

### 8.2.9 Test Set-up



## 9 Test equipment and ancillaries used for tests

To simplify the identification of the test equipment and/or ancillaries which were used, the reporting of the relevant test cases only refer to the test item number as specified in the table below.

No.	Instrument/Ancillary	Manufacturer	Type	Serial-No.	Internal identification
<b>Radiated emission in chamber F</b>					
F-1	Control Computer	F+W		2934939v001	300005258
F-2	Trilog-Antenna	Schwarzbeck	VULB 9163	9163-371	300003854
F-3a	Amplifier	Veritech Microwave Inc.	0518C-138	- / -	- / -
F-4b	Switch	Netgear	GS108P	26V12A3H50336	300000368
F-5	EMI Test receiver	R&S	ESCI	100083	300003312
F-6	Turntable Interface- Box	EMCO / ETS- LINDGREN	Model 105637	44583	300003747
F-7	Tower/Turntable Controller	EMCO / ETS- LINDGREN	Model 2090	64672	300003746
F-8	Tower	EMCO / ETS- LINDGREN	Model 2175	64762	300003745
F-9	Ultra Notch-Filter Rejected band Ch. 62	WRCD		9	
<b>Radiated immunity in chamber F</b>					
F-10	Control Computer	F+W		FW0502032	300003303
F-11	Signal Generator	R&S	SMB 100A	1406.6000K02- 113856	300005266
F-13	RF-Amplifier	Bonn	BLWA 0860- 250/100D	035491	300003210
F-14	Stacked Logper Antenna	Schwarzbeck	STLP9128 E	9128 E 013	300003408
F-14a	Bicon-Antenna	EMCO	3109	8906-2309	300000575
F-14b	Bicon-Antenna	Schwarzbeck	Balun VHBD 9134 elements BBFA 9146	3011 0057	300005385
F-15	RF-Amplifier	ar	1000LM20	20562	-/-
F-16	Directional Coupler	ar	DC7144A	312786	300003411
F-16a	Directional coupler	emv	DC 2000	9401-1677	300000592
F-18	Power Meter	R&S	NRP2	104973	300005114
F-19	Power sensor	R&S	NRP-Z91	103332	300005114-1
F-20	Power sensor	R&S	NRP-Z91	103333	300005114-2
F-35	RF- Amplifier	Bonn	BLMA 2060-5	097392A	300003908
F-36	Stacked Microwave Log.-Per. Antenna	Schwarzbeck	STLP9149	9149-044	300003919
<b>Harmonics and flicker in front of chamber F</b>					
F-21	Flicker and Harmonics Test System	Spitzenberger & Spies	PHE4500/B I PHE4500/B II	B5983 B5984	300003314
F-28	Power Supply	Hewlett Packard	6032 A	2920 A 04466	300000580
<b>Radiated emission in chamber F &gt; 1GHz</b>					
F-29	Horn antenna	Schwarzbeck	BBHA 9120 B	188	300003896
F-30	Amplifier	ProNova	0518C-138	005	F 024
F-31	Amplifier	Miteq	42-00502650-28-5A	1103782	300003379
F-32	Horn antenna	Emco	3115	9709-5289	300000213
F-33	Spectrum Analyzer	R&S	FSU26	200809	300003874
F-34	Loop antenna	EMCO	6502	8905-2342	300000256

## 10 Observations

No observations, exceeding those reported with the single test cases, have been made.

## Annex A Photographs of the test set-up

Photo 1: Radiated Emission 30MHz - 1GHz

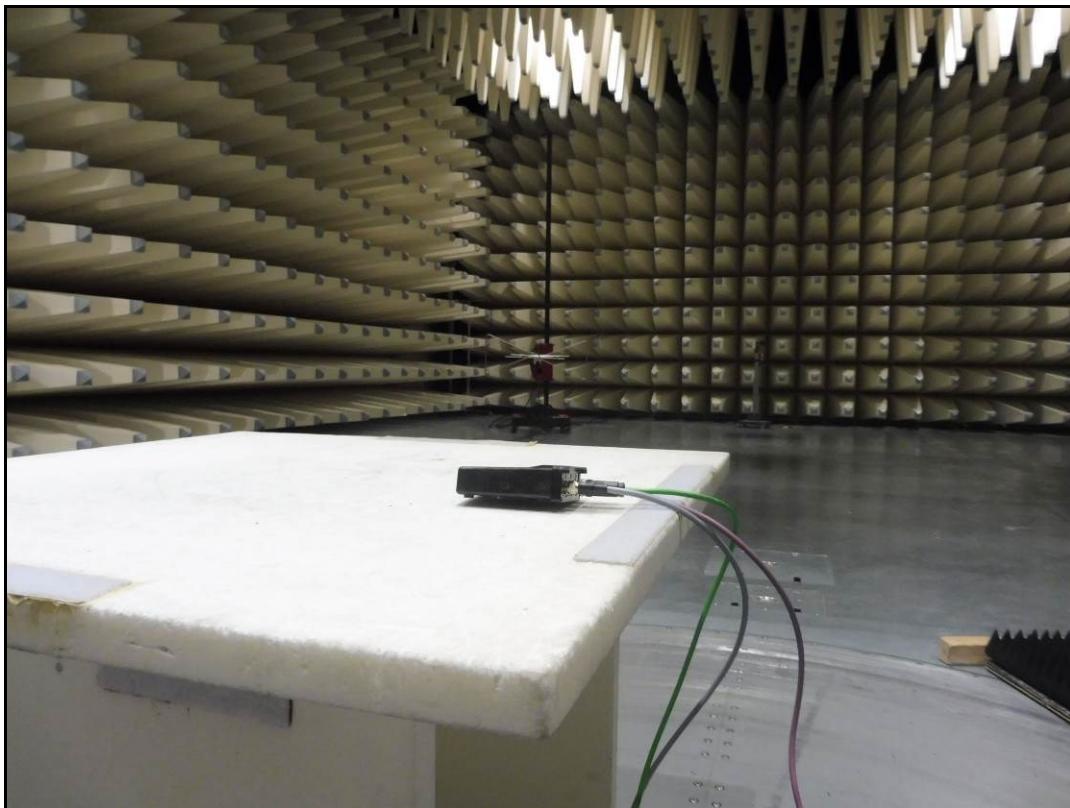
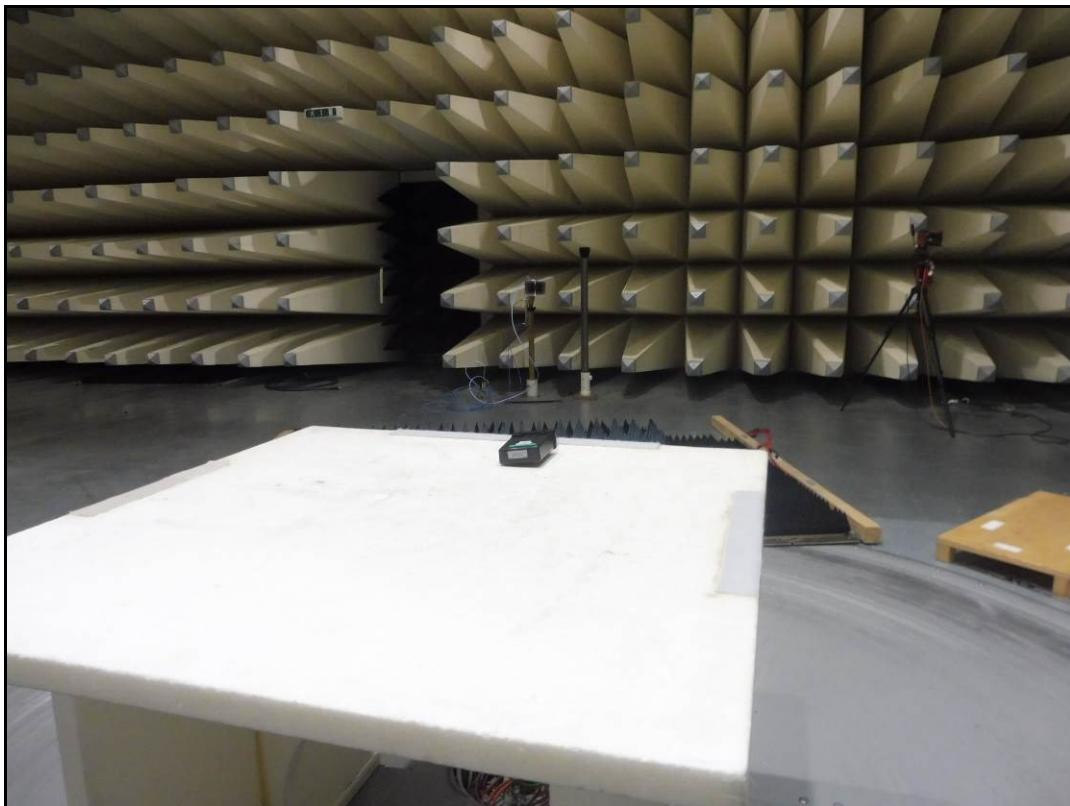


Photo 2: Radiated Emission 1GHz - 10GHz



## Annex B Photographs of the EUT

Photo 3: EUT-A



Photo 4: EUT-A

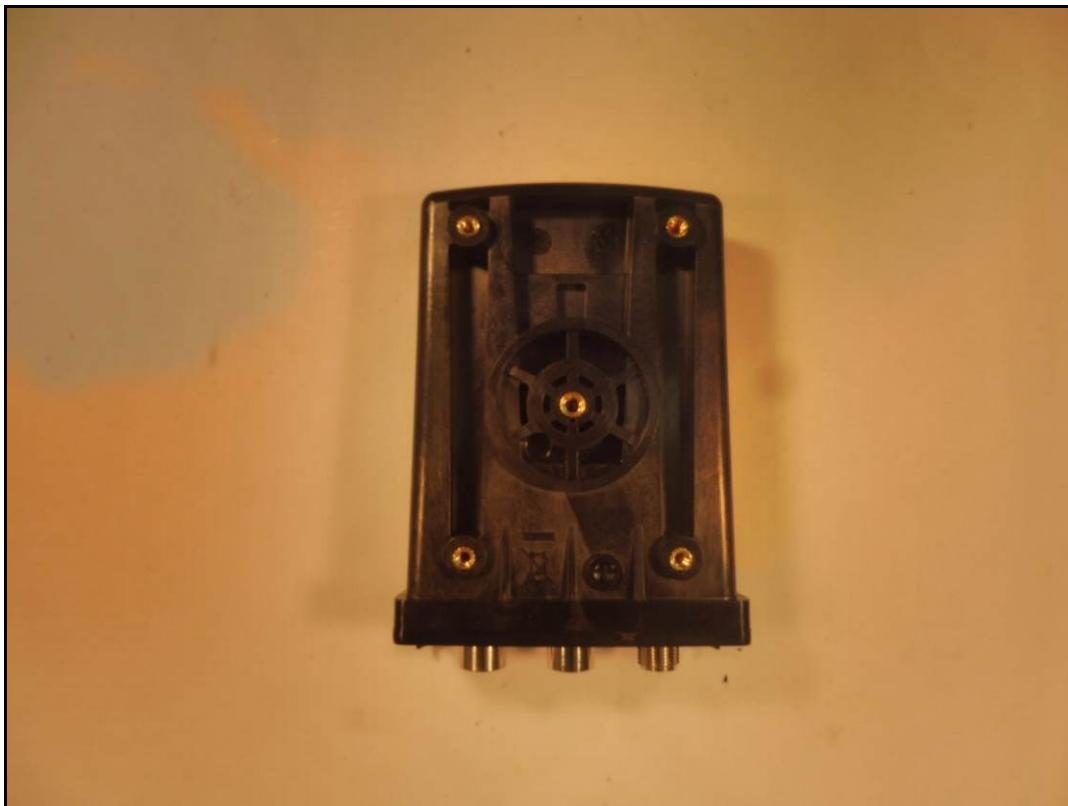


Photo 5: EUT-A



Photo 6: EUT-A



Photo 7: EUT-internal

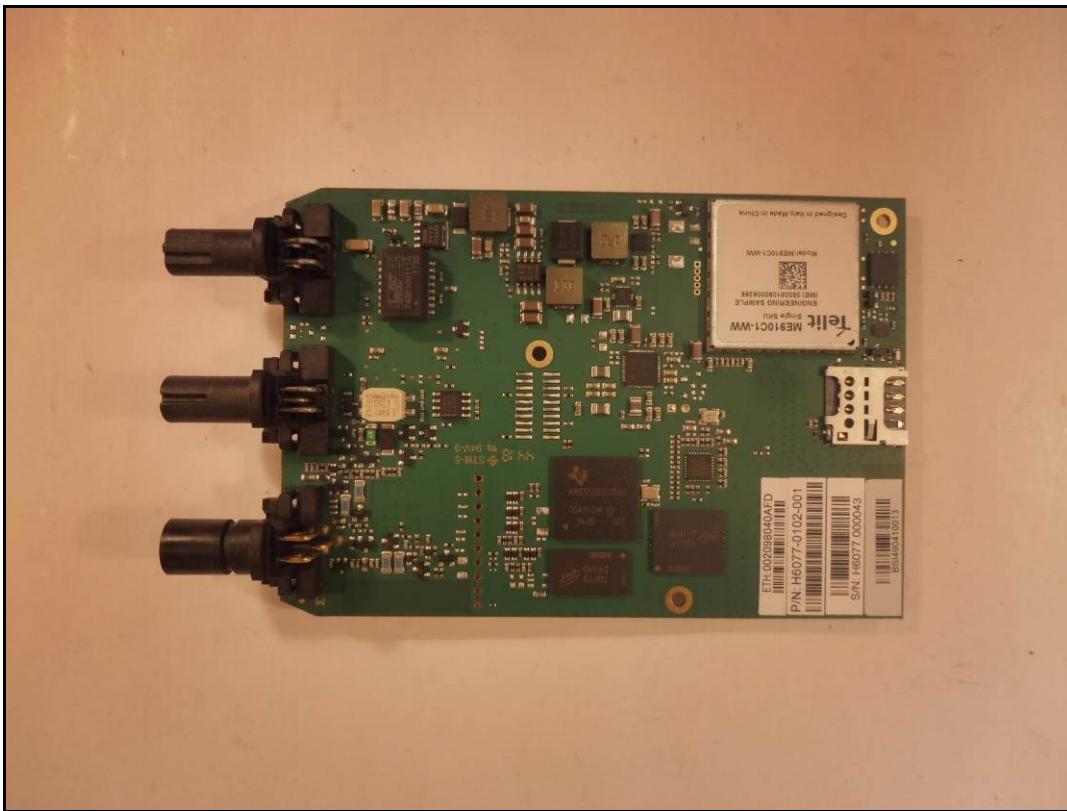


Photo 8: EUT-internal

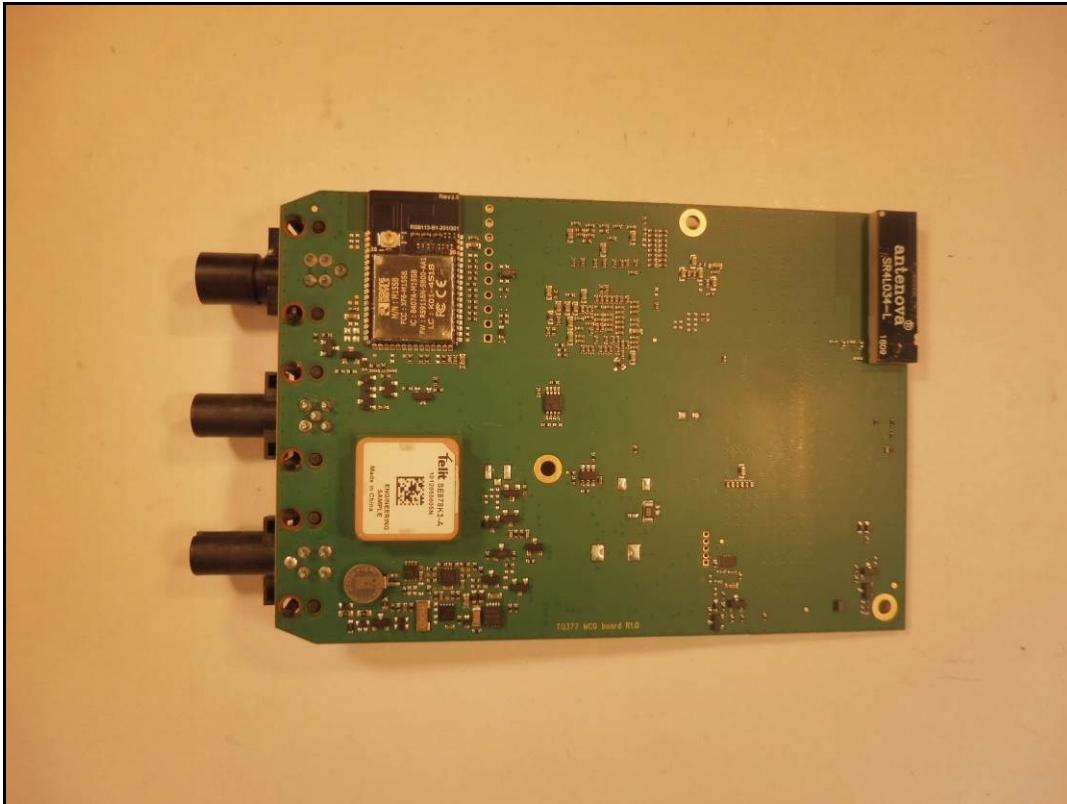


Photo 9: EUT-internal

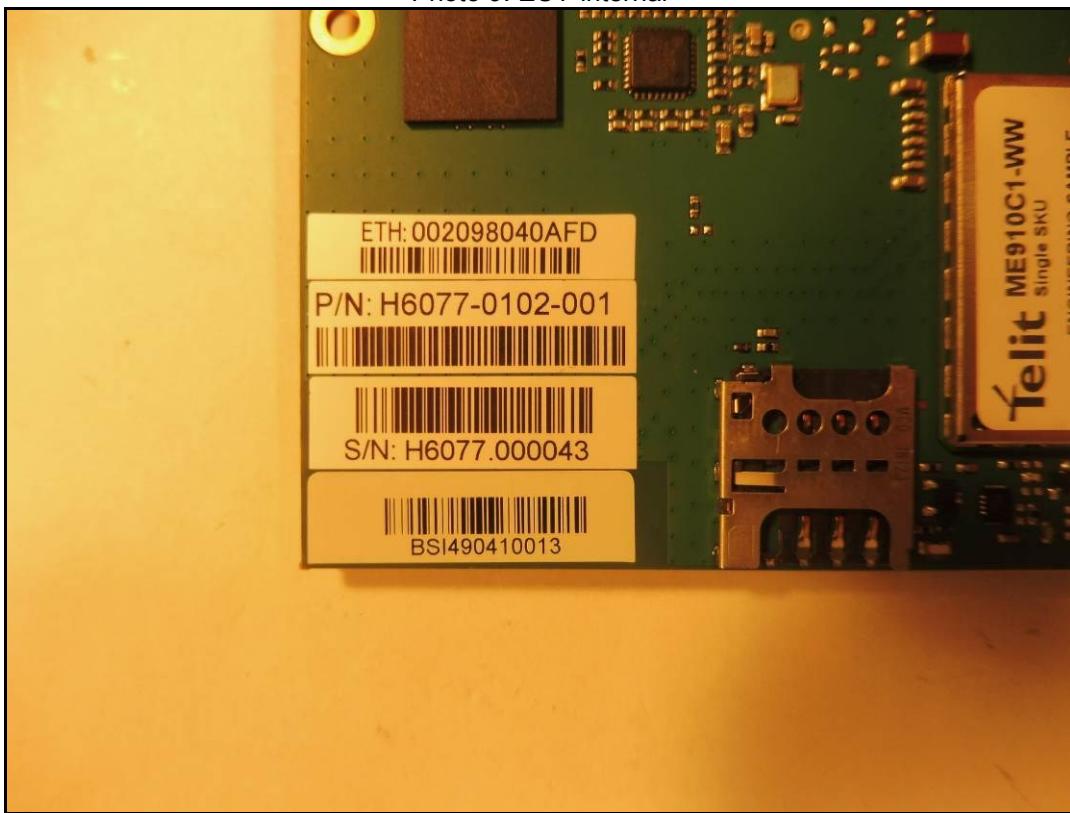


Photo 10: EUT-internal



Photo 11: EUT-internal



Photo 12: EUT-internal



Photo 13: EUT-internal

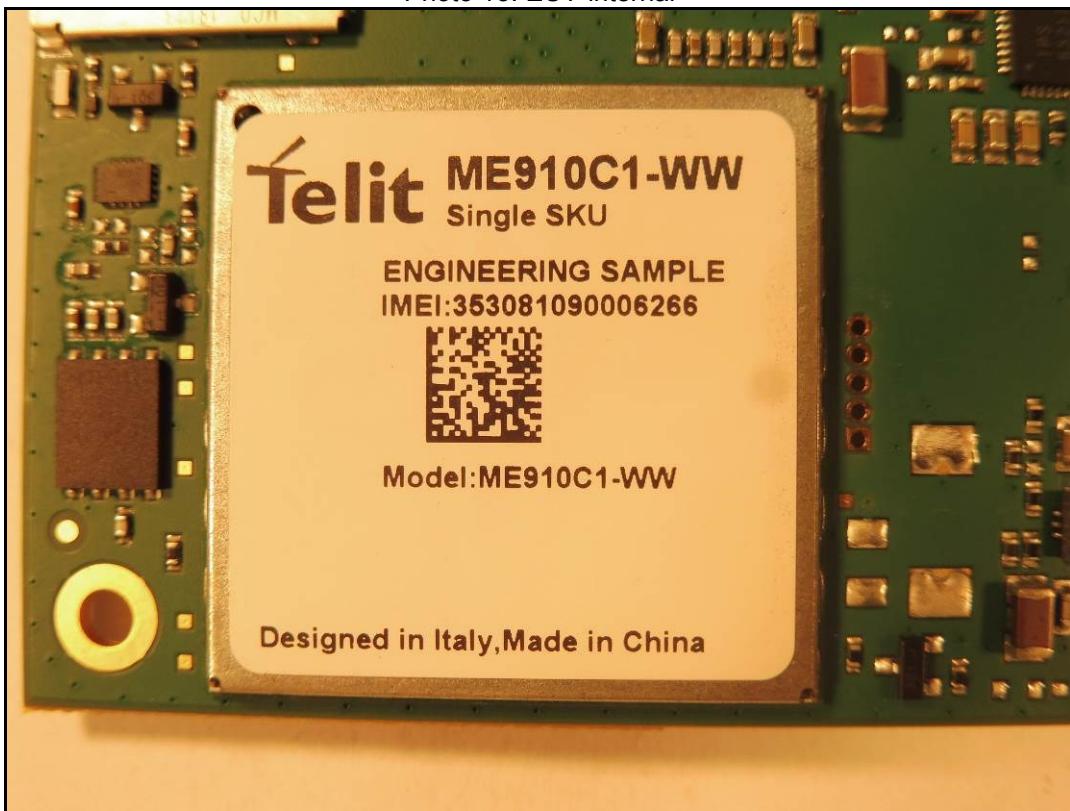
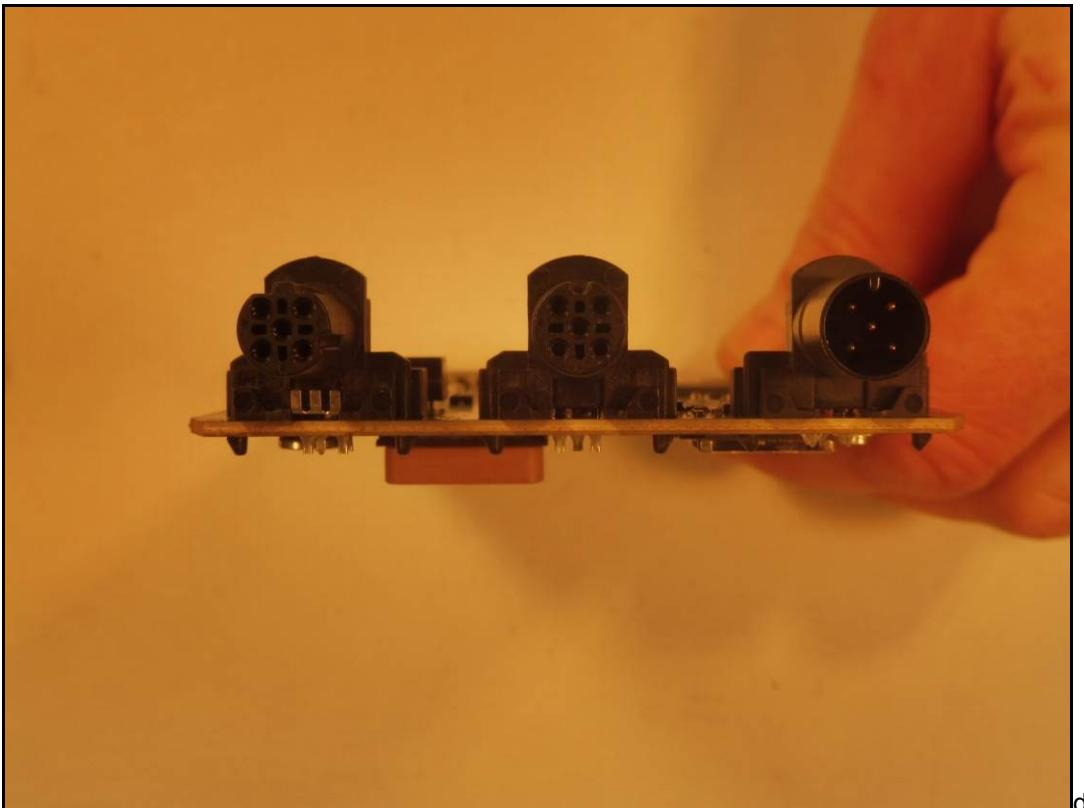


Photo 14: EUT-internal



**Annex C Document history**

<b>Version</b>	<b>Applied changes</b>	<b>Date of release</b>
-/-	Initial release	2019-03-20
_A	FCC ID on cover page added, editorial changes	2019-05-22

**Annex D Further information****Glossary**

DUT	-	Device under Test
EMC	-	Electromagnetic Compatibility
EUT	-	Equipment under Test
FCC	-	Federal Communication Commission
FCC ID	-	Company Identifier at FCC
HW	-	Hardware
IC	-	Industry Canada
Inv. No.	-	Inventory number
N/A	-	not applicable
S/N	-	Serial Number
SW	-	Software