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Idvorsky Laboratories

RADIO SPECTRUM TEST REPORT #	**1378-3-2**
Date of issue	13.10.2023.
Date of testing	06.04.2023.
Job #	1378
Customer	**Workaround GmbH** Building 64.08a, Rupert-Mayer-Straße 44, 81379 München, **Germany**
Manufacturer	**Workaround GmbH** Building 64.08a, Rupert-Mayer-Straße 44, 81379 München, **Germany**
Product/EUT	BLE barcode scanner (brand name **ProGlove**)
Model	**MARK Display**
Serial No.	MDMR C 28 014311
VERDICT (based solely on tests listed in Clause 1)	**PASS**
Remarks: FCC ID: 2AOJL-MARK-Display	

Tested by:
LAB engineer Andrijana Lazić

Verified by:
LAB engineer Andrijana Lazić

Idvorski laboratorije Beograd-Zvezdara

Approved by:
Technical Manager Saša Jorgovanović

Disclaimer:
This testing and results apply only for tested sample of the product (EUT). Laboratory is not responsible for the data submitted by the customer. Laboratory accepts no responsibility either misuses or wrong interpretations and decisions based on this report.

1. TEST SUMMARY

EUT is tested in the laboratory.

The purpose of the measurement is to find the peak antenna gain used by the EUT.

STANDARD	TEST METHOD	MODE OF OPERATION	LIMITS	VERDICT
/	**Peak antenna gain measurement**	Normal modulation (continuous transmission)	**< 0 dBi**	**PASS** **(-1.78 dBi)**

2. CONTENTS

3. IDENTIFICATION of the EUT

3.1. Data*

EUT: BLE barcode scanner

Model: **ProGlove MARK Display**
Serial No.: MDMR C 28 014311
FCC ID: 2AOJL-MARK-Display

WIRELESS COMMUNICATION
BLUETOOTH LOW ENERGY

BLUETOOTH RADIO	Supports Bluetooth Low Energy 4.0, 4.1, 4.2, 5.0
FREQUENCY RANGE	Frequency band used BLE: 2400-2483.5 MHz
MAX RADIO-FREQU. POWER TRANSMITTED	< 20dBm
TRANSMISSION RANGE	Free field: 40 m (131 ft)** Indoor: 10-20 m (33-66 ft)** **may decrease in industrial environments (e.g. due to walls, metal shelving, machines)

BARCODE DECODING CAPABILITIES

1D	Auto decodes all standard 1D codes including GS1 DataBar linear codes et al.
2D	PDF417, MicroPDF417, Data matrix, QR Code, Micro QR Code, Aztec, MaxiCode, et al.
POSTAL	US PostNet, US Planet, UK Postal, Australia Postal, Japan Postal, Dutch Postal (KIX) et al.

DISPLAY

DISPLAY	E-PAPER DISPLAY
SIZE	1.54 inch
RESOLUTION	200 x 200 pixel resolution, 188 Dpi

ELECTRICAL PROPERTIES

BATTERY	670 mAh, Lithium polymer (rechargeable)
CHARGING TIME	2 hours with ProGlove Charging Station
OPERATING TIME / SCANS	approx. 6000 scans depending on the application and environmental conditions

MECHANICAL PROPERTIES

DIMENSIONS	50 x 45 x 18 mm (1.47 x 1.77 x 0.7 in)
WEIGHT	48 g (1.7 oz)

ENVIRONMENTAL CONDITIONS

DROP RESISTANCE	50 drops from 2 m (6.5 ft) onto concrete
TUMBLES	500 tumbles from 1 m
PROTECTION AGAINST DUST AND WATER	IP 54
TEMPERATURE	Operating Temperature: 0°C - 50°C (32°F – 122°F) Charging Temperature: 5°C - 40°C (41°F – 104°F) Storage Temperature: -20°C - 60°C (-4°F – 140°F)
HUMIDITY	5% - 95% non condensing
ELECTROSTATIC DISCHARGE (ESD)	±19kVdc air discharge ±17kVdc contact discharge

INTERFACES

ANDROID	Insight Mobile (App/SDK)
IOS	ProGlove iOS SDK
USB	ProGlove Gateway

SCANNER PROPERTIES

READING FIELD OF VIEW	horizontal: 31°, vertical 23°
SKEW, PITCH & ROLL	Skew tolerance: ±60° Pitch tolerance: ±60° Roll tolerance: 360°
AMBIENT LIGHT	0 - 96,900 lux
AIMER	650 nm, 1 mW

UTILITIES & ACCESSORIES

CONFIGURATION & DEVICE MANAGEMENT	https://insight.proglove.com
DIGITAL DOCUMENTATION	https://docs.proglove.com
ANDROID INTEGRATION	Insight Mobile: Provides a full featured integration for Android enterprise applications.
GATEWAY INTEGRATION	ProGlove Gateway: Hardware connector to enable the full capabilities of the ProGlove Ecosystem via USB-Interface.
TRIGGER	Scanner can be triggered only with ProGlove wearables (REEL, Index-Trigger et al.)

SCAN RANGES
Minimum distance determined by symbol length, scan-angle and environmental conditions

MID RANGE

5 mil (0.127 mm) code 128	7.4 in./18.8 cm to 16.0 in./40.6 cm
5 mil (0.127 mm) PDF417	8.1 in./20.6 cm to 13.1 in./33.3 cm
10 mil (0.254 mm) DataMatrix Example: A 10 mil DataMatrix symbol, which can carry 25 alphanumeric characters, has a size of 4.57 mm * 4.57 mm	7.0 in./17.8 cm to 17.0 in./43.2 cm
100% UPCA	2.3 in./5.8 cm to 38.0 in./96.5 cm
20 mil (0.508 mm) code 39	2.1 in./5.3 cm to 54.0 in./137.2 cm
100 mil (2.54 mm) code 39	11.0 in./ 27.9 cm to 172.0 in./ 436.9 cm

WARRANTY & SLA

WARRANTY	12 months factory warranty
PROGLOVE CARE	36 and 60 months maintenance contracts available. For more information please contact your ProGlove representative or visit https://proglove.com

SAFETY & REGULATORY

RADIO AND ELECTROMAGNETIC COMPATIBILITY	EU: 2014/53/EU Radio Equipment Directive (RED) FCC ID: 2AOJL-MARK-2 IC: 23450-MARK2
ELECTRICAL SAFETY	EU: acc. to 2014/53/EU Radio Equipment Directive (RED) EN 62368-1:2014 / A11: 2017 INTERNATIONAL: IEC 62368-1:2014 US: UL 62368-1, 2nd Ed, 2014-12-01 and CAN/CSA C22.2 No. 62368-1-14
LASER CLASSIFICATION	According to EN 60825-1: 2014 and IEC 60825-1 (Ed. 3.0) Laser class 2 device. Caution Laser Radiation - Do not stare into beam.
ENVIRONMENTAL	RoHS Directive 2011/65/EU; Amendment 2015/863, REACH SVHC 1907/2006, WEEE

COUNTRY CERTIFICATION

Regulatory markings are affixed to the device, indicating that the radio modules are approved for use in the following regions: European Economic Area*, Canada, United States of America, Australia, New Zealand.

Detailed information on the regulatory markings can be found in the Declaration of Conformity (DoC) at www.proglove.com

*CE is valid in the European Economic Area and additional countries: Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Iceland, Liechtenstein, Switzerland and Norway.

**Supplied by the customer*

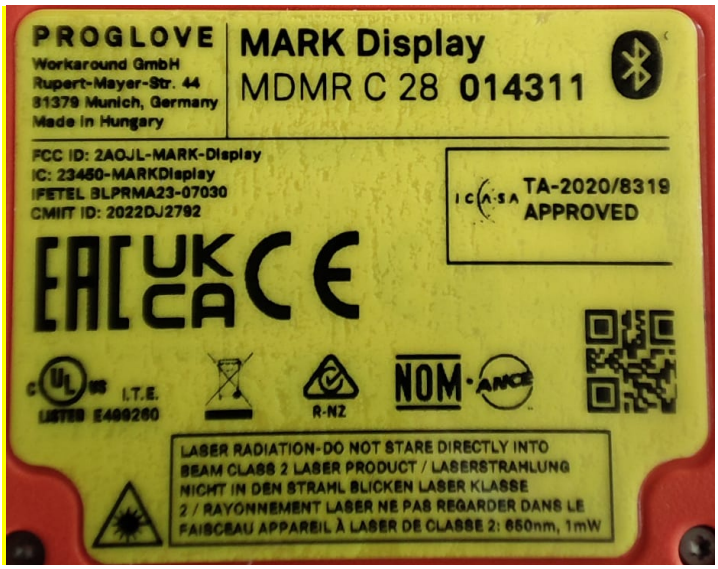
3.2. Photographs/schematics

EUT, top side

EUT, front side

EUT, rear side

EUT, lateral sides



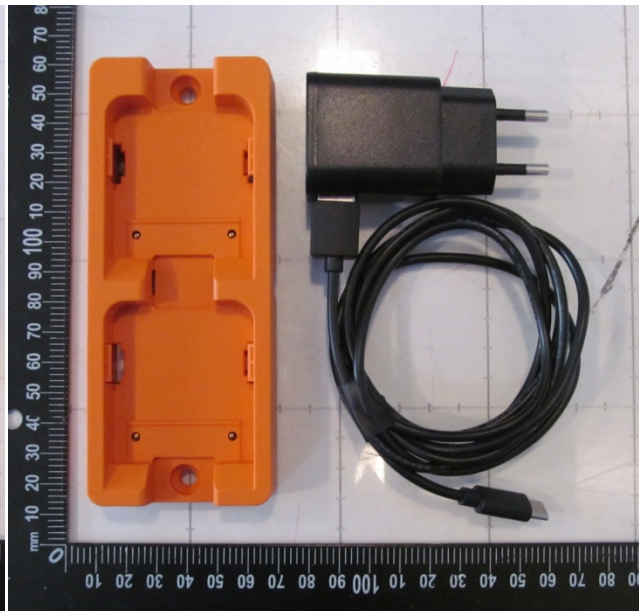
EUT, the label

Note: Design of the marking label submitted by the manufacturer (not attached on the EUT).

3.3. Auxiliary equipment

MARK	NAME / TYPE / PURPOSE	QUANTITY
PGCS 2200 19063	Charging Station + AC/DC adapter	1
/	Glove/trigger	1

Glove (trigger)



Charging Station S with the AC/DC adapter

3.4. Modes of operation

MODE OF OPERATION	DESCRIPTION
Normal modulation (continuous transmission)	The EUT is battery-powered (~3.7 V DC). The EUT is transmitting a pseudo-random bitstream (modulated) continuously at the fixed channel. Special barcodes are used to set transmission at the fixed channel with 1 Mbps data rate (see figure 1 below). The Tx output power (power delivered to the antenna port) is +7 dBm. [1]

[1]The maximum conducted RF output power is +7dBm according to the MARK Display Tune Up procedure provided by manufacturer.

Figure 1: Barcodes for setting transmission at the fixed channel

	No Modulation (TXNOMOD)		Random Mod. (TXRAND) (PRBS9)
Channel 37 (2402MHz) (index 0)			
Channel 00 (2404MHz) (index 1)			
Channel 39 (2480MHz) (index 39)			

3.5. Limits

Maximum peak antenna gain to be < 0 dBi as declared by the manufacturer.

3.6. Product related notes

Product information according to the clause 5.4.1 of the standard (declared by the customer):

Modulation	Other types of wide band modulation than FHSS
TX output power [(1)]	+7 dBm
Power spectral density	<10 dBm / MHz
The different transmit operating modes	Equipment with only one antenna
Operating frequency range(s)	2402 MHz (channel 37) to 2480 MHz (channel 39)
Occupied channel bandwidth	1 MHz
Type of equipment (stand-alone, plug-in, combined, etc.)	Stand-alone
Antenna type	Integral antenna
Antenna gain	< 0 dBi
Supply voltage	3.7 VDC
The type of power source	Battery
The equipment type (e.g. Bluetooth, IEEE 802.11, IEEE 802.15.4, etc.)	Bluetooth LE
Adaptive / non- adaptive equipment	Non-adaptive equipment
Duty cycle, Tx-Sequence, Tx-gap	Not applicable
Medium Utilization	Not applicable

[(1)]The maximum conducted RF output power is +7dBm according to the MARK Display Tune Up procedure provided by manufacturer.

This model of **MARK Display** scanner has the following changes in design comparing to its previous version according to the manufacturer's statement:

- new main PCB (the same as MARK Basic PCB)
- new enclosure materials - injection molded.

4. TESTING LOCATION AND CONDITIONS

Location: **Idvorsky Laboratories Ltd. Belgrade**
Volgina 15, 11060 Belgrade, Serbia

Conditions:

Temperature:	21.9 °C
Relative humidity:	37.4 %
Atmospheric pressure:	991 hPa

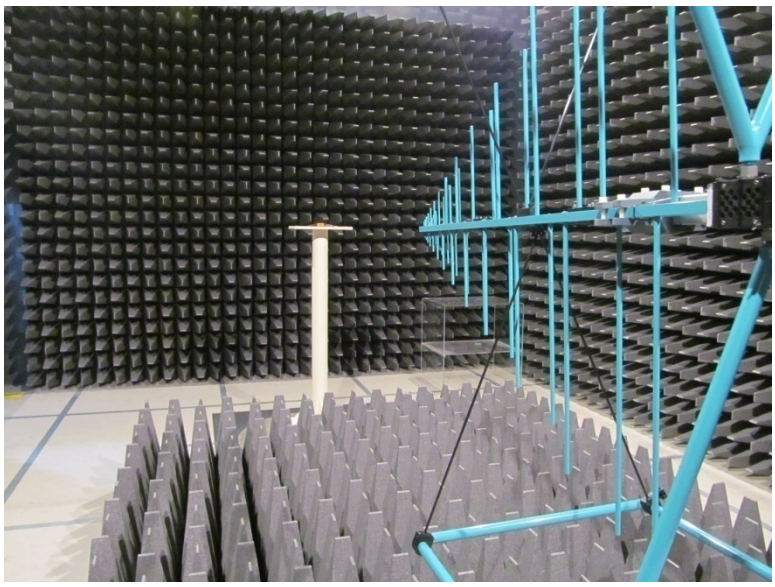
5. TEST RESULTS

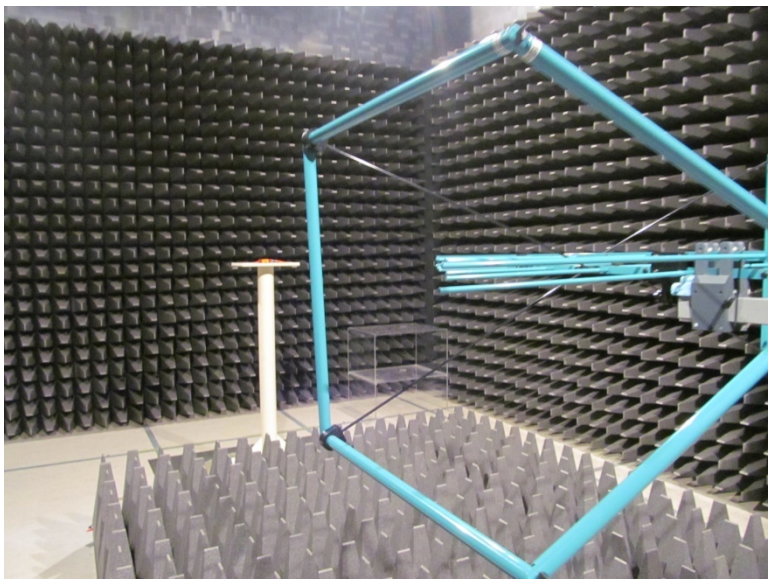
The tests are performed at the lowest, the middle and the highest operating channel frequency.

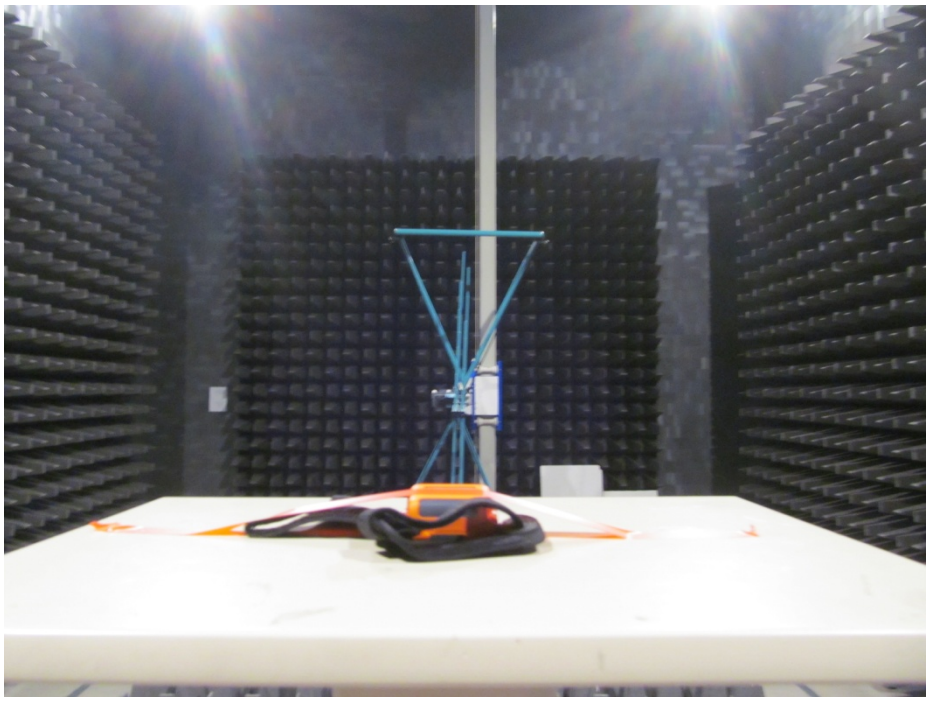
5.1. Measurement of peak antenna gain

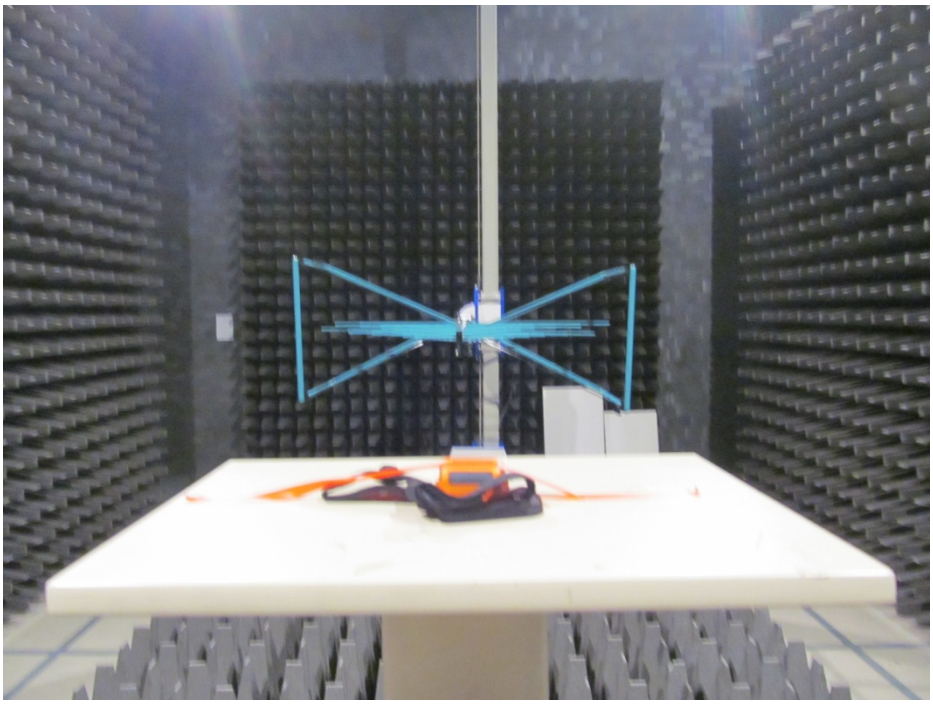
Date: 06.04.2023.
Tested under: Normal test conditions
Test conducted by: Andrijana Lazić

5.1.1. Setup







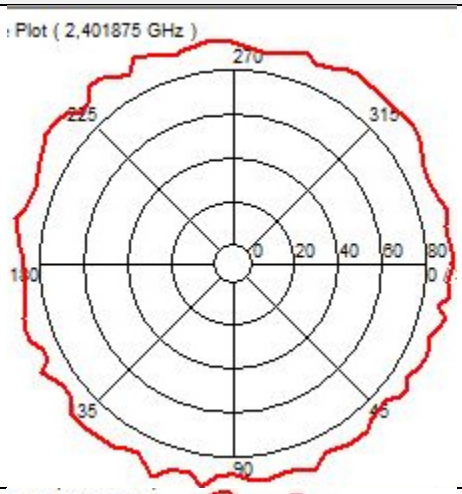
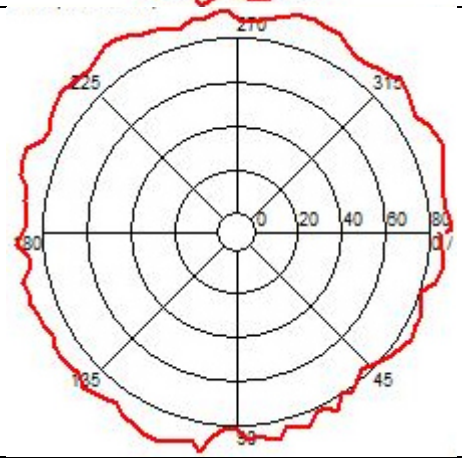
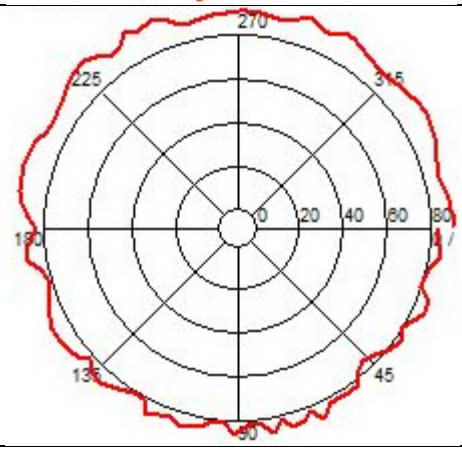


Test location:	semi-anechoic chamber
EUT to receiving antenna distance:	3 m
EUT height:	1.5 m
Azimuth during pre-scan:	0° (photos)
Azimuth during radiation pattern measurement:	0 – 360° with 5° step
Elevation angle:	0° (photo) – EUT is set in typical position for use, according to the manufacturer
Receiving antenna polarization during pre-scan:	VER and HOR (HOR is determined as the worst case for the measurements)
Mode of operation:	Normal modulation (continuous transmission)

See clause 5.1.4 for the measurement details.

5.1.2. Results

Graphical representation of the measurement results:

Frequency [MHz] / Data rate	Antenna radiation pattern, horizontal polarization
2402 / 1 Mbps	
2440 / 1 Mbps	
2480 / 1 Mbps	

Maximum peak gain found:

Frequency [MHz] / Data rate	P_R [dBm](1)	CL [dB](2)	AF [dB/m](3)	r[m](4)	Correction factor [dB](5)	P_T [dBm](6)	Azimuth [°]	Elevation angle [°]	G_T [dBi](7)
2402 / 1 Mbps	-42.67	6.20	29.92	3	11.77	7	235	0	-1.78
2440 / 1 Mbps	-44.79	6.38	30.25	3	11.77	7	241	0	-3.39
2480 / 1 Mbps	-46.42	6.56	30.70	3	11.77	7	231	0	-4.39

(1) RF power measured on the receiver, without corrections
(2) Cable losses
(3) Receiving antenna factor
(4) EUT to antenna distance
(5) See 5.1.4.
(6) The maximum conducted RF output power is +7dBm according to the MARK Display Tune Up procedure provided by manufacturer
(7) $G_{T_{[dBi]}} = P_{R\,[dBm]} + 11.77 + AF_{[dB(m^{-1})]} - P_{T[dBm]} + CL_{[dB]}$

Maximum peak antenna gain is < 0 dBi (-1.78 dBi).

5.1.3. Deviations

None.

5.1.4. Comments

The test is performed with an unmodified sample, by radiated method. The test is performed in semi-anechoic chamber with absorbers on the floor. RF power ($P_{R\,[dBm]}$) was measured in the maximum radiation direction, with peak detector, at 3 m distance from EUT. The maximum peak gain was calculated using Friis transmission equation:

$$P_{R\,[dBm]} = P_{T[dBm]} + G_{T_{[dBi]}} + G_{R_{[dBi]}} + 20log_{10}\left(\frac{\lambda}{4\pi r}\right) \quad (1)$$

Antenna gain from antenna factor:

$$AF = \frac{9.73}{\lambda\sqrt{G}} \quad (2)$$

$$20log_{10}(AF) = 20log_{10}(9.73) - 20log_{10}(\lambda) - 10log_{10}(G) \quad (3)$$

$$AF_{[dB(m^{-1})]} = 19.76 - 20log_{10}(\lambda) - G[dBi] \quad (4)$$

$$\lambda = \frac{c}{f} = \frac{3*10^8}{f} = \frac{3*10^2}{f\,[MHz]} \quad (5)$$

$$20log_{10}(\lambda) = 20log_{10}\left(\frac{c}{f}\right) = 20log_{10}\left(\frac{3*10^2}{f\,[MHz]}\right) = 20log_{10}(300) - 20log_{10}f_{[MHz]} = 49.54 - 20log_{10}f_{[MHz]} \quad (6)$$

$$AF_{[dB(m^{-1})]} = 19.76 - (49.54 - 20log_{10}f_{[MHz]}) - G[dBi] \quad (7)$$

$$G_{R[dBi]} = 20log_{10}f_{[MHz]} - 29.78 - AF_{[dB(m^{-1})]} \quad (8)$$

Combining equations (1) and (8):

$$P_{R\,[dBm]} = P_{T[dBm]} + G_{T_{[dBi]}} + 20log_{10}f_{[MHz]} - 29.78 - AF_{[dB(m^{-1})]} + 20log_{10}\left(\frac{\lambda}{4\pi r}\right) \quad (9)$$

$$P_{R\,[dBm]} = P_{T[dBm]} + G_{T_{[dBi]}} + 20log_{10}f_{[MHz]} - 29.78 - AF_{[dB(m^{-1})]} + 20log_{10}(\lambda) - 20log_{10}(4\pi r) \quad (10)$$

$$P_{R\,[dBm]} = P_{T[dBm]} + G_{T_{[dBi]}} + 20log_{10}f_{[MHz]} - 29.78 - AF_{[dB(m^{-1})]} + 49.54 - 20log_{10}f_{[MHz]} - 31.53 \quad (11)$$

$$P_{R\,[dBm]} = P_{T[dBm]} + G_{T_{[dBi]}} - 11.77 - AF_{[dB(m^{-1})]} \quad (12)$$

$$P_{T[dBm]} + G_{T_{[dBi]}} = P_{R\,[dBm]} + 11.77 + AF_{[dB(m^{-1})]} \quad (13)$$

(for matched antenna)

Where:

P_T is the power fed into the transmitting (EUT's) antenna input terminals
G_T – gain of transmitting antenna
G_R – gain of receiving antenna
r – distance from EUT to receiving antenna,
λ – wavelength
AF – receiving antenna factor.

Cable losses are also taken into account in the final calculation.

6. MEASUREMENT EQUIPMENT

The following equipment is used for tests:

Type	Manufacturer	Model	Ser. No.	Last cal. date	Cal. Interval (months)	IN number
Antenna	Teseq	CBL6144	35349	02.11.2022.	36	0115
EMI receiver	Schaffner	SMR4503	81	20.10.2021.	20	0138
Software	Teseq	Compliance 5 E/I v5.26.4	517-2881623-74 and 517-2846725-70	N/A		0125
Semi anechoic chamber	Comtest	3m	/	21.01.2022.	36	0305
Antenna mast	Maturo	CAM-4.0	/	N/A		306
Controller	Maturo	MSU	/	N/A		307
FU absorbers + ferrite tiles	Comtest	DMAS HT45 + CAF-6	/	N/A		0308 + 309

N/A - Calibration not applicable
Calibration interval is calculated/defined by using ILAC-G24:2007 methods of control chart and in-use time.

7. MEASUREMENT UNCERTAINTY

Expanded uncertainty of measurement, expressed as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for normal distribution corresponds to a coverage probability of approximately 95 %.

For test 5.1: 4.62 dB

8. GENERAL REMARKS

Date format is dd.mm.yyyy.
Decimal mark is indicated by dot (.).

Revisions history record:

Test Report #	Date:	Description:
1378-3	24/04/2023	Initial version
1378-3-1	27/09/2023	Correction of FCC ID and correction of the label as submitted by the manufacturer. The missing cable loss $CL_{[dB]}$ added in formula (7). Remark: calculations of $\mathbf{G_T}$ in Test Report #1378-3 already have been performed with included value of the cable loss, no changes and no impact on results
1378-3-2	13/10/2023	Correction of obtained/calculated results of antenna gain in accordance with the maximum conducted RF power of the transmitter including Tune Up procedure provided by manufacturer.

9. APPENDIXES

None.

END OF THE REPORT